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Oncoplastic and Reconstructive Breast Surgery

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Oncoplastic and Reconstructive Breast Surgery

Foreword by
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To our mentors, models of integrity and discipline for our surgical practice, and who left an indelible mark on us with their skills, creativity, and love of science and art of oncoplastic and reconstructive surgery of the breast.

To all the patients who allowed us to repair an important part of their lives. We got it right many times, but sometimes made unavoidable mistakes when we were not able to achieve the best outcome. This is the experience we want to share in this book, in order to help surgeons make positive decisions.

To our families, particularly our wives Yara Rietjens and Linei Urban, who never ceased to love and supply us with their unlimited sensitivity and energy. And finally, of course, to Bruna and Daniel Rietjens, and Lara Maria and João Paulo Urban, our beloved children, for whom we want to create a better future, and try to leave a better world.

Mario Rietjens (Milan)
Cicero Urban (Curitiba)

Foreword

Surgical management of malignant diseases represents an exemplary model of multidisciplinary management. The combined modality approach to the treatment of breast cancer patients that includes primary surgical treatment, radiation therapy, and chemotherapy needs careful integration of these modalities with the new methods of reconstructive breast cancer surgery. This book provides such a practical approach to the successful management of the disease. For this endeavor, the authors have assembled leaders in the field of oncoplastic breast surgery from around the globe to provide a truly international flavor for the reader. The content of this textbook is therefore relevant to clinicians around the world.

There are 49 chapters, with major sections covering topics ranging from the basic principles of plastic surgery to the difficulties of partial breast reconstruction, to the most advanced field of breast repair after mastectomy. Furthermore, there is a special section dealing with reconstruction in particular subgroups of patients, such as the elderly, pregnant patients, and previously irradiated patients.

The breast is the heart of femininity, and although it is often exploited for commercial reasons, it remains in the mind of every one of us as the true symbol of womanhood, with the role of nurturer, nourisher, and comforter. These gestures evoke a strong sense of affection and the importance that this delicate organ has in the minds of women, who combine the seductive aspect as well as the maternal role, of men, capturing the source of pleasure and desire, and also of children, who find satisfaction and the bond to life itself.

Here, therefore, the desire surfaces for every woman who has experienced breast cancer to rediscover pleasure in her own company, to reconcile with her own shaken femininity, offering the possibility to look in the mirror and rediscover the beauty of her own body, to develop the desire of pregnancy, to hold to the breast and nurture her own baby. To be able to return to normal daily life, also grateful for the goals achieved by science today: increasingly more conservative surgery, with respect for women's physical and psychological integrity, and reconstructions that allow the restoration of a natural looking breast, with minimum scarring.

In conclusion, this textbook is an excellent, user-friendly guidebook for anyone who cares for or treats patients with cancer of the breast, particularly residents, fellows, and practitioners of general surgical oncology and, for this reason, it would be a worthy addition to most surgical and oncological libraries.

Milan, Italy

Prof. Umberto Veronesi
Scientific Director
European Institute of Oncology

Foreword

Surgery is still an important part of breast cancer treatment. *Oncoplastic and Reconstructive Breast Surgery* edited by Mario Rietjens and Cicero Urban is a major contribution to the surgical literature in the field of breast cancer. Although mastectomy and axillary lymph node dissection have been well-known techniques for many years, a novel approach for mastectomy should be reconsidered in the case of risk-reducing mastectomy or when a nipple-sparing mastectomy is proposed for selected breast cancers. Conservative treatment is now widely proposed in stage I and II breast cancer leading to wider glandular defects requiring immediate remodeling to avoid disabling cosmetic results. The attitude toward the axillary lymph nodes has changed in the last few years. Sentinel node techniques have been introduced successfully in patients with no tumors and can even be performed twice in cases of local recurrence after conservative treatment.

But the most recent change in breast surgery is the development of oncoplastic indications at the time of the primary surgery. A huge armamentarium of plastic surgery techniques is now available for performing immediate breast reconstruction or remodeling of the breast tissue in cases of wide tumorectomy. The technique of lipofilling represents a true revolution in plastic surgery and can be applied in many situations of breast cancer surgery, provided that statistical studies confirm the safety of the procedure in cancer patients. Indications for implants or autologous myocutaneous flaps should be discussed for each patient requiring an immediate total breast reconstruction. The most sophisticated techniques such as those using microsurgery require close collaboration between the different specialties as well as a high level of competence. This book provides an extensive description of all the techniques available today, with a most practical presentation for surgeons who want to extend their surgical knowledge. The chapters include not only details regarding surgical indications but also data about the risk of complications. The book will be extremely useful for both cancer surgeons trained in oncoplastic surgery and plastic surgeons called upon to reconstruct the breast or to improve the breast morphology after extensive tumorectomies.

Milan, Italy

Prof. Jean-Yves Petit
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Preface

Non enim vivere bonum est, sed bene vivere
It is not well living, but living well.

Seneca

The unprecedented progress that breast surgery has experienced in the past century has led to a radical change of paradigms. It is no longer possible to dissociate esthetic and oncology surgery. This interdisciplinary and translational feature represents a new stage for both breast surgery and plastic surgery all over the world.

Breast surgeons must have thorough knowledge of the existing concepts in plastic surgery of the breast, as a plastic surgeon who regularly performs breast reconstruction procedures must also be familiar with oncologic principles of breast cancer surgery and keep up to date with developments in chemotherapy, hormonetherapy, radiotherapy, and monoclonal therapies which will influence surgical decisions. Many results considered unsatisfactory in reconstructive surgical procedures in the past are due to this lack of interdisciplinary understanding. Good reconstruction depends on choosing the technique that is most suitable for each patient's esthetic-functional condition and for the oncologic and clinical factors involved. It all begins with a well-performed and properly balanced oncologic surgical procedure—radical where it needs to be, but conservative and carefully performed in order to preserve breast tissue that will improve the patient's quality of life while maintaining local control of disease.

Nevertheless, most breast cancer surgical procedures do not follow oncoplastic standards, and so patients still experience mutilation resulting from mastectomy without immediate reconstruction. It is important not simply to preserve life but also to preserve a good quality of life and to understand women in a holistic manner. The breast represents more than just its shape or function during the breast-feeding period. It is the true feminine identity itself, which goes through a period of great conflict when cancer is diagnosed. Surgery is a difficult and traumatic event that will affect one in every eight women, and it places breast cancer at the center of public health measures all over the world.

The scope of this book, with its 49 chapters written by renowned and experienced authors, is new. It approaches oncoplastic and reconstructive breast cancer surgery from the viewpoints of the fundamentals of molecular biology and breast anatomy, the basics of diagnosis and clinical therapeutics, ethics and bioethics, clinical oncology, psychology, and quality of life, evaluation of esthetic outcomes, and oncoplastic and reconstructive techniques, which are described in detail. There is also an accompanying website where one can view videos of surgical procedures conducted by the Plastic Surgery Division of the European Institute of Oncology in Milan (Italy), and from Hospital Nossa Senhora das Graças (HNSG) Breast Unit in Curitiba (Brazil). The various surgical techniques are clearly explained and demonstrated. By such an approach, we aim to link oncologic surgical principles with esthetic-functional and reconstructive ones, which were in opposition for many decades. The radical approach of the past is now obsolete, with the utmost effectiveness obtained with minimal mutilation. More conservative breast surgical

procedures, less radical mastectomies, preservation of the axilla with the sentinel lymph node technique, less aggressive techniques (such as recently developed intraoperative radiotherapy), individualized chemotherapy and target therapies through predictive factors, and more accurate prognoses are all achievements associated with the development of reconstructive techniques that are more efficient but less traumatic. They are what is today an inseparable oncologic-reconstructive-aesthetic-functional combination.

The patient, who is seen in a holistic way, doubtlessly enjoys the great benefit of this change in paradigms: physically, psychologically, and spiritually. It was exactly by bearing this thoroughness in mind that the present work was designed, dedicated to all the professionals involved in breast health care and especially to surgeons. We would like to thank all the authors and colleagues who kindly and selflessly helped with the chapters, and especially Jim Hurley II, a dear friend and a skilled oncoplastic surgeon from Chambersburg (USA), for his final review of the English. We also sincerely thank and acknowledge Umberto Veronesi and Jean-Yves Petit, who have dedicated a great deal of their lifetime to patients with breast cancer and therefore have allowed women all over the world to benefit from their creativity and scientific knowledge.

Mario Rietjens
Cicero Urban

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Part I

Basic Principles for Oncoplastic and Reconstructive Breast Surgery

Oncoplastic Surgery: Blending Science and Art

1

Gail S. Lebovic

1.1 Background

Since the beginning of recorded time, the breast has been a symbol of motherhood, femininity, and sexuality. It has been portrayed throughout history in works of art symbolizing each of these aspects of a woman's life—and even in religious works of art, the breast has been memorialized as a central focus of a woman's anatomy. Similarly, there is evidence of the challenges and ravages of breast cancer dating back as far as the seventeenth century B.C. [1]. Many accounts of this dreaded disease are documented throughout history, and in some regards the psychological fear and trauma associated with breast cancer has not changed much at all through the ages—even though our diagnostic abilities and treatment options have managed to dramatically improve the outcomes of women with breast cancer. One of the most comprehensive examinations of the breast throughout history was written by Marilyn Yalom [2]. Her work illustrates how and why the breast has become such an important symbol of femininity throughout history, and why the breast continues to be so important to women in today's modern societies. Her description of the breast as both "life-giving" and "life-destroying" gives us the essence of why breast surgeons must be trained with a keen sense of blending science and art.

When we examine the disease processes that affect the breast(s), the historical journey becomes complex and is one that is quite triumphant when looking at how far we have come. Early cases of breast cancer reported large fungating tumors that killed women quickly, and the entire experience was no less than horrific. Unfortunately, even though modern methods of detection have improved early diagnosis, physicians still see late-stage tumors such as those described hundreds of years ago (Fig. 1.1).

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As far as we can tell, although Hippocrates discussed the potential for removal of the breast, the first documented account of mastectomy is credited to Johan Schultes (1595–1645). However, a detailed description of the operation was only published after his death in 1665 [3–5]. Early mastectomies were made possible with the introduction of surgical instruments that allowed very rapid removal of the diseased tissue. Although the idea of removing the diseased area gained popularity, women often died from bleeding, infection, shock, or anesthetic complications. However, once anesthetic techniques were perfected, and antibiotics became a routine part of surgical regimens, successful removal of the breast was accomplished. As surgeons go, Halsted is most often credited as the innovative surgeon who perfected the technique of radical mastectomy in the USA in 1882. In fact, Halsted achieved a 5 year cure rate of 40 %, which was highly regarded. In addition to his aggressive removal of tissue, other factors likely contributed to this success rate as well, such as his use of antiseptic techniques and his use of rubber gloves. Apparently, Halsted had asked Goodyear to develop gloves in 1889. Other surgeons such as Crile and Haagensen were also important in the consistent move toward innovation in fighting breast cancer through surgery, and the Halsted radical mastectomy was the mainstay of breast cancer treatment throughout most of the last century. In fact, it was used in over 90 % of all breast cancer patients treated between 1910 and 1964 [6].

As we examine the results of the Halsted radical mastectomy (i.e., removal of the entire breast, including much of the skin along with the nipple–areola complex, underlying pectoralis muscles, and the axillary contents), we quickly begin to understand the physical and psychological challenges that women face(d) when deciding to undergo this presumed "life-saving" surgery (Fig. 1.2). Although hundreds of thousands of women have lived through this life-altering surgery, it is clear that the psychological impact on women undergoing mastectomy is profound, and includes body image changes as well as many other emotional challenges that must be addressed in order for

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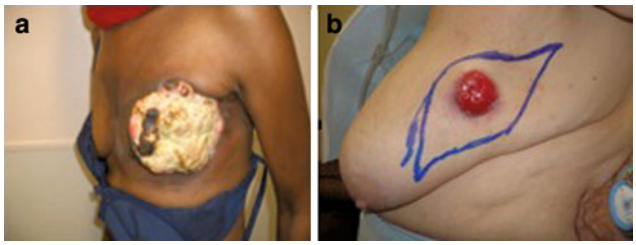

Fig. 1.1 Advanced breast cancer showing fungating lesions extruding through the skin

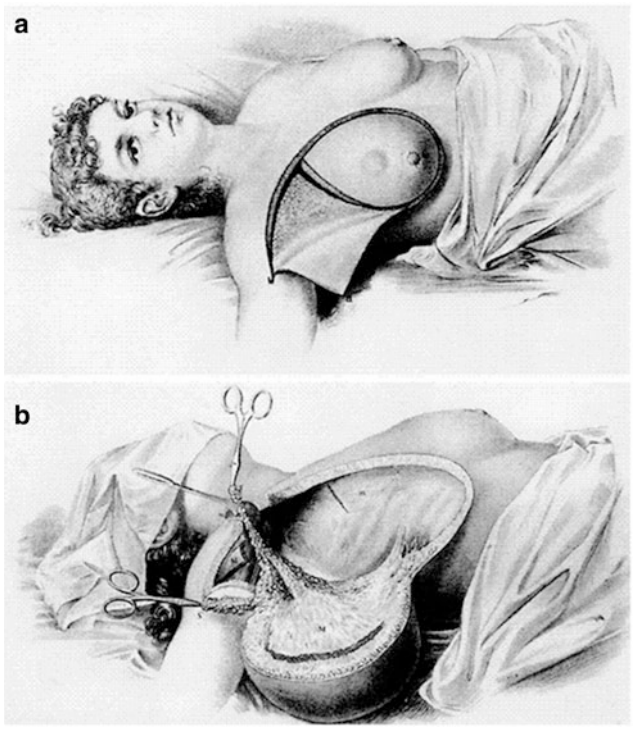

Fig. 1.2 Etchings of Halsted radical mastectomy showing enormous en bloc resection of the breast, underlying muscles, and overlying skin

successful adaptation to a "new way" of life. Some of the critical issues that most women struggle with after being diagnosed with breast cancer are as follows:

- Fear, anxiety, and stress
- Depression
- Grief
- Body image
- Sexuality
- Fertility
- Planning for the future
- Social support system

Each and every woman will weigh differently the priority of these things in their own particular life, but for most women the single greatest challenge is the adjustment to their new body image.

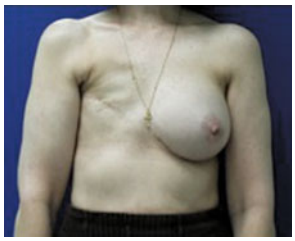

Fig. 1.3 Patient following standard radical mastectomy. Note the body posture with the right shoulder slightly forward as if "guarding" or "hiding" the mastectomy site

The photograph in Fig. 1.3 shows a woman many years after radical mastectomy of the right breast. In this photograph her body language speaks to us, as it shows her stance with her right shoulder angled upward and forward in a manner suggestive of protecting, guarding, and/or trying to "hide" the area of her mastectomy. Many studies confirm that breast reconstruction assists women in their adjustment to mastectomy; however, it does not eliminate the need for psychological adjustment and, in fact, consideration to undergo breast reconstruction brings with it additional and somewhat different issues for a woman to grapple with (Table 1.1). It is essential for the breast surgeon to be trained not only in the technical aspects of dealing with breast cancer but in the skills to assist women struggling with these difficult and often very delicate psychological challenges as well.

1.2 Breast Surgery: Evolution of the Science

With women's advocacy groups forming throughout the 1960 s to 1970 s, social awareness about breast issues and breast cancer began to change dramatically. Just a few decades ago, women were loathe to speak about breast cancer in social circles, whereas today, women take to the streets, gather by the thousands, and celebrate their successes in conquering their battle with breast cancer. This awakening coupled with the "feminist movement" of the 1970 s created an environment for women to begin questioning their "rights" in the treatment of breast cancer. At the time, most women underwent open surgical biopsy with preoperative consent for the surgeon to proceed with mastectomy if the frozen section tested positive for cancer. One can only imagine how traumatic it was for women who faced the uncertainty of waking up from surgery with or without their breast(s). This practice soon came under scrutiny and ultimately called for the standard of care to include a preoperative confirmation of the diagnosis of cancer prior to mastectomy, as well as informed patient consent prior to surgery. There is no doubt that the work of the well-known patient advocate Rose Kushner irreversibly changed history in regard to breast cancer treatment. She was the first breast cancer survivor to bring these issues to Washington, and her efforts led to the creation of legislation

Table 1.1 Emotional pros and cons of breast reconstruction

Pros	Cons
Feel whole again	Fear
Maintain femininity	Not essential for well-being
Balanced physically	Too old to matter (i.e., being vain)
Marital/sexual acceptance	Interfere with treatment
Avoid embarrassment of prosthesis	Concern about masking disease
Surgeon's recommendation	Uncertainty about breast appearance
Forget about disease	Requires additional surgery, risk of complications

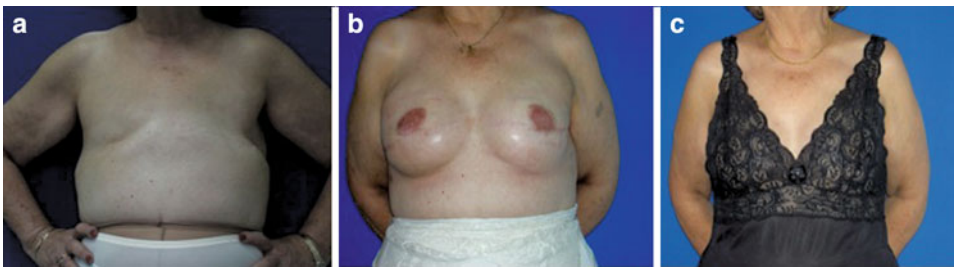

Fig. 1.4 The *left image* shows the patient 30 years after bilateral modified radical mastectomies. She requested bilateral reconstructions with nipple reconstructions (*central image*). Note the horizontal incision limits the ability to get projection in the center of the reconstructed breast, resulting in a somewhat globular shape (compare with Fig. 1.6). The patient's improved body image and self-confidence is evident in her selection of undergarments as seen in the *right image*

that helped fuel many changes in the USA. Her efforts were of paramount importance.

Although surgical removal of the breast was touted as a giant step forward in the treatment of breast cancer, no doubt surgeons and their patients both struggle(d) to accept this method as the "best" possible solution. For decades, a growing consciousness began to form about the possibility of imaging the breast in order to find tumors at an earlier stage. Thankfully, through the development of imaging techniques that ultimately led to screening mammography programs, the diagnosis of smaller and often "earlier" cancers was made possible. Thus, with the advent of modern-day breast imaging and the diagnosis of earlier and often noninvasive tumors, improved survival rates and better treatment options became a reality [7–9]. For the breast surgeon, this included the notion that perhaps surgical treatment need not be so aggressive. In addition, the interaction between physicians in different subspecialties became popular as it was noted that a more comprehensive plan could be developed if and/or when a patient's treating physicians communicated directly with one another in the best interest of the patient.

As radiologists began to diagnose smaller tumors, surgeons began to modify the techniques of Halsted, and they began saving the pectoralis muscles and more of the overlying skin of the chest. Studies quickly noted that survival rates were equivalent to those for radical mastectomy, and thus the "modified" radical mastectomy became popularized. This huge change in breast surgery was most likely due to the earlier stage of disease at the time of diagnosis, but nonetheless, this changed breast surgery forever. As can be seen in Fig. 1.4 the standard modified radical mastectomy has a typical horizontal scar across the breast area and in most cases does not require a skin graft for closure, which was quite commonly needed with the radical mastectomy.

From here, surgeons began to hypothesize that perhaps the breast tissue itself (including the nipple–areola complex) could be preserved if additional therapy (such as radiotherapy and/or chemotherapy) were administered to help decrease or eliminate the potential for recurrent disease. Of course, the scientific community required classic studies to be performed in order to prove this hypothesis, and through decades of tedious clinical trials, Umberto Veronesi and his clinical group at the Milan Cancer Center ultimately proved the hypothesis. Veronesi's pioneering work as well as numerous other scientific studies by various surgeons around the world have shown that survival rates for women undergoing breast conservation are equivalent to those having mastectomy if, and only if, many factors are also taken into consideration, such as appropriate selection of patients, wide excision of the tumor with substantial clear histologic margins, and the use of adjuvant therapy (chemotherapy and/or radiation therapy) as needed [10, 11]. Ultimately, with these critical decisions being made in the field of breast surgery and through the extraordinary

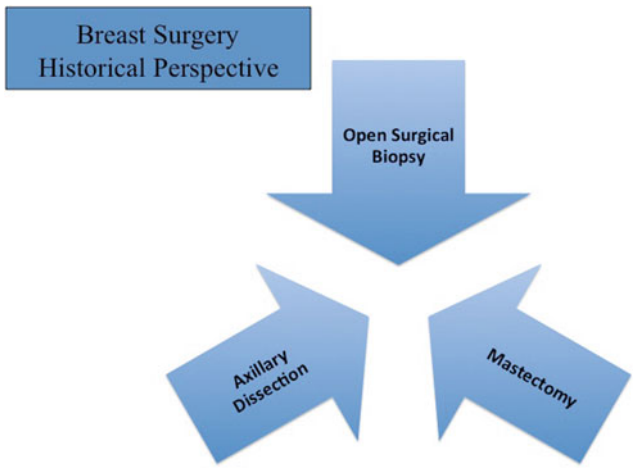

Fig. 1.5 Historical perspective of breast surgery with a few of the procedures available throughout much of the last century

courage and foresight of innovative surgeons, scientists, oncologists, radiation oncologists, and other breast cancer specialists working together, the field of breast surgery began to evolve dramatically and it has never been the same since.

Although the idea of breast conservation surgery became a reality, and surgeons and patients alike hoped that mastectomy would become a distant historical footnote, studies ultimately showed that not all women were truly good candidates for breast conservation. Interestingly, not all women choose breast conservation either, and so mastectomy has remained a mainstay in the treatment of breast cancer. Two important questions remain: How can we best identify suitable candidates for breast conservation, and how can we improve the aesthetic appearance of the breast(s) following mastectomy? In fact, the selection of appropriate patients for the appropriate procedure becomes the critical question for the breast surgeon's judgment.

Given today's current imaging techniques, as well as other sophisticated methods to assist with patient assessment such as genetic testing, the selection of appropriate patients has become much more comprehensive and precise. Today, preoperative assessment is the cornerstone of effective, efficient, and appropriate breast surgery and it is a vital expertise that the breast surgeon must be able to offer in order to provide optimal care to patients. The principles of oncoplastic surgery within the multidisciplinary framework for preoperative assessment of patients can be summarized as follows:

- Primary diagnosis, extent of disease, and risk assessment prior to surgical intervention
- Psychosocial needs and desires of the patient
- Surgical planning to include resection and reconstruction options
- En bloc tumor resection (with wide margins) and intraoperative margin assessment if possible
- Marking of tumor bed margins for adjuvant radiation and follow-up
- Axillary node sampling (sentinel node)
- Need for adjuvant treatment (type and timing)

Simultaneous to the changes occurring in the evolution of the "science" of breast cancer surgery, changes in the evolution of the "art" of breast surgery were occurring as well. These changes resulted in dramatic achievements in the field of plastic and reconstructive surgery, and breast reconstruction became the pinnacle achievement for many surgeons.

Prior to the parallel changes occurring in each subspecialty involved in the care of the breast cancer patient, the surgeon had few choices in the decision-making process. The treatment of breast cancer was obvious and monotonous—mastectomy (radical or modified radical) (Fig. 1.5). However, as diagnostic techniques improved and as treatment options became more complex, the evolution of the multidisciplinary approach to the breast cancer patient became widely popularized, and today, the multidisciplinary approach is recognized as a much more efficient and effective method for treating patients. Today, this approach serves as the ideal model for treatment of breast cancer as well as many other diseases, and this approach allows us to achieve much better surgical outcomes (Fig. 1.6).

1.3 Breast Surgery: Evolution of the Art

In parallel to the changes occurring in the diagnosis of breast disease and the improvements in the treatment of breast cancer, the focus on the female breast became much more socially acceptable. With the introduction of television, magazines, pornography, and more sexually directed marketing, the world's view of a woman's breast began to change, since breasts were literally much more visible each and every day. Historically, being "well endowed" has long been a "virtue" that artists and writers have documented throughout the ages.

In the seventeenth century, Marinello became very interested in methods for preserving the beauty of the breast and his account of the perfect breast: "The breast of a beautiful woman should be wide and full of meat so that no sign of underlying bone be detected and the skin colour should be 'snow-white'. The beautiful neck is like snow but the breast is like milk… the best breasts are small ones, round, firm, like the round and beautiful apple; they should neither be too attached nor too small… two raw apples looking like ivory." His description gives us a clear idea of how dedicated he was to developing the art of surgical methods to restore the breasts' own natural beauty [3]. Many others were equally as interested in the "art" of

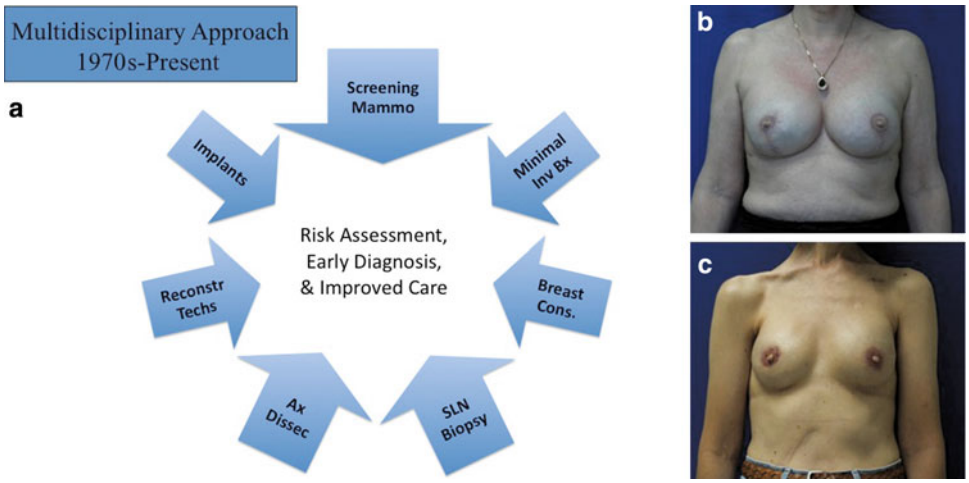

Fig. 1.6 **a** Multidisciplinary approach showing many aspects to patient evaluation and workup that can be used to assist with preoperative planning and surgical decision making *Mammo* mammography, *Inv Bx* invasive biopsy, *Cons.* conservation, *SLN* sentinel lymph node, *Ax Dissec* axillary dissection, *Reconstr Techs* reconstruction techniques. **b** Case example using a multidisciplinary approach and oncoplastic surgical techniques. The Patient presented with BRCA mutation, following bilateral prophylactic mastectomies with bilateral breast and nipple reconstructions. The final result shows skin-sparing mastectomies, tissue expansion with ultimate bilateral submuscular saline implants, and nipple reconstructions. **c** Case example using a multidisciplinary approach and oncoplastic surgical techniques. The patient presented with bilateral ductal carcinoma in situ. Mastectomies with bilateral breast and nipple reconstructions were performed. The final result shows total skin-sparing mastectomies, with ultimate bilateral submuscular saline implants (no expansion needed) and nipple reconstructions.

breast surgery, and thus this field began to blossom and take shape.

Some of the earliest methods for breast enhancement relied simply on garments such as corsets and brassieres. These external means of enhancing the breasts, such as padded bras, remain popular today and are well evidenced by the multi-billion-dollar lingerie industry. However, surgical enhancement and correction of breast "deformities" has been an alluring challenge to surgeons since the late 1800 s. By the twentieth century, many surgeons were developing and refining various surgical techniques for improving the size, shape, and general appearance of the breasts.

Although correction of large and ptotic breasts seemed important and interesting to women and the surgical community, many women were even more interested in methods for enlarging the breasts, and some of the earliest methods for breast enhancement utilized injectables such as paraffin wax and other substances. Unfortunately, most of these methods proved disastrous. In fact one of the first to inject paraffin into the breast for enlargement was Robert Gersuny, and he was also the first to describe paraffinomas in 1899. Later, Buck and Brockaert also described the poor results with this technique, and in fact the results were so bad that decades passed before other invasive techniques were even considered for breast enhancement.

However, as we all know, "necessity is the mother of invention," and in 1950 J. H. Grindlay and his colleagues implanted polyurethane sponges in an attempt to achieve permanent breast enlargement. Although this technique was considered quite innovative, it too proved to be disastrous, with the end result yielding severely fibrotic, hardened (calcified) breasts that were usually misshapen and very unattractive in appearance.

Later, substances such as silicone oil and gel were introduced into the breast(s) via injection. Scientists and surgeons originally believed that these materials were biologically inert. However, injection of these materials into the breasts often results in a substantial inflammatory response, infections, etc., and ultimately led to the abandonment of these techniques. Instead, the innovative idea of encapsulating these materials within a silicone rubber shell and placing these gel implants into the breast took hold, and the first implantable breast-enhancing "implant" devices were developed [3]. The ability to create a rubber silicone shell filled with physiologic saline created a lot of excitement as well, but the first saline-filled implants were fraught with problems, including frequent rupture and severe rippling. Since virtually all of the first breast enhancements (augmentations) were performed in the subglandular position, the results were less than optimal aesthetically. These initial saline implants were also prone to rupture because the shell was too thin, and fold-fault fracture causing leaks and deflation were very common, which led to the demise of the early saline-filled implants. The next monumental phase in the development of breast implants was continued refinement in the production of various silicone materials and implants. These gels have various degrees of viscosity,

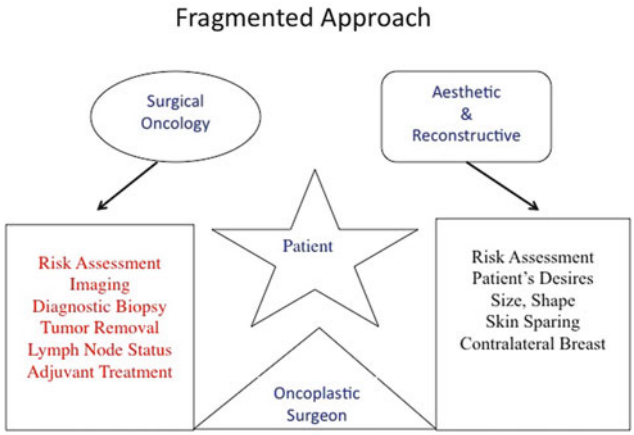

Fig. 1.7 Most commonly, the approach to the breast surgery patient is fragmented. This usually requires two surgeons with distinctly different goals and concerns

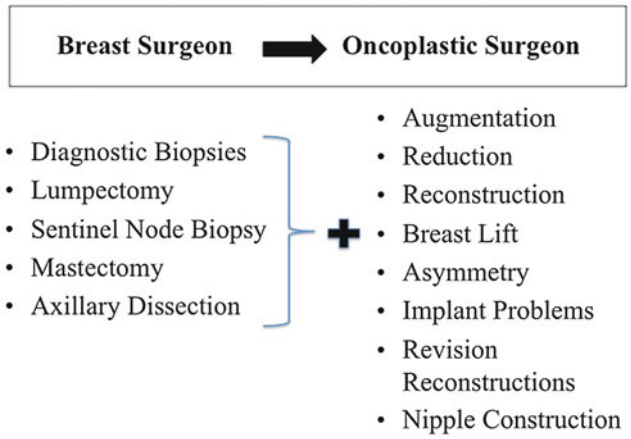

Fig. 1.9 Additional procedures to be added to breast surgery training programs

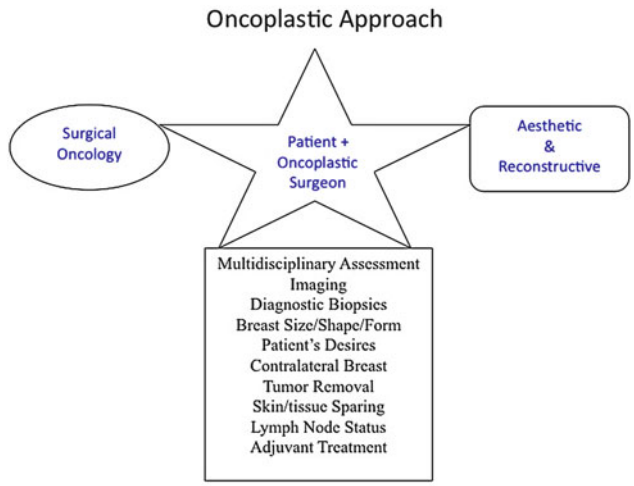

Fig. 1.8 An integrated approach will result from changing the training curriculum and skills requirements of the multidisciplinary breast fellowships. In this manner, the breast (oncoplastic surgeon) will be knowledgeable to work either in a team setting or independently with the required skills to care for the patient in a more integrated fashion

	Guidelines for Standardized Training In Oncoplastic Surgery
LEVEL I	Risk Assessment using Multidisciplinary Model Aesthetic Principles, evaluation & techniques Comprehensive surgical plan Diagnosis, Rx, Follow-up Aesthetic approach to incisions Large resections with breast conservation Reconstructions with local tissue flaps
LEVEL II	Perform skin/nipple sparing mastectomy Perform breast reduction with/without nipple transfer Perform mastopexy
LEVEL III	Perform augmentation mammoplasty Perform mastopexy with implants Perform skin/nipple sparing mastectomy + reconstruction Perform reconstruction with implants/expanders Perform nipple reconstruction with skin flaps
LEVEL IV	Specialty training to include myocutaneous flaps

Fig. 1.10 Guidelines for training in oncoplastic surgery. *Rx*

making multiple different types of implants possible, including shaped implants for special situations. At last, the era of breast augmentation was on its way to success.

Numerous different types of breast implants were produced and marketed through the 1970 s and 1980 s, some with better rates of surgical success than others. It did not take long for surgeons to figure out that the utility of breast implants could be expanded to the realm of breast reconstruction. However, the paucity of skin left after mastectomy created some difficulty in regard to closing the skin wound over an implant. Once again the entrepreneurial spirit led to development of the "tissue expander," and this wonderful new implant allowed surgeons to begin the era of "immediate" breast reconstruction. Often these expanders can be left in place as the permanent implant. Most importantly, breast reconstruction with tissue expanders is much less invasive and difficult for patients than other types of reconstruction such as myocutaneous flaps. Thus, the patient has less pain, a shorter recovery time, and less time away from work. Expanders are widely used throughout the world, and they remain the "workhorse" for breast reconstruction since they can be used for immediate and/or delayed reconstruction, and can maximize the efficiency of breast reconstruction [12].

Breast reconstruction following mastectomy became hugely successful and popular in the 1980 s until 1990, when implants were banned from clinical use in the USA by the FDA. This sparked a global examination of silicone gel implants in an attempt to examine various problems that some felt might be associated with breast implants.

Fig. 1.11 Recommended curriculum for oncoplastic surgery training

Oncoplastic Curriculum

Levels	Disciplines	Credits/ Hours
Basic Core Disciplines	•Breast Cancer Molecular Biology	10/20
	•Anatomy and Physiology of the Breast	10/20
	•Epidemiology	5/20
	•Bioethics and Legal Medicine	5/20
	•Medical Photography	5/10
	•Radiology of the Breast	10/20
	•Breast Pathology	10/20
	•Radiotherapy	5/10
	•Breast Cancer Clinical Oncology	10/20
	•Psychosocial Aspects of Patient Care	
Basic Surgical Training	•Minimally Invasive Biopsy techniques	10 cases
	•Sentinel Lymph Node Biopsy techniques	10 cases
	•Level II techniques	10 cases
	•Level III techniques	10 cases
Advanced Surgical Training	•Level IV techniques	10 cases
Total Minimum Credits		70 credits/ 160 Hours

Ultimately, after extensive review and with additional changes and new developments in the manufacturing process, silicone gel implants were reintroduced into the surgical domain. Currently, they are widely used throughout the world, and limited use was allowed once again in the USA under guidelines outlined by the FDA [13].

Many scientists agree that it is not the implants themselves that are responsible for some of the difficulties encountered following breast augmentation and or reconstruction. There are numerous factors that contribute to outcomes following aesthetic and reconstructive breast surgery, including patient selection, surgical technique, and postoperative complications such as seroma, hematoma, and subclinical infection. Although selection of a specific implant is important, other factors such as surgical approach (submuscular versus subglandular) and surgical technique are also critical in achieving optimal outcomes.

From the review of the enormous changes that have occurred in breast surgery during the past 40 years, it is quite interesting to note the parallel changes that occurred in breast cancer surgery as well as cosmetic and reconstructive breast surgery. Interestingly, although the process of breast augmentation may seem very different from that of breast reconstruction, most of the critical issues needed to obtain excellent outcomes are shared between the two. This includes many of the psychological and preoperative patient assessment issues as well. Consider first those patients undergoing augmentation or other elective breast surgery. These women should undergo a thorough multidisciplinary preoperative workup quite similar to that which all breast cancer patients endure. Although in one group of these patients cancer has already been diagnosed, women undergoing elective breast surgery should be screened for potential breast cancer risk since later in life they will face the need for screening mammography, etc. [14]. This consideration is critical to the patient when choosing various aspects of the augmentation, such as implant type, placement, etc. Thus, we see how quickly the lines begin to blur between surgical oncology and aesthetic breast surgery.

It is precisely because of these types of observations that in the late 1980 s and early 1990 s a few surgeons scattered around the world began to have similar thoughts about the approach to breast surgery. Independently, each of them began to blend the principles of surgical oncology with those of aesthetic and reconstructive surgery, resulting in the birth of oncoplastic surgery. At least a decade later, surgeons began to subspecialize in breast surgery; however, the evolution of the training programs for this subspecialty has varied widely in various environments and is in critical need of updating, expanding the curriculum, and standardization.

1.4 Oncoplastic Surgery: Blending Science and Art

Part of the difficulty for today's breast surgeons stems from the historical development of surgical subspecialties and breast surgery in particular. Because most breast cancer surgery was performed (and often still is) by general

surgeons, and because reconstructive surgery remained in the solitary domain of the plastic and reconstructive surgeons, the care of breast patients has been quite fragmented in its approach (see Fig. 1.7). Historically general/breast surgeons were primarily concerned with issues relating to cancer. Their focus was primarily on the oncologic portion of the surgical intervention and their surgical plan remained separate from the patient's needs, wants, and desires in regard to reconstructive and/or breast surgery to create symmetry between the two breasts. Since breast cancer surgery inherently creates a "net asymmetry" between the two breasts, the surgeon cannot ignore the impact this has on the patient's psychological well-being and feeling of "wholeness" since most women are seeking symmetry as the ultimate outcome.

As described in the previous sections, the way that breast surgery evolved resulted in a fragmented approach and often did not result in the best outcomes for the patient. Thus, those surgeons committed to subspecializing in breast surgery began to practice "oncoplastic surgery" by combining or blending the principles of surgical oncology with those of plastic and reconstructive surgery. As illustrated in Fig. 1.8, the objective is to change the fragmented surgical approach to one that is more complete, utilizing a multidisciplinary approach to the patient and planning the patient's surgery in a comprehensive fashion. The ideal situation would be to have each and every "breast surgeon" trained as an "oncoplastic surgeon"—that is to say that the terms would be synonymous. This would allow the breast surgeon to take care of the patient's needs, wants, and desires. There are numerous advantages to this approach for the patient, and for the surgeon as well. Although this may be possible in the future, unfortunately, owing to the way that breast surgery evolved, at this point, relatively few breast surgeons are trained and competent in all of the skills required to practice in this manner.

The term "oncoplastic surgery" was first coined by Werner Audretsch, and was meant to describe this integrated "holistic" approach to the breast cancer patient. In effect, it is also used to describe the training required by the breast surgeon in order to be fully aware of the available and appropriate procedures for each patient seeking care. That is not to say that every breast surgeon *must* perform these procedures alone. On the contrary, oncoplastic surgery can be practiced in a team setting where a surgical oncologist works directly with a plastic and reconstructive surgeon, but this should not preclude the ability of the breast surgeon to be trained and become proficient in all of the procedures necessary to perform all aspects of breast surgery. This allows the oncoplastic surgeon to be a much better guide for patients, particularly while helping them formulate a comprehensive surgical plan.

Although the surgical community in general lagged well behind in its acceptance of this approach, eventually in the late 1990 s a multidisciplinary breast training fellowship was established in the USA. However, these fellowships were limited in their scope, and did not train fellows to perform the cosmetic and/or reconstructive breast procedures necessary to practice in a comprehensive fashion. Since 2000, much debate has ensued over this issue, and unfortunately much of the debate stems from deeply ingrained territorial discussions between specialists rather than a productive realignment in the best interest of the patient. The goal ultimately is to provide patients with the most effective and efficient care, and in doing so it will be necessary to revitalize and expand the curriculum for the multidisciplinary breast fellowships [15, 16]. Since it has now been more than 10 years since the inception of the multidisciplinary breast training fellowships, expansion of the training curriculum is most appropriate at this time. Figure 1.9 illustrates the various surgical procedures that the current US fellowship trained breast surgeons are skilled in versus those that need to be added to their training curriculum in order for them to be competent in oncoplastic surgery.

The international community is further ahead than the USA in the adoption of oncoplastic surgery. Thus, in order to formulate criteria for updating the multidisciplinary breast fellowships, an international steering committee was convened. This team of breast specialists included all disciplines included in breast health care as well as highly regarded oncoplastic/breast surgeons from seven countries. Representative breast surgeons with their board certifications in general surgery, obstetrics/gynecology, and plastic and reconstructive surgery were present at the meeting and contributed to the outline for the recommended training guidelines. Each of the surgeons on the committee had been practicing oncoplastic surgery for a minimum of 10 years and all were in agreement on formulating these guidelines for future breast surgery training programs.

As with all specialties, when establishing guidelines for training it is important to consider those clinicians already currently practicing who may be "grandfathered" into a newly established program. Furthermore, it is important to consider various practice environments, and the locoregional differences in training. However, as a result of the discussions with this esteemed group of clinicians, a consensus among them was reached and included a classification system for those surgeons already trained in breast surgery who do not have the training or skills to provide comprehensive types of breast surgery as well as those who already have these skills. This is most important as the training fellowships revisit their current curriculum, and prepare to update and expand their program training modules.

Figure 1.10 illustrates the definition of the four different levels of oncoplastic surgery practice and Fig. 1.11 defines recommended curricular activities necessary to gain

competence in each area. Of key importance is level IV since this requires additional specialty training in myocutaneous flaps in order to be proficient in this area.

1.5 Conclusions

Often as surgeons we become so focused on the conquest of eliminating disease that we forget about the "person" sitting in front of us who has just had his or her life turned on its end, and from that day forward who will never be the same again. The role of the surgeon in this dynamic process can be good news, or it can be very bad news. Even more difficult are the images that are conjured up in a patient's mind in regard to how he or she will look after surgery, and how his or her friends, family, and partner will feel about their newly formed body. These questions loom large over every woman facing breast surgery—and many of these same questions apply whether or not a woman is diagnosed with breast cancer or is having elective breast surgery. Any woman who has decided or who needs to have breast surgery understands her life will never be the same in some manner. We as surgeons need to truly understand this, and our approach to patient care must revolve around this premise.

Most women seeking breast surgery (cosmetic and/or reconstructive) prefer to have one surgeon that they trust perform their surgery, and they do not take kindly to nor do they understand the logic behind having two surgeons or having to see a surgeon who might not "specialize" in breast surgery for a procedure such as a breast reduction. Likewise, it makes no sense that a "breast surgeon" does not know how to perform a breast reduction or breast lift. As evidenced by the extraordinarily low numbers of women having breast reconstruction after mastectomy, it is clear that this current, fragmented approach to breast surgery actually acts as a deterrent to patients seeking optimal breast care, and it is time for a change in the training of breast surgeons around the world. Being a breast surgeon with the ability to guide a patient through the challenging journey of breast cancer is most certainly a privilege; however, greater satisfaction comes with being able to practice fully integrated breast surgery with the skills of an oncoplastic surgeon—a breast surgeon skilled in the science and art of helping patients fulfill their needs, wants, and desires.

References

1. Edwin Smith surgical papyrus. 17th century BC
2. Yalom Marilyn (1997) History of the breast. Knopf, New York
3. Paolo Santoni-Rugiu and philip sykes (2007) A history of plastic surgery. Springer, Berlin
4. Schultes J (1655) Armamentarium Chirurgicum. Balthasari, Kuehnen, Ulm. 1655
5. Schultes J (1674) The chyrurgean. John Starkey, London
6. Merrill Neddy (2008) Mastectomy through the ages. The edge of the American West,
7. Jemal A, Siegel R, Ward E, Murray T, Xu J, Thun MJ (2007) Cancer statistics. CA Cancer J Clin 57(1):43–66
8. Beatty JD, Porter BA (2007) Contrast-enhanced breast magnetic resonance imaging: the surgical perspective. Am J Surg, 193(5):600–605 (discussion 605)
9. Lehman CD, Gatsonis C, Kuhl CK, Hendrick RE, Pisano ED, Hanna L et al (2007) MRI evaluation of the contralateral breast in women with recently diagnosed breast cancer. N Engl J Med 356(13):1295–1303
10. Fisher B, Anderson S, Bryant J, Margolese RG, Deutsch M, Fisher ER et al (2002) Twenty-year follow-up of a randomized trial comparing total mastectomy, lumpectomy, and lumpectomy plus irradiation for the treatment of invasive breast cancer. N Engl J Med 347(16):1233–1241
11. Veronesi U, Cascinelli N, Mariani L, Greco M, Saccozzi R, Luini A et al (2002) Twenty-year follow-up of a randomized study comparing breast-conserving surgery with radical mastectomy for early breast cancer. N Engl J Med 347(16):1227–1232
12. Brody GS (2009) Silicone breast implant safety and efficacy. Medscape
13. US Food and Drug Administration (FDA) (2006) FDA approves silicone gel-filled breast implants after in-depth evaluation. FDA Web site http://www.fda.gov/NewsEvents/Newsroom/PressAnnouncements/2006/ucm108790.htm Nov 2006
14. Sharabi SE, Bullocks JM, Dempsey PJ, Singletary SE (2010) The need for breast cancer screening in women undergoing elective breast surgery: an assessment of risk and risk factors for breast cancer in young women. Aesthet Surg J, 30(6):821–831
15. Skillman JM, Humzah MD (2003) The future of breast surgery: a new subspecialty of oncoplastic breast surgeons? Breast 12(3): 161–162
16. Rainsbury RM (2003) Training and skills for breast surgeons in the new millennium. ANZ J Surg 73(7):511–516

Oncoplastic and Reconstructive Anatomy of the Breast

2

Cicero Urban, Mario Rietjens, Flavia Kuroda, and James Hurley II

2.1 Introduction

Breast cancer surgery has gone through various changes over the past decades. New techniques have been introduced and others have been applied to already existing models, which have made the surgical approach more complex, and biologically individualized. Although concern with local control of disease still persists as an essential element, this is currently associated with an aesthetic–functional concept.

Therefore, breast anatomy itself, or the way it is traditionally approached, needs updating. Form, volume, inframammary fold (IMF), height, and breast projection as well as the size and shape of the nipple and areola complex (NAC), liposubstitution level, and ptosis are some of the points concerning surface anatomy that have acquired more importance within the oncoplastic and reconstructive context. Similarly, the abdominal wall and the dorsal structure of the thorax must be part of the surgeon's background, as one needs to have a reconstructive and oncoplastic view in order to make more suitable surgical decisions.

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Patient requests were rarely considered as part of medical decisions in the past, in contrast with current breast cancer management, where oncologic and reconstructive surgery, chemotherapy (before or after definitive treatment), and radiation therapy are not separate issues, and should be combined with patient desires. So, it is expected that all surgeons involved in breast cancer surgery are comfortable with all alternatives for breast reconstruction, as well as the anatomic and functional relationships. It is within such a perspective that this chapter has been written.

2.2 Advances in Breast Surgery and Anatomic Repercussions

The decision to perform a mastectomy or breast-conserving therapy is based on local recurrence rates, and on aesthetic–functional outcomes, including the relationship between the tumor size and the breast size, as well as the location of the tumor inside the breast and its relation to the skin and the NAC and IMF.

Oncoplastic surgery combines plastic surgery techniques with oncologic breast surgery. This combination has resulted in multiple benefits for patients, as it allows larger resections, with wider margins, aiming to avoid compromising aesthetic–functional outcomes. However, this type of surgery implies knowledge of advanced mammaplasty techniques [1]. As a consequence, the vascularization and innervation of the NAC acquires fundamental importance in the choice of which mammoplasty technique should be used.

Skin-sparing mastectomy (SSM), initially described by Toth and Lappert in 1991, in which the breast, the NAC, the biopsy sites, and the skin above the tumor are removed, is already established for ductal carcinoma in situ and invasive cancers. In such a procedure most of the skin and the IMF are preserved, which makes it easier for immediate reconstruction performed by temporary expanders, definitive implants, or autologous tissues [2]. Histological studies of local recurrences in this type of surgery do not identify

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significant residual mammary tissue as a causative factor in the great majority of cases. These recurrences remain constant throughout time and are proportional to tumor size and to positive axillary lymph nodes. The mean time for local recurrence is between 2 and 4 years, and concomitant distant metastasis are frequent. This shows that this type of local recurrence, in contrast to the type that occurs after breast-conserving therapy, is rarely an isolated event, or one that may have any relationship with incomplete surgery, although representing a biological marker of tumor aggressiveness and risk of metastasis. Instead of having a minor importance in the oncologic context, the anatomy and the histology of the IMF became the basis for immediate breast reconstruction, and the IMF became one of the most important structures to be preserved.

Another recent technical alternative is nipple-sparing mastectomy. The results are considered better from the aesthetic–functional point of view. Therefore, preserving the NAC has a positive psychological influence. However, the long-term local recurrence rate is unknown for biologically different kinds of invasive tumors, and data reported in the literature are from retrospective cohorts [2]. Anatomical, histological, and electron-microscopic studies have been performed to ascertain the oncologic safety of this type of surgery, and trials are currently ongoing.

Sentinel node (SN) biopsy was introduced in the 1990s. Over 1,500 clinical studies have been performed around the world, involving over 11,000 patients. The SN is the first lymph node in the chain of breast lymphatic drainage. It is considered one of the greatest examples of success of applying evidence-based medicine to surgery. It is the standard procedure in patients with a clinically negative axilla, owing to two fundamental advantages: better axillary staging, when compared with axillary dissection, as the examination in the first lymph node is more detailed; and lower morbidity among patients with a negative axilla, owing to less extensive surgery [3]. Concern with lymphatic anatomy was reborn after the introduction of SN biopsy.

Axillary dissection is currently recommended only for patients with SN metastasis and inflammatory breast cancer. The recent publication of ACOSOG Z0011 results showed that it is possible to avoid axillary dissection even with SN metastases in breast-conserving therapy under certain conditions [4]. The most feared side effect is lymphedema, which can occur in 10–20 % of patients, in various degrees of severity, and mostly as an irreversible morbidity.

Regarding breast reconstruction, currently there is a preference for immediate reconstruction, as the psychological impact is positive and aesthetic results are generally better without compromising adjuvant treatments or detection of future recurrences. Techniques employing temporary expanders and implants are the most frequently used. They bring the advantage of a faster procedure with low risk of complications. Among the techniques that use autologous flaps, the most frequently used ones are the transverse rectus abdominis myocutaneous (TRAM) flap and the latissimus dorsi flap, with or without addition of an implant. The TRAM flap allows the correction of excessive adipose tissue in the abdominal region as in an abdominoplasty, with transposition of skin islands and fat to reconstruct the breast. It can be monopedicled using only one rectus abdominis muscle or bipedicled, when both muscles are sacrificed. Microsurgical techniques represent a great advance in reconstructive surgery. They have the advantage of not causing major damage to the abdominal wall, and the risk of hernia is basically nonexistent.

So, anatomic concepts for reconstructive breast surgeons are not limited to the breast.

2.3 Surface Anatomy

The breasts, vertically, are found on the anterior thoracic wall, extending between the second and sixth ribs, overlying the pectoralis major muscle superomedially, and the serratus anterior muscle in the lower third and medial areas. Considering the horizontal dimensions, they lie from the side edge of the sternum to the mid axillary line [5, 6]. This extension is critical, as it represents the size of the IMF, the so-called breast base, which is frequently used as a reference for the choice of implants or flaps in breast reconstruction. Differences in this base are known as a significant cause of asymmetry, and it is critical that the IMF be maintained or reconstructed in breast cancer surgery.

In the axillary region there is a prolongation beyond the anterior axillary line called the tail of Spencer. In adult women (i.e., after puberty), this has the shape of a drop, assuming the shape of a cone in nulliparous women and a more pendulous contour in multiparous women.

Determining factors for mammary aesthetics are volume, parenchyma distribution, tissue elasticity, location and appearance of the NAC, quality of the skin envelope, and the relation between the final shape of the breast, thoracic wall, and the body [7].

The normal breast has good skin and parenchyma elasticity, and most of the volume is located at the inferior and lateral pole. The NAC in a young person will be at a higher projection point, where all breast lines converge. The areola is usually round and from 15 to 45 mm in diameter. The nipple, placed at the central region of the areola, has between 4 and

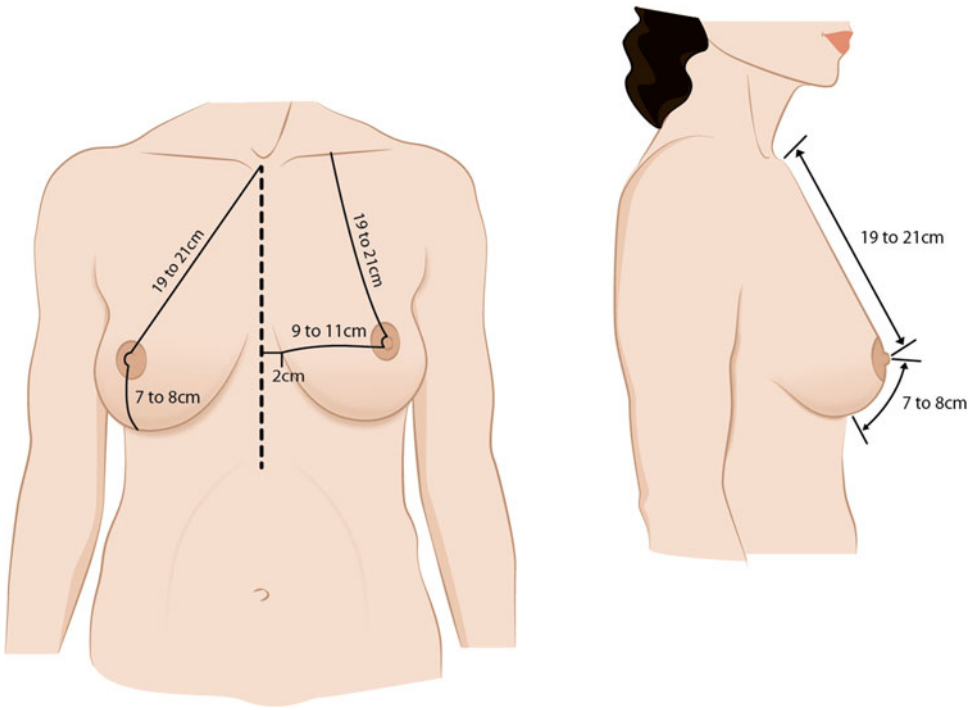

Fig. 2.1 Surface anatomy demonstrating the relations between the nipple and areola complex, the sternum, and the inframammary fold

12 mm of projection and is where the lactiferous ducts converge in a number ranging from 15 to 20 (five to nine true mammary duct orifices and other sebaceous glands, tubercles, and tubes [8]). It contains a huge concentration of nerve sensorial terminations and an abundant lymphatic system called the subareolar or Sappey plexus [9–11]. The blood is supplied to the NAC by the internal mammary artery via its perforating branches, by the anterior intercostal arteries, by the lateral thoracic artery, and by branches from the axillary artery. The internal mammary artery is the main and constant contributor of blood to the NAC by means of its perforating branches numbering from one to four and anterior intercostal branches numbering from four to six [6–11].

The color of the NAC has particular importance as it differs according to ethnicity. It is a factor to be considered for reconstruction and for the final aesthetic result of the breast. It contains sebaceous and sudoriferous glands as well as an intermediate type of mammary and sudoriferous gland called Montgomery's glands. These open at the Morgagni tubercles and are able to secrete milk. There are also smooth muscle fibers in the areola, and through certain stimuli they can contract, reducing the size of the areola and projecting the papilla forward [6, 9, 10].

The relationship between the NAC and the IMF, within this context, can also differ according to the breast and the patient's age. The nipple is usually located between 19 and 25 cm from the manubrium, between 9 and 12 cm from the medial line of the sternum, and between 7 and 10 cm from the IMF. These distances are relative and may differ according to the ethnic origin of the patient, and do not represent an anatomical abnormality (Fig. 2.1).

2.4 Surgical Anatomy of the Breast

The breasts are located over the pectoralis major muscle. Considering their structure, of cutaneous origin, a layer of adipose tissue and a layer of mammary tissue form them. The plane that separates the mammary tissue from the adipose tissue has great surgical value, as it can be identified in the flap during the surgical procedure and can be utilized in mastectomies and even in conservative surgical procedures.

In relation to the covering of the mammary tissue by fascia, it is important to consider the superficial fascia, which is found over the deep fascia of the skin (2–3 mm below), except at the areola and the nipple. This layer can be identified during the surgical dissection, allowing the separation of the mammary tissue from the skin where there is no bleeding, in an avascular plane. This fascia is connected with the deep fascia of the breast through fibrous fascia called Cooper's ligaments, which support the breast. On the posterior face of the gland there is a layer of thin adipose tissue that connects with the superficial fascia. This is separated from the pectoralis major muscle fascia by a layer of dense connective tissue called the posterior suspensory ligament of the breast. At the lateral and the inferior borders the breast lies on the fascia of the anterior

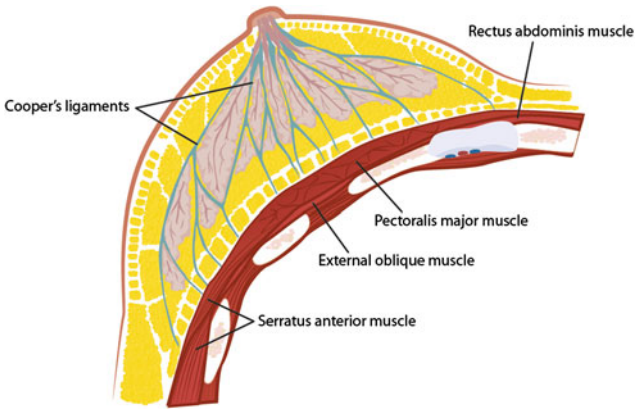

Fig. 2.2 Relationship between breast lobes, Cooper's ligaments, fat tissue, and thoracic muscles

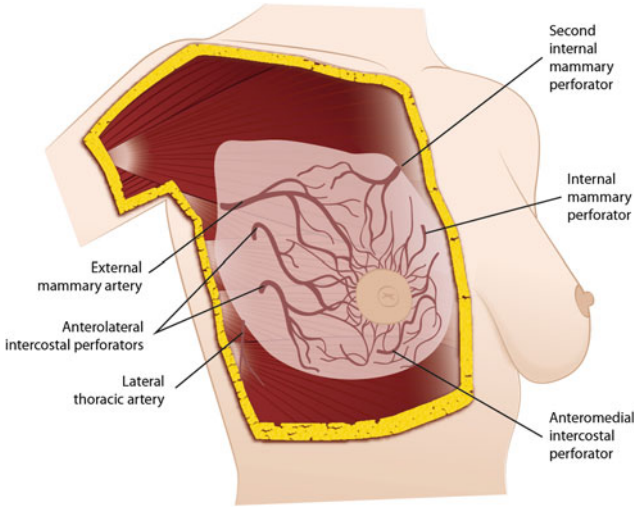

Fig. 2.3 Oblique view of the arterial vascularization of the breast

serratus muscle and the anterior rectus abdominis muscle, respectively [6, 9].

Fifteen to twenty independent lobes that branch out in lobules and alveoli form the mammary gland. A lobe is made up of various lobules that branch out in ten to 12 alveoli. These form the functional units of the breast, and are responsible for the production and drainage of milk. They are enveloped by fatty fibrous tissue. The drainage system is made up of collecting ducts that drain to the lactiferous ducts situated at a retroareolar position where milk is stored and ejected then by the apex of the nipple [6] (Fig. 2.2).

The subclavian artery, the axillary artery, and intercostal arteries and their branches form the arterial vascularization of the breast. The knowledge of their relationships is important, as in reduction mammoplasties. It is essential that at least one of these arterial pathways be preserved so the areola and the nipple can remain viable. Therefore, there are techniques for the preservation of the upper pedicle, the lateral pedicle, or the inferior pedicle blood supplies.

The breast is supplied with blood coming from three main sources. The first one and also the most important one (representing over 60 % of the supply) is the internal mammary artery, which may originate from the second, third, or fourth intercostal space. It perforates these spaces and enters the breast in its superomedial portion, taking a superficial track from where it sends arterioles to the skin and to the mammary tissue [5, 6, 9]. It is important to identify and preserve the integrity of this system while making the skin flaps during SSM.

The second system originates in the axillary artery. The pectoral branch of the thoracoacromial artery, the highest thoracic artery, subscapular artery, and mainly the lateral mammary branches of the lateral thoracic artery are responsible for about 30 % of the blood supply of the breast. One of the lateral mammary branches is more developed and mainly supplies the upper outer quadrant of the breast [5, 6, 9]. The surgical relevance of this vessel is because it is used for mammary reconstruction procedures that demand microsurgical anastomoses.

The third source of breast blood supply comes from lateral cutaneous branches of the intercostal arteries, which are less important [5, 6, 9] (Figs. 2.3, 2.4).

The venous drainage is formed by a deep system and a superficial system. Low-caliber vessels that drain just below the superficial fascia form an interconnected traverse longitudinal network, like a knit cloth, which drains to the internal mammary vein and the anterior superficial jugular vein, the superficial system. In the deep system, the afferent branches discharge into three main pathways: tributaries of the internal mammary vein, tributaries of the intercostal veins, and the vertebral system. There is special interest in the mammary venous drainage owing to the potential use of certain branches in breast reconstructive surgical procedures. The drainage follows the course of the arteries, with a large number of anastomoses between the superficial and the deep system, and has the axillary vein (originating from the cephalic vein and the humeral vein) as its main system. Around the areola, the veins form a venous circle which together with the drainage of the mammary tissue follows a peripheral course up to the internal thoracic, axillary, and intercostal veins [6, 9]. Metastases can pass through any of these routes, following their way to the heart and then to the lung capillaries. Owing to a system of avalvular venous drainage that connects Batson's venous vertebral plexus to thoracic, abdominal, and pelvic organs, one can explain the route of metastases to the vertebra, ribs, and central nervous system from the breast, mainly through intercostal posterior veins.

Interest in studying lymphatic drainage has increased because of SN studies. In most cases, the SN position is at level I, close to the thoracodorsal artery and vein. The breast

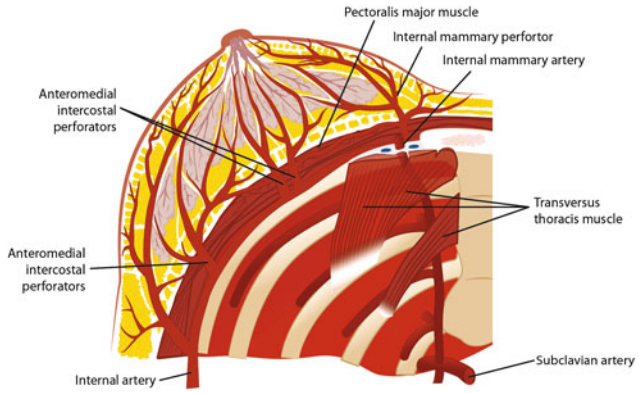

Fig. 2.4 Coronal view of the arterial vascularization of the breast

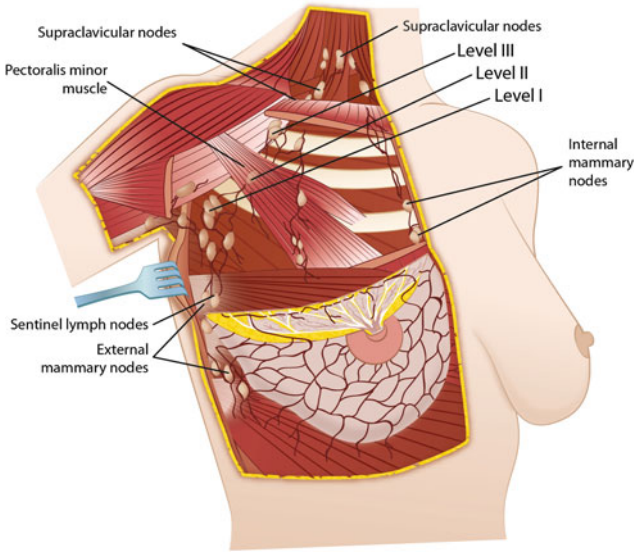

Fig. 2.5 Lymphatic drainage of the breast and the most frequent localization of the sentinel node

lymph vessels have their drainage established by two plexuses: superficial or Sappey's subareolar, and deep or aponeurotic. The former is made up by collecting trunks, which gather skin drainage, superficial breast planes, the nipple and areola, and the upper limb, supraumbilical region, and dorsum. The latter follows through the pectoralis muscles up to Rotter's lymph nodes (situated between the pectoralis major and the pectoralis minor muscles) and then toward the subclavian lymph nodes. Although the lymphatic flow is unidirectional, there is a great interrelation between the superficial system and the deep system as to breast drainage, which explains the broad variation of lymph drainage found in breast cancer [12]. Approximately 3 % of the breast lymph flows to the lymph nodes in the internal mammary chain and 97 % flows to the axillary lymph nodes. Any quadrant of the breast is able to drain to the internal mammary chain. Axillary nodes range in number from 20 to 30, and lymph node groups of axillary drainage can be divide into [5]:

- The axillary vein group or lateral group, consisting of four to six lymph nodes located medial or posterior to the axillary vein, holding most of the drainage from the superior portion of the breast.
- The external mammary group, also called the pectoral group, situated at the inferior border of the pectoralis minor muscle in association with the lateral thoracic vessels. It consists of four or five lymph nodes and holds most of the lymphatic drainage from the breast.
- The subscapular lymph node group or posterior lymph node group, consisting of six or seven lymph nodes situated along the posterior wall of the axilla up to the lateral border of the scapula and are associated with subscapular vessels. They also contain drainage from the cervical posterior region and the shoulder.
- The central group, consisting of three or four lymph nodes and situated posterior to the pectoralis minor muscle, interwoven with the adipose tissue of the axilla. They hold drainage from the three groups mentioned above and they can also contain drainage directly from the breast. A sequence of this drainage moves on to the subclavicular lymph nodes or to apical lymph nodes. Clinically, this is the most palpable group, which is of extreme relevance to the clinical evaluation of axillary metastases.
- The subclavicular or apical group, consisting of six to 12 lymph nodes, situated posterior and superior to the border of the pectoralis minor muscle. It obtains drainage directly or indirectly from all the other groups. The lymphatic efferents of these ducts form the subclavian trunk, which pours into the right lymphatic duct and to the left side into the thoracic duct. Through this route there is also the possibility of drainage for lymph nodes from the deep cervical area.
- Rotter's group or the interpectoral group, consisting of one to four small lymph nodes situated between the pectoralis major and the pectoralis minor muscles associated with branches of thoracoacromial vessels.

There is another division of axillary lymph nodes that is routinely used by surgeons, taking into account the relation between the axilla and the pectoralis minor muscle. The lymph nodes that are situated lateral and below the pectoralis minor muscle are referred to as Berg's level I and encompass the external mammary group, the axillary vein, and the subscapular vein. Those situated behind this muscle are referred to as level II and correspond to the central group and part of the subclavicular group. The lymph nodes

situated above the superior border of the pectoralis minor muscle are referred to as level III and include the subclavicular group [5].

The lymph nodes of the internal mammary chain are situated in the intercostal spaces of the parasternal area. They are close to the internal mammary vessels, in the adipose extrapleural tissue. They are found medial to the mammary vessels in the first and second intercostal spaces and lateral to them in the third space [5]. There are also other accessory networks such as the one that connects the two breasts, called transmammary and paramammary, which is related to the hepatic lymph nodes and subdiaphragmatic nodes (Fig. 2.5).

Breast innervation in the inferior portion is dependent on the intercostal nerves, whereas in the superior portion it is dependent on levels 3 and 4 of the cervical plexus. The cutaneous sensation of the breast results from the anterior and lateral cutaneous branches originating from the second to the sixth intercostal branches, although mainly from the last three branches. The superior area of the breast is also innervated from the cervical plexus by the supraclavicular nerve. Important nerves to be identified in the axillary dissection are as follows: the nerve of the pectoralis major muscle, the nerve of the pectoralis minor muscle, the long thoracic nerve or Bell's nerve (if damaged it results in winged scapula), and the thoracodorsal nerve. The latter is easily visualized following the subscapular vessels up to the anterior–superior border of the latissimus dorsi muscle, and its identification as well as preservation is important when considering reconstructive cases with a latissimus dorsi flap. The intercostobrachial nerve is found below the axillary vein and is responsible for the sensory innervation of the superior third of the arm and the innervation of the sudoriferous glands of the axilla. It should, whenever possible, be preserved, as paresthesia in the medial portion of the arm and in the floor of the axilla is an important complaint from patients.

The most important muscles related to breast are as follows:

- The pectoralis major muscle is in close relation with most of the breast surface. It is a flat muscle and it is divided in two portions: clavicular and costosternal. The latter originates from the sternum and from the costal cartilages of the second and sixth ribs. It inserts in the major tubercular groove of the humerus and in the bicipital groove. The cephalic vein, which is often used for long-term catheters in chemotherapy, is the separation point between this muscle and the deltoid muscle, at the deltopectoral groove. Its function is flexion, adduction, and medial rotation of the arm. The medial and lateral portions of the pectoral nerves innervate it. These nerves, if sacrificed in axillary surgery, may cause retraction, local fibrosis, and loss of function [13]. The pectoralis major muscle is used for the protection of implants during mammary reconstructive procedures and also in aesthetic surgical procedures. Sometimes the implant covering is compromised when there is an anatomical variation as occurs when the inferior insertion of the muscle is in an upper part of the thoracic wall.
- The pectoralis minor muscle appears on the sternal fascia of the third, fourth, and fifth ribs and inserts in the coracoid process of the scapula. It is innervated by the medial pectoral nerve, which is a branch from the brachial plexus (C8-T1) [13]. It travels posteriorly to the axillary muscle and anteriorly to the axillary vein.
- The serratus anterior muscle originates on the surface of the upper eight ribs and inserts along the vertebral border of the scapula. The function of this muscle is to keep the scapula pressed against the thorax wall and it is innervated by the long thoracic nerve (Bell's nerve), originating from posterior branches of C5, C6, and C7 of the brachial plexus. The path of this nerve is posterior to the axillary vein and then emerges at the medial level of the subscapular fossa. It is important that this nerve is preserved during axillary dissection to avoid instability of the scapula, therefore reducing the strength of the shoulder, a condition known as winged scapula.
- The latissimus dorsi muscle originates on the spinous process and supraspinous ligaments of the seventh thoracic vertebra and on all sacral and lumbar vertebrae. It inserts in the bicipital sulcus of the humerus. The thoracodorsal nerve originating from the brachial plexus

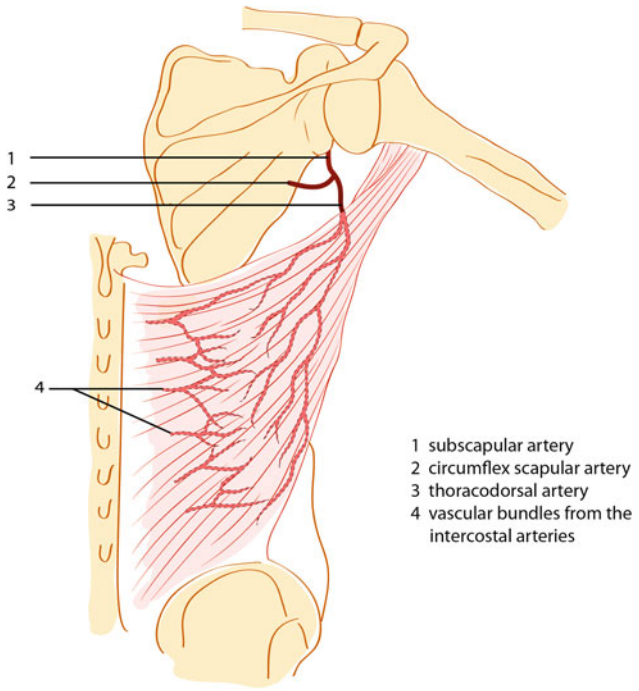

Fig. 2.6 Arterial supply to latissimus dorsi muscle

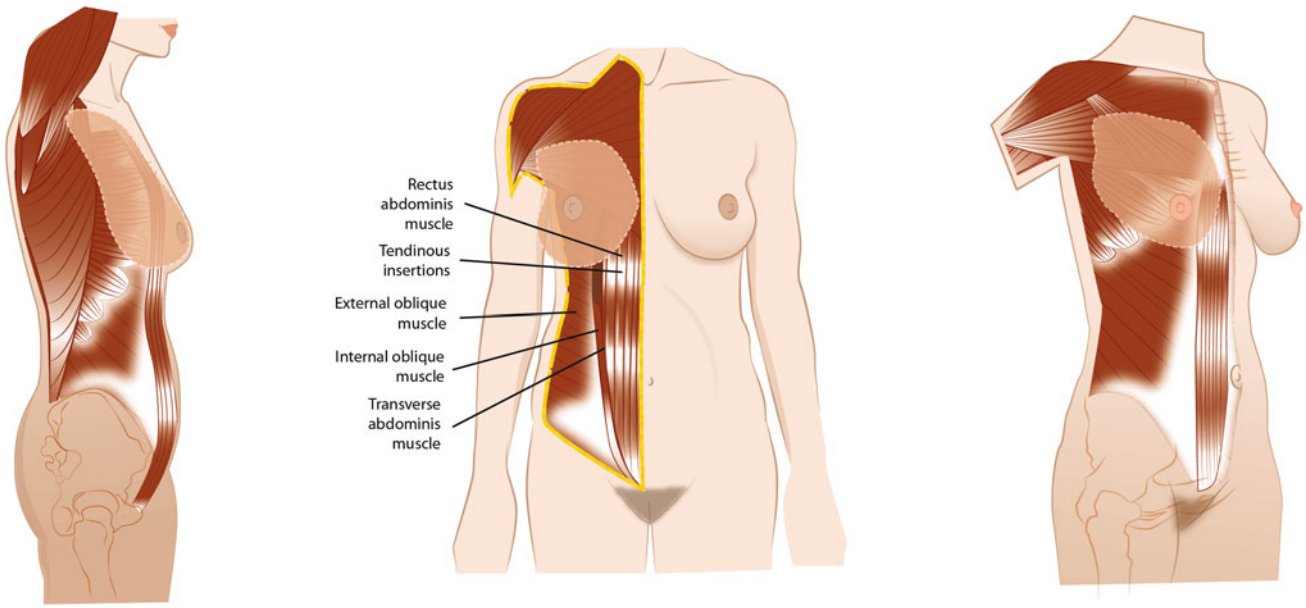

Fig. 2.7 Rectus abdominis muscle anatomy

rooted in C6, C7, and C8 innervates it. The nerve passes by the axilla and is contained in the axillary lymph nodes of the subscapular group. In the case of injury to this nerve, there is no motor disability; however, it is not possible to use this muscle for breast reconstructions. The arterial supply is shown in Fig. 2.6.

- The rectus abdominis muscle is the muscle that recovers the anterior wall of the abdomen. It inserts is the inferior margin of the fifth, sixth, and seventh costal cartilages. As this muscle goes down to the pubis, it becomes narrower and inserts into the body of the pubis inferiorly. It also has the so-called tendineae (areas of interruption of the muscle), which are usually four in number. One is positioned at the navel level, two are above this level, and one is below it. The muscle is enveloped by a fibrous fold that originates in the aponeurosis of the internal oblique muscle, external oblique muscle, and transverse abdominis muscle, which joins along with the medial line forming the linea alba. This is the inferior limit for the muscle dissection in TRAM flaps. The posterior face of this muscle lies on the subpectoral tissue. From bottom to top, its blood supply is from the inferior epigastric artery, which is a branch of the external iliac artery, and the blood supply of the superomedial portion is from the superior epigastric artery, which is a branch of the internal thoracic artery, originating at the subclavian artery. These two arteries produce a rich network of anastomoses among them (the choke system), therefore establishing communication between the subclavian artery and the external iliac artery. This anatomy is very important for breast reconstruction. This type of surgery can be performed by using the rectus abdominis muscle either unilaterally or bilaterally together with the subcutaneous tissue and skin, tying off the inferior epigastric artery and rotating the flap through a tunnel previously prepared toward the mammary site; or simply by using subcutaneous tissue and abdominal skin and performing microanastomoses between perforating vessels and either internal mammary vessels or lateral thoracic vessels (Figs. 2.7, 2.8).

The IMF has been subject of special attention lately because of its importance to immediate reconstruction in SSM and nipple-sparing mastectomy. It is situated at the level of the fifth rib in a medial position and in its lateral portion it overlies the sixth intercostal space. It is an important anatomic landmark in breast surgery, because it defines the shape and structure of the breast, and i a boundary for reconstructive and aesthetic surgical procedures. From the onset of breast development, it anchors the inferior pole of the breast to the chest wall, and with age, the breast begins to sag or become ptotic relative to this point [14, 15]. The relationship between it and the pectoralis major muscle is also important with respect to breast implant support. It is located inferior to the inferior origin of the pectoralis major muscle [16]. Considerable attention should be paid to its role in creating a naturally appearing breast in different techniques. In augmentation mammoplasty, the IMF provides a relatively well hidden site for an incision to place a mammary implant and provides inferior support for subpectoral implants that is essential to prevent migration [18]. Its distance from the areola and its bilateral symmetry preservation are some points that must be

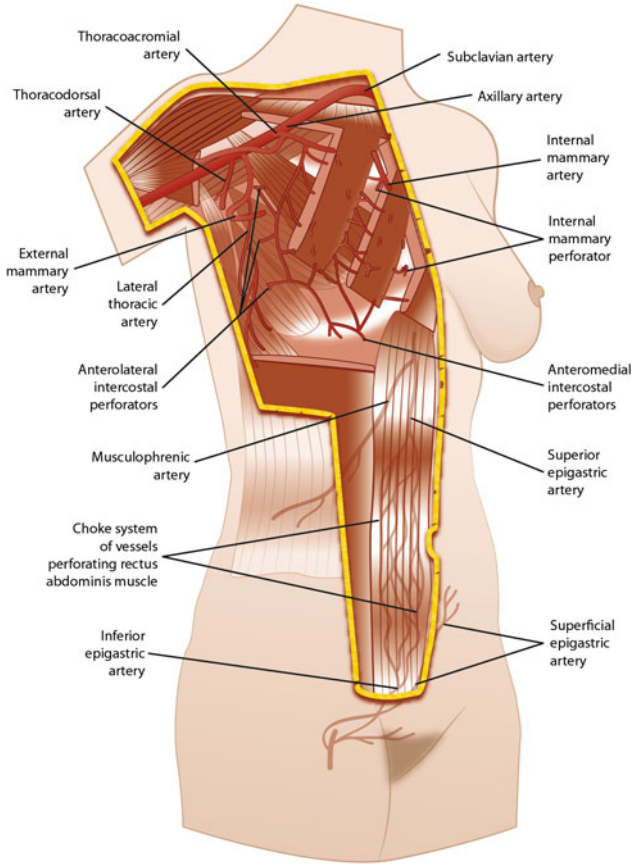

Fig. 2.8 Arterial supply to rectus abdominis muscle, and the choke system

observed for a satisfactory aesthetic–functional result. It represents a zone of adherence of the superficial fascial system as well as an increase in dermal collagen [14, 15, 17]. It has a ligament that originates at the periosteum of the fifth rib medially and the fascia between the fifth and the sixth rib laterally, inserting into the deep dermis [18]. However, the existence and origin of this ligament is not universally agreed upon by anatomists. Preserving it in mastectomies is still a subject of debate owing to the possibility of there being remaining mammary tissue at the site. Gui et al. [19] found that 28 % of their IMF specimens contained breast tissue and lymph nodes. However, aiming to explain this, Carlson et al. [20] showed that preserving it keeps <0.02 % of the total mammary tissue. If the IMF is breached, it must be repaired to reconstitute the natural breast crease at the time of breast reconstruction to maintain the correct breast implant position and achieve an optimal final aesthetic outcome [17, 19]. Chapter 34 is dedicated to IMF reconstruction.

2.5 Conclusions

Aesthetic–functional breast anatomy is essential to reconstructive breast cancer surgery. The spatial organization of the mammary ducts, the vascularization, and the innervation have relevant therapeutic implications in the era of SN and oncoplastic surgery, so the reconstructive breast surgeon must be aware of all of these important anatomic relationships.

References

1. Urban CA (2008) New classification for oncoplastic procedures in surgical practice. Breast 17(4):321–322
2. Chung AP, Sacchini V (2008) Nipple-sparing mastectomy: where are we now? Surg Oncol 17(4):261–266
3. Lyman GH, Giuliano AE, Somerfield MR, Benson AB 3rd, Bodurka DC, Burstein HJ et al (2005) American society of clinical oncology guideline recommendations for sentinel lymph node biopsy in early-stage breast cancer. J Clin Oncol 23(30): 7703–7720
4. Giuliano AE, Hunt KK, Ballman KV, Beitsch PD, Whitworth PW, Blumencranz PW et al (2011) Axillary dissection vs no axillary dissection in women with invasive breast cancer and sentinel node metastasis. JAMA 305(6):569–575
5. Djohan R, Gage E, Bernard S (2008) Breast reconstruction options following mastectomy. Cleve Clin J Med. 74(1):17–23
6. Pandya S, Moore RG (2011) Breast development and anatomy. Clin Obstet Gynecol 54(1):91–95
7. Westreich M (2009) Anthropomorphic measurement of the breast. In: Shiffman MA (ed) Breast augmentation: principles and practice. Springer, Berlin, pp 27–44
8. Love SM, Barsky SH (2004) Anatomy of the nipple and breast ducts revised. Cancer 101(9):1947–1957
9. Romrell LJ, Bland KI (1998) Anatomy of the breast, axilla, chest wall, and related metastatic sites. In: Bland KI, Copeland EM (eds) The breast: comprehensive management of benign and malignant diseases. W.B. Saunders, Philadelphia, pp 21–38
10. Nicholson BT, Harvey JA, Cohen MA (2009) Nipple-areolar complex: normal anatomy and benign and malignant processes. Radiographics 29(2):509–523
11. Van Deventer PV (2004) The blood supply to the nipple-areola complex of the human mammary gland. Aesthetic Plast Surg 28(6):393–398
12. Suami H, Pan WR, Mann GB, Taylor GI (2008 Mar) The lymphatic anatomy of the breast and its implications for sentinel lymph node biopsy: a human cadaver study. Ann Surg Oncol 15(3):863–871
13. Macchi V, Tiengo C, Porzionato A, Parenti A, Stecco C, Mazzoleni F et al (2007 Mar) Medial and lateral pectoral nerves: course and branches. Clin Anat 20(2):157–162
14. Boutros S, Kattash M, Wienfeld A, Yuksel E, Baer S, Shenang S (1998) The intradermal anatomy of the inframammary fold. Plast Reconstr Surg 102(4):1030–1033

15. Muntan CD, Sundine MJ, Rink RD, Acland RD (2000) Inframammary fold: a histologic reappraisal. Plast Reconstr Surg 105(2):549–556
16. Nanigian BR, Wong GB, Khatri VP (2007) Inframammary crease: positional relationship to the pectoralis major muscle origin. Aesthet Surg J 27(5):509–512
17. Akhavani M, Sadri A, Ovens L, Floyd D (2011) The use of a template to accurately position the inframammary fold in breast reconstruction. J Plast Reconstr Aesthet Surg 64(10):259–261
18. Bayati S, Seckel BR (1995) Inframammary crease ligament. Plast Reconstr Surg 95(3):501–508
19. Gui GP, Behranwala KA, Abdullah N, Seet J, Osin P, Nerurkar A et al (2004) The inframammary fold: contents, clinical significance and implications for immediate breast reconstruction. Br J Plast Surg 57(2):146–149
20. Carlson GW, Grossl N, Lewis MM, Temple JR, Styblo TM (1996 Sep) Preservation of the inframammary fold: what are we leaving behind? Plast Reconstr Surg 98:447–450

Breast Imaging

3

Linei Urban and Cicero Urban

3.1 Introduction

The incidence of breast cancer has increased all over the world, which can be a result of social-demographic changes and access to health care services. Holland is the country with the highest incidence, and its rate adjusted by age is 90.2/100,000. In the USA the rate is 86.9/100,000. High rates are also found in other European countries, as well as in Australia, New Zealand, and South America, and especially in Uruguay and Argentina. Most populations in Africa and Asia have low rates of the disease. Incidence rates increase with age, and reach a peak in the age range between 65 and 70 years [1–3].

Despite the increase in the incidence of breast cancer, an increase in mortality rate in developed countries has not been observed. Up until 1987, breast cancer was the main cause of death by cancer among women in the USA, and then it was surpassed by lung cancer. That occurred because breast cancer had a lower mortality rate, mainly due to mammographic tracking, whereas lung cancer had a growing incidence among women because of tobacco smoking [4].

In Brazil, of cancers, breast cancer has the incidence among women. The highest incidence is observed in the south and southeast regions (the rates are 71/100,000 and 73/100,000, respectively). However, contrary to what is observed in developed countries, there has been an increase in the gross mortality rate in the past few decades, from 5.77 per 100,000 women in 1979 to 9.70 per 100,000 women in 1998. For that reason, breast cancer is still the main cause of death by cancer among women [5].

3.2 Diagnostic Methods in Breast Cancer

Mammography is currently the most important method in breast evaluation. Other diagnostic methods, such as ultrasonography, magnetic resonance imaging (MRI), scintigraphy, and PET–CT, are used as auxiliary methods in the diagnosis of breast cancer and they are chosen according to the lesion that will be evaluated [6].

There are two different levels of approach for breast evaluation, and these have an influence on the choice of imaging methods: asymptomatic patient evaluation for breast cancer screening and symptomatic patient evaluation to diagnose either a benign or a malignant tumor.

3.2.1 Breast Cancer Screening

The aim of breast cancer screening is to spot the tumor at an early stage, before its clinical manifestation, increasing the chances of extended the patient's life. Mammography was the only method that pointed to an absolute reduction in mortality rate (between 25 % and 30 %) among patients undergoing regular screening owing to detection of ductal carcinomas in situ and infiltrating carcinomas of a smaller size and lower staging when compared with the group of nontracked patients [7–15]. Ultrasonography and MRI appear to be useful in specific groups of patients; however, no long-term study has been conducted to determine the impact on mortality.

Mammography can detect five to seven cancer cases in every 1,000 asymptomatic women undergoing the first examination and two to three cases in every 1,000 women undergoing annual screening [16]. The Health Insurance Plan Study provided the first evidence for the potential of

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mammography to reduce the mortality rate. In this study, performed in the 1960 s, around 6,000 women were randomized in two groups, a control one and another one undergoing physical examinations and mammograms. After a 7 year follow-up, a 30 % mortality rate reduction in the group of women that underwent screening [17–19] was noticed. After that study, mammography began to be widely used for screening breast cancer. By the end of the 1980 s, a variety of other studies confirmed a reduction of the mortality rate of patients aged 50 years and older undergoing regular screening [7–15]. There are also benefits, although not so evident, for women between 40 and 50 years old. Although no study has demonstrated an association between self-examination of the breasts and lower mortality rate, this type of test still has to be encouraged.

Ultrasonography is not appropriate as an initial method for tracking, mainly owing to its limited ability to evaluate microcalcifications, which are the early manifestations of cancer in 50 % of cases. Some studies have proposed the use of ultrasonography as the method for screening of asymptomatic patients with negative mammographic findings but high breast density [Breast Imaging Reporting and Data System (BI-RADS®) density categories 3 and 4) [20]. Kolb et al. [21] published a study performed with 11,130 asymptomatic patients undergoing mammography and ultrasonography which shows that additional ultrasonography and mammography increased the detection of breast cancer in dense breast patients by 42 %. Nevertheless, so far there are not enough randomized studies showing a decrease in mortality rate among this group of patients, which is a requirement for application of the method as a screening method in large populations.

MRI appears to be the most sensitive method for detecting breast cancer among high-risk patients, mainly for those with identified genetic alterations (*BRCA1* and *BRCA2*) or a marked family history [16, 22, 23]. Krieger et al. [22] followed up 1,909 women with marked family history or with *BRCA1* and/or *BRCA2* mutations for an average period of 2.9 years, and found 33.3 % sensitivity for mammography and 79.5 % for MRI. Kuhl et al. [24] evaluated 529 asymptomatic women with marked family history or genetic mutation, for a period of 5.3 years, and they found 33 % sensitivity for mammography, 40 % for ultrasonography, and 91 % for MRI. However, randomized prospective studies are required to establish the impact of mortality on these new tracking methods.

In Brazil, the Ministry of Health in association with INCA and the Brazilian Society of Mastology designed a consensus document with recommendations on breast cancer control to be implemented by the end of 2003. The recommendations for detection of cancer at an early stage are as follows [25]:

1. Clinical examinations of the breast for all women above 40 years of age, performed annually
2. Mammography for all women between 50 and 69 years old, with a maximum interval of 2 years between examinations
3. Breast examinations and an annual mammogram for women from 35 years old with high risk of breast cancer
4. Guarantee of access to diagnosis, treatment, and follow-up for all women with alterations found in the examinations performed.

3.2.2 Evaluation of Symptomatic Patients

All imaging methods are useful for the evaluation of a patient with symptoms or signs that point to breast cancer. The combination of mammography and ultrasonography is particularly useful in this group of patients. Moy et al. [26] reported that only 2.6 % of patients from a group of 374 symptomatic women with breast cancer did not have symptoms or signs on mammography and ultrasonography. Kolb et al. [21] also reported that mammography itself diagnosed only 48 % of the tumors in patients with dense breasts, whereas mammography and ultrasonography together detected 97 % of the cases. The possibility of a patient presenting with a tumor after negative findings on mammography and ultrasonography is 3 %.

The choice of an initial method for a symptomatic patient may be influenced by the patient's age range. If the patient is young (below 35 years old), ultrasonography is the method chosen for initial evaluation, considering that most patients will show dense breasts. For patients aged 35 years and above, an initial evaluation by mammography is recommend, and complementary ultrasonography or MRI applies for patients in which clinical suspicion is maintained [25].

If there are suspicious findings on a physical examination, no test or group of tests is able to guarantee that a patient does not have breast cancer. The final course of action in this group of patients must be based mainly on clinical parameters.

3.3 Breast Imaging Reporting and Data System (BI-RADS®)

BI-RADS® is the result of a mutual effort between members of the American College of Radiology and the National Cancer Institute, Centers for Disease Control and Preventions, Food and Drug Administration, American Medical Association, American College of Surgeons, and College of American Pathologists. This system is designed to standardize the medical report, reduce misunderstandings in the

Table 3.1 BI-RADS® categories

Category	Definition	Risk of malignancy (%)	Recommendation
0	–	–	Additional imaging required
1	Negative	–	Annual follow-up
2	Benign finding(s)	0	Annual follow-up
3	Probably benign	<2	Term follow-up
4 (A, B, C)	Suggestive of malignancy	3–95	Biopsy recommended
5	Highly suggestive of malignancy	>95	Biopsy required
6	Known neoplasia	–	Conduct according to case

Adapted from [6]

interpretation of images, and make follow-up of patients easier, besides allowing internal quality auditing. It should be used in mammography, ultrasonography, and MRI [6].

After evaluation of images, the medical report must be written in a clear and concise way so it can give the professional who requested the test a good idea of what was diagnosed as well as the recommended course of action. The medical report must contain the following five parts:

1. Indication for examination (a brief description of the reason for the examination)
2. Breast composition (description of the breast standard, this indicates the risk of a lesion being obscured by normal mammary tissue)
3. Findings (an accurate description of the findings according to established terms and standards must be given)
4. Comparison with previous studies (important in cases of dubious findings, and less important in cases of mammograms which reveal either negative findings or benign lesions)
5. Overall assessment (classification of the examination in one of the system categories, and recommendation for the course of action; see Table 3.1)

BI-RADS® category 0 must be reserved for cases in which an additional evaluation has to be performed, such as additional mammographic views with local compression or magnification, or even the complementary use of other tests (e.g., ultrasonography or MRI). It can also be used in cases where a comparison with previous tests is important, before a final impression is reached.

Cases classified as negative (category 1) or with benign findings (category 2) are followed up through annual routine tests.

In cases of probably benign lesions (category 3) which show a risk of malignancy lower than 2 %, a semester follow-up is recommended until 2–3 years has elapsed (according to the lesion) with the aim of determining the stability of the lesion. After such a period, if no alteration in the lesion is noticed, it is classified as category 2, and returns to the annual tracking group.

For lesions classified as category 4, the subdivision into categories 4A, 4B, and 4C is optional, but strongly recommended. Category 4A must be used when the risk of malignancy is low and a 6 month control period after biopsy or negative cytological findings is indicated. Category 4B indicates an intermediate risk of malignancy, so a good anatomic–radiological co-relation is needed. Category 4C includes findings of moderate suspicion in which malignancy is expected.

Lesions classified as highly suggestive of malignancy (category 5) have a risk of malignancy higher than 95 %. This group must be reserved for the group of classic tumor lesions such as spiculated masses, pleomorphic calcifications, and ductal calcifications in which a malignant lesion can only be ascertained after surgical evaluation of the region in question.

Category 6 is reserved for the group of lesions that are already diagnosed as being cancerous, and for which neoadjuvant chemotherapy or a second opinion is required. This category is not appropriate in cases of follow-up after breast-conserving surgery.

3.4 Mammography

3.4.1 Normal Mammographic Findings

There is a big variation in the appearance of a normal breast in a mammogram, mainly as to the size, shape, and composition of the parenchyma. The composition of the parenchyma may vary from almost totally substituted to extremely dense, and the sensitivity of mammography is directly related to this composition.

Liposubstituted breasts have excellent background tissue for tumor visualization, whereas high density can obscure tumor visualization.

The BI-RADS® composition of the breast is divided into four categories [6]:

1. Category 1: breasts with severe adipose substitution (less than 25 % glandular tissue) (Fig. 3.1a)

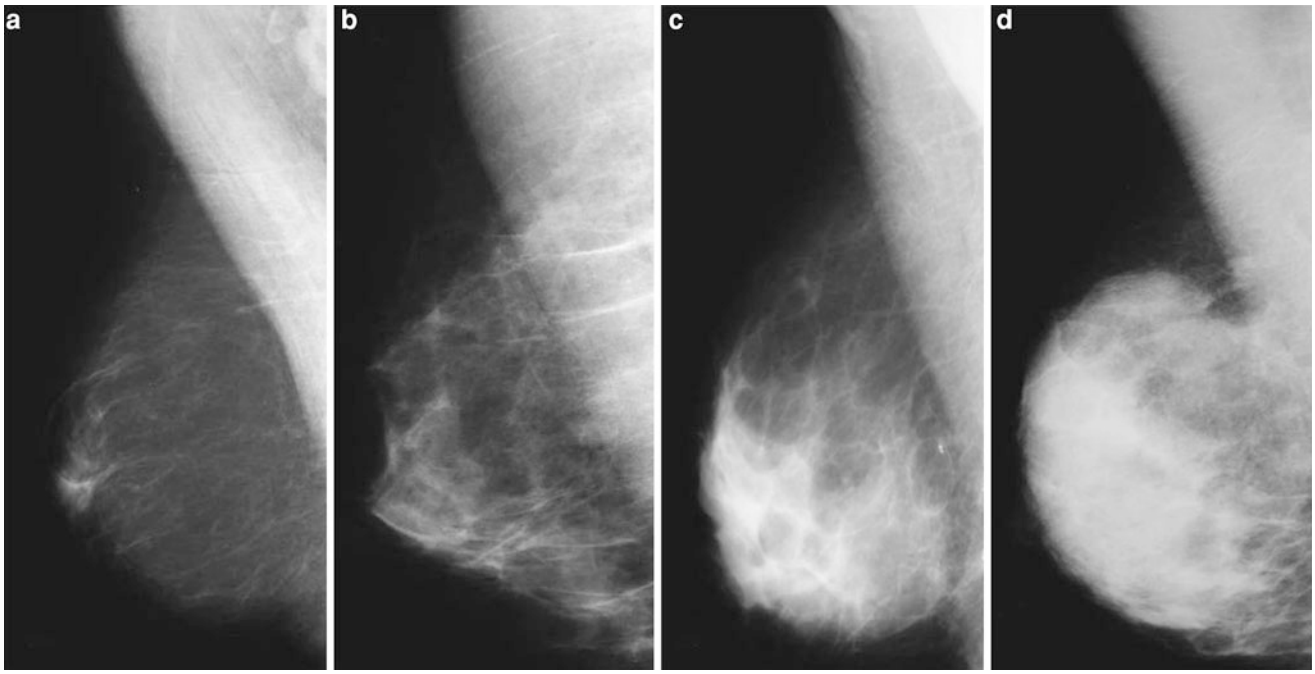

Fig. 3.1 Mammographic patterns of mammary density according to BI-RADS®: severe adipose substitution (**a**), sparse fibroglandular densities (**b**), heterogeneously dense (**c**), and extremely dense (**d**)

2. Category 2: breasts with sparse fibroglandular densities (25-50 % glandular tissue) (Fig. 3.1b)
3. Category 3: heterogeneously dense breasts, which can obscure the detection of small lesions (approximately 51-72 % glandular tissue) (Fig. 3.1c)
4. Category 4: extremely dense breasts, which can reduce the sensitivity of mammography (over 75 % fibroglandular tissue) (Fig. 3.1d)

Younger women tend to have a greater amount of fibroglandular tissue, although there is considerable variation within the same age range. As the age range increases or when the woman breastfeeds, the fibroglandular tissue tends to be replaced by fat. The replacement always occurs from the posterior region to the anterior region and from medial to lateral, in a symmetric way. An increase in mammary density can be observed during pregnancy and owing to the use of hormone-replacement therapy (HRT).

3.4.2 Abnormal Mammographic Findings

Masses and calcifications are the commonest abnormal findings in mammography. Other lesions that have been observed are architectural distortion, focal asymmetry, global asymmetry, retraction or cutaneous thickening, mammillary retraction, and axillary lymphadenomegaly.

3.4.2.1 Masses

Masses are described as lesions occupying space that is seen in at least two views. They are described according to shape, margin, and density [6].

The shapes can be round, oval, lobulated, or irregular (Fig. 3.2). Whereas oval and round shapes are usually related to benign lesions, an irregular shape is more associated with malignant lesions.

Margins are also an important indicator of malignancy, and they are described as circumscribed, microlobulated, obscured, indistinct, or spiculated (Fig. 3.3). Circumscribed lesions are defined as lesions that show at least 75 % of the margins as well defined, and they are associated with a possibility of malignancy lower than 2 % [32, 33]. These lesions are classified as probably benign (BI-RADS® 3 category) and it is recommended that a semester control is done. Microlobulated lesions and indistinct ones have a higher risk of malignancy, whereas spiculated ones are highly suggestive of malignancy.

The density of masses may also point to their origin, being described as high density, low density, isodense to parenchyma, and fat density (Fig. 3.4). Generally, benign lesions tend to be less dense than malignant ones, although this is not always true. The existence of fat density inside the mass confirms its benign nature.

Finding associated lesions may help define the nature of lesions, such as gross calcifications (associated with

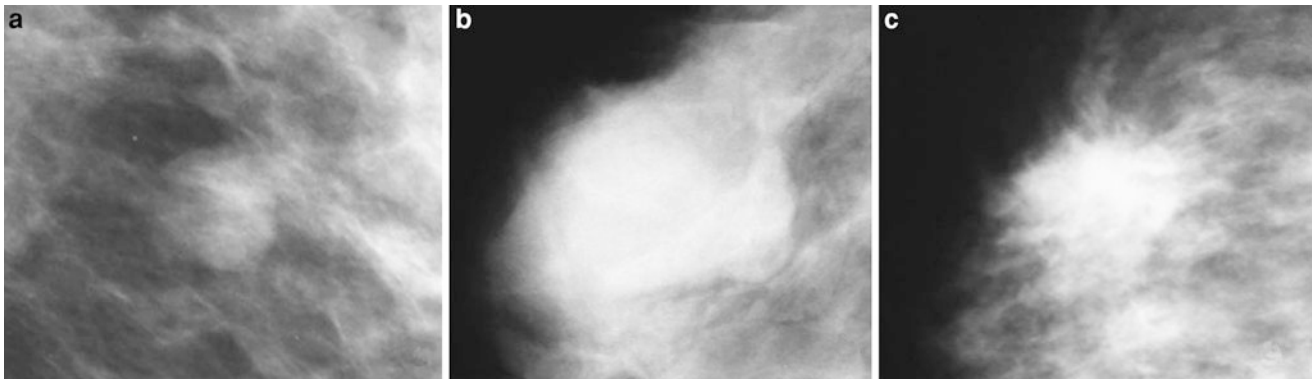

Fig. 3.2 Shapes of masses screened: round (**a**), oval (**b**), and irregular (**c**)

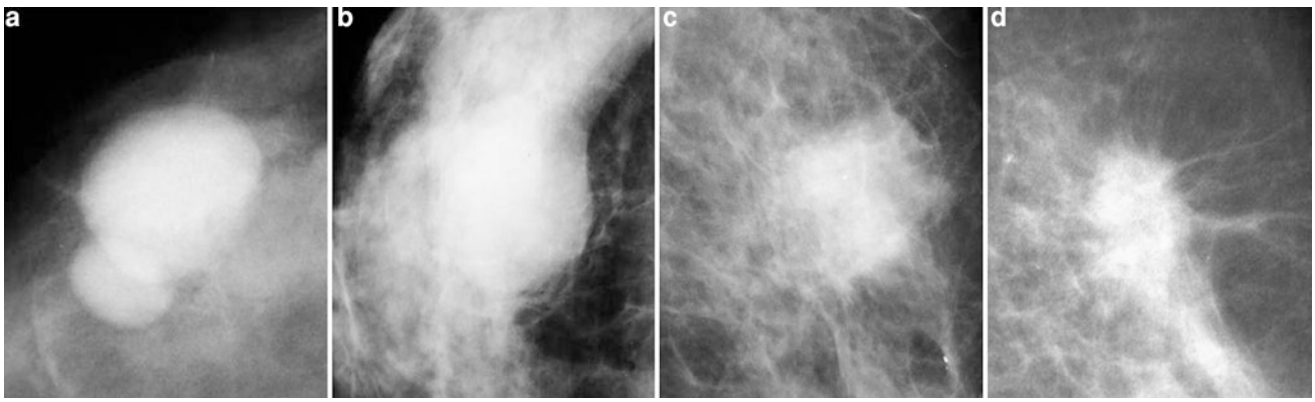

Fig. 3.3 Margins of masses screened: circumscribed (**a**), obscured (**b**), indistinct (**c**), and spiculated (**d**)

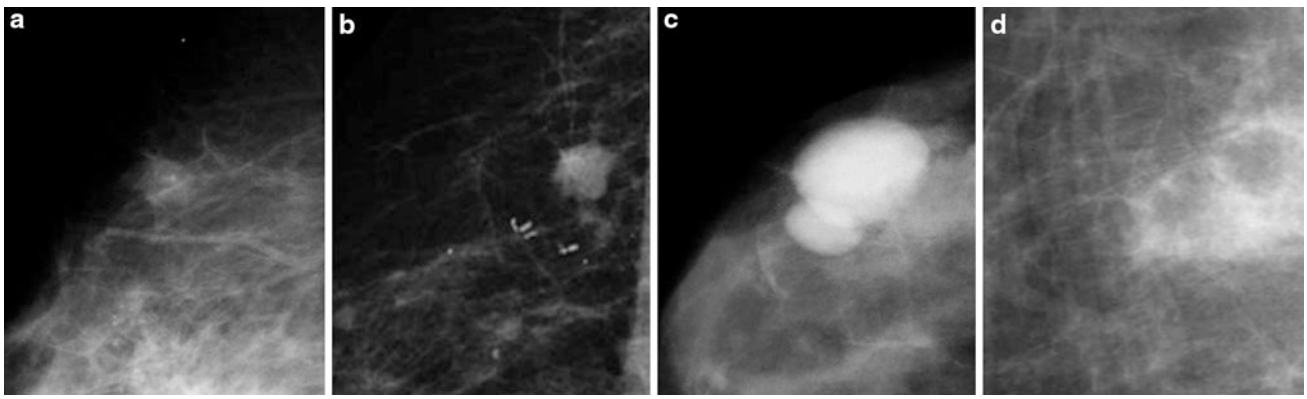

Fig. 3.4 Density of masses screened: low density (**a**), isodense (**b**), high density (**c**), and fat density (**d**)

fibroadenoma in involution) and pleomorphic calcifications (related to malignant lesions), cutaneous retraction, and mammillary retraction.

3.4.2.2 Calcifications

Calcifications are described according to their morphology and distribution. Morphology shows a good correlation with the nature of calcifications, and they can be classified as [6]:

1. Typically benign: skin calcifications (lucent-centered), vascular calcifications (parallel lines associated with vascular structures), "popcorn"-type calcifications (coarse and associated with mass images, corresponding to fibroadenoma in involution), gross tubular calcifications (associated with duct ectasia), round (frequently formed in acini and lobes), rodlike calcifications (lucent-centered), "eggshell" calcifications (calcium deposit on

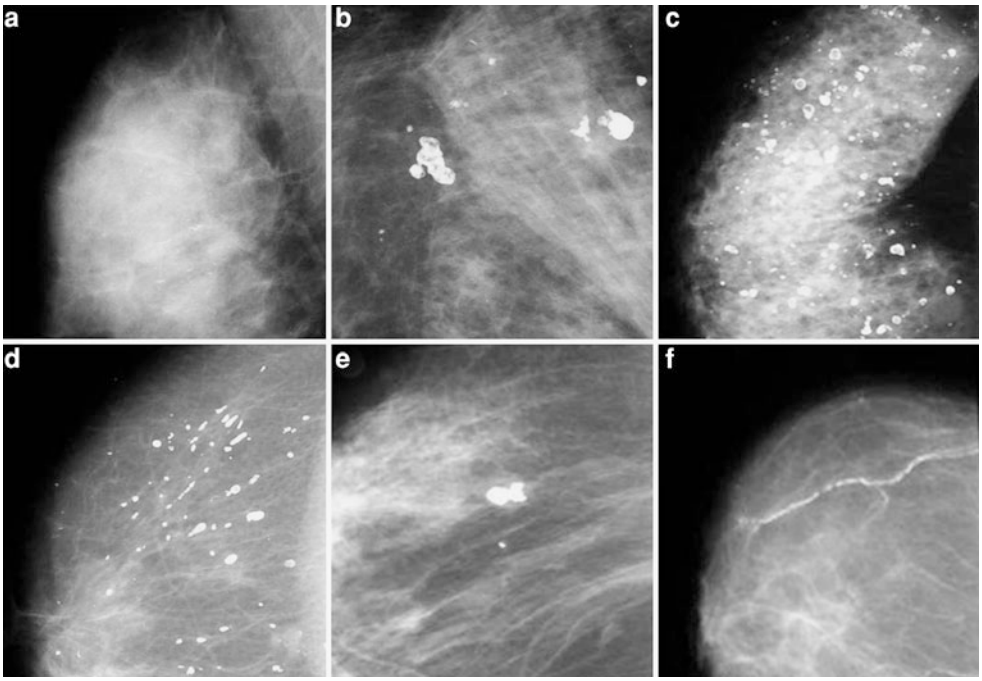

Fig. 3.5 Typically benign calcifications: "milk of calcium" (**a**); dystrophic (**b**), round and rodlike (**c**); gross tubular (**d**), "popcorn" type (**e**), and vascular (**f**)

the cyst walls or of fat necrosis), "milk of calcium" calcifications (sediment calcifications inside the cysts), suture calcifications (formation of calcium around the sutures), dystrophic calcifications (in irradiated breasts and those undergoing traumas) (Fig. 3.5).

2. Of intermediate concern: amorphous or indistinct calcifications (frequently small and with morphology that is difficult to define, commonly mistaken for benign calcifications; when grouped they should be correlated with biopsy findings); heterogeneous calcifications (they are larger and tend to coalesce, so they can be associated with malignancy or with an initial phase of dystrophic calcifications of fibrosis, fibroadenoma or trauma) (Fig. 3.6).
3. Higher probability of malignancy: fine pleomorphic calcifications (they show a wide variety of shapes and sizes, generally less than 0.5 mm) and ductal calcifications (fine and irregular calcifications on the duct tracks, which suggest that there is participation of the duct through the tumor) (Fig. 3.7).

We can describe the distribution of calcifications as follows:

1. Diffuse: distributed at random in the breasts, generally found in benign calcifications.
2. Regional: found in a broad area of the breast, but with no duct track. One or more quadrants may be involved, and the risk of malignancy is associated mainly with calcification morphology.
3. Clustered: they is used when at least five calcifications occupy a small volume of the breast, and there is high risk of malignancy.
4. Linear: this points to a ductal distribution, increasing the risk of malignancy.
5. Segmental: this point to damage to the ducts and their branches in an area of the breast, also increasing the risk of malignancy.

3.4.2.3 Architectural Distortion

Architectural distortion is defined when normal architecture of the breast is altered; however, there is no evident mass (Fig. 3.8). When there are no records of trauma or surgery, distortion leads to a condition highly suspicious of malignancy or a radial scar; therefore, histological evaluation is recommended [6].

3.4.2.4 Special Cases

Some alterations can be seen through mammography, and they are described as follows [6]:

1. Isolated duct dilation: If not associated with other relevant clinical suspicious findings, it is not considered important.
2. Intramammary lymph nodes: They are usually smaller than 10 mm, they have a fatty hilum, and have a reniform shape. They can appear in any breast region, although they are mainly found in lateral quadrants.
3. Global asymmetry: This generally represents an anatomic variation, which is identified during the comparison with the contralateral breast. It cannot be associated with the palpable mass, the architectural distortion area, masses, or microcalcifications.
4. Focal asymmetry: This is defined as a lesion that cannot fill the criteria of mass required, and is visualized in both

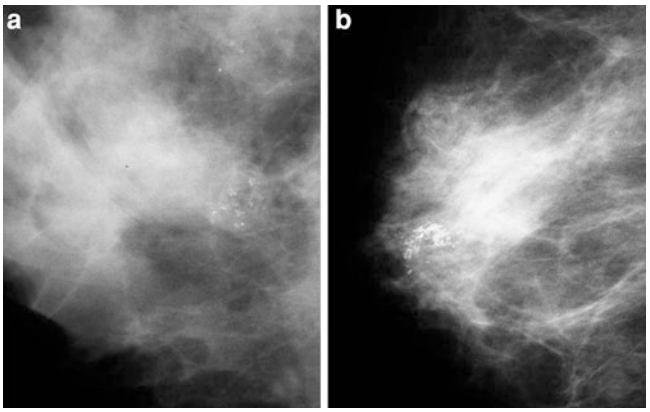

Fig. 3.6 Microcalcifications of intermediate concern: amorphous (**a**) and heterogeneous (**b**)

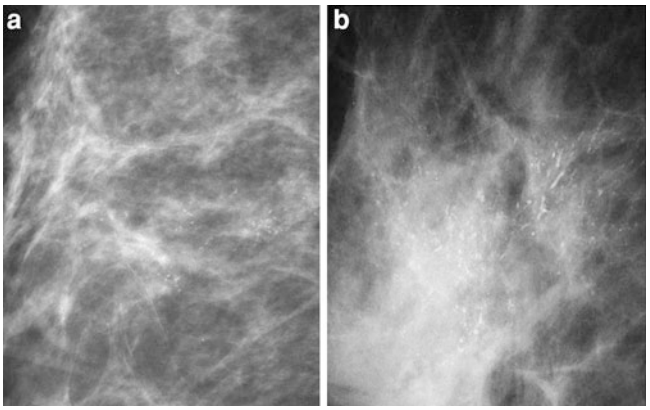

Fig. 3.7 Microcalcifications of higher probability of malignancy: fine pleomorphic (**a**) and ductal (**b**)

views as similar shapes. It may represent a normal parenchyma island; however, often it has nonspecific characteristics, so it demands additional investigation.

5. Related findings: Some findings may increase the suspicion of malignancy when identified together with the suspicion of a lesion, represented by skin retraction, nipple retraction, skin thickening, and axillary lymphadenomegaly among others.

3.5 Ultrasonography

Mammary ultrasonography is a diagnostic method that aids in the characterization of alterations detected either in clinical or mammographic examinations [27, 28]. Besides allowing differentiation of solid masses and cystic ones, it supplies additional data to characterize lesions as benign or malignant; it also aids in the analysis of dense breasts through mammograms and it guides percutaneous procedures.

3.5.1 Normal Ultrasonographic Findings

As in mammography, the ultrasonographic aspect of the breast also varies according to its composition. The mammary echotexture results from the combination of the fibroglandular tissue (echogenic), fat (hypoechoic), and connective tissue (ligaments of Cooper, echogenic). These echotexture patterns may affect the sensitivity for lesion detection, therefore reducing the sensitivity for solid mass detection in very liposubstituted breasts, or even simulate alterations in cases of heterogeneous breasts, which must be evaluated and differentiated in real time throughout the examination.

Three echotexture patterns are described according to BI-RADS® [6]:

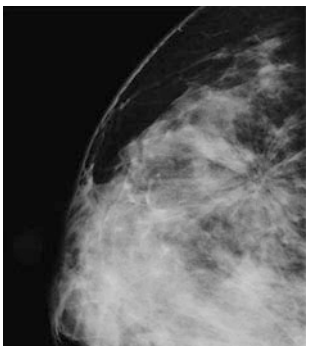

Fig. 3.8 Architectural distortion in mammography

1. Homogeneous—fat (Fig. 3.9a)
2. Homogeneous—fibroglandular (Fig. 3.9b)
3. Heterogeneous—fibroglandular elements, fat elements, connective tissue and ducts, interspersed; a pattern of younger breasts with little liposubstitution (Fig. 3.9c)

3.5.2 Abnormal Ultrasonographic Findings

The evaluation of masses detected both through mammography and through physical examinations is the most frequent indication for ultrasonography. Calcifications are poorly evaluated through this method, as their detection becomes more difficult, and their morphological evaluation is not possible.

3.5.2.1 Masses

Masses must be detected and analyzed on more than one view to differentiate them from normal anatomic structures. They are echographically described according to shape, orientation, margins, transition with mammary tissue, echogenicity pattern, posterior acoustic aspect, and relations with and effects on the adjacent tissue [6, 28].

The shape can be defined as round, oval, or irregular (Fig. 3.10). When it is oval, it is called macrolobulated if it

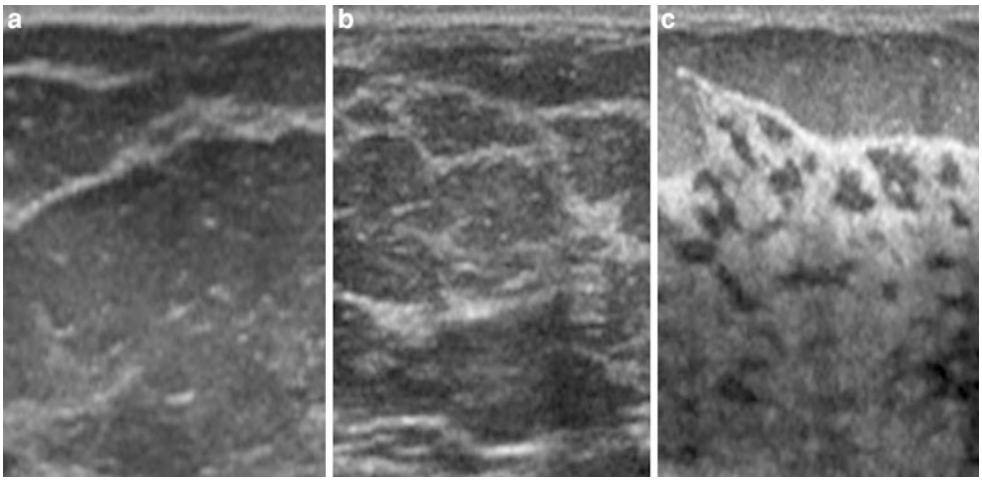

Fig. 3.9 Echotexture patterns in ultrasonography according to BI-RADS®: homogeneous—fat (**a**), homogeneous—fibroglandular (**b**), and heterogeneous (**c**)

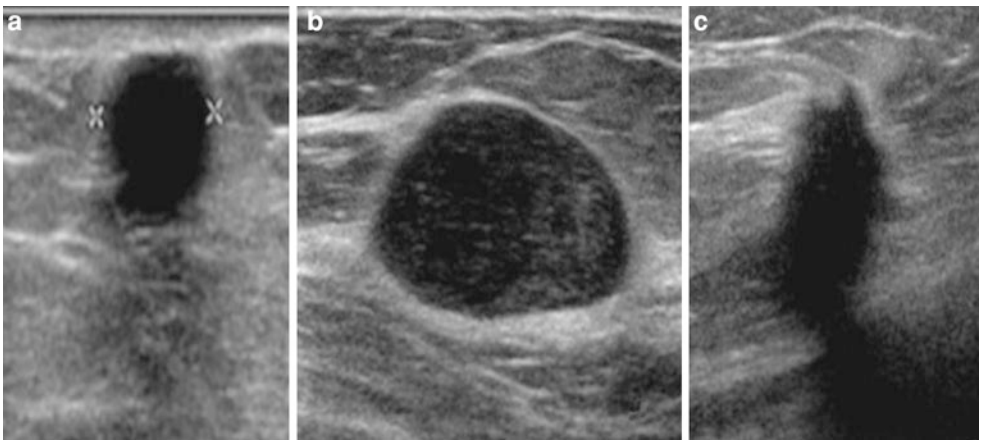

Fig. 3.10 Shape of masses screened through ultrasonography: round (**a**), oval (**b**), and irregular (**c**)

has up to three lobulations. Interpretation of the examination concerning benignity and malignancy of the mass is similar to that for mammography, and irregular masses are the most suspicious.

Orientation is a particular aspect of ultrasonography (Fig. 3.11). Masses that are parallel to the skin, that is, wider than higher, are generally benign. When the orientation is vertical, that is, higher than wider, this is more suggestive of malignancy, as it represents a growth through normal tissue planes.

Margins are described as circumscribed, indistinct, spiculated, angular (projections forming acute angles), and microlobulated (various small lobulations of 1–2 mm) (Fig. 3.12). Except for the circumscribed margin, the various aspects are suggestive of malignancy. The spiculated margins and/or microlobulated margins are the ones that have the highest predictive value for malignancy [28, 29].

The transitional zone with the adjacent mammary parenchyma is described as defined or undefined. The well-defined transition or that with an echogenic halo indicates benignity, as it shows a lesion of slow growth compressing

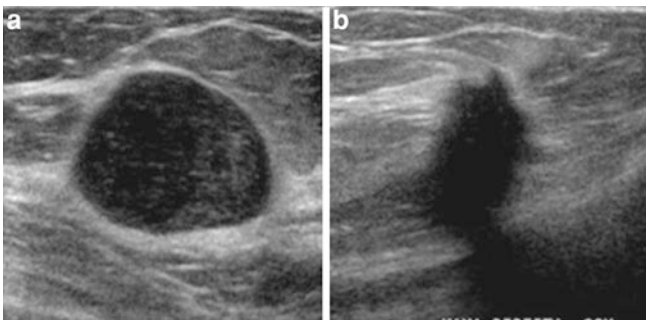

Fig. 3.11 Orientation of masses in ultrasonography: parallel to the skin (**a**) and perpendicular to the skin (**b**)

the parenchyma around and not infiltrated. The transition without defined demarcation is associated with some carcinomas and abscesses. The finding of an echogenic pseudo-capsule around the lesion must be interpreted together with the lobe shape (oval or slightly lobulated) to reinforce the sureness of benignity [28].

The echogenicity pattern aids primarily with the differentiation between cystic mass (anechoic) and solid mass

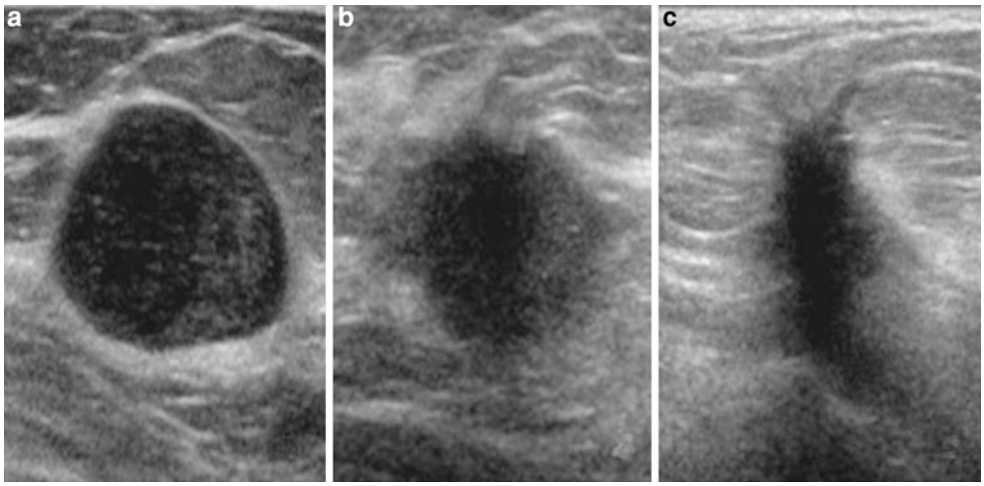

Fig. 3.12 Margins of masses in ultrasonography: circumscribed (**a**) indistinct (**b**), and spiculated (**c**)

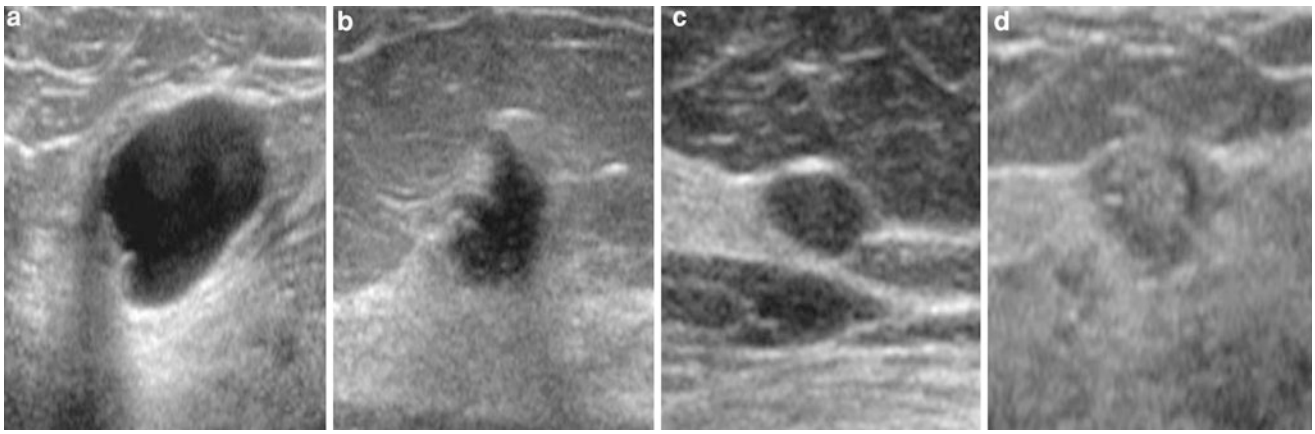

Fig. 3.13 Echogenicity patterns of masses in ultrasonography: anechoic (**a**), hypoechoic (**b**), isoechoic (**c**), and hyperechoic (**d**)

(hypoechoic, isoechoic, and hyperechoic), defined in relation to fat (Fig. 3.13). Homogeneously hyperechoic masses are considered of higher predictive value for benignity. Solid hypoechoic and isoechoic masses need other characteristics for evaluation concerning malignancy. Complex masses have mixed echogenicity, with both anechoic and echogenic components [28].

The posterior acoustic phenomena result from attenuation of the mass (Fig. 3.14), except for posterior peripheral shadow, which occurs as a result of an alteration of the speed of the acoustic beam at the curved edges in either oval or round masses. These phenomena include acoustic reinforcement, that is, more echogenic posterior area, which is found mainly in cysts. Also, an acoustic shadow has been observed, that is, a darker central posterior area, which is associated with calcifications, fibrosis, or neoplasia with high desmoplastic reaction. Some masses do not cause an alteration of the acoustic beam through the mass. These aspects are not reliable for the definition of benignity or malignancy and they must be considered in co-relation with other aspects [28, 29].

Masses may have some effects on adjacent mammary parenchyma. Benign lesions tend to produce fewer alterations, such as compression. More aggressive and infiltrating lesions may obliterate the adjacent tissue planes, pull or thicken Cooper's ligaments, and cause edema or architectural distortion of the parenchyma, as well as rupture of the regular anatomic planes. The ducts may be pulled and dilated, and the skin may have focal or diffuse thickening (normal is 2 mm or less), retraction, and irregularity.

3.5.2.2 Calcifications

Ultrasonography has very low sensitivity for the detection of calcifications, especially microcalcifications. It also does not allow their morphological analysis, which is important for characterization of malignancy. Among other factors, the low sensitivity results from heterogeneous breast echotexture and from the small size of the microcalcifications (less

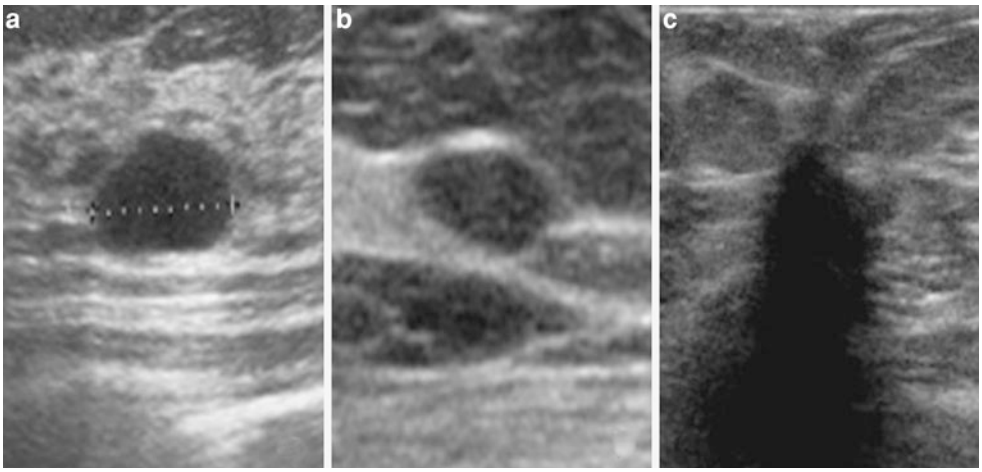

Fig. 3.14 Acoustic phenomena of masses in ultrasonography: acoustic reinforcement (**a**), no alteration of the acoustic beam (**b**), and acoustic shadow (**c**)

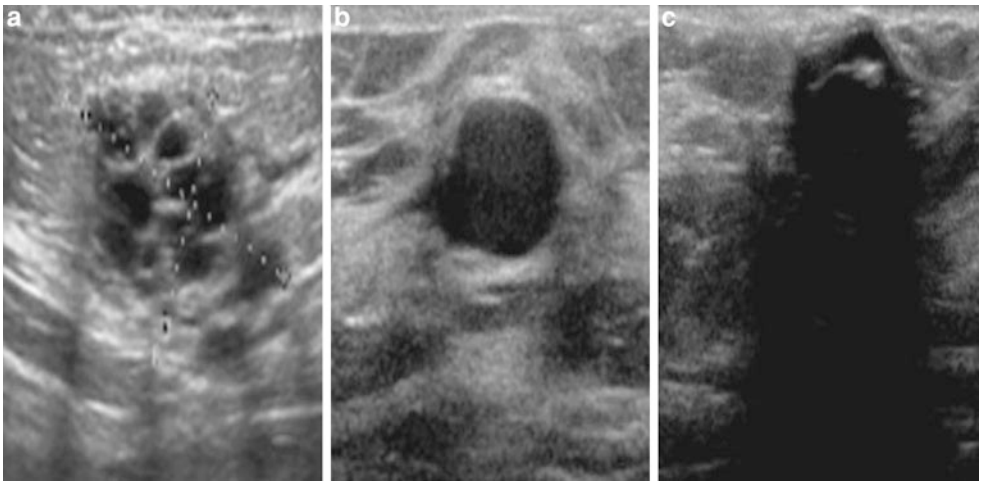

Fig. 3.15 Special cases observed through ultrasonography: clustered microcysts (**a**), complicated cysts (**b**), and foreign body related to draining (**c**)

than 0.5 mm), with no typical posterior acoustic shadow [6, 28].

3.5.2.3 Special Cases

Some alterations exhibit characteristic findings [6]:

1. Clustered microcysts: These are defined as small anechoic clustered images (less than 2-3 mm) with thin septations inside (less than 0.5 mm), with no associated solid component. When not palpable, they are considered as probably benign lesions (category 3). This finding occurs mainly with fibrocystic alterations and in the apocrine metaplasia (Fig. 3.15a).
2. Complicated cysts: These are cysts that have thin echoes inside the fluid level or even mobile debris, with no solid component attached to the wall. These are also considered as probably benign lesions (category 3) (Fig. 3.15b).
3. Skin masses: These are the so-called epidermal and sebaceous inclusion cysts, keloids, neurofibromas, and accessory nipples. They are classified as benign lesions (category 2).
4. Foreign bodies: These may correspond to surgery marking clips, threads, catheters, silicone, metal, or glass from trauma. Clinical history is very important for differentiation. Free silicone in the parenchyma has a typical aspect of a "snowstorm," that is, an echogenic area that causes a marked acoustic shadow, obscuring the deep structures (Fig. 3.15c).
5. Intramammary lymph nodes: These are described as oval masses, circumscribed, with an echogenic center and a hypoechoic periphery. They are located mainly in the upper quadrants and sides of the breast, and their size ranges from 0.3 to 1 cm.
6. Axillary lymph nodes: The aspects are similar to those of the intramammary lymph nodes, and they can measure more than 2 cm. When they are too big (above 4 cm) or with a hypoechoic center, they must be evaluated so the possibility of a metastatic disease is not ignored.

3.5.2.4 Vascularity

This is an additional piece of data for the evaluation of masses or suspicion areas, although with limited value. The complete absence of vascularity is usually observed in cysts. A rather increased vascularity may be suggestive of neovascularity and it is usually observed not only inside the mass but also in the peripheral area of a lesion, or diffusely in the surrounding tissue [6].

3.6 Magnetic Resonance Imaging

MRI is the most accurate method for the detection of breast cancer and it is indicated in selected cases to increase the sensitivity that results from traditional methods (mammography and ultrasonography). The method has the advantage of showing a three-dimensional view of the breast, with high sensitivity and no use of ionizing radiation. Among the disadvantages are the high cost of the procedure and its low specificity [30].

MRI analysis must be made through images obtained from the dynamic technique during the endovenous injection of paramagnetic contrast material (gadolinium), associated with enhancement kinetics. Then, images are obtained with spatial high resolution for a detailed morphological evaluation of the lesion with the aim of detecting characteristics of suggestive malignancy. Interpretation of MRI findings must consider the clinical history data (including physical examinations—palpation of the masses, skin appearance, scars; surgical antecedents of those of biopsies; menstrual cycles; HRT; radiotherapy) and comparison with the findings of previous examinations (mammography and ultrasonography—identification of areas with suggestive lesions, mainly microcalcifications, evaluation of temporal stability, or the appearance of new lesions, among others).

3.6.1 Normal Magnetic Resonance Imaging Findings

Breast anatomy is thoroughly demonstrated through MRI, by which not only the parenchyma can be evaluated, but also vessels, lymph nodes (intramammary and those from axillary prolongations), the retromammary area, and the thoracic wall; these latter are difficult to access through other imaging methods.

The parenchyma is characterized and described according to BI-RADS® criteria [6]:

1. Severe adipose substitution
2. Disperse fibroglandular density
3. Heterogeneously dense
4. Extremely dense

Contrary to what occurs in mammography, dense breasts are not difficult to diagnose through MRI, which minimizes the overlapping effect of the parenchyma, and also through contrast material, which makes lesions appear more evident. On the other hand, hormone variations have an influence on the interpretation of images, mainly considering enhancement and parenchyma edema. In premenopause breasts, parenchyma enhancement varies according to the menstrual cycle, so incidental points of enhancement (uniform, diffuse, or scattered in some areas) are common and more evident in the first and fourth weeks. Some of these points may appear as quick and intense enhancement as in malignant lesions, being differentiated only when they disappear in subsequent examinations in a different phase of the menstrual cycle. The examination must be performed, preferably, in the second week of the cycle (between 7 and 14 days), when the number of points (foci) and speed of enhancement are the lowest when compared with the other phases [31, 32].

In the postmenopause period, the use of combined (estrogen/progesterone) HRT can cause reversion of the usual atrophy in the period and result in an aspect similar to that in the premenopause period, and even appearing to be a parenchyma edema and a regular edema. When there is any doubt in interpretation, it is recommended that a reevaluation be made after HRT has been suspended for 6–8 weeks. In cases of therapy with selective modulators of estrogen receptor (tamoxifen), there is no hormone stimulation, which reduces the vascularity and density of parenchyma. Enhancement foci in breasts of patients using tamoxifen cannot be considered usual, because their hormone activity is blocked. Pregnant patients and lactating ones may also experience an increase of breast density and enhancement, owing to an increase in vascularity.

Breast vascularity is important and it defines a geographic pattern of normal parenchyma enhancement. There is a preferable enhancement in the external upper quadrant and in the inferior portion as well, as the center of the breast is the last part to be enhanced owing to the existence of a different vascular supply. This geographic pattern of the normal parenchyma enhancement occurs symmetrically in both breasts.

The larger ducts that converge below the nipple and drain out of each segment are about 2 mm in diameter. Dilated ducts with proteinaceous contents or with hemorrhagic debris can be seen in weighted sequences in precontrast T1 analysis as increased signal, and the postcontrast analysis can be done through images with subtraction to not obscure the area with enhancement.

Lymph nodes are easily detected and characterized through their reniform shape with a fatty hilum (high signal in weighted sequences in precontrast T1 images, with no fat saturation), besides having a strong enhancement after the

use of intravenous contrast material. The T2-weighted images are also useful for characterizing lymph nodes, as they produce increased signal intensity when compared with the normal parenchyma.

Pectoralis muscles and the thoracic walls are considered anatomically distinctive and the evaluation of isolated neoplasic involvement of one of these structures or both of them influences the staging and surgical treatment. Deep tumors may produce retraction of the pectoralis muscles or get too close and obliterated fat planes, but with neoplasic involvement there is an irregular enhancement through contrast material in damaged areas of the muscle. The thoracic wall is made up of the serratus anterior muscle, the intercostal muscles, and the ribs. Neoplasic involvement in these structures will also be highlighted as abnormal on MRI.

3.6.2 Abnormal Magnetic Resonance Imaging Findings

MRI findings are evaluated not only through morphological characterization of lesions, but also through the type of enhancement by means of contrast and the dynamic characteristics, which may occur not only in three-dimensional lesions, such as masses, but also in areas of the parenchyma. Microcalcifications are not demonstrated through MRI, and they must be spotted in conventional mammograms for the correlation with magnetic resonance images and detection of suggestive enhancement in the area.

The main visualized alterations on MRI are described according to BI-RADS® [6] as in the following sections.

3.6.2.1 Focus

This is a tiny nonspecific enhancement area (less than 5 mm) which is too small to be characterized. It does not necessarily represent a lesion that occupies some space, such as a mass. The foci may occur as multiple areas or as enhancement dots, separated by a normal parenchyma or by fat, spread in the breast (Fig. 3.16). The foci were known as unidentified breast objects, bright unidentified breast objects, or incidental enhanced lesions, and they do not have any importance for clinical practice when identified in isolation.

3.6.2.2 Masses

These are described as three-dimensional lesions that occupy some space. They can be morphologically evaluated (shape and margins) and can also be evaluated through their enhancement patterns (Fig. 3.17).

They may be round, oval, lobulated, or irregular. As in the other methods, a round shape is the shape most related to benignity, whereas an irregular shape is related to malignancy.

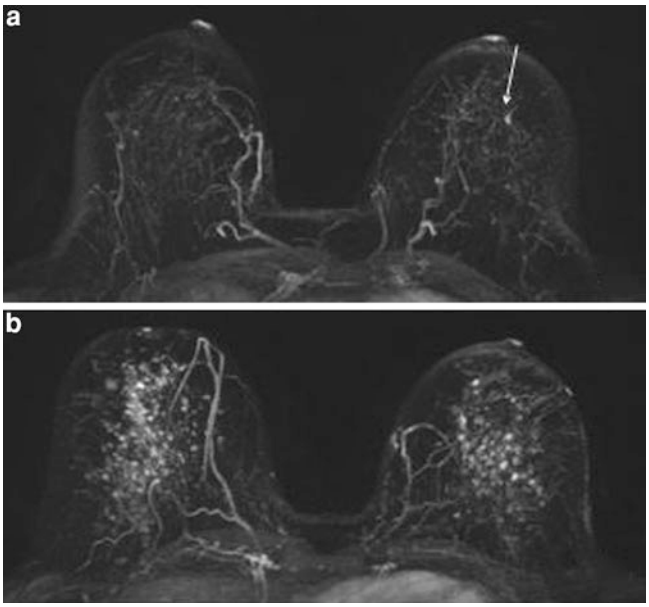

Fig. 3.16 Foci: **a** maximum intensity projection (MIP) reconstruction showing an isolated focus (*arrow*) in a patient with a benign functional alteration; **b** MIP reconstruction showing diffuse foci, also in a patient with a benign functional alteration

The analysis of the margins depends on the spatial resolution of the images. The margin is described as regular (circumscribed), irregular ("serrated," or even indistinct), or spiculated (linear projections irradiate from the mass). Irregular margins and spiculated ones are the most suggestive of malignancy.

As data additional to the morphological analysis, the characteristics of the internal enhancement contribute to the differentiation of benign masses from malignant ones. The enhancement pattern can be described as homogeneous (uniform and confluent—more suggestive of benignity) or heterogeneous (there are variable signal intensities inside the mass). The enhancement can also be described as peripheral, with dark internal septations and with internal and central septation enhancement. The heterogeneous aspect is the most suggestive of malignancy, mainly when it is peripheral, although septation enhancement and central enhancement are also suggestive. Inflammatory cysts may have their own enhancement, but they are hyperintense in the T2-weighted images, owing to their fluid content. Fat necrosis may also have a peripheral enhancement with a dark center, but it can be differentiated through the clinical record, through mammographic characteristics, and through the signal in the sequences with fat saturation through MRI. These two lesions are described as false-positive potentials in the analysis of lesions with peripheral enhancement, which is typical of malignancy. The enhancement pattern

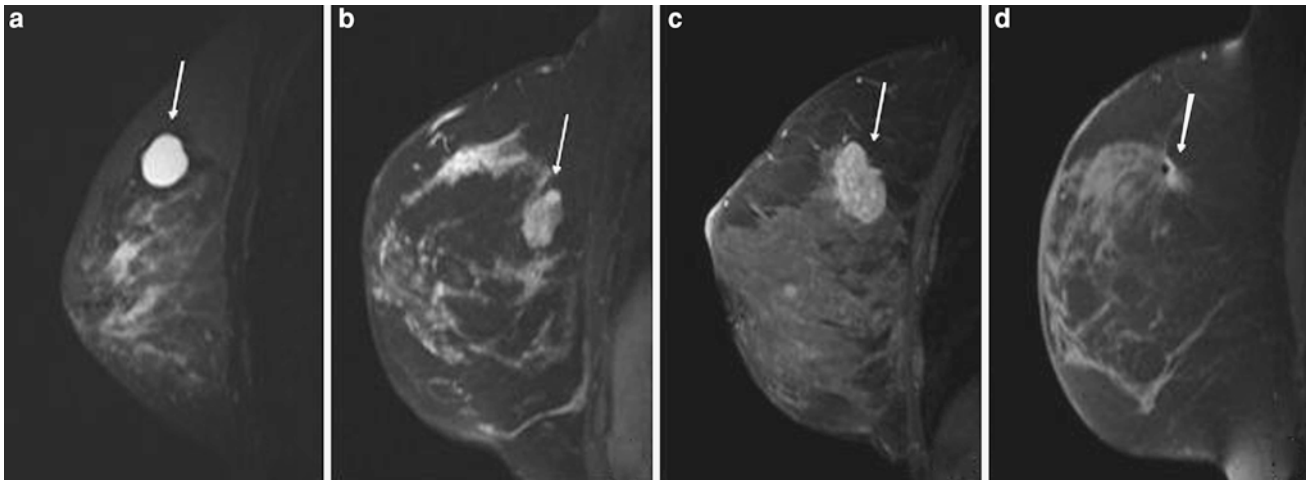

Fig. 3.17 Masses: **a** sagittal short τ inversion recovery image showing a round mass with regular margins (*arrow*) (simple cyst); **b** sagittal fast spin echo (FSE) T1 postcontrast image showing an oval mass with regular margins and a hypoenhanced septum (*arrow*) (fibroadenoma); **c** sagittal FSE T1 postcontrast image showing an irregular mass with indistinct margins and heterogeneous enhancement (*arrow*) (invasive ductal carcinoma); **d** sagittal FSE T1 postcontrast image showing an irregular mass with spiculated margins and peripheral enhancement (*arrow*) (steatonecrosis)

with dark internal septations is highly suggestive of fibroadenoma and it is an indicator of benignity [33]. Masses without enhancement are also suggestive of fibroadenoma with a high fatty hilum content.

3.6.2.3 Non-mass-like Enhancement

Non-mass-like enhancement describes an area of enhancement that can be classified neither as mass nor as a focus. This includes patterns that can extend over a region of various sizes according to a specific distribution and, except for the internal homogeneous pattern, there will always be areas of normal mammary fat tissue interspersed in the enhancement areas.

The distribution is described as focal (it generally occupies less than 25 % of the volume of a quadrant), linear (it can seem like a plane in other views and it does not follow the duct track), ductal (it follows the duct track toward the nipple, with ramifications), segmental (triangular region or in a cone, with an apex to the nipple, which resembles a duct and its branches), regional (it encompasses a huge tissue volume, with a geographic aspect and with no relation to the distribution of one duct system), and multiple regional and diffuse (equal all over the extension of the breast) (Fig. 3.18). Regional distribution patterns, in multiple regions and in a diffuse way, are the most suggestive of benign disease, such as proliferative alterations, whereas the ductal and the segmental patterns are highly suggestive of malignancy (ductal carcinoma).

Internal enhancement patterns can be described, as a whole, as homogeneous or heterogeneous, symmetric (in both breasts like an image in the mirror) or asymmetric. An additional description can be added when the aspect of the heterogeneous enhancement is considered. A dotted pattern describes similar tiny dots (1–2 mm) spread and not following the ductal distribution, more in accordance with the normal variety of mammary parenchyma enhancement or with fibrocystic alterations. An agglomerated pattern represents a cluster of enhancement foci in one area, being either confluent with a "cobblestone-like" appearance or in "string of pearls" when it is linear (suggestive of ductal carcinoma in situ). The dendritic or reticular pattern occurs mainly in partially involuted breasts, where there are glandular parenchyma extensions, interspersed with stretches of fat tissue.

3.6.2.4 Associated Findings

The associated findings may increase suspicion of breast cancer and they are considered important because some of them influence the surgical treatment and the staging. The associated findings include [6]:

1. Skin retraction or nipple retraction.
2. Skin thickening: focal or diffuse (normal thickness up to 2 mm).
3. Skin invasion: There is an abnormal enhancement of the skin, which is also thick in most cases.
4. Edema: There is a trabecular thickening with or without associated skin thickening.
5. Lymphadenomegaly: There are enlarged and round lymph nodes with loss of fatty hilum signal; they are highly suggestive.
6. Pectoralis muscle or thoracic wall invasion: There is abnormal enhancement stretching to the pectoralis muscle with or without retraction, as well as to ribs and intercostal spaces.

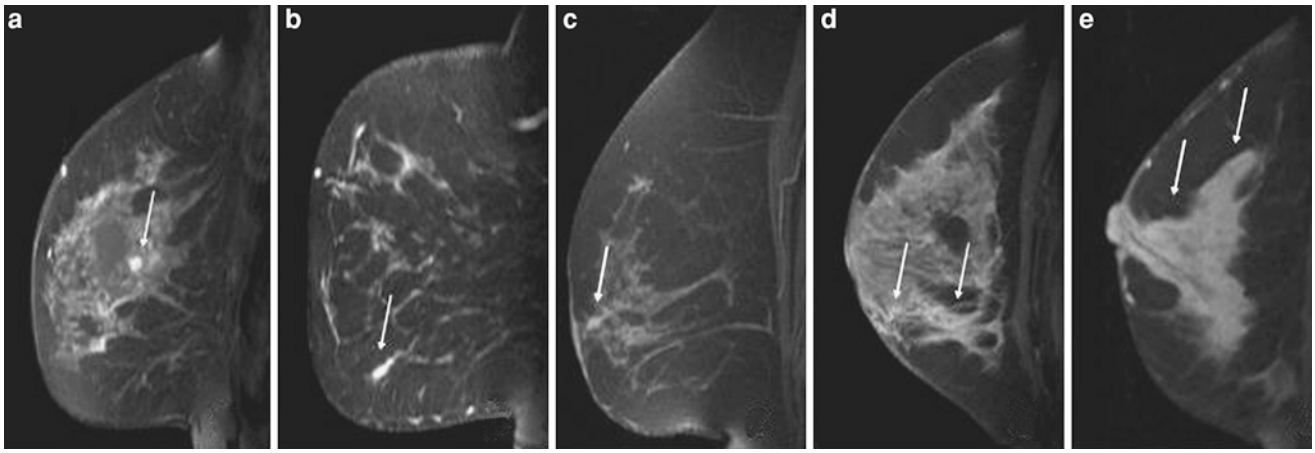

Fig. 3.18 Non-mass-like enhancement: **a** sagittal FSE T1 postcontrast image showing focal enhancement (*arrow*) (benign functional alteration); **b** sagittal FSE T1 postcontrast image showing linear enhancement (*arrow*) (scar); **c** sagittal FSE T1 postcontrast image showing ductal enhancement (*arrow*) (intraductal carcinoma); **d** sagittal FSE T1 postcontrast image showing segmental enhancement (*arrows*) (invasive ductal carcinoma); **e** sagittal FSE T1 postcontrast image showing regional enhancement (*arrows*) (benign functional alteration)

7. Hematoma: There is an increase of the signal in the weighted sequence in precontrast T1 images.
8. Abnormal signal void: This occurs because of a magnetic object, and is caused by metal (as occurs with surgical clips).
9. Cyst: This is described as a well-circumscribed structure filled with fluid; it can be round or oval and with an imperceptible wall. In the weighted margins in T1 images, the cysts appear with a hypointense signal with respect to the adjacent tissue, except for cysts with protein content due to blood products. In precontrast sequences, only the inflammatory cysts will exhibit peripheral enhancement.

3.6.3 Kinetic Curve

The kinetic curve is obtained from a dynamic sequence performed with intravenous injection of contrast material (gadolinium) and it describes the enhancement characteristics of a specific region determined by the region of interest. This region must be the one with the largest and fastest enhancement or the most suggestive area.

The physiopathological basis has not been properly elucidated yet, but it is known that the intensity of enhancement depends not only on the increase of vascularity and the permeability of the vessels, as commonly found in malignant lesions, but also on the interaction of the contrast material with the lesion tissues.

Considering the enhancement pattern in dynamic series, we can distinguish two phases according to BI-RADS®: the initial phase (the period between the injection of the constant material and the second minute after injection) and the delayed phase (the period that starts 2 min after injection of the contrast material). Fischer et al. [34] consider the initial phase to be the phase up to the third minute after the intravenous injection of contrast material, and the delayed phase to be the phase between 3 and 8 min.

In the initial phase, signal intensity after injection of contrast material is quantitatively evaluated and the speed of enhancement is classified as slow, medium, or rapid. Mainly in malignant lesions, the maximum intensity of enhancement tends to be reached in the initial phase. Kuhl et al. [35] evaluated 266 lesions with mean enhancement for malignant lesions of 104 % ± 41 and for benign lesions of 72 % ± 35, with a sensitivity of 91 % and a low specificity of 37 %. Low specificity was attributed to the fact that benign lesions can also have fast and intense enhancement.

The delayed phase is evaluated in a qualitative way through the morphology curve. Visual classification is made as follows:

1. Type 1 curve (persistent)—signal intensity increases throughout the dynamic series and the highest point is obtained in the last postcontrast series (Fig. 3.19a). According to Fischer et al. [34], signal intensity in the delayed phase increases to 10 % above the peak value of the initial rise by 3 min.
2. Type 2 curve (plateau)—signal intensity reaches a plateau after the initial phase and it does not vary significantly in the subsequent phases (Fig. 3.19b). The maximum signal intensity is reached after 2 or 3 min. A variation of signal intensity of ± 10 % of the peak value of the initial rise at 3 min is acceptable [34].
3. Type 3 curve (washout)—signal intensity decreases immediately after it reaches its highest point, usually on the first or second postcontrast sequence (Fig. 3.19c).

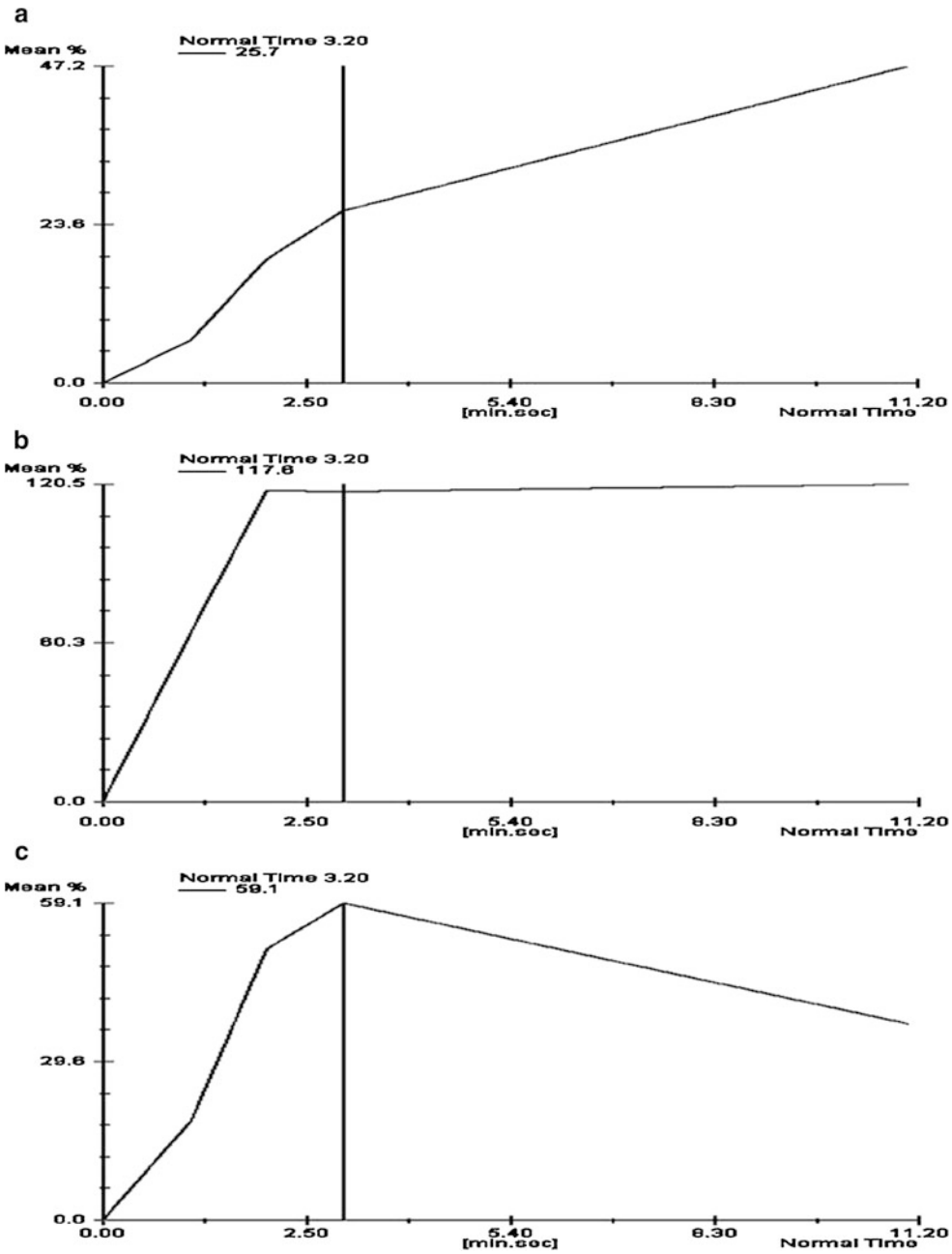

Fig. 3.19 Types of kinetic curve for dynamic magnetic resonance imaging (MRI) evaluation: pattern type I (**a**), pattern type II (**b**), and pattern type III (**c**)

According to Fischer et al. [34], the signal intensity in the late phase reduces by over 10 % of the initial peak value by 3 min.

As a general rule, the vast majority of benign lesions follow a persistent curve pattern and the malignant ones follow a washout pattern or a plateau one. The probability that each type of curve is associated with breast cancer was studied by Kuhl et al. [35], and the following results were found: type 3 curve—87 %, type 2 curve—64 %, and type 1 curve—6 %. In the same study it was demonstrated that the analysis of the shape of the aspect is more specific (83 %) than the quantitative analysis of the signal intensity (37 %), although both methods have the same sensitivity (91 %).

3.6.4 Current Clinical Applications of Magnetic Resonance Imaging

Clinical indications are still discussed in some aspects, with the best cost–benefit relationship for patients with high risk of developing breast cancer or for those proven to have cancer. In the following sections, we highlight some examples.

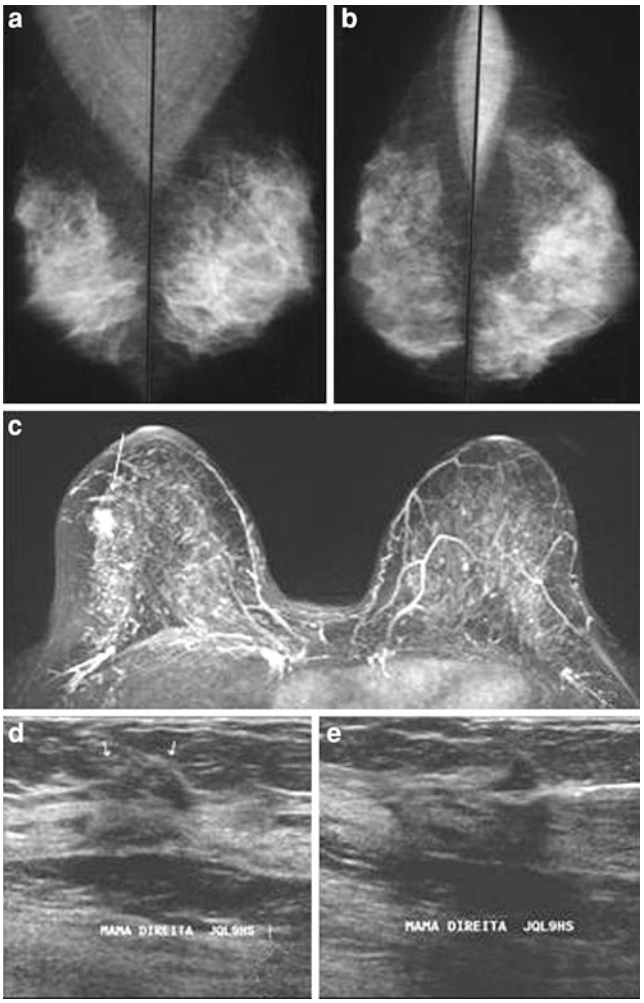

Fig. 3.20 A 45-year-old patient, asymptomatic, with family history of two sisters having breast cancer. Mammography (**a**, **b**) and ultrasonography did not show abnormalities. The patient underwent MRI (**c**) for tracking, and the image shows a suspicious enhancement area in the right breast (*arrow*). On ultrasonography (**d**) performed after the MRI, an irregular hypoechoic area was observed (*arrows*). Patient undergoing a percutaneous biopsy (**e**), diagnosed as having invasive ductal carcinoma

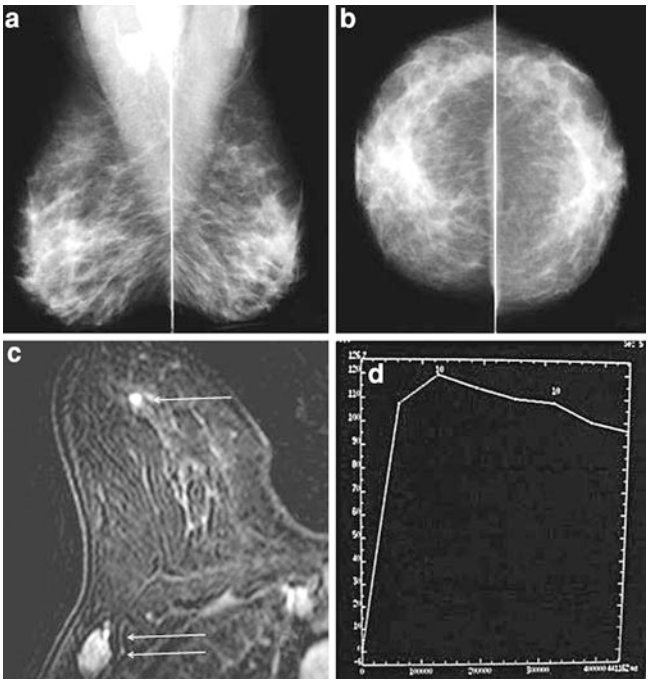

Fig. 3.21 A 55-year-old patient with a palpable lymph node in the right axillary region. Mammography (**a**, **b**) showed a dense lymph node in the axillary region. Ultrasonography did not reveal suspicious findings in the breast. MRI (**c**, **d**) confirmed the lymph node enlarging in the axillary region (*two arrows*) and showed a small enhanced mass in the superolateral quadrant of the right breast (*arrow*), with a type 3 kinetic curve type, which was confirmed as invasive ductal carcinoma when surgery was performed

3.6.4.1 Patients with High Risk of Breast Cancer

Women considered high risk for developing breast cancer are those with documented mutations in genes *BRCA1* and *BRCA2*, a marked family history (estimated risk over 20 % according to the risk calculation models), personal history of breast cancer, previous biopsy showing lobular carcinoma in situ or atypical ductal hyperplasia, and previous thoracic radiation between 10 and 30 years of age (Fig. 3.20) [36].

The importance of mammographic tracking in this group is low, as most of the subjects will develop breast cancer during their premenopause period, a stage when the mammary parenchyma is denser. Another limiting factor is the higher radiosensitivity in this group, as reported in some studies. Kriege et al. [37] compared the accuracy of mammography, ultrasonography, and MRI for diagnosis in 1,904 patients with high risk on both genetic and family history grounds, and found sensitivities of 33 %, 60 %, and 100 %, respectively. Other multicenter studies found similar results [38–43]. The most recent study was published by Kuhl et al. [43], demonstrating sensitivity for cancer detection of 33 % for mammography, 37 % for ultrasonography, and 92 % for MRI in high-risk patients, with 98 % specificity for all methods. No case of hidden carcinoma was found, and all tumors were smaller than 1 cm (46 % invasive carcinomas and 53 % carcinomas in situ).

On the basis of these data, in 2007 the American Cancer Society published recommendations for the performance of mammography and MRI annually for all patients with confirmed mutation, first-grade patients with confirmed mutation, patients with risk of developing breast cancer above 20 %, and patients undergoing thoracic radiation for over 10 years [44]. These recommendations have been recently confirmed in a publication by the American College of Radiology and the Society of Breast Imaging [45].

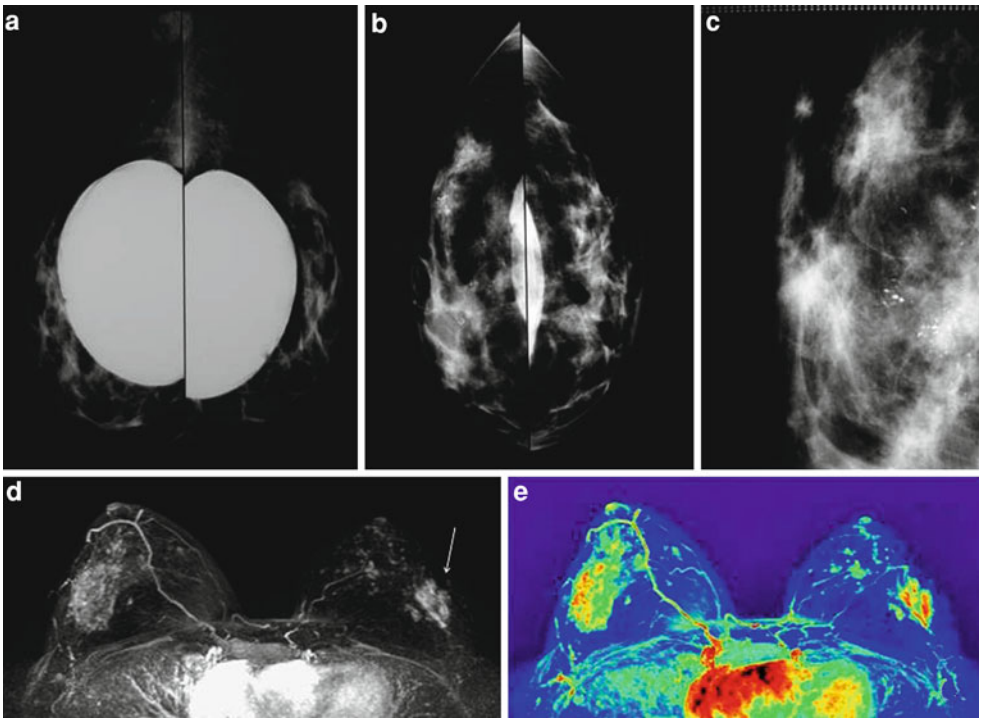

Fig. 3.22 A 51-year-old patient with mammary prosthesis undergoing mammography (**a**–**c**), which showed pleomorphic microcalcifications in the superolateral quadrant of the right breast, with the diagnosis of invasive intraductal carcinoma confirmed by biopsy findings. MRI (**d**, **e**) for staging showed that the lesion extended to the papilla, besides having another invasive focus in the contralateral breast (*arrow*)

3.6.4.2 Detection of Hidden Primary Tumor of the Breast with a Positive Axillary Lymph Node

A hidden tumor is defined in patients with axillary lymph node metastasis of breast cancer with no primary focus detected through conventional methods (mammography and ultrasonography), corresponding to less than 1 % of all breast cancer cases [46, 47]. Contrast MRI is highly sensitive for the detection of a hidden tumor, changing the course of action in relation to the treatment of some patients, even to the point of considering a conservative treatment for some selected cases (Fig. 3.21).

Studies so far have only been of small populations, although with interesting results on the capacity to detect primary lesions through MRI. The proportion detected was 75 % and 86 %, respectively, in the studies by Morris et al. [48] and Orel et al. [49], all of the tumors with proven histological basis. The lesions appear predominantly as a mass-like enhancement with morphology suggestive of malignancy and sizes ranging between 5 mm and 30 mm. In spite of the highly predictive negative rate, in the case of a negative MRI findings, the possibility of a primary breast lesion cannot be completely excluded.

3.6.4.3 Preoperative Staging of Breast Cancer

The surgical planning depends on a careful preoperative evaluation of the extension of the disease (Fig. 3.22). MRI is currently the most sensitive method to detect additional foci of multifocal disease (detecting a range of 1−20 %), multicentric disease (2−24 %), and contralateral disease (3−24 %) not found by traditional methods (mammography and ultrasonography), besides allowing an evaluation of the extension for the pectoralis muscle, the thoracic wall, and the papillary–areola complex. The main point of discussion is whether to find out these foci of neoplasia represent an increase in the extended life of the patients undergoing conservative surgery [50–52].

Fischer et al. [34] evaluated 463 patients with confirmed diagnosis of breast cancer and found multifocal lesions not detected by other methods in 8.9 % of cases, multicentric ones in 7.1 % of cases, and contralateral ones in 4.5 % of cases, which results in a change of attitude in therapy using MRI in 19.6 % of cases. Later, Fischer et al. [50] published another study evaluating the influence of preoperative MRI on the local recurrence rate of breast cancer and found a reduction from 6.5 % to 1.2 % among the group undergoing MRI. They associated this fact with better diagnosis of the tumor extension and better staging.

On the other hand, a study by Turnbull et al. [53] did not show any difference in the percentage of patients requiring reoperation between the group undergoing MRI (19 %) and the group that did not undergo MRI (19 %). They also demonstrated that MRI contributed to a delay in the surgical procedure and an increase in the number of mastectomies. Therefore, multicentric studies are still not considered necessary to define specific groups that could benefit from routine preoperative staging through MRI [54]. An attempt to develop a systematization was recently published by an EUSOMA working group, which recommended preoperative MRI for some specific groups, such as patients with

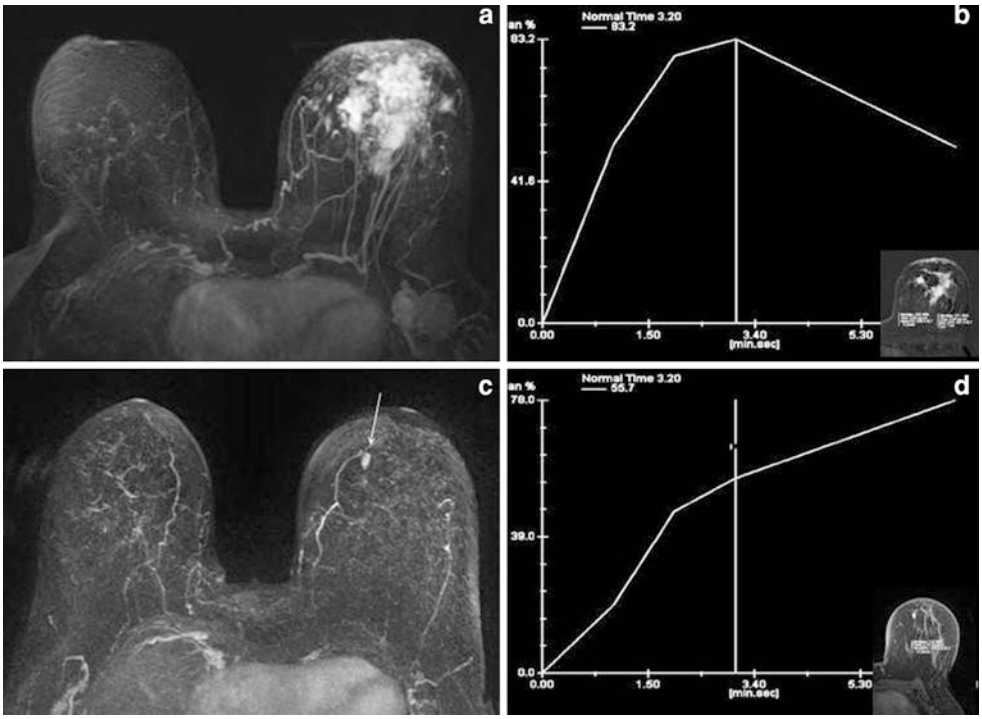

Fig. 3.23 A 36-year-old patient with edema and redness of the left breast. MRI showed an extensive lesion in the left breast (**a**), with a type 3 enhancement curve (**b**), besides skin thickening and axillary lymphadenomegaly. The patient underwent neoadjuvant chemotherapy, and examination after the third cycle (**c**) revealed tumor regression with a small residual lesion (*arrow*) and a type 1 enhancement curve (**d**)

multiple undetermined or suggestive lesions with clinical findings that diverge from those findings from screening, with significant familial or genetic risk, or with diagnosis of Paget disease or lobular histological subtype, besides those patients with indication for partial radiotherapy [55].

3.6.4.4 Evaluation of Response to Neoadjuvant Chemotherapy

Neoadjuvant chemotherapy is performed on patients with an advanced stage of the disease, aiming to reduce tumor staging before treatment through surgery. Adequate monitoring of the effects of the preoperative therapy is relevant to evaluate the efficacy of medication after the first cycles, which implies the continuation or change of chemotherapy scheme, besides aiding the surgical planning.

Although the response to neoadjuvant chemotherapy is traditionally assessed through clinical examination, mammography, and ultrasonography, the use of MRI for this monitoring has been shown to be more effective than conventional methods (Fig. 3.23). MRI helps differentiate fibrosis induced by chemotherapy of the tumor itself, besides being useful for the evaluation of multicentric, multifocal, and contralateral disease [56].

Even with so many advantages, MRI also has some limitations for this group. Chemotherapy drugs reduce vascularization and capillary permeability, besides producing fibrosis, necrosis, and tumor inflammation, which changes the enhancement parameters for this group. This is related to less accuracy in the evaluation of tumor volume, which may be underestimated or overestimated [56, 57].

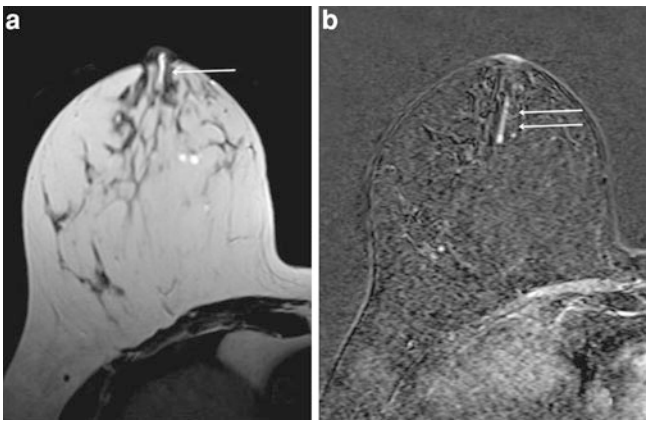

Fig. 3.24 A 43-year-old patient with family history of papillary brain stroke on the right. Mammography and ultrasonography did not show any abnormality. MRI showed a small dilated duct (**a**, *arrow*) with a linear enhancement area inside the duct (**b**, *double arrow*). Surgery confirmed the diagnosis of intraductal carcinoma

Martincich et al. [58] showed that the integration between morphological and functional parameters can improve the precocious response to neoadjuvant treatment (after the second cycle), with a good histopathological correlation. In this study an accuracy of 93 % was obtained to predict the full pathological response, with reduction of the tumor volume and of the enhancement through contrast material. Pickles et al. [56] evaluated 68 patients before and during the precocious phases as well as after chemotherapy, and showed that quantifying the dynamic parameters of enhancement and the change of tumor volume

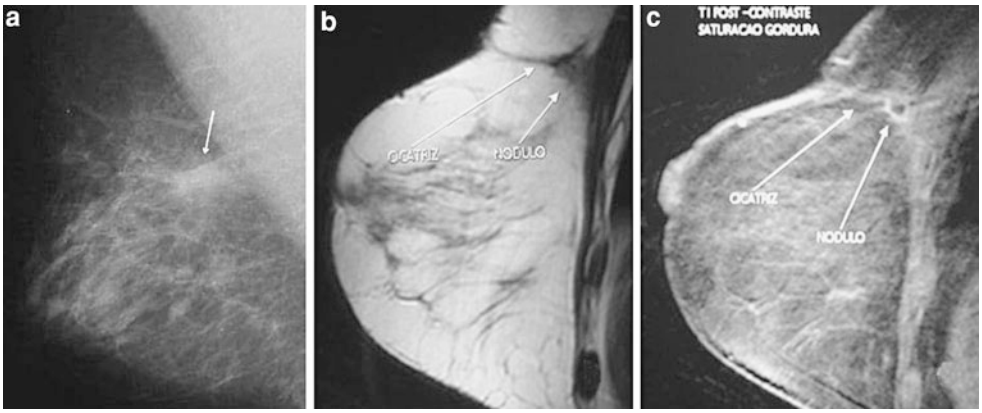

Fig. 3.25 A 63-year-old patient with a history of 6-year quadrantectomy. The control mammogram (**a**) shows focal asymmetry of the scar topography. MRI shows asymmetry (**b**), but with a fat area inside (**c**) confirming the diagnosis of postsurgical steatonecrosis

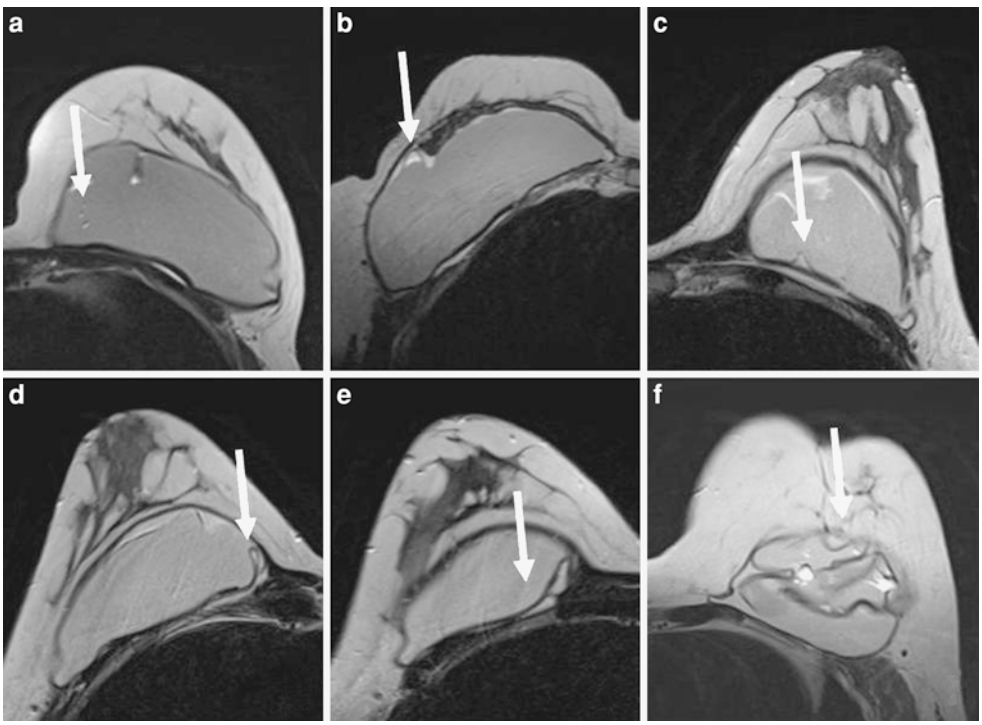

Fig. 3.26 Signs of intracapsular rupture on MRI: **a** thin drops of fluid inside the prosthesis; **b** focal area of liquid subjacent to the capsule; **c** small leakage of silicone external to the capsule; **d** "tear drop" sign; **e** "linguini" sign; **f** "salad oil" sign

allow differentiation between responsive and unresponsive patients.

3.6.4.5 Papillary Lesion with Pathological Discharge

Papillary flow can be a breast cancer manifestation. Mammography and ultrasonography are the first examinations to be performed, although often they do not detect the lesion, owing to difficulties in evaluating the retroareolar region. Ductography also helps detect the lesion, although with limitations, mainly because of the intermittent papillary flow. MRI appears to a good choice for diagnosis in this group because it is able to detect small intraductal lesions, therefore aiding surgical planning (Fig. 3.24).

Morrogt et al. [59] evaluated 376 patients with papillary discharge, of which 306 had negative findings on mammography and ultrasonography. This group then underwent ductography and MRI, and 46 tumors (15 % of cases) were observed. Ductography did not detect six tumors (predictive positive value of 19 % and predictive negative value of 63 %) and MRI did not detect one tumor (predictive positive value of 56 % and predictive negative value of 87 %). The authors concluded that ductogalactography has a low predictive negative value so it may not exclude disease and

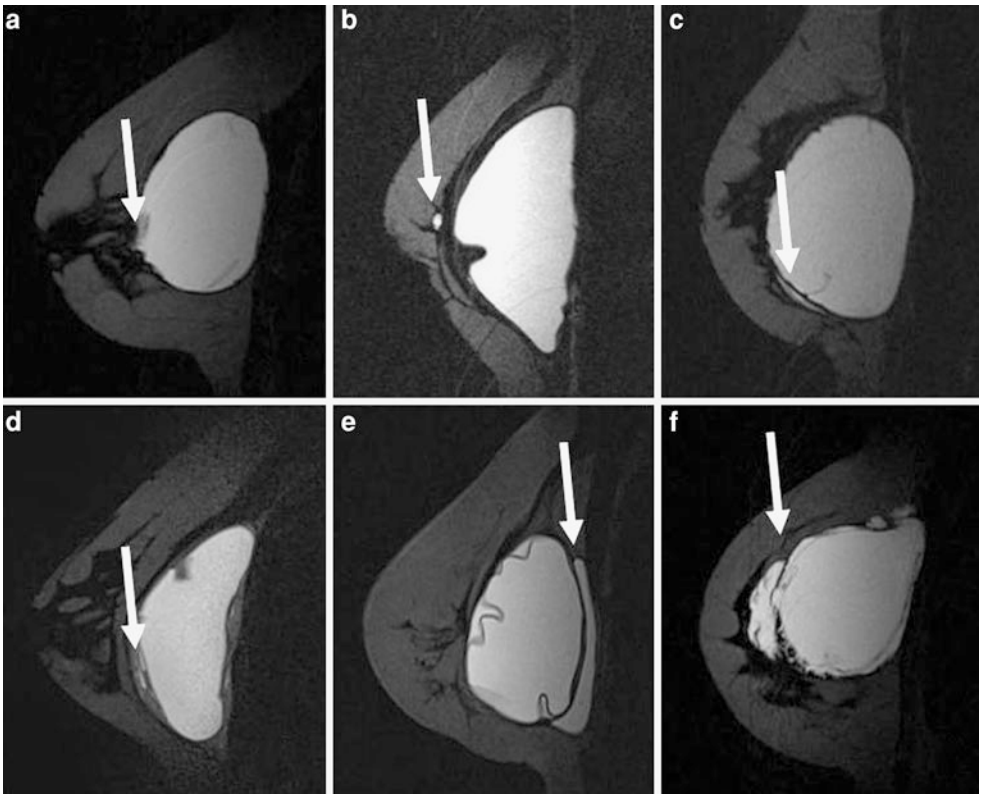

Fig. 3.27 Signs of extracapsular rupture on MRI: **a** focal area of silicone leakage outside the reaction capsule; **b** focal silicone area in front of the pectoralis muscle; **c** laminar area of silicone leakage; **d** intermediate silicone leakage around all the reaction capsule; **e** extensive leakage of silicone behind the capsule; **f** leakage of silicone for the parenchyma

that MRI can aid the surgical planning, although it does not exclude duct resection when there is suspicion of discharge. But Liberman et al. [59] concluded that MRI can be a good alternative to galactography in cases when papillary discharge suspected with negative findings on mammography and ultrasonography, as it detected the focus in 100 % of the patients evaluated. This way, concomitant evaluation with mammography and MRI is recommended for patients with suspected papillary discharge.

3.6.4.6 Postoperative Evaluation to Detect Local Recurrence

Recurrence occurs at an annual rate of 1–2 %, but it is uncommon during the first 18 months after the treatment [60]. Evaluation through physical examination, mammography, and ultrasonography is difficult owing to postoperative and radiotherapy changes, such as surgical scar, architectural distortion, calcifications, increase in mammary density, and fat necrosis, which can mimic the appearance of a recurring neoplasia, or even obscure it. MRI appears to be a promising method for the evaluation of local recurrence, mainly in cases of difficult evaluation through conventional methods (Fig. 3.25).

Up until 18 months after the surgical and radiotherapy treatments, MRI has limited value, as there is still secondary enhancement of inflammation induced by the treatment both in the scar region and in the areas with normal tissue, due to radiotherapy. After this period, MRI is able to detect tumor recurrence and differentiate it from areas of secondary enhancement resulting from the treatment. Benign sequelae such as fat necrosis, seroma, and hematoma can be safely differentiated through MRI, because of their signal characteristics [30, 61].

3.6.4.7 Evaluation of Inconclusive Findings of Conventional Imaging Examinations

MRI shows morphological and enhancement details that allow better differentiation between benign and malignant lesions when a biopsy is not viable and the evaluation through conventional imaging methods is inconclusive. The dynamic study helps differentiate a well-circumscribed carcinoma that morphologically mimics a benign mass or a thick content cyst, as well as to characterize lobular neoplasia that mimics focal asymmetries, cases of palpable lesions that are not shown by the traditional methods, and cases of diabetic mastoplasty that simulate a carcinoma, among others. In cases of suspected microcalcifications seen on mammography, MRI cannot be used to exclude the presence of neoplasia, so there is need for a biopsy because of limited sensitivity in the evaluation of low-grade intraductal carcinomas. But in cases of high-grade intraductal carcinomas, MRI has higher sensitivity than mammography. This was demonstrated by Kuhl et al. [62], who prospectively studied 7,319 women. They found a sensitivity of

61 % for mammography and 80 % for MRI in the detection of low-grade intraductal carcinomas, whereas for high-grade intraductal carcinomas, sensitivity was 52 % for mammography and 98 % for MRI.

3.6.4.8 Evaluation of a Mammary Prosthesis

MRI has been more frequently used to evaluate a mammary prosthesis for aesthetic or reconstruction (after mastectomy or quadrantectomy). The aims of evaluation through MRI of women with a prosthesis range from checking implant disruption (Figs. 3.26, 3.27), to checking for neoplasia (high-risk women or those in which there is suspicion of alteration in clinical–imagiological examinations), to evaluation of extension of a confirmed neoplasia and checking for recurring tumor in reconstructed breast after mastectomy. In patients with injection of silicone in the parenchyma, for which conventional methods are limited in their evaluation capability, MRI appears to be highly efficient to differentiate siliconomas from carcinomas (Fig. 3.16). In a meta-analysis, Cher et al. [63], concluded that the use of MRI to evaluate the integrity of the prosthesis has sensitivity of 78 % and specificity of 91 %, with a positive predictive value ranging between 50 % and 100 % and a negative predictive value ranging between 70 % and 100 %. Holmich et al. [64] compared the clinical diagnosis and the MRI diagnosis of prosthesis rupture and concluded that the clinical examination focusing on the detection of a rupture had low sensitivity and specificity, detecting less than 30 % of rupture cases; only 50 % of the implants considered clinically intact through MRI were actually intact. Therefore, the FDA recommends the annual use of MRI from the third year after surgery to detect silent ruptures [65].

References

1. Veronesi U et al (2005) Breast cancer. Lancet 365:1727–1741
2. Jemal A et al (2005) Cancer Statistics, 2005. CA Cancer J Clin 55:10–30
3. Ries LAG, et al (1994) Cancer statistics review 1973–91: tables and graphs. National institutes of health publication, National Cancer Institute, Bethesda n94–2789
4. Kelsey JL (1990) Breast cancer epidemiology: summary and future directions. Epidemiology 131:984–986
5. INCA (2011) Estimativas da incidência e da mortalidade por câncer no Brasil. Disponível em: hppt://www.inca.gov.br/estimativa2011, Accessed 10 oct 2011
6. American College of Radiology (2003) Breast imaging reporting and data system (BI-RADS), 4th edn. American College of Radiology, Reston
7. Chu KC, Smart CR, Taronev RE (1998) Analysis of breast cancer mortality and stage distribution by age for the health insurance plan clinical trial. J Natl Cancer Inst 80:1125–1132
8. Andersson I, Janzon L (1997) Reduced breast cancer mortality in women under age 50: update results from the malmo mammographic screening program. J Natl Cancer Inst Monogr 22:63–67
9. Bjurstam N et al (1997) The Gothenburg breast screening trial: first results on mortality, incidence, and mode of detection for women ages 39–49 years at randomization. Cancer 80:2091–2099
10. Brown D (2000) Death rates from breast cancer fall by a third. BMJ 321:849
11. Frisell J et al (1997) Follow-up after 11 years: update of mortality results in the stockholm mammographic Screening Trial. Breast Cancer Res Treat 45:263–270
12. Jackman VP (2002) Screening mammography: controversies and headlines. Radiology 225:323–326
13. Miller AB et al (1992) Canadian national breast screening study I: breast cancer detection and death rates among women aged 40–49 years. Can Med Assoc J 147:1459–1476
14. Miller AB et al (1992) Canadian national breast screening study II: breast cancer detection and death rates among women aged 50–59 years. Can Med Assoc J 147:1447–1488
15. Tabar L et al (1995) Efficacy of breast cancer screening by age: new results from the Swedish two-county trial. Cancer 75:2507–2517
16. Liberman L (2004) Breast cancer screening with MRI: what are the data for patients at high risk? New Engl J Med 351:497–500
17. Shapiro S (1977) Evidence on screening for breast cancer from a randomized trial. Cancer 39:2772
18. Shapiro S, Strax P, Venet L et al (1982) Ten- to fourteen-year effect of screening on breast cancer mortality. J Natl Cancer Inst 69:349–355
19. Shapiro S (1977) Evidence on screening for breast cancer from a randomized trial. Cancer 39:2772
20. Crystal P et al (2003) Using sonography to screen women with mammographically dense breast. AJR 181:177–182
21. Kolb TM, Lichy J, Newhouse JH (2002) Comparison of the performance of screening mammography, physical examination and breast US, and evaluation of factors that influence them: an analysis of 27,825 patients' evaluations. Radiology 225:165–175
22. Kriege R et al (2004) Efficacy of MRI and mammography for breast-cancer screening in women with a familial or genetic predisposition. New Engl J Med 351:425–437
23. Warner E et al (2004) Surveillance of BRCA2 and BRCA2 mutation carriers with magnetic resonance imaging, ultrasound, mammography, and clinical breast examination. JAMA 292:1713–1725
24. Kuhl CK et al (2005) Mammography, breast ultrasound, and magnetic resonance imaging for surveillance of women at high familiar risk for breast cancer. J Clin Oncol 23:8469–8476
25. BRASIL (2004) Ministério da Saúde. Instituto Nacional de Câncer. Coordenação de Prevenção e Vigilância. Controle do câncer de mama: documento de consenso. Rio de Janeiro, INCA/CONPREV
26. Moy L, Slanetz PJ, Moore R et al (2002) Specificity of mammography and US in the evaluation of a palpable abnormality: retrospective review. Radiology 225:176–181
27. Sickles EA (1986) Nonpalpable, circumscribed, noncalcified solid breast masses: likelihood of malignancy based on lesion size and age of patients. Radiology 192:439–442
28. Stravos TM et al (1995) Solid breast nodules: use of sonography to distinguish between benign and malignant lesions. Radiology 196:123–134
29. Rahbar H et al (1999) Benign versus malignant solid breast masses: US differentiation. Radiology 213:889–894

30. Hylton N (2005) Magnetic resonance imaging of the breast: opportunities to improve breast cancer management. J Clin Oncol 23:1678–1684
31. Kuhl CK et al (1997) Healthy premenopausal breast parenchyma in dynamic contrast-enhanced MR imaging of the breast: normal contrast medium enhancement and cyclical-phase dependency. Radiology 203:137–144
32. Muller-Schimpfle M et al (1997) Menstrual cycle and age: influence on parenchymal contrast medium enhancement in MR imaging of the breast. Radiology 203:145–149
33. Nunes LW, Schnall MD, Orel SG et al (1997) Breast MR imaging interpretation model. Radiology 202:833–841
34. Fischer U, Kopka L, Grabbe E (1999) Breast carcinoma: effect of preoperative contrast-enhanced MR imaging on the therapeutic approach. Radiology 213:881–888
35. Kuhl CK et al (1999) Dynamic breast MR imaging: are signal intensity time course data useful for differential diagnosis of enhancing lesions? Radiology 211:101–110
36. Warner et al (2001) Comparison of breast magnetic resonance imaging, mammography, and ultrasound for surveillance of women at high risk for hereditary breast cancer. J Clinl Oncol 19:3524–3531
37. Kriege M, Brekelmans CT, Boetes C et al (2004) Magnetic resonance imaging screening study group. Efficacy of MRI and mammography for breast-cancer screening in women with a familial or genetic predisposition. N Engl J Med 351:427–437
38. Kuhl CK, Schrading S, Leutner CC et al (2005) Mammography, breast ultrasound, and magnetic resonance imaging for surveillance of women at high familial risk for breast cancer. J Clin Oncol 23:8469–8476
39. Leach MO, Boggis CR, Dixon AK et al (2005) Screening with magnetic resonance imaging and mammography of a UK population at high familial risk of breast cancer: a prospective multicentre cohort study (MARIBS). Lancet 365:1769–1778
40. Warner E, Plewes DB, Hill KA et al (2004) Surveillance of BRCA1 and BRCA2 mutation carriers with magnetic resonance imaging, ultrasound, mammography, and clinical breast examination. JAMA 292:1317–1325
41. Sardanelli F, Podo F, D'Agnolo G et al (2007) High breast cancer risk Italian trial. Multicenter comparative multimodality surveillance of women at genetic-familial high risk for breast cancer (HIBCRIT study): interim results. Radiology 242:698–715
42. Lehman CD, Isaacs C, Schnall MD et al (2007) Cancer yield of mammography, MR, and US in high-risk women: prospective multi-institution breast cancer screening study. Radiology 244:381–388
43. Kuhl C, Weigel S, Schrading S et al (2010) Prospective multicenter cohort study to refine management recommendations for women at elevated familial risk of breast cancer: the EVA Trial. J Clin Oncol 20:1450–1457
44. Warner E, Yaffe M, Andrews KS et al (2007) American cancer society guidelines for breast screening with MRI as an adjunct to mammography. CA Cancer J Clin 57:75–89
45. Lee CH, Dershaw D, Kopens D et al (2010) Breast cancer screening with imaging: recommendations from the Society of Breast Imaging and the ACR on the use of mammography, breast MRI, breast ultrasound, and other technologies for the detection of clinically occult breast cancer. J Am Coll Radiol 7:18–27
46. Stomper PC et al (1999) Breast MRI in the evaluation of patients with occult primary breast carcinoma. Breast J 5:230–234
47. Schorn C et al (1999) MRI of the breast in patients with metastatic disease of unknown primary. Eur Radiol 9:470–473
48. Morris E et al (1997) MR imaging of the breast in patients with occult primary breast carcinoma. Radiology 205:437–440
49. Orel S et al (1999) Breast MR imaging in patients with axillary node metastases and unknown primary malignancy. Radiology 212:543–549
50. Fischer U et al (2004) The influence of preoperative MRI of the breasts on recurrence rate in patients with breast cancer. Eur Radiol 10:1725–1731
51. Kuhl CK, Schmiedel A, Morakkabati N et al (2002) Breast MR imaging of the asymptomatic contralateral breast in the work up or follow-up of patients with unilateral breast cancer. Radiology 217–268
52. Liberman L, Moris EA, Kim CM et al (2003) MR imaging findings in the contralateral breast in women with recently diagnosed breast cancer. AJR 180:333–341
53. Turnbull L, Brown S, Harvey I et al (2010) Comparative effectiveness of MRI in breast cancer (COMICE) trial: a randomized controlled trial. Lancet 375:563–571
54. Tan MP (2009) An algorithm for the integration of breast magnetic resonance imaging into clinical practice. Am J Surg 197:691–694
55. Sardanelli F et al (2010) Magnetic resonance imaging of the breast: recommendations from the EUSOMA working group. Eur J Cancer 46:1296–1316
56. Pickles M et al (2005) Role of dynamic contrast enhanced MRI in monitoring early response of locally advanced breast cancer to neoadjuvant chemotherapy. Breast Cancer Res Treat 91:01–10
57. Rieber A, Brambs HJ, Gabelmann A et al (2002) Breast MRI for monitoring response of primary breast cancer to neoadjuvant chemotherapy. Eur Radiolgy 12:1711–1719
58. Martincich L et al (2004) Monitoring response to primary chemotherapy in breast cancer using dynamic contrast-enhanced magnetic resonance imaging. Breast Cancer Res Treat 83:67–76
59. Morrogh M, Morris EA, Liberman L et al (2007) The predictive value of ductography and magnetic resonance imaging in the management of nipple discharge. Ann Surg Oncol 14:3369–3378
60. Dershaw D (2002) Breast imaging and the conservative treatment of breast cancer. Radiol Clin Am 40:501–516
61. Berg WA, Nguyen TK, Middleton MS, Soo MS et al (2002) MR imaging of extra-capsular silicon from breast implant: diagnostic pitfalls. AJR 178:465–472
62. Kuhl C, Schrading S, Bieling HB et al (2007) MRI for diagnosis of pure ductal carcinoma in situ: a prospective observational study. Lancet 370:485–492
63. Cher DJ, Conwell JA, Mandel JS (2001) MRI for detecting silicone breast implant rupture: Meta-analysis and implications. Ann Plast Surg 47:367–380
64. Hölmich LH et al (2005) The diagnosis of breast-implant rupture: Clinical findings compared with findings at magnetic resonance imaging. An Plastic Surg 54:583–589
65. Mc Carthy MC, Pusic AL, Kerrigan CL. Silicon breast implants and magnetic resonance imaging screening for rupture: do US Food and Drug Administration recommendations reflect an evidence-based practice approach to patient care? Plast Reconstr Surg 2008; 121:1127-1134

Breast Cancer Pathology

4

Mauro G. Mastropasqua

4.1 Introduction

In recent years, the role of pathology in breast cancer has changed dramatically. Currently, it no longer has a purely diagnostic role, based exclusively on morphology. Pathologists are now asked to provide some information about prognostic and predictive factors, in other words about the risk assessment and the choice of the best treatment, according to Veronesi's paradigm: "from maximum tolerable treatment to minimum effective treatment".

These changes can be summarized in this way: in the past we were dealing with "what to treat", now we are dealing with "how to treat", aiming at dealing with "whom to treat".

Although the first target of pathologists is diagnosis, which is obviously necessary and sometimes difficult, it is surely not sufficient for planning the therapies without addition of some information about endocrine responsiveness and the expected risk of progression [1].

4.2 Diagnostic Procedures

Diagnosis ought to be the first and essential goal of pathologists. The diagnostic procedures are aimed at clarifying the subsequent clinical strategies, both medical and surgical. Along with the clinical examination and radiologic features, there is the morphological evaluation, which aids in choosing the appropriate diagnostic and therapeutic approaches. For example, in the case of benign diseases, the surgery may be more conservative in order to obtain the best cosmetic result. In the case of malignancies, the diagnosis needs to be complemented by the evaluation of other issues useful for planning a (neo-)adjuvant therapy, without forgetting the cosmetic results. In fact, the certainty of very acceptable cosmetic results has driven more and more women to undergo screening programmes and surgery with major confidence and trust.

Fine-needle aspiration provides cells from the suspected lesions, usually solid or cystic, that clinicians want to be verified by cytology. The result of such a technique depends on several factors: the size and the topography of the lesion and the expertise of the sampler and the pathologist (when they are not the same person). Although cytology is safe, quick, cheap and accurate, and mostly useful for diagnosis, it has some limitations: it is not possible to distinguish between invasive and noninvasive lesions, and it is not possible to obtain enough information about the biological characteristics of the tumour for neoadjuvant treatments.

A core biopsy is essential when the patient must undergo neoadjuvant (chemo-)therapy because the tissue from the lesion is processed with histological techniques and allows a more accurate pathological assessment of those features required for the appropriate choice of therapy, e.g. the presence of an invasive component, histological type, grade, hormone receptor status, human epidermal growth factor receptor 2 (HER2)/neu amplification/overexpression, and proliferation index.

In other cases, the biopsy findings may be diagnostic and, at the same time, therapeutic when just a cluster of calcifications represents the lesion and they are completely removed by the vacuum-assisted method.

Rarely, core biopsy fails to confirm the clinically suspected diagnosis: the failure rate is about 1 % [2]. In these unfortunate cases, lumpectomy or incisional surgical biopsies can be performed for diagnostic purposes, usually as frozen-section biopsies, in order to obtain a diagnosis and then, according to the diagnosis, to complete the necessary surgical procedure in the same surgical session. This technique, in fact, aids the surgeon to quickly plan the correct surgical strategy in one step because of the prompt answer by pathologist (usually in about 15 min).

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Sometimes frozen-section biopsy findings are not diagnostic and, fortunately in only very rare cases, may diverge from the definitive histological findings. The discrepancies between the diagnoses from frozen sections and definitive sections from paraffin-embedded blocks are more likely to be false negative than false positive [3].

For these reasons and because of the particular conditions under which the tissue is processed in pathology laboratories and the intrinsic difficulties of such a technique (e.g. tissue quality, technical quality), it is advisable not to perform frozen-section examinations on very small lesions. Unfortunately, there is no agreement on what is small: in our laboratory, we usually do not perform frozen-section examinations on lesions up to 0.5 cm, to avoid missing material for the definitive histology. Anyway, as a rule, good sense must be used and frozen-section examinations can be performed whenever grossly the lesion can be divided into two moieties, both of them sufficiently representative.

Intraoperative frozen-section examination is very useful in the evaluation of retroareolar tissue during nipple-sparing mastectomies: in such cases, it is mandatory that the surgeon orients the real margin of the tissue sent to the pathology department with ink or threads so that the pathologist too can orient the specimen and can give a more accurate answer, also in terms of the distance from the margin.

Finally, frozen sections are used for the assessment of resection margins. Nevertheless, for these purposes the technique has lower accuracy, mostly due to the fatty tissue of the breast. The fat is extremely difficult to obtain as a snap frozen section, resulting in a very high likelihood of missing lesions, which are revealed only in sections from paraffin-embedded tissue [4].

4.3 Gross Pathology and Handling of Surgical Specimens

The choice of breast-conserving surgery rather than more radical surgery depends on many factors, and it is the surgeon who decides on the basis of previous clinicoradiological reports in order to achieve safe margins around the lesion, also paying attention to the aesthetic results.

Both quadrantectomy and mastectomy ought to be considered with care by pathologists, with the aim of obtaining all the information needed for the best treatment. Before being sent to the pathologist, the specimen must be well oriented (Fig. 4.1) to give the pathologist the possibility of providing clinicians with the correct information about the margin status, mostly when the request is made during the same intervention: with the surgeon waiting in the operating theatre, the pathologist in his or her laboratory cuts the specimen, searches for the known lesion, and even for further misdiagnosed lesions, and then communicates the results to the surgeon, who can make a wide excision, if required. In this way, if the margins are not safe, further surgical procedures on the patient will be avoided. Inking the specimen before cutting aims at obtaining from histological slides the microscopic distance of those non-eye-catching lesions (Fig. 4.2).

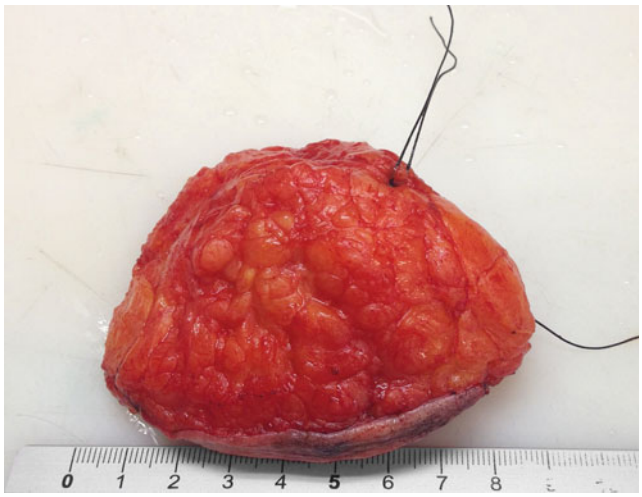

Fig. 4.1 Quadrantectomy (*upper* lateral quadrant of the *right* side) specimen orientated by the surgeon with threads indicating the areolar margin (one thread) and upper medial quadrant (two threads)

For margins, there are some recent recommendations depending on the type of tumour that should be kept in mind. For invasive cancers, it is sufficient that the ink does not touch the tumour cells to consider the margins as free; for ductal intraepithelial neoplasia, which sometimes shows a discontinuous pattern of growth along the ducts, a margin of at least 2 mm is considered safe; for lobular intraepithelial neoplasia, even if the tumour cells are at the resection margins, this does not require a re-excision [5].

There are several techniques for cutting the specimens, and the technique used depends on the expertise of the pathologist. It is advisable to cut the specimen before the fixation in formalin in order to better appreciate the macroscopic characteristics of the lesion (colour, firmness and consistence) and also to better achieve a suitable size (see later).

The number of samples to be kept from a breast tumour depends mostly on its size. For a tumour up to 2 cm, the entire tumour should be embedded, whereas for larger tumours, although there is not a rule, it is advisable to select at least one sample more for each extra centimetre. Obviously, if there are macroscopically different areas, irrespective of the size of the lesion, all of them should be sampled and embedded.

Crucial is the fixation of the samples: choosing the right fixative, its appropriate volume relative to the specimen size and the time for fixation allows optimal assessment both for

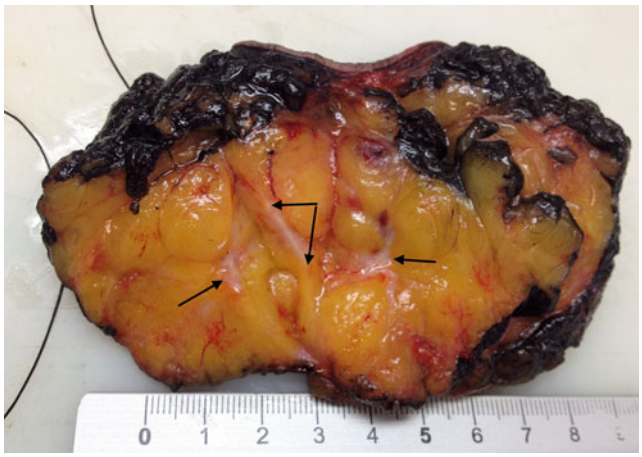

Fig. 4.2 Same specimen as for Fig. 4.1, cut after inking, revealing a tumour with safe margins. The tumour has been cut twice perpendicularly to address the largest diameter

simple morphological evaluations and for more complex biological evaluations of the molecular features. The best fixative is formalin because it guarantees the best results from immunohistochemistry (IHC), in situ hybridization (ISH) and molecular analysis of nucleic acids. The appropriate time for fixation differs among laboratories, according to their standardized procedures, but it must be within 6–48 h to prevent subsequent modifications of their own standardized procedures, made to compensate for the artefact due to hyperfixation or hypofixation [6, 7].

4.4 Pathological Features (Size, Type, Grade)

4.4.1 Size

Although assessment of tumour size appears to be a very simple task, it must be done properly. In fact, it is decisive, because it is one of the most important independent prognostic factors [8]. It is essential to take measurements in three planes and not only the largest axis, although the latter will be reported for the pathologic stage. Furthermore, it is advisable to make measurements on fresh tissue in order to avoid the shrinkage effects due to the formalin fixation. Sometimes there may be a discrepancy between the size measured on radiography or ultrasonography and the pathologically (macroscopic and microscopic) reported size: this can be due to the extent of a noninvasive component around the lesion, or the presence of another lesion, even benign, adjacent to the neoplasia that may result in incorrect macroscopic evaluation. In these cases, the measurement must be confirmed on the histological slides and reported as the "maximum histological diameter" in the pathology report. I recommend taking histological measurements even in all those cases where the size is critical for a change in the stage (see later, TNM).

A "microinvasive carcinoma" is defined as a tumour with a largest diameter of its invasive component of up to 1 mm, usually associated with a larger noninvasive counterpart.

For multiple tumours, each nodule should be measured, but the largest one determines the pathological stage. Those cases where multiple foci of carcinoma are present in a larger area of noninvasive tumour are very tricky. As the histological slide is a very thin slice of the tissue and cannot remodel the three-dimensional shape of the tumour, we cannot firmly assert that those foci do not join together in one or more deeper cuts. It would be more accurate to cut the blocks of tissue deeper and deeper, at least on three levels, in order to try to remodel the shape, leaving to the pathologist's subjectivity and good sense the final consideration of the real size of the infiltrating tumour.

4.4.2 Type

According to the WHO classification [9], breast tumours are divided into epithelial and mesenchymal types. Epithelial ones are more frequent and are further classified into noninvasive and invasive. According to their morphology, both of them are of ductal and lobular type. Amongst the invasive tumours, there are some special types which are different not only on a pure morphological basis, but also reflect a different better or poorer prognosis (see later).

Many authors currently use the term "carcinoma in situ" of ductal or lobular type according to the morphology. Nevertheless, the term "carcinoma in situ" encompasses a wide range of proliferations: potentially neoplastic; surely neoplastic from low grade to high grade; potentially progressing to an invasive carcinoma. They are different from each other not only in their morphological characteristics, but even in their genetic alterations, risk of relapse and likelihood to progress to a frank carcinoma [10]. Instead of the term "carcinoma" for such very different proliferations, it has been proposed to use the term "intraepithelial neoplasia" of ductal or lobular type (ductal intraepithelial neoplasia, DIN; lobular intraepithelial neoplasia, LIN), avoiding the word "carcinoma", mainly but not only for two reasons: first, just to emphasize that DIN/LIN are not a threat for the life disease; and to protect patients from the devastating psychological effects that the term "carcinoma" may cause [11].

As already said, there are many entities, some of them with unknown (if any) malignant potential, and others with different risk of progression. That may be confusing: for these reasons we suggest changing and unifying this terminology according to [9]. Therefore, we identify as DIN

1A flat epithelia atypia, as DIN 1B atypical ductal hyperplasia, as DIN 1C ductal carcinoma in situ grade 1, as DIN 2 ductal carcinoma in situ grade 2 and as DIN 3 ductal carcinoma in situ grade 3.

For the morphological classification of breast cancer and the list of types and special types, we follow and suggest following the WHO [9], even if in the molecular era it seems useless to characterize breast cancers with traditional morphological terminology. Morphological classification of breast tumours could be interpreted as a vintage occupation of pathologists since the publication of molecular classification based on gene expression profiling [12, 13]. But we should not forget that changes at the molecular level mirror differences at the morphological level, driving the biological and clinical behaviour of breast cancer. Abandoning completely the morphology would result surely in an increase in expense without a significant advantage. For example, tubular carcinoma is a special type of breast cancer, and is well known to have a very good prognosis. We do not need to spend a lot of money to obtain the same information from gene expression profiling. On the other hand, molecular classification identifies some breast cancers with very poor prognosis (the so-called basal-like tumours): unfortunately among those cancers there are some special types, such as adenoid cystic carcinomas, low-grade apocrine carcinomas and low-grade metaplastic carcinomas, which although according to molecular imprinting have a poor prognosis, have a very good clinical outcome. That means that there are some instances where the morphological identification of a special tumour type by itself provides the whole set of information relative to the expected outcome and responsiveness to the therapy, without any need to perform additional investigations, which may indeed be detrimental.

Paget's disease of the nipple is a very uncommon epidermal manifestation of breast cancer, characterized by infiltration of neoplastic large tumour cells with pale cytoplasm and hyperchromatic nuclei with prominent nucleoli in the epidermal layer of nipple–areola complex. It is usually associated with an underlying noninvasive or invasive carcinoma, but it may be found even alone, without any underlying tumour. If it is present, there is no topographic predilection for the tumour, which may be located anywhere in the breast. According to the margin status, the size of the underlying tumour and clinicoradiological presurgical data, patients may be offered conservative surgery combined with breast irradiation instead of mastectomy [14].

4.4.3 Grade

Grading the tumour represents an important issue as it is an important prognostic factor [1]. The universally accepted method for grading breast cancers follows the Bloom and Richardson [15] system, modified by Elston and Ellis [16].

Noninvasive tumours are graded into three classes according to the diameter of the cells, their chromatin, mitotic index and the presence of necrosis.

Even for invasive carcinomas the system classifies the tumours into three classes, according to the formation of tubules, nuclear pleomorphism and the number of mitoses. Although this is an objective system, there are some interobserver and intraobserver discrepancies, due to both the preanalytical phase (type and timing of fixation, which may affect the mitoses and the nuclear shape) and the intrinsic heterogeneity of the tumour (which can alternate being more differentiated areas and less differentiated areas). Whereas extreme grades, G1 and G3, show a very high interobserver consistency, G2 is the most difficult to standardize and has poor reliability when evaluated by several pathologists [17].

4.5 Sentinel Node Biopsy and Lymphadenectomy

4.5.1 Sentinel Node Biopsy

Besides breast-conserving surgery, the introduction of the sentinel node biopsy (SNB) approach to patients was another milestone along the way to conservative treatment of breast cancer [18]. Before the introduction of such a technique, the standard approach was a complete axillary dissection, which provided the information useful to report the nodal status. Unfortunately, this technique, although of great prognostic significance, is of doubtful therapeutic impact, and may also have iatrogenic consequences, such as pain, limitation of movements and chronic lymphoedema of the arm. Fortunately, some clinical trials provided evidence suggesting that SNB is useful in order to avoid an unnecessary complete axillary dissection. Furthermore, it allows one to plan therapy with minimal morbidity for the patient and no impact on the quality of life. Finally, it is able to identify the status of the entire axillary nodes as true negative and may be performed intraoperatively, reducing the discomfort of a double intervention for the patient. Actually, the examination may be performed both during the surgery on fresh nodes, and after the surgery on formalin-fixed and paraffin-embedded specimens. Whatever the method used, it is mandatory that the node is examined entirely until the complete consumption of the tissue to obtain its high negative predictive value. To attain such a result, the node must be extensively scrutinized with a serial sectioning at a very close cutting interval (50 μm), because just a few histological sections represent a minimal part of the entire node, and the less that is examined, the lower is

the detection rate of micrometastatic deposits. For both methods, fresh and fixed specimens, IHC can be used in order to better resolve doubts about the nature of the cells. The advantage of frozen sectioning is that the surgery may be done in just one step: in fact, if the node is positive, the patient will undergo axillary clearance in the same operative session.

Another advantage introduced by SNB is the possibility of finding and studying very small metastatic deposits. Currently, according to the Union Internationale Contre le Cancer (UICC) [19] and the American Joint Committee on Cancer (AJCC) [20] staging systems, they are subdivided into three categories: (macro)metastases, micrometastases and isolated tumour cells (ITC). Metastases have a largest diameter of more than 2 mm; micrometastases range between 2 mm and 0.2 mm; ITC are little clusters of tumour cells up to 0.2 mm in largest diameter. The ITC definition is not only on the basis of size, but also includes their morphological behaviour: they "don't show evidence of metastatic activity", which means proliferative activity, stromal reaction and penetration of vessel sinus walls [19, 20]. This definition emphasizes the scarce knowledge of their actual behaviour and their prognostic significance.

To standardize those cases, mostly metastatic lobular cancers, where the cells are not in strict contact with each other, creating severe difficulties in linear measurement, it has been proposed to consider as ITC cases where there are clusters of up to 200 cells in a unique histological cross-section [19, 20].

4.5.2 Lymphadenectomy

Lymphadenectomy specimens ought to be accurately examined macroscopically in order to retrieve all the nodes, even the smallest ones. The nodal status is an important and essential part of the staging system and the more nodes that are histologically examined, the higher is the likelihood of finding (micro)metastasis. Furthermore, for the same reason, each node from a lymphadenectomy sample, if negative, should be cut into more sections (from three to six) in order to obtain more accurate information on the nodal status. According to the TNM staging system [19, 20], the nodal stage depends on the number of metastatic nodes when at least a single node is found to be (macro)metastatic. In such cases, even if in the other nodes there are only micrometastases, the stage changes according to the number of metastatic nodes, irrespective of the size.

Conversely, if the nodes are only micrometastatic, the number of metastatic nodes does not affect the stage.

4.6 Staging

A further step in the pathway after breast cancer diagnosis is to establish the extent of the disease and to formulate the prognosis, separating patients into distinct categories in order to choose the appropriate therapy. The task pertaining to pathologists is the pathological stage, usually obtained according to the UICC/AJCC TNM staging system [19, 20]. TNM is an acronym of "tumour" (size/extent of the primary tumour), "node" (the status of regional lymph nodes, i.e. number and size of metastases, if any) and "metastasis" (the presence in distant sites). The pathological TNM staging is done after morphological evaluation of the specimen and is indicated with the prefix "p", to distinguish it from the clinical one, made on the basis of clinicoradiological data and indicated with the prefix "c".

Although the last version of the TNM staging system was published just a couple of years ago, we think it is time to change this classification and aim at a more accurate personalization of the stage. The European Institute of Oncology (IEO), on the basis of very great experience from the treatment and follow-up of over 30,000 breast cancer patients, and from the experience of a skilled multidisciplinary group of physicians, has started to use, along with the traditional staging, a modern version of the TNM staging system, which has been proposed for a revision [21].

Our aim is to use a workable and flexible classification, ready to accept the new insight coming from translational research.

The first innovation would be to eliminate the "Tis" category, because as previously said, instead of "carcinoma in situ", we would prefer to say "intraepithelial neoplasia", which is not a carcinoma and for that reason is not worthy of being staged among the carcinomas.

Instead of creating categories for the tumour size, which encompass very different diameters, we would prefer to assign the exact maximum diameter of a tumour as a suffix to the "Tsize". In fact, for example, the UICC/AJCC TNM considers as the same category (pT2) tumours ranging from 2.1 cm up to 5 cm. Two tumours at the extreme of this category obviously would not have the same prognosis, even if we took into account the tumour volume as a unique risk factor. It would be more accurate to stage the tumour as pTsize, where "size" is expressed in centimetres.

The same might be said for the nodes: the pN2a category includes tumours with four to nine metastatic ipsilateral axillary nodes. We cannot argued against the number of total retrieved nodes from lymphadenectomy specimens. The prognosis is different not only between cases with four and cases with nine metastatic nodes, also between cases with four positive nodes out of four nodes, and a cases with

four positive nodes out of 20 nodes. Our current modality of staging is to put a suffix after the N ("+") followed by the ratio between positive and total retrieved axillary nodes (pN + nodes/total nodes).

Finally, we think that distant metastases should be clearly identified in the TNM classification, instead of being anonymously indicated as M1: that is because different sites of metastases can be treated with different modalities [21]; these may be useful for one site and not for another. We suggest putting a suffix after the M to clearly identify the site (e.g. pM1 PUL indicates a metastasis to the lung).

Besides these classical features, we propose using the biological features to categorize tumours; this indispensable for planning a tailored therapy.

Further prognostically significant features that we usually add to the traditional TNM classification were taken into account, mainly as optional, by the last version [19, 20]: the multifocality (m), the extensive intraductal component (EIC), and peritumoral vascular invasion (PVI).

4.7 Prognostic and Predictive Factors

Once the diagnosis has been made and the cancer has been staged, the tasks of pathologists are not yet finished. In fact, the biological characterization of breast cancer is aimed at the correct identification of the patients who are most likely to benefit from targeted therapies. Currently, there are four worldwide-accepted biological markers useful to achieve this goal [1]: assessment of oestrogen receptor (OR) and progesterone receptor (PgR) to select candidate patients for endocrine therapies; evaluation of HER2 status to select candidate patients for endocrine and anti-HER2 treatments, and the calculation of the proliferation fraction by the Ki67 labelling index to select candidate patients for different types of endocrine and chemotherapies.

The improvement of intraobserver and interobserver reproducibility for assessment of OR, PgR, HER2 and Ki67 labelling index by IHC relies on the adoption of some expertise-driven strategies, such as avoidance of tissue samples previously frozen and use of a representative and promptly formalin-fixed paraffin-embedded block including both normal breast and tumour tissue but possibly devoid of any necrotic or fibrotic component.

In recent years, immunohistochemical evaluation has been demonstrated to be better than extractive methods [22].

Currently, most laboratories use IHC, so pathologists are more directly involved in the assessment of (semi-)quantitative IHC assays for evaluation of the hormonal (OR, PgR) and HER2 status. Despite the long-standing experience with IHC assays, the standardization of the techniques, the availability of ready-to-use kits and a lot of published recommendations for the interpretation and scoring, there is evidence from external quality control programmes run in different countries, in Europe and the USA, and from central pathology revision for large clinical trials, that shows how unsatisfactory OR, PgR, HER2 and Ki67 determination is in breast carcinomas and how unacceptable the interlaboratory variability is.

It is well documented that preanalytical variables (e.g. type and length of fixation), differences in the choice of antibodies, antigen retrieval techniques and detection systems and expertise in and accuracy of the interpretation and scoring of the results all contribute to the adequacy of the final evaluation.

Nevertheless, the postanalytical phase appears to be the most critical, as the best concordance is achieved in cases exhibiting strong immunoreactivity, and the poorest concordance is achieved in cases with low-level immunoreactivity or heterogeneous staining.

To reduce these discrepancies, the American Society of Clinical Oncology (ASCO) and the College of American Pathologists (CAP) have jointly published guideline recommendations [6, 7] aimed at improving the reproducibility amongst pathologists.

4.7.1 Hormonal Status (OR and PgR)

To obtain the best results, it is necessary to start from the tumour specimen: the block of tissue to be submitted to IHC should not be chosen at random, but it must have, along with the tumour, a rim of normal tissue to be used as a built-in normal control to check that the immunohistochemical reaction has run correctly: just let us think of negative tumours, where, in the absence of normal lobules and ducts, you cannot be sure that there have not been any problems during the analytical phase. On the other hand, the presence in the normal ducts and lobules of myoepithelial cells which are negative for OR and PgR allows false-positive cases to be avoided. During the evaluation of OR and PgR, pathologists should check for any unexpected immunostaining in normal tissues, and for expected immunostaining of nonneoplastic luminal epithelial cells. In addition, panoramic evaluation of the whole tissue section should always precede observation at higher magnification in order to guarantee a homogeneous distribution of the reagents during the stain.

In the case of tumours with homogeneous staining throughout, the fields where counting should be done can be selected randomly; conversely, in the case of tumours with significant staining heterogeneity, the selection of fields should mirror this heterogeneity.

Furthermore, in the case of different blocks from the same tumour reflecting different areas or histological types, or in the case of multiple tumours, if the sample chosen was

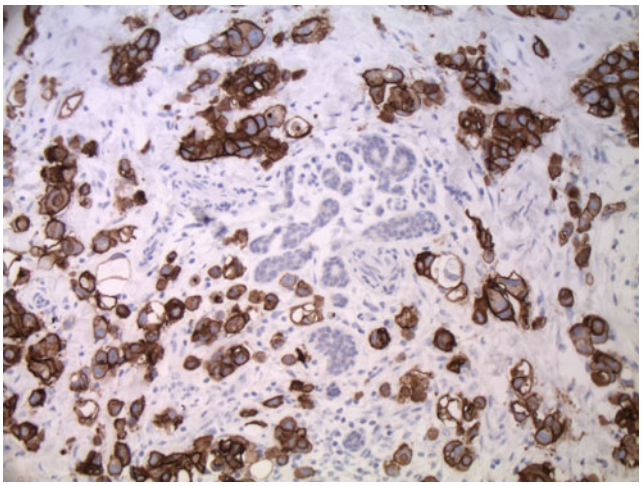

Fig. 4.3 Invasive ductal carcinoma showing strong and complete positive membrane immunohistochemical staining for human epidermal growth factor receptor 2 (HER2), just around a ductulolobular unit, which is not immunoreactive

negative for all markers, preventing the likelihood of targeted therapies, pathologists should try to test other blocks, aiming at verifying any possible positive area of the tumour.

In their reports, pathologists must provide not only quantitative information about tumours that are positive for OR and PgR expression, but must also quantify how positive they are, reporting the percentage, because of the lack of any clinically validated cut-off value. Only definitive nuclear staining must be taken into account, and intensity of staining is considered optional [1, 6].

Tumours that are OR-negative and PgR-positive almost do not exist, or they are very unusual in our experience. In such a phenotype, it is advisable to repeat the immunohistochemical assessment, better on different blocks.

4.7.2 Human Epidermal Growth Factor Receptor 2

HER2 plays a prognostic and predictive role: HER2-positive tumours have a poorer prognosis; HER2 status drives the selection of the most appropriate adjuvant therapies; targeted therapies improve both disease-free and overall survival when test for HER2 is positive but not when it is negative [1].

Among the different testing procedures, IHC and fluorescence ISH (FISH) are the most widely used, because they allow correlation of the biological features of the tumours with their morphological characteristics.

However, as well as for OR and PgR, there are considerable interlaboratory and intralaboratory discrepancies in assessing HER2 status, which may interfere with the correct selection of breast carcinoma patients who are most likely to benefit from anti-HER2 therapy. Possible reasons for these discrepancies include technical aspects and variable interpretation of the results. The former are the same as for those listed for OR and PgR; the latter are obviously different, because the scoring method is different [7].

As immunohistochemical assessment of HER2 status is the most widely used method (Fig. 4.3), it is necessary to standardize the interpretation and reporting of the results. We provide some suggestions: avoiding specimen edges, areas of retraction and crushing artefacts, tumour cells with a cytoplasmic staining pattern instead of a membranous one, and sections with significant staining of benign lobules and ducts. For the latter, the difference in chromatic intensity between malignant and benign cells should be determined in order to assess the correct score.

The score is obtained by assigning a value from 0 to 3 + according to the membrane staining intensity and completeness of the tumour cells: sections of tumours containing 10 % or fewer immunoreactive cells (independent of the intensity or completeness of staining) are scored 0; sections of tumours with weak and incomplete membranous staining are scored 1 + ; sections with weak/moderate and complete membranous staining are scored 2 + ; sections with strong and complete membranous staining are scored 3 + .

In order to assign positivity or negativity to the tumours, and thus to predict which patients are most likely to benefit from targeted therapies, according to ASCO/CAP guidelines cases scored as 0 and 1 + are considered negative; cases scored as 2 + and 3 + in less than 30 % of tumour cells are considered equivocal; cases scored as 3 + in over 30 % of tumour cells are considered positive [7].

The FISH technique has the well-known disadvantages of a longer time for slide preparation and scoring, higher costs, including the requirement of a fluorescence microscope, the impossibility of storing the slides and, consequently, the need for image archiving. On the other hand, FISH allows a more accurate evaluation, reducing the false-positive/false-negative rates. Some authors believe that only FISH should be used [23]; however, this is not always feasible.

IHC and FISH are the two currently most used methods, and which is the best method to identify patients for anti-HER2 therapy remains controversial. Most laboratories screen all tumours with IHC, because it is faster, easier and cheaper, and then retest equivocal tumours with FISH; other laboratories use FISH as the only method for HER2 testing.

The concordance between IHC and FISH is generally higher than 80 %, with approximately 10 % of cases showing positive immunostaining despite the lack of gene amplification by FISH, and vice versa. Concordance studies between IHC and FISH have demonstrated an overall

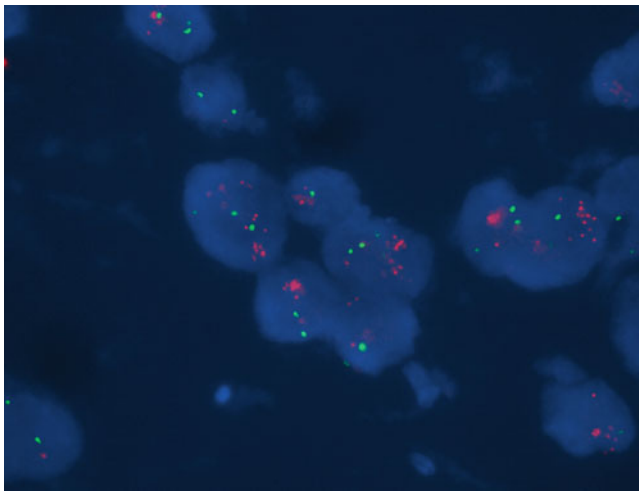

Fig. 4.4 Fluorescence in situ hybridization for HER2 showing some nuclei with increased gene copy numbers of the HER2 gene (*red dots*) and a normal number of centromeres of chromosome 17 (*green dots*). In this sample the ratio is much >2.2

concordance rate ranging from 82 to 92 % [7]; for 2 + cases, the concordance is between 12 and 26 % [24].

ASCO/CAP guidelines identify as amplified (positive) tumour cells showing more than six copies of the HER2 gene, or alternatively, a ratio higher than 2.2 between the gene copy number and the number of centromeres of chromosome 17; if the ratio ranges between 1.8 and 2.2, or the HER2 gene copy number ranges between 4 and 6 the result will be considered as equivocal; lesser values (ratio less than 1.8 and gene copy number less than 4) will be considered not amplified (negative) (Fig. 4.4).

4.7.3 Ki67

The proliferation fraction of tumour cells plays a role as a prognostic parameter in breast cancer, but it could also play a role as a predictive marker in some subpopulations of patients [25, 26]. Routinely, pathologists calculate the proliferative fraction by IHC with monoclonal antibody MIB1 against the Ki67 antigen, a nuclear protein expressed in all proliferating cells during the cell cycle, reaching a peak during the mitotic phase. Unfortunately, as there is no standardization regarding what to count, how to count, where to count, how many cells to count, which cells are positive and which one are not, the interobserver and intraobserver results are very different, and Ki67 is not yet considered a useful prognostic marker [27]. Nevertheless, the panellists at the 2011 St. Gallen Consensus Conference included the Ki67 value as a parameter to take into account in deciding whether to add or not add chemotherapy for some subpopulations of patients [1].

The increasing interest of scientists in this marker led an international panel of investigators expert in dealing with Ki67 and breast cancer to come together and discuss this topic in order to obtain a consensus and to issue recommendations aimed at reducing discrepancies for optimal testing [28]. This committee named the "International Ki67 in Breast Cancer Working Group" agreed that Ki67 evaluation might be important both in clinical practice and in clinical trials, that the standardization of the method of counting may give greater power to the results from clinical trials, that Ki67 is a robust biomarker and that preanalytical and analytical phases, if standardized, do not influence its evaluation; the postanalytical phase represents the more critical issue and needs to be standardized.

Once the problems of standardization have been overcome this marker may be powerfully used in clinical practice.

References

1. Goldhirsch A, Wood WC, Coates AS et al (2011) Strategies for subtypes—dealing with the diversity of breast cancer: highlights of the St Gallen international expert consensus on the primary therapy of early breast cancer. Ann Oncol 22:1736–1747
2. Riedl CC, Pfarl G, Memarsadeghi M et al (2005) Lesion miss rates and false-negative rates for 1115 consecutive cases of stereotactically guided needle-localized open breast biopsy with long-term follow-up. Radiology 237:847–853
3. Niemann TH, Lucas JG, Marsh WL Jr (1996) To freeze or not to freeze. a comparison of methods for the handling of breast biopsies with no palpable abnormality. Am J Clin Pathol 106:225–228
4. Noguchi M, Minami M, Earashi M et al (1995) Pathologic assessment of surgical margins on frozen and permanent sections in breast conserving surgery. Breast Cancer 2:27–33
5. Morrow M (2009) Breast conservation and negative margins: how much is enough? Breast 18(Suppl 3):S84–S86
6. Hammond ME, Hayes DF, Dowsett M et al (2010) American society of clinical oncology/college Of american pathologists guideline recommendations for immunohistochemical testing of estrogen and progesterone receptors in breast cancer. J Clin Oncol 28:2784–2795 Erratum in: (2010) J Clin Oncol 28:3543
7. Wolff AC, Hammond ME, Schwartz JN et al (2007) American society of clinical oncology/college of American pathologists guideline recommendations for human epidermal growth factor receptor 2 testing in breast cancer. J Clin Oncol 25:118–145
8. Mirza AN, Mirza NQ, Vlastos G, Singletary SE (2002) Prognostic factors in node-negative breast cancer: A review of studies with sample size more than 200 and follow-up more than 5 years. Ann Surg 235:10–26
9. Tavassoli FA, Devilee P (eds) (2003) Pathology and genetics of tumours of the breast and female genital organs. IARC Press, International Agency for Research on Cancer, Lyon
10. Viale G (2005) Histopathology of primary breast cancer. Breast 14:487–492
11. Veronesi U, Zurrida S, Goldhirsch A et al (2009) Breast cancer classification: time for a change. J Clin Oncol 15:2427–2428
12. Perou CM, Sørlie T, Eisen MB et al (2000) Molecular portraits of human breast tumours. Nature 406:747–752

13. Sorlie T, Perou CM, Tibshirani R et al (2001) Gene expression patterns of breast carcinomas distinguish tumour subclasses with clinical implications. Proc Natl Acad Sci USA 98:10869–10874
14. Caliskan M, Gatti G, Sosnovskikh I et al (2008) Paget's disease of the breast: the experience of the European institute of oncology and review of the literature. Breast Cancer Res Treat 112:513–521
15. Bloom HJ, Richardson WW (1957) Histological grading and prognosis in breast cancer. A study of 1409 cases of which 359 have been followed for 15 years. Br J Cancer 11:359–377
16. Elston CW, Ellis IO (1991) Pathological prognostic factors in breast cancer I. The value of histological grade in breast cancer: experience from a large study with long term follow-up. Histopathology 19:403–410
17. Sloane JP, Amendoeira I, Apostolikas N et al (1999) Consistency achieved by 23 European pathologists from 12 countries in diagnosing breast disease and reporting prognostic features of carcinomas. European commission working group on breast screening pathology. Virchows Arch 434:3–10
18. Veronesi U, Viale G, Paganelli G et al (2010) Sentinel lymph node biopsy in breast cancer. Ten-year results of a randomized controlled study. Ann Surg 251:595–600
19. Sobin LH, Gospodarowicz MK, Wittekind C (eds) (2009) TNM classification of malignant tumours, 7th edn. Wiley, Hoboken
20. Edge SB, Byrd DR, Compton CC, Fritz AG, Greene FL, Trotti A (eds) (2010) AJCC cancer staging manual, 7th edn. Springer, New York
21. Arnone P, Zurrida S, Viale G et al (2010) The TNM classification of breast cancer: need for a change. Updates Surg 62:75–81
22. Regan MM, Viale G, Mastropasqua MG et al (2006) Re-evaluating adjuvant breast cancer trials: assessing hormone receptor status by immunohistochemical versus extraction assays. J Natl Cancer Inst 98:1571–1581
23. Sauter G, Lee J, Barlett JM et al (2009) (2009) Guidelines for human epidermal growth factor receptor 2 testing: biologic and methodologic considerations. J Clin Oncol 27:1323–1333
24. Perez EA, Roche PC, Jenkins RB et al (2002) HER2 testing in patients with breast cancer: poor correlation between weak positivity by immunohistochemistry and gene amplification by fluorescence in situ hybridization. Mayo Clin Proc 77:148–154
25. Viale G, Giobbie-Hurder A, Regan MM et al (2008) Prognostic and predictive value of centrally reviewed Ki-67 labeling index in postmenopausal women With endocrine-responsive breast cancer: results From Breast International Group Trial 1–98 comparing adjuvant tamoxifen with Letrozole. J Cin Oncol 26:5569–5575
26. Viale G, Regan MM, Mastropasqua MG et al (2008) Predictive value of tumor Ki-67 expression in two randomized trials of adjuvant chemoendocrine therapy for node-negative breast cancer. J Natl Cancer Inst 100:207–212
27. Harris L, Fritsche H, Mennel R et al (2007) American Society of Clinical Oncology 2007 update of recommendations for the use of tumor markers in breast cancer. American Society of Clinical Oncology. J Clin Oncol 25:5287–5312
28. Dowsett M, Nielsen T, A'Hern R et al (2011) Assessment of Ki67 in breast cancer: Recommendations form the International Ki67 in Breast Cancer Working Group. J Natl Cancer Inst 103:1656–1664

Molecular Classification and Prognostic Signatures of Breast Tumors

5

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5.1 Introduction

Breast cancer is a complex and heterogeneous disease where tumors of the same apparent prognostic type can differ widely in their responsiveness to therapy and survival rates. Traditionally, the classification of breast cancer is performed on the basis of clinical–histopathological parameters, such as age, tumor size, histological grade, lymph node status, and analysis of estrogen receptor (ER), progesterone receptor (PR), and human epidermal growth factor receptor 2 (HER2) expression. The evaluation of these combined factors has been widely used in clinical practice and formed the basis to classify patients into various risk categories such as the St. Gallen criteria [1] and the Nottingham Prognostic Index [2]. However the markedly extensive breast cancer heterogeneity combined with the lack of reliable predictive factors among these categories limits their ability to distinguish subtle phenotypic differences that may present relevant therapeutic implications.

In the past decade, with the development of high-throughput microarray platforms, genome-wide-based methods have been widely employed and a molecular classification of breast cancer has emerged. Gene expression profiling studies have showed that expression pattern analysis can refine the classification of breast tumors into different subtypes, known as "intrinsic" subtypes, and represented a significant improvement over the traditional methods of tumor classification [3, 4]. In addition, several prognostic gene signatures to predict clinical outcome and customize therapy have originated from these studies (for reviews, see [5–9].

In this chapter we will discuss some of these gene expression signatures and their emerging roles in providing new insights into breast cancer classification and in assessing the patient's prognosis and defining therapy.

5.2 Molecular Classification: The Gene Expression "Intrinsic" Subtypes

Genome-wide studies, using microarray-based methods, have allowed the analysis of the DNA copy number changes or gene expression of thousands of genes in a single experiment in a given tumor sample [10–12]. These methods revealed the complexity of the notable breast cancer heterogeneity at the molecular level [13–15] as clearly demonstrated by the large variation in the gene expression patterns.

The pioneer study described by Perou et al. [3], based on gene expression analysis, set the basis for the current molecular classification of breast tumors known as the "intrinsic" subtypes. These authors performed complementary DNA microarray analysis in a set of normal and malignant human breast tissues from 42 individuals. With use of a hierarchical clustering method, the samples were clustered into four molecular subtypes according to differences in their gene expression profiles (of 1,753 genes): luminal, normal breast-like, HER2, and basal-like. In a very simplistic description, luminal tumors were characterized by high expression of hormone receptors and associated genes; normal breast-like cancers were defined by poorly characterized tumors; HER2 subtypes exhibited high expression of HER2 and other genes located in the 17q amplicon and low expression of ER and associated genes; and basal tumors exhibited high expression of basal epithelial genes, basal cytokeratins, and epidermal growth factor receptor (EFGR), and low expression of ER and associated genes. The morphological and

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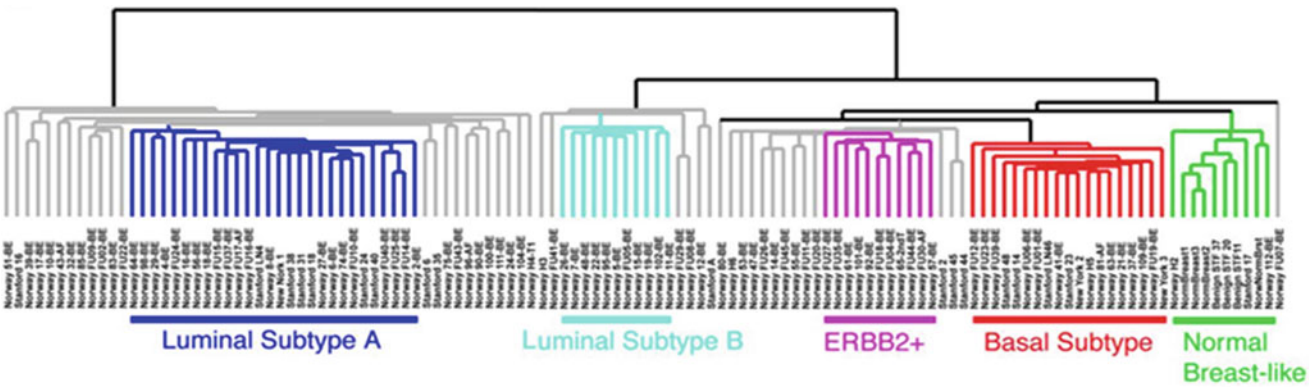

Fig. 5.1 Breast cancer classification into five molecular subtypes. Hierarchical clustering of 115 tumor tissues and seven nonmalignant tissues using the "intrinsic" gene set. Experimental dendrogram showing the clustering of the tumors into five subgroups. Branches corresponding to tumors with low correlation to any subtype are shown in *gray*. (From Sorlie et al. [20])

immunohistochemical features of basal-like cancers were similar to those described for tumors arising in *BRCA1* germ-line mutation carriers [16–19].

In subsequent larger studies from the same group, it was demonstrated that the luminal subtype could be further divided into at least two subgroups (luminal A and luminal B) [4, 20, 21], each with different gene expression profiles and different prognosis (Fig. 5.1). Luminal A tumors exhibited high levels of expression of ER-activated genes and low proliferation rates and were associated with a good prognosis, whereas luminal B tumors were more often of higher histological grade and exhibited higher proliferation rates and a worse prognosis. This initial molecular taxonomy has been validated in several other studies, which also identified a few less defined subtypes, including the interferon-rich, molecular apocrine, and claudin-low tumors [20–28]. The complete molecular characterization of these less defined subtypes has not been performed and the clinical implications have not been fully identified and/or are not known.

The five major molecular subtypes identified in these studies differ not only in regard to their pattern of gene expression and clinical features but also in regard to the response to treatment and clinical outcome [5, 6, 20, 29, 30]. Patients with luminal tumors respond well to endocrine therapy; however, luminal A and luminal B tumors respond differently to the type of endocrine agent used (tamoxifen or aromatase inhibitors) and also exhibit a variable response to chemotherapy [31–34]. Patients with luminal A tumors present with an overall good prognosis with a 5 year survival rate of approximately 90 %. Patients with HER2-amplified tumors respond to trastuzumab antibody monoclonal therapy and to anthracycline-based chemotherapy; however, they generally have a poor prognosis and their 5 year survival rate can be as low as 20 % [35, 36]. Finally, patients with the basal-like tumor subtype have no response to endocrine therapy or trastuzumab therapy; however, they can be sensitive to platinum-based chemotherapy and poly(ADP-ribose) polymerase 1 inhibitors [37–39]. These tumors are especially common in African-American women and generally also have poor prognosis [40–42]. Interestingly, in the neoadjuvant setting, the intrinsic subtypes have also been found to exhibit different responses to treatment. The pathological complete response rates to standard chemotherapy based on anthracycline and taxane was approximately 7 % for the luminal A subtype, 17 % for the luminal B subtype, 36 % for the HER2-positive subtype, and 43 % for the basal-like subtype [32].

To study the utility of these subtypes in breast tumor classification, a total of 189 breast tumors across 1,906 "intrinsic" genes were analyzed by Parker et al. [32]. They identified a set of 50 genes that were further validated and compared for reproducibility of classification across different prediction methods and different patient cohorts. This analysis profiled by quantitative real-time PCR a total of 122 breast cancers from the 189 individuals into the "intrinsic" subtypes luminal A, luminal B, HER2-positive, basal-like, and normal-like. Owing to its high reproducibility, a standardized method of classification was developed, the Prediction Analysis of Microarray 50 (PAM50) Breast Cancer Intrinsic Classifier test, which is currently commercially available (ARUP Laboratories, Salt Lake City, UT, USA). The PAM50 assay offers the measurement of the expression level of 55 genes (50 classifier genes and five housekeepers) and is recommended for all patients diagnosed with invasive breast cancer, regardless of tumor stage or ER status.

The gene expression intrinsic subtypes were discussed for consideration at the last St. Gallen International Breast Cancer Conference [42]. A simplified clinicopathological classification that defines subtypes on the basis of the immunohistochemical analysis of ER, PR, and HER2 status and Ki-67 labeling index (Ki-67 is a cell proliferation marker), similar to what was proposed by Cheang et al. [31], was

Table 5.1 Intrinsic and immunohistochemical (*IHC*) subtypes and type of treatment recommended (St.Gallen's conference, 2011)

Intrinsic subtype	IHC subtype	Definition	Type of treatment
Luminal A	Luminal A	HER2 positive Ki-67 low	Endocrine therapy alone
Luminal B	Luminal B (HER2 negative)	HER2 negative ER positive PR positive Ki-67 high	Endocrine therapy with or without cytotoxic therapy
	Luminal B (HER2 positive)	HER2 positive ER positive PR positive	Cytotoxic therapy plus anti-HER2 therapy plus hormonal therapy
HER2 overexpression	HER2 positive	HER2 positive ER negative PR negative	Cytotoxic therapy plus anti-HER2 therapy
Basal-like	Triple negative	HER2 negative ER negative PR negative	Cytotoxic therapy

Modified from Goldrisch et al. [42] and Perou et al. [3]
ER estrogen receptor, *PR* progesterone receptor, *HER2* human epidermal growth factor receptor 2, ki-67 antigen ki-67- protein marker for cell proliferation

endorsed (Table 5.1). The breast cancer subtypes defined by this classification are similar but not identical to the five intrinsic subtypes and represent a convenient approximation that can be used in considerably less expensive and less complex assays. In general, the therapy recommendations for this classification follow the "intrinsic" subtype classification: luminal A tumor patients generally require only endocrine therapy, considering that they are mostly less responsive to chemotherapy; luminal B patients, in addition to endocrine therapy, should receive chemotherapy (both anthracycline-based and taxane-based); patients with HER2-positive tumors should receive chemotherapy and 1 year of treatment with trastuzumab; and patients with triple-negative tumors should be treated with chemotherapy (also anthracycline-based and taxane-based in addition to an alkylating agent, typically cyclophosphamide).

The St. Gallen panel [42] did not endorse the measurement of cytokeratin 5/6 or epidermal growth factor receptor for the determination of basal-like tumors for clinical decision making. In the future, this formal subtyping is very likely to be refined and expanded to include the measurement of novel tumor markers; presently, however, the St. Gallen consensus recommends the classification of breast cancer subtypes and the guide to therapeutic decisions to be based only on the four clinicopathological markers described above.

Although gene expression profiling has greatly contributed to the determination of breast cancer subtypes and their associated differential prognosis, presently this defined "intrinsic" molecular classification is not routinely used in clinical practice to classify the patient's breast tumor subtype, and no new target therapies have yet resulted for these subtypes [43–45]. Several technical challenges limit its use in clinical practice, including not only the prohibitive costs of the equipment and reagents for the expression assays and the lack of suitable technical personnel to conduct the complex informatics data analysis, but mainly the lack of reproducibilty and uniformity among laboratories in relation to the selection of the "intrinsic" genes to be used. This latter limitation can be easily perceived by the existence of multiple versions of molecular classification systems developed or under development. In addition, most gene expression microarray analyses were performed by independent investigators using different methods and applied to different patient populations. Another important variability was the cellular composition of the tissue samples (stroma, tumor, and normal cells) in these studies [46, 47]. Cleator et al. [46], in evaluating the cellular composition of the classified samples, demonstrated that the percentage of invasive cancer cells within a sample influenced the expression profile; at least 10 % of the genes (144 genes) were found to correlate with cellular composition.

Other challenges include biological inherent facts, such as that the subtypes assigned by microarrays do not always correspond to the same subtype defined by the routine immunohistochemical (IHC) staining that is used in standard clinical assays [32, 48, 49]. In the retrospective analysis by de Ronde et al. [48], 195 stage II and stage III breast tumors from patients that received neoadjuvant treatment were classified by both IHC and messenger RNA expression analysis on then basis of the molecular classification. The IHC and molecular subtypes showed high concordance with the exception of the HER2 group, where 60 % of the HER2-positive tumors were not classified as the HER2 molecular subtype. In addition, for the ER-positive tumors, neither the PR status nor the endocrine responsiveness index (all the

Table 5.2 Commonest prognostic gene expression breast cancer signatures commercially available

Gene expression signatures	Patient population	Prediction	Number of genes	Material	Assay	Company
Onco*type* Dx	ER positive/ negative LN negative Tamoxifen treated	Risk of recurrence	21 genes	FFPE	RT-PCR	Genomic Health (Redwood City, CA, USA)
MammaPrint	ER positive/ negative LN negative Tumor size < 5 cm Age < 61 years	Risk of distant metastasis	70 genes	Frozen	Microarray	Agendia (Huntington Beach, CA, USA, and Amsterdam, The Netherlands)
PAM50	LN negative ER positive/ negative No systemic therapy	Risk of relapse	55 genes	Frozen/ FFPE	qRT-PCR/ microarray[a]/ nCounter[b]	ARUP Laboratories (Salt Lake City, UT, USA): (qRT-PCR format) Nanostring Technologies (Seattle, WA, USA): nCounter format
MapQuant DX	ER positive/ negative LN positive/ negative	Molecular grading	97 genes	Frozen/ FFPE	Microarray	Ipsogen (New Haven, CT, USA, and Marseilles, France)
Breast Cancer Index	ER positive LN negative	Risk of late recurrence Response to endocrine therapy	2 genes, HOXB13:IL17R molecular grade index	FFPE	RT-PCR	BioTheranostics (San Diego, CA, USA)

ER estrogen receptor, *LN* lymph node, *FFPE* formalin-fixed paraffin-embedded, *RT-PCR* real-time PCR, *qRT-PCR* quantitative real-time PCR
[a] PAM50, marketed by Arup Laboratories as a breast cancer classifier
[b] In development

tumors showed similar degrees of response to chemotherapy) accurately distinguished the tumors into the luminal A and luminal B subtypes. In fact, several studies have suggested that these ER-positive subtypes may not be completely separate entities [50–52].

Once these and others critical challenges are overcome and a universally accepted signature for identifying breast cancer subtypes is established, assays that can maintain a similar level of analytical reproducibility and clinical utility can be developed and implemented for the molecular classification of a patient's breast tumor. However such assays should not be expected, at least not soon, to replace the traditional breast cancer classification systems.

5.3 Prognostic Gene Expression Signatures

In the daily management of breast cancer, the selection of the most appropriate adjuvant treatment for an individual patient remains a challenge, despite the excellent assistance of the established therapy guidelines such as those of the St. Gallen consensus [1, 42], the National Institutes of Health [53], and Adjuvant! Online (http://www.adjuvantonline.com). The ability to identify breast cancer patients with either a very high or a very low risk of recurrence, who would need adjuvant systemic therapy, from those who could be spared such type of treatment is critical. The power of making this distinction at the time of diagnosis, from the analysis of the patient's primary tumor, would substantially improve breast cancer survival.

Several multigene signatures that predict outcome and response to therapy in breast cancer have been developed through the data obtained from gene expression profiling (for reviews, see [5–9] (Table 5.2). In these studies, major prognostic factors, such as lymph node status and ER status, were addressed and have allowed subgroups of tumors with a very distinct clinical outcome that could not be predicted by conventional prognostic factors to be distinguished in the analysis of the patient's primary tumors. The main objective in most of these studies was to predict which patients would benefit from a more aggressive treatment and which patients would be unlikely to respond and therefore for whom there would not be a significant survival benefit.

Vant'veer et al. [54], some of the pioneers of these studies, proposed a prognostic gene signature to identify a group of good prognosis patients with minimal risk of

development of distant metastasis within 5 years after diagnosis. The expression of 25,000 genes was analyzed in primary breast tumors, and a set of 70 genes with differential expression profiles separated the patients into two categories, "poor" and "good" signature groups, on the basis of their risk of developing distant metastasis. Among the genes that were upregulated in the poor signature group were genes involved in the cell cycle, angiogenesis, invasion and metastasis, and signal transduction, such as *CCNE2*, *MCM6*, *MMP9, MP1*, *RAB6B*, *PK428*, *ESM1*, and the vascular endothelial growth factor receptor *FLT1*. Subsequent studies confirmed the reproducibility of the initial 70-gene signature as a predictor of outcome independently of traditional clinical–histopathological prognostic markers [55–57]. This validation analysis led to the development of the commercial test MammaPrint developed by Agendia (Amsterdam, The Netherlands). This test is approved by the Food and Drug Administration for use in patients less than 61 years old, who are lymph-node-negative, and who present with a tumor smaller than 5 cm in size. This signature is currently being evaluated in a large clinical trial, MINDACT (Microarray In Node-Negative and 1–3 Positive Lymph-Node Disease May Avoid Chemotherapy Trial), which is performed in breast cancer patients with ER-positive, lymph-node-negative disease with long-term follow-up and known clinical outcome. The primary end point is to test its robustness and clinical applicability in identifying patients who could be spared the use of chemotherapy without affecting the survival outcome. On the basis of an independent validation study [58], this trial now also includes patients with one to three positive axillary lymph nodes.

The other prognostic signature also commercially available is the Onco*type* DX breast cancer assay (Genomic Health, Redwood City, CA, USA). This assay was developed on the basis of the identification of 250 selected genes with different expression profiles [59–61], initially tested in patients from the National Surgical Adjuvant Breast and Bowel Project (NSABP) B-20 clinical trial [62]. After statistical analysis and clinical validation, 21 genes (16 cancer-related genes and five reference genes) were selected and their expression analysis was translated into a "recurrence score" (RS), which was then used to assign the patients to one of three groups, on the basis of the risk of developing distant metastasis: low risk (RS < 18), intermediate risk (RS ≥ 18 and RS < 31), and high risk (RS ≥ 31) [63]. This validation study was performed in lymph-node-negative, ER-positive breast cancer patients who were treated with tamoxifen in the large, multicenter NSABP B-14 trial [64]. Subsequent studies have demonstrated its clinical utility as an independent prognostic parameter in ER-positive and lymph-node-positive patients who received adjuvant chemotherapy [65] and also in postmenopausal patients with ER-positive tumors who were treated with aromatase inhibitors [66]. An ongoing large prospective clinical trial, TAILORX [Trial Assigning Individualized Options for Treatment (Rx)], is further testing the clinical utility of Onco*type* DX with the primary end point of accessing whether adjuvant chemotherapy plus hormonal therapy produces a better outcome when compared with hormonal therapy alone in patients who have a low or intermediate score (RS between 11 and 25).

In contrast to MammaPrint, which is performed by a microarray assay in frozen tumor tissue samples, Onco*type* DX can be performed by real-time PCR in formalin-fixed paraffin-embedded samples, not requiring therefore the highest-quality RNA material. The Onco*type* DX prognostic test has been endorsed by the American Society of Clinical Oncology [67] for clinical use and was included in the last National Comprehensive Cancer Network guidelines (Breast Cancer version 1.201) and the St. Gallen International Expert Consensus [42]. The recommendation for its use is limited to newly diagnosed patients with lymph-node-negative, ER-positive breast cancer who were treated with tamoxifen. The clinical utility and appropriate application recommendations for other multigene assays, such as MammaPrint, are under investigation.

The PAM50 multigene gene-expression-based assay, described above as an "intrinsic" subtype classification assay, is also used to predict prognosis. This assay can predict relapse-free survival, based on a risk of relapse (ROR) score, for patients with lymph-node-negative tumors who were not treated with adjuvant systemic therapy [32]. The prediction value of the ROR was evaluated in an independent set of 786 patients with ER-positive tumors who were treated only with tamoxifen [33]. For both lymph-node-negative and lymph-node-positive patients, the ROR together with tumor size outperformed standard clinicopathological variables, such as Ki-67, PR, and histological grade. For the lymph-node-negative patients the PAM50 ROR identified a group with more than 95 % 10 year survival who had not been submitted to chemotherapy.

Several other prognostic signatures were developed, including ones that take into consideration the patient's tumor grade, such as MapQuant Dx (Ipsogen, Marseille, France), a microarray-based assay originally based on 97 differentially expressed genes, which was validated as strongly associated with risk of recurrence among patients with grade 2 tumors [68, 69], and the Theros Breast Cancer Index (BCI BioTheranostics, San Diego, CA, USA), which is based on a quantitative real-time PCR assay and provides an assessment of the likelihood of distant recurrence in patients diagnosed with ER-positive and lymph-node-negative breast cancer. It uses a combination of indices (HOXB13:IL17BR two-gene ratio) and a proliferation-related five-gene molecular grade index, which discriminates grade

1 from grade 3 breast tumors [70, 71]. Several other prognostic signatures that predict clinical outcome were developed on the basis of cancer cell characteristics and processes, including wound healing, hypoxia, stem cells, and stroma–fibroblast interactions [72–77].

Although the importance of the gene expression signature of breast tumors has been well established and may be a more accurate prognostic marker than other well-established clinical–histopathological criteria, one cannot assume that all the genes present in these gene expression signature panels are equally important or have an independent role in breast cancer pathogenesis and recurrence. Successful enrichment, reliable identification, and molecular profiling of pure epithelial tumor cells are still key issues to be addressed [78, 79].

Interestingly, although there is very little overlap among these signatures in relation to the gene composition, most of them are related to proliferation and ER-signaling cellular processes [52, 80, 81]. It is no coincidence that the prediction power of most of these signatures is more robust and indicated for ER-positive tumors/luminal subtype and less for the ER-negative subtypes [81], hence the specific clinical indication of most of these prognostic gene-expression-based assays for patients with ER-positive, lymph-node-negative disease for whom it is safer to recommend a treatment based only on hormonal therapy. Recent studies have provided evidence that other genes related to cellular processes, including the expression of immune-response genes, have the potential to predict survival, especially within the HER2-positive and basal-like subtypes of tumors [82–86].

5.4 Conclusions

The rapid advances in the DNA microarray technology and the ability of performing large-scale validations have allowed the development of gene expression signatures that can be used to identify breast cancer molecular subtypes and predict response to therapy and clinical outcome. It is without question that the continued improvement of molecular tumor profiling in gene-expression-based assays and the development of next-generation technologies, such as large-scale sequencing, will lead to successful application of these and newly developed gene signatures in the clinical setting. These efforts will certainly be reflected in the stratification of breast cancer disease into a newly refined taxonomy, allowing for the understanding of the genetic diversity in the different breast cancer subtypes. In addition, considering that the success of a treatment largely depends on the ability to match a particular tumor phenotype to a specific tumor genomic target, these new technologies will provide the identification of new therapeutically targetable markers, leading to the development of novel diagnostic tests to guide the most appropriate and individualized cancer therapy. Finally, considering the current dissemination of the genomically based testing and treatment strategies for cancer, it is imperative to address the use of these tests on the impact of the therapeutic decision making and the patient's health outcome, taking into consideration the social and economic variants of specific breast cancer patient populations.

References

1. Goldhirsch A, Ingle JN, Gelber RD et al (2009) Thresholds for therapies: highlights of the St. Gallen international expert consensus on the primary therapy of early breast cancer. Ann Oncol 8:1319–1329
2. Galea MH, Blamey RW, Elston CE et al (1992) The Nottingham Prognostic Index in primary breast cancer. Breast Cancer Res Treat 3:207–219
3. Perou CM, Sorlie T, Eisen MB et al (2000) Molecular portraits of human breast tumors. Nature 6797:747–752
4. Sorlie T, Perou CM, Tibshirani R et al (2001) Gene expression patterns of breast carcinomas distinguish tumor subclasses with clinical implications. Proc Natl Acad Sci USA 19:10869–10874
5. Sotiriou C, Pusztai L (2009) Gene-expression signatures in breast cancer. N Engl J Med 360:790–800
6. Weigelt B, Baehner FL, Reis-Filho JS (2010) The contribution of gene expression profiling to breast cancer classification, prognostication and prediction: a retrospective of the last decade. J Pathol 220:263–280
7. Colombo PE, Milanezi F, Weigelt B et al (2011) Microarrays in the 2010 s: the contribution of microarray-based gene expression profiling to breast cancer classification, prognostication and prediction. Breast Cancer Res 13:212–227
8. Fumagalli D, Desmedt C, Ignatiadis M et al (2011) Gene profiling assay and application: the predictive role in primary therapy. J Natl Cancer Inst Monogr 124–127
9. Reis-Filho JS, Pusztai L (2011) Gene expression profiling in breast cancer: classification, prognostication, and prediction. Lancet 378:1812–1823
10. Pinkel D, Segraves R, Sudar D et al (1998) High resolution analysis of DNA copy number variation using comparative genomic hybridization to microarrays. Nat Genet 20:207–211
11. Duggan DJ, Bittner M, Chen Y et al (1999) Expression profiling using cDNA microarrays. Nat Genet 21:10–14
12. Pollack JR, Sørlie T, Perou CM et al (2002) Microarray analysis reveals a major direct role of DNA copy number alteration in the transcriptional program of human breast tumors. Proc Natl Acad Sci USA 99:12963–12968
13. Shipitsin M, Campbell LL, Argani P et al (2007) Molecular definition of breast tumor heterogeneity. Cancer Cell 11:259–273
14. Stingl J, Caldas C (2007) Molecular heterogeneity of breast carcinomas and the cancer stem cell hypothesis. Nat Rev Cancer 7:791–799
15. Weigelt B, Reis-Filho JS (2009) Histological and molecular types of breast cancer: is there a unifying taxonomy? Nat Rev Clin Oncol 6:718–730
16. Laakso M, Loman N, Borg A et al (2005) Cytokeratin 5/14-positive breast cancer: true basal phenotype confined to BRCA1 tumors. Mod Pathol 18:1321–1328

17. Lakhani SR, Reis-Filho JS, Fulford L et al (2005) Prediction of BRCA1 status in patients with breast cancer using estrogen receptor and basal phenotype. Clin Cancer Res 11:5175–5180
18. Turner NC, Reis-Filho JS (2006) Basal-like breast cancer and the BRCA1 phenotype. Oncogene 25:5846–5853
19. Eerola H, Heinonen M, Heikkila P et al (2008) Basal cytokeratins in breast tumours among BRCA1, BRCA2 and mutation-negative breast cancer families. Breast Cancer Res 10:R17
20. Sorlie T, Tibshirani R, Parker J et al (2003) Repeated observation of breast tumor subtypes in independent gene expression data sets. Proc Natl Acad Sci USA 100:8418–8423
21. Sorlie T, Wang Y, Xiao C et al (2006) Distinct molecular mechanisms underlying clinically relevant subtypes of breast cancer: gene expression analyses across three different platforms. BMC Genomics 7:127
22. Farmer P, Bonnefoi H, Becette V et al (2005) Identification of molecular apocrine breast tumours by microarray analysis. Oncogene 24:4660–4671
23. Doane AS, Danso M, Lal P et al (2006) An estrogen receptor-negative breast cancer subset characterized by a hormonally regulated transcriptional program and response to androgen. Oncogene 25:3994–4008
24. Hu Z, Fan C, Oh DS et al (2006) The molecular portraits of breast tumors are conserved across microarray platforms. BMC Genomics 7:96
25. Teschendorff AE, Caldas C (2008) A robust classifier of high predictive value to identify good prognosis patients in ER-negative breast cancer. Breast Cancer Res 10:R73
26. Hennessy BT, Gonzalez-Angulo AM, Stemke-Hale K et al (2009) Characterization of a naturally occurring breast cancer subset enriched in epithelial-to-mesenchymal transition and stem cell characteristics. Cancer Res 69:4116–4124
27. Banneau G, Guedj M, MacGrogan G et al (2010) Molecular apocrine differentiation is a common feature of breast cancer in patients with germline PTEN mutations. Breast Cancer Res 12:R63
28. Prat A, Parker JS, Karginova O et al (2010) Phenotypic and molecular characterization of the claudin-low intrinsic subtype of breast cancer. Breast Cancer Res 12:R68
29. Rouzier R, Perou CM, Symmans WF et al (2005) Breast cancer molecular subtypes respond differently to preoperative chemotherapy. Clin Cancer Res 11:5678–5685
30. Martin M, Romero A, Cheang MC et al (2011) Genomic predictors of response to doxorubicin versus docetaxel in primary breast cancer. Breast Cancer Res Treat 128:127–136
31. Cheang MCU, Chia SK, Voduc D et al (2009) Ki67 index, HER2 status, and prognosis of patients with luminal B breast cancer. J Natl Cancer Inst 101:736–750
32. Parker JS, Mullins M, Cheang MC et al (2009) Supervised risk predictor of breast cancer based on intrinsic subtypes. J Clin Oncol 27:1160–1167
33. Nielsen TO, Parker JS, Leung S et al (2010) A comparison of PAM50 intrinsic subtyping with immunohistochemistry and clinical prognostic factors in tamoxifen-treated estrogen receptor-positive breast cancer. Clin Cancer Res 16:5222–5232
34. Iwamoto T, Bianchini G, Booser D et al (2011) Gene pathways associated with prognosis and chemotherapy sensitivity in molecular subtypes of breast cancer. J Natl Cancer Inst 103:264–272
35. Arteaga CL, Sliwkowski MX, Osborne CK et al (2011) Treatment of HER2-positive breast cancer: current status and future perspectives. Nat Rev Clin Oncol 9:16–32
36. Mukohara T. Role of HER2-targeted agents in adjuvant treatment for breast cancer. *Chemother Res Pract* 730360, 2011
37. Banerjee S, Reis-Filho JS, Ashley S et al (2006) Basal-like breast carcinomas: clinical outcome and response to chemotherapy. J Clin Pathol 59:729–735
38. Rakha EA, Reis-Filho JS, Ellis IO (2008) Basal-like breast cancer: a critical review. J Clin Oncol 26:2568–2581
39. Fong PC, Boss DS, Yap TA et al (2009) Inhibition of poly(ADP-ribose) polymerase in tumors from BRCA mutation carriers. N Engl J Med 361:123–134
40. Carey LA, Dees EC, Sawyer L et al (2007) The triple negative paradox: primary tumor chemosensitivity of breast cancer subtypes. Clin Cancer Res 13:2329–2334
41. Millikan RC, Newman B, Tse CK et al (2008) Epidemiology of basal-like breast cancer. Breast Cancer Res Treat 109:123–139
42. Goldhirsch A, Wood WC, Coates AS et al (2011) Strategies for subtypes-dealing with the diversity of breast cancer: highlights of the St. Gallen international expert consensus on the primary therapy of early breast cancer. Ann Oncol 22:1736–1747
43. Desmedt C, Ruíz-García E, André F (2008) Gene expression predictors in breast cancer: current status, limitations and perspectives. Eur J Cancer 44:2714–2720
44. van der Vegt B, de Bock GH, Hollema H et al (2009) Microarray methods to identify factors determining breast cancer progression: potentials, limitations, and challenges. Crit Rev Oncol Hematol 70:1–11
45. Weigelt B, Pusztai L, Ashworth A et al (2011) Challenges translating breast cancer gene signatures into the clinic. Nat Rev Clin Oncol 9:58–64
46. Cleator SJ, Powles TJ, Dexter T et al (2006) The effect of the stromal component of breast tumours on prediction of clinical outcome using gene expression microarray analysis. Breast Cancer Res 8:R32
47. Mackay A, Weigelt B, Grigoriadis A et al (2011) Microarray-based class discovery for molecular classification of breast cancer: analysis of interobserver agreement. J Natl Cancer Inst 103:662–673
48. de Ronde JJ, Hannemann J, Halfwerk H et al (2010) Concordance of clinical and molecular breast cancer subtyping in the context of preoperative chemotherapy response. Breast Cancer Res Treat 119:119–126
49. Weigelt B, Mackay A, A'Hern R et al (2010) Breast cancer molecular profiling with single sample predictors: a retrospective analysis. Lancet Oncol 4:339–349
50. Shak S, Baehner FL, Palmer G et al (2006) Subtypes of breast cancer defined by standardized quantitative RT–PCR analysis of 10 618 tumors. Breast Cancer Res Treat 100:S295–S295
51. Desmedt C, Haibe-Kains B, Wirapati P et al (2008) Biological processes associated with breast cancer clinical outcome depend on the molecular subtypes. Clin Cancer Res 14:5158–5165
52. Wirapati P, Sotiriou C, Kunkel S et al (2008) Meta-analysis of gene expression profiles in breast cancer: toward a unified understanding of breast cancer subtyping and prognosis signatures. Breast Cancer Res 10:R65
53. Eifel P, Axelson JA, Costa J et al (2001) National institutes of health consensus development conference statement: adjuvant therapy for breast cancer. November 1–3, 2000. J Natl Cancer Inst 93:979–989
54. van't Veer LJ, Dai H, van de Vijver MJ et al (2002) Gene expression profiling predicts clinical outcome of breast cancer. Nature 6871:530–536
55. van de Vijver MJ, He YD, van't Veer LJ, et al (2002) A gene expression signature as a predictor of survival in breast cancer. N Engl J Med 347:1999–2009
56. Buyse M, Loi S, van't Veer L, et al (2006) Validation and clinical utility of a 70-gene prognostic signature for women with node-negative breast cancer. J Natl Cancer Inst 98:1183–1192
57. Bueno-de-Mesquita JM, van Harten WH, Retel VP et al (2007) Use of 70-gene signature to predict prognosis of patients with node-negative breast cancer: a prospective community-based feasibility study (RASTER). Lancet Oncol 8:1079–1087

58. Mook S, Schmidt MK, Viale G et al (2009) The 70-gene prognosis-signature predicts disease outcome in breast cancer patients with 1–3 positive lymph nodes in an independent validation study. Breast Cancer Res Treat 116:295–302
59. Cobleigh MA, Bitterman P, Baker J et al (2003) Tumor gene expression predicts distant disease-free survival (DDFS) in breast cancer patients with 10 or more positive nodes: high throughout RT-PCR assay of paraffin-embedded tumor tissues. Prog Proc Am Soc Clin Oncol 22:850–850
60. Esteban J, Baker J, Cronin M et al (2003) Tumor gene expression and prognosis in breast cancer: multi-gene RT-PCR assay of paraffin-embedded tissue. Prog Proc Am Soc Clin Oncol 22:850
61. Paik S, Shak S, Tang G et al (2003) Multi-gene RT-PCR assay for predicting recurrence in node negative breast cancer patients: NSABP studies B-20 and B-14. Breast Cancer Res Treat 82:A16
62. Fisher B, Dignam J, Wolmark N et al (1997) Tamoxifen and chemotherapy for lymph node-negative, estrogen receptor-positive breast cancer. J Natl Cancer Inst 89:1673–1682
63. Paik S, Shak S, Tang G et al (2004) A multigene assay to predict recurrence of tamoxifen-treated, node-negative breast cancer. N Engl J Med 351:2817–2826
64. Fisher B, Costantino J, Redmond C et al (1989) A randomized clinical trial evaluating tamoxifen in the treatment of patients with node-negative breast cancer who have estrogen-receptor-positive tumors. N Engl J Med 320:479–484
65. Habel LA, Shak S, Jacobs MK et al (2006) A population based study of tumor gene expression and risk of breast cancer death among lymph node-negative patients. Breast Cancer Res 8:R25
66. Dowsett M, Cuzick J, Wale C et al (2010) Prediction of risk of distant recurrence using the 21-gene recurrence score in node-negative and node-positive postmenopausal patients with breast cancer treated with anastrozole or tamoxifen: a TransATAC study. J Clin Oncol 11:1829–1834
67. Harris L, Fritsche H, Mennel R et al (2007) American Society of Clinical Oncology 2007 update of recommendations for the use of tumor markers in breast cancer. J Clin Oncol 33:5287–5312
68. Loi S, Haibe-Kains B, Desmedt C et al (2007) Definition of clinically distinct molecular subtypes in estrogen receptor-positive breast carcinomas through genomic grade. J Clin Oncol 25:1239–1246
69. Ma XJ, Salunga R, Dahiya S et al (2008) A five-gene molecular grade index and HOXB13:IL17BR are complementary prognostic factors in early stage breast cancer. Clin Cancer Res 14:2601–2608
70. Jerevall PL, Ma XJ, Li H et al (2011) Prognostic utility of HOXB13:IL17BR and molecular grade index in early-stage breast cancer patients from the Stockholm trial. Br J Cancer 104: 1762–1769
71. Chang HY, Sneddon JB, Alizadeh AA et al (2004) Gene expression signature of fibroblast serum response predicts human cancer progression: similarities between tumors and wounds. PLoS Biol 2:E7
72. West RB, Nuyten DS, Subramanian S et al (2005) Determination of stromal signatures in breast carcinoma. PLoS Biol 3:e187
73. Chi JT, Wang Z, Nuyten DS et al (2006) Gene expression programs in response to hypoxia: cell type specificity and prognostic significance in human cancers. PLoS Med 3:e47
74. Liu R, Wang X, Chen GY et al (2007) The prognostic role of a gene signature from tumorigenic breast-cancer cells. N Engl J Med 356:217–226
75. Finak G, Bertos N, Pepin F et al (2008) Stromal gene expression predicts clinical outcome in breast cancer. Nat Med 14:518–527
76. Reyal F, van Vliet MH, Armstrong NJ et al (2008) A comprehensive analysis of prognostic signatures reveals the high predictive capacity of the proliferation, immune response and RNA splicing modules in breast cancer. Breast Cancer Res 10:R93
77. Desmedt C, Michiels S, Haibe-Kains B et al (2011) Time to move forward from "first-generation" prognostic gene signatures in early breast cancer. Breast Cancer Res Treat 128:643–645
78. Espinosa E, Vara JÁ, Navarro IS et al (2011) Gene profiling in breast cancer: time to move forward. Cancer Treat Rev 37:416–421
79. Fan C, Oh DS, Wessels L et al (2006) Concordance among gene-expression-based predictors for breast cancer. N Engl J Med 355:560–569
80. Fan C, Prat A, Parker JS, et al (2011) Building prognostic models for breast cancer patients using clinical variables and hundreds of gene expression signatures. BMC Med Genomics 9(4):3
81. Miglietta A, Toselli M, Ravarino N et al (2010) COX-2 expression in human breast carcinomas: correlation with clinicopathological features and prognostic molecular markers. Expert Opin Ther Targets 14:655–664
82. Schmidt M, Gehrmann M, Hengstler JG et al (2010) New prognostic and predictive factors in breast cancer. Minerva Ginecol 62:599–611
83. Barısık NO, Keser SH, Gul AE et al (2011) The value of COX-2 expression in the prognostic parameters of invasive ductal carcinoma of the breast. Med Oncol 28:703–708
84. Rody A, Karn T, Liedtke C, et al (2011) A clinically relevant gene signature in triple negative and basal-like breast cancer. Breast Cancer Res 13:R97
85. Hallett RM, Dvorkin-Gheva A, Bane A et al (2012) A gene signature for predicting outcome in patients with basal-like breast cancer. Sci Rep 2:227
86. Schmidt M, Hellwig B, Hammad S, et al (2012) A comprehensive analysis of human gene expression profiles identifies stromal immunoglobulin kappa C as a compatible prognostic marker in human solid tumors. Clin Cancer Res

Breast Cancer Patient and Reconstructive Consultation

6

J. Michael Dixon and Cameron Raine

6.1 Introduction

Patients with primary or recurrent breast cancer having a mastectomy or very wide excision should be considered for whole or partial breast reconstruction. It is important to have reconstructive surgeons present at the multidisciplinary team meetings at which such decisions are made. For patients with larger operable invasive cancers, options other than mastectomy should be considered. This includes bilateral therapeutic mammaplasty which allows large areas of breast tissue to be excised and to leaves smaller symmetrical breasts. Another option in development for smaller breasted women who otherwise require mastectomy is wide local excision of the cancer and immediate breast lipofilling. Where there are options, these can and should be discussed with the patient. For those women who are deemed suitable candidates for whole or partial breast reconstruction, both the timing and the options for reconstructive surgery should be considered and discussed with the patient.

6.2 Guiding Principles in Breast Reconstruction

Treatment of the cancer should not be compromised by breast reconstruction. The need to achieve an aesthetically satisfactory breast reconstruction, however important this is to the patient, should not stand in the way of ensuring that any surgery removes all disease to limit local recurrence and radiation and systemic therapy is delivered in a timely manner to maximise long-term local and systemic control.

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One issue of concern is that if major complications develop after reconstructive surgery, then this could delay administration of radiotherapy and chemotherapy. The overwhelming body of evidence indicates that immediate breast reconstruction is safe and appropriate for most patients undergoing mastectomy and does not impact significantly on the timing of adjuvant therapy [1]. Furthermore, studies have indicated that, in general, better results are obtained with immediate reconstruction compared with delayed reconstruction because skin and other soft tissues can be preserved; these are normally removed as part of a standard mastectomy [2]. Good oncological surgery which removes all the breast tissue does not have to be destructive, and in most patients it is not necessary to remove all the skin over the breast, the nipple–areola complex or the pectoral fascia. This does not mean that excellent results cannot be obtained by delayed breast reconstruction [3].

In every centre there should be a multidisciplinary team approach to breast cancer management and a similar multidisciplinary approach should be available when considering breast reconstruction . Any surgical plan must incorporate information from all members of the breast management team, including the breast surgeon, radiologists, oncologists, pathologists, nurses and support staff. If a plastic surgeon who was not present at the multidisciplinary meeting is to be involved in the discussion about breast reconstruction, then that surgeon needs to be aware of what the patient has been told about her breast cancer and what options have been discussed with the patient. If risk-reducing mastectomy is planned, then the reconstructive surgeon needs to know whether it is to be a skin-sparing or nipple-sparing mastectomy before having any discussions with the patient. The best option for the patient is a joint consultation between the oncological surgeon and the plastic surgeon. In some centres the onocological surgery and reconstruction is performed by appropriately trained oncoplastic surgeons. It is imperative such individuals offer the same range of procedures that a combination of a breast oncological surgeon and a plastic surgeon can offer. If the

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oncoplastic surgeon is not able to offer free flap breast reconstruction, then onward referral to a suitable plastic surgeon should be arranged if a free flap is considered the patient's best option.

Breast reconstruction is not normally done in one operation, but typically requires two or three operations. Even if breast reconstruction is performed immediately, surgery to achieve true symmetry usually involves additional procedures in the ensuing months. This can include changing a tissue expander for a permanent implant, a nipple or areola reconstruction, revision of autologous tissue transfer, liposuction or lipofilling for contour refinement or scar revisions. Patients who undergo unilateral breast reconstruction often require a contralateral breast procedure such as mastopexy, augmentation, a reduction or even risk-reducing mastectomy. From the outset, the patient's expectations need to take account of the long-term reconstructive plan and patients need to be aware that to achieve good symmetry often requires more than one operation.

Patient preference and lifestyle are very important when planning reconstructive breast surgery. Patients may express a strong preference for one type of reconstruction and seek a particular reconstructive surgeon on the basis of the types of surgery the surgeon can offer. Although implant-based reconstructions are often considered simple, they can be far from simple to achieve good cosmetic results and require considerable expertise and are not without complications [3]. Patients who participate in sports or other activities that require significant abdominal strength may not wish abdominal flap operations. Certain lifestyles can dictate where scars should be placed, for instance when raising a latissimus dorsi (LD) flap, and so the reconstructive surgeon needs to be aware of the patient's occupation and other aspects of the patient's lifestyle prior to making any recommendation or discussing options with patients.

6.3 Patient Consultation

The main aim of the discussion dealing with breast reconstruction is to inform women regarding the reconstructive options that are available in general and that are appropriate for them in particular. The current advice is that women should be provided with verbal, written and photographic information regarding the full range of reconstructive options [3]. Any reconstructive options that are unsuitable for the individual patient should be specifically identified and the reasons explained. It is also important that women considering reconstruction are seen by specialist reconstructive surgeons. For many patients this will mean seeing more than one surgeon. Preferably, as outlined already, these surgeons should see the patient together and provide the patient with clear information on the reconstructive choices, and who will do what during any planned surgery.

Some concern has been expressed in relation to performing breast reconstruction in patients with advanced disease. This includes locally advanced and metastatic disease. There is evidence that removing the cancer even in patients with known metastatic disease improves their overall outcome [4]. This means that mastectomy with or without reconstruction should not be discounted in patients with metastatic disease. For these women, breast reconstruction is entirely feasible once appropriate systemic therapy has produced stabilisation of metastatic disease. In patients with locally advanced breast cancer, systemic therapy can produce dramatic responses allowing both greater tissue and greater skin preservation [5], and in patients who require mastectomy can make breast reconstruction an option for many women. Even in patients who have locally advanced cancer with skin involvement, breast reconstruction is possible with myocutaneous flaps.

When agreement has been reached that whole or partial breast reconstruction is appropriate for the patient; the aim of the reconstructive consultation is to evaluate the various reconstructive options against the background of the patient's wishes and expectations whilst considering the patient's suitability for any given technique.

There is a huge variation not only in the type of reconstructions different units perform but also in the percentage of patients who have immediate or delayed reconstruction across and between countries [1–3]. There is no scientific basis for this huge variation, and within countries steps need to be taken to ensure consistent availability of the whole range of reconstructive options in all regions and centres. It is important that centres that perform breast reconstruction compare their own use of different reconstructive techniques with those of other centres in the country in which they work. Patients should be informed of all their potential options and have the opportunity to discuss available options in detail. An important part of the initial consultation is that patients are made aware of the rates of postoperative complications and that they are given a realistic perspective on the pain and discomfort associated with the procedure, including realistic outlines of recovery time from each of the various operations and the necessity for most patients to undergo more than one procedure to obtain symmetry [3]. One audit showed patients were poorly informed in relation to the pain and discomfort involved and the time it took to recover after various procedures [3]; following the audit, various recommendations were made:

- Clinicians should act to better inform women about both the procedures they decide to undergo and the reconstructive options available.
- Clinicians should ensure that women are offered a full range of appropriate reconstructive options, whether or not these are available locally.

Table 6.1 Complication rates as reported by patients at 3 months following mastectomy and immediate or delayed breast reconstruction

	Postdischarge complications (%)		
	Mx	IBR	DBR
Readmission for treatment or surgery	10	16	15
Wound infection requiring antibiotics	19	25	28
Unplanned removal of implant	–	10	7
Surgery to remove some or all of flap	–	4	6

Source UK National Mastectomy and Breast Reconstructive Audit: third annual report 30 June 2010 [3]
Mx mastectomy, *IBR* immediate breast reconstruction, *DBR* delayed breast reconstruction

- Clinicians should give accurate data on postoperative complications to inform women about the risks of different operations.
- Women considering reconstruction should be informed preoperatively that the chance of requiring further surgery either during their initial admission or postoperatively is around one in ten.
- Women must be informed how to report their levels of pain and be able to access appropriate pain relief, and be provided with adequate psychological support following their surgery.

Complication rates, particularly implant loss, have been underestimated and in large series can be significant [3] (Table 6.1). The discussion should include the possible need for symmetrising surgery on the contralateral normal breast to obtain true symmetry.

Patients considering bilateral risk-reducing mastectomy and bilateral breast reconstruction are often referred through family history clinics after having discussed options, including screening and the use of currently available pharmaceutical agents to reduce breast cancer development.

Patients wishing to be considered for delayed partial breast reconstruction may attend because of asymmetry following breast-conserving surgery and radiotherapy. These patients attend to discuss possible reconstructive options because of the impact that breast asymmetry has on their everyday quality of life.

6.4 Assessing the Patient's Fitness for Reconstructive Surgery

There are a variety of factors which need to be considered when considering a patient's suitability for breast reconstruction, including age, co-morbidities, body mass index, smoking history, diabetes, steroid/other drug therapy and religious affiliation [6, 7].

6.4.1 Smoking

There are more than 4,000 chemicals in cigarette smoke, including nicotine and carbon monoxide [8]. One effect of nicotine is to cause vasoconstriction of the dermal–subcutaneous vascular plexus. This has important consequences as in reconstructive surgery many tissue flaps rely on this plexus for survival [9]. As well as inducing a hypoxic state and causing vasoconstriction, smoking can lead to increased platelet aggregation, which results in the formation of tiny thromboses in capillaries. This is detrimental to wound healing, which relies heavily on blood flow in newly formed capillaries. Smokers have higher levels of fibrinogen and haemoglobin, which increase blood viscosity and increase the likelihood of blood clotting, and blood flow can be reduced by up to 42 % in smokers [10]. The combination of decreased oxygen delivery to tissues, the thrombogenic effects of smoking and increased viscosity and reduced flow could be the reasons why wound healing in smokers is significantly impaired.

The link between smoking and wound healing was first documented in the 1970 s. Problems with wound healing in smokers have been documented at multiple sites in the body. One study of patients undergoing abdominoplasty found that smokers were 3.2 times more likely to have wound problems than non-smokers. The number of cigarettes smoked in this study was not, however, a reliable predictor of those likely to develop wound healing complications [11]. Facelifts in smokers have been reported to be associated with a 12.5 times increased risk of developing retroauricular skin necrosis compared with non-smokers [12]. A study of 425 patients undergoing mastectomy and breast-conserving surgery and after adjusting for other confounding factors identified smoking as an independent predictor for wound infection and skin necrosis regardless of the number of cigarettes smoked [13]. The odds ratio for infection was 2.95 for light smoking (1–14 g/day) and 3.46 for heavy smoking (more than 15 g/day). The odds ratio for necrosis and epidermolysis was 6.85 for light smoking and 9.22 for heavy smoking.

In patients undergoing pedicled transverse rectus abdominis myocutaneous (TRAM) flap breast reconstructions, the number of wound infections was higher in both current and former smokers [14]. Complications related to the reconstruction were significantly more likely in current smokers (odds ratio 3.9) and former smokers (odds ratio 3.5) than in non-smokers. A study by Padubidri et al. [15] looking at patients having TRAM flaps and tissue expanders

reported the complication rate using tissue expanders for smokers was 37.1 %, which was statistically higher then the 26.6 % for non-smokers. In the TRAM flap group, active smokers had a significantly higher overall complication rate and a significant increase, in particular, of mastectomy flap necrosis. A study of 716 patients having free TRAM flaps showed significantly higher numbers of abdominal flap necrosis, mastectomy flap necrosis and abdominal hernias in smokers [16]. Mastectomy skin flap necrosis occurred in 18.9 % of smokers and 9 % of non-smokers ($p = 0.005$). This study demonstrated a dose effect, with smokers who had a history of smoking more than a pack of cigarettes (20 cigs in a pack)a day for 10 years being at increased risk of developing problems compared with smokers who had smoked for a smaller number of pack-years (55.8 % vs 23.8 %). One observation in this study was that delayed breast reconstruction in smokers was associated with a significantly lower rate of wound complications compared with immediate breast reconstruction in smokers. The risk of wound complications in delayed reconstructions was in fact similar to the rate in non-smokers. Complications were also less common in women who stopped smoking 4 weeks or more before surgery. A study by Gill et al. [17] examined risk factors and associated complications in 758 patients having deep inferior epigastric perforator (DIEP) flaps for breast reconstruction and found the risk factors associated with breast or abdominal complications included smoking ($p = 0.001$), postreconstruction radiotherapy ($p = 0.001$), and hypertension ($p = 0.0370$). Smoking and postreconstruction radiotherapy were the only significant risk factors for fat necrosis in this study.

6.4.2 Interaction with Obesity and Diabetes

It is recognised that cigarette smoking, obesity, age, diabetes and nutrition are all factors which play an important role in wound healing. Smokers who are obese or who have diabetes are at an even greater increased risk of wound healing problems than smokers without these risk factors. McCarthy et al. [18] studied 1,170 patients undergoing expander/implant reconstructions. They maintained a prospective database which included the variables of age, smoking status, body index, history of diabetes, hypertension and/or radiation as well as the timing of the reconstruction (immediate or delayed) and the laterality of reconstruction. The chances of developing complications were 2.2 times greater in smokers and 2.5 times greater in women over the age of 65 years. Patients who were obese had nearly twice the odds of having a complication. The same was true for patients with hypertension. The odds of reconstruction failure were five times greater in smokers, and failure was nearly seven times greater in obese patients and four times more likely in those who had hypertension. This study concluded that smoking, obesity, hypertension and age over 65 years were all independent risk factors for perioperative complications following expander implant breast reconstruction.

6.4.3 Smoking Cessation

There is one small randomised clinical trial involving 108 patients on the effect of preoperative smoking intervention on postoperative complications; there were 40 patients in the control group and 68 patients in interventional group [19]. Patients assigned to intervention were given counselling and nicotine-replacement therapy. The study showed a significant reduction in complications in the interventional group, with a reduction in wound-related complications and the need for secondary surgery. In this study patients stopped smoking 6–8 weeks before surgery and did not smoke for 10 days after the operation. In the literature there is no consensus on the optimal duration of preoperative smoking cessation, but there is some evidence that there are potential benefits from even a brief period of abstention. Most studies are, however, retrospective studies and have inherent weaknesses in their design.

6.4.4 Diabetes Mellitus

Studying any risk factor in isolation is always difficult because patients with diabetes often have other associated risk factors, such as obesity. One study of skin-sparing mastectomy flap complications after breast reconstruction showed a significantly increased risk of skin-sparing mastectomy flap complications in diabetics [20].

6.5 Postmastectomy Radiotherapy and Its Impact on Breast Reconstruction

Indications for postmastectomy radiotherapy have expanded over the past decade. One study of 919 patients who had breast reconstruction separated them into three groups: mastectomy with postoperative radiotherapy before reconstruction ($n = 57$), immediate reconstruction then postmastectomy radiotherapy ($n = 59$) and reconstruction without postmastectomy radiotherapy ($n = 665$) [21]. Overall, the complication rates for patients having radiotherapy either before or after mastectomy were significantly higher than those for controls, 40 % versus 23 % ($p < .001$). Immediate reconstruction before postmastectomy radiotherapy increased both the overall rate of complications (47.5 % vs 23.2 %) and the rate of late

Table 6.2 Options for breast reconstructionbreast reconstruction

Technique	Indications for	
	Immediate reconstruction	Delayed reconstruction
Prosthesis	Small breasts	As for immediate reconstruction *plus* well-healed scar *plus* no radiotherapy[a,b]
	Adequate skin flaps	
Tissue expansion and prosthesis	Adequate skin flaps	As for immediate reconstruction *plus* well-healed scar *plus* no radiotherapy[a,b]
	Tension-free skin closure	
	Small to medium-sized breasts	
Myocutaneous flaps	Larger skin incision	As for immediate reconstruction
	Doubtful skin closure	
	Large breasts	Can be used if there has been previous radiotherapy

[a] Unless using acellular dermal matrix
[b] Radiotherapy significantly increases complication rates

complications (33.9 % vs 15.6 %) compared with controls (both $p < .001$). Delayed breast reconstruction in patients who had either had or not had postoperative radiotherapy produced similar complication and satisfaction rates, but prior radiotherapy was associated with decreased aesthetic satisfaction compared with no postmastectomy chest wall radiotherapy, with only 50 % of patients being happy in the group who had radiotherapy compared with 66.8 % in those who did not have radiotherapy.

A particular issue when using implant-based reconstructions in patients likely to have breast radiotherapy is how best to manage these patients. The literature suggests that there is a significantly increased risk of capsular contracture and other secondary complications in patients who receive radiotherapy compared with patients with who have breast reconstruction with implants who do not have radiotherapy [22, 23]. Complications after irradiation of implants are also commoner than one sees in patients undergoing autologous breast reconstruction who received radiation [24]. Some prefer to delay breast reconstruction in patients in whom it is clear that postoperative radiotherapy is required, whereas others are happy to use implant or autologous reconstructions. This lack of consensus can make it difficult for patients who are likely to need postmastectomy radiotherapy when they are considering their options for reconstruction. They may receive conflicting advice from different individuals because individual surgeons differ in their approach to breast reconstruction in the presence of postoperative radiotherapy.

6.6 Evaluation of Candidates for Breast Reconstruction

Important factors in assessing whether patients are suitable for breast reconstruction and determining the optimal technique include assessment of a patient's general health, the body habitus, breast size and shape, extent of any mastectomy scar, site of any mastectomy scar, the thinness of the mastectomy flaps, previous radiotherapy, the smoking history and patient preference.

It is important to assess the quality of the tissue that is present and is likely to remain when performing a breast reconstruction. There is a need to determine the amount of skin and soft tissue required to create acceptable symmetry before being able to determine what might be appropriate options (Table 6.2).

6.7 Whole Breast Reconstruction: Patients with Newly Diagnosed Breast Cancer in Whom Mastectomy Is Recommended

6.7.1 Treating the Breast Cancer

For patients undergoing mastectomy as their primary surgical option, it is important not to delay removal of the cancer and removal of or biopsy of regional lymph nodes as this may impact on the patient's long-term prognosis. A recent audit showed a huge variation in the time patients waited for mastectomy alone compared with mastectomy and immediate breast reconstruction [3]. If it looks as though it is going to take a long time either for the patient to choose her reconstructive option or to assemble a team to perform a reconstructive procedure, then other options for the patient should be considered. One of these options, which is underutilised in many centres, is to give systemic therapy as the initial treatment. For premenopausal women and those postmenopausal women with large oestrogen-receptor-negative or human epidermal growth factor receptor 2 (HER2)-positive cancers, then neoadjuvant chemotherapy is an excellent option, particularly if the oncologist has already considered that it is likely the patient will receive chemotherapy in the adjuvant setting [5]. In

HER2-positive cancers, dramatic rates of complete disease response, including disappearance of ductal carinoma in situ, is possible with the use of neoadjuvant chemotherapy together with trastuzumab [25]. In postmenopausal women with large tumours, almost 80 % are oestrogen-receptor-positive and these cancers respond well to aromatase inhibitors [26, 27]. In such women, use of an aromatase inhibitor for a number of months to shrink the cancer will allow over half of these women to become suitable for breast conservation or they can take aromatase inhibitors for a few weeks as a temporary measure while consideration is given to the best form of reconstruction.

Should the scheduling of reconstructive surgery be delayed for any reason, then an option is to excise the invasive cancer through an appropriately placed incision that does not interfere with later breast reconstruction procedures. This can allow adjuvant systemic therapy to be administered prior to mastectomy and reconstruction.

A useful option in some patients is to perform an initial sentinel lymph node biopsy in a patient with an invasive cancer who has no obvious nodal disease on clinical and ultrasound assessment of the axilla. One of the values of preoperative axillary assessment using a combination of imaging with fine needle aspiration cytology and/or core biopsy or sentinel lymph node biopsy is that it allows assessment of the likelihood and extent of any axillary lymph node involvement. This helps evaluate the likely need for postmastectomy radiotherapy. Although there are some who believe that postoperative radiotherapy has limited impact on the cosmetic outcome of whole breast reconstruction, most surgeons believe radiotherapy has a significant negative impact on breast reconstructions, particularly if breast implants are being used [21–24], allowing them to delay reconstruction until the completion of treatment [28]. Knowledge of the likely requirement for postoperative radiotherapy can influence the decision to proceed with immediate breast reconstruction and, if so, then the preferred technique. Although there are some who believe that it is not possible, with any degree of certainty, to determine whether postoperative radiotherapy is likely to be needed, it is clear that it is possible, with a high degree of accuracy by preoperative assessment of the type and extent of the primary cancer in the breast and any nodal involvement, to predict those who are likely to need postoperative radiotherapy [28]. One major reason patients receive postoperative chest wall radiotherapy after mastectomy is multiple axillary node involvement, and thus an initial sentinel lymph node biopsy to assess the status of the axilla prior to mastectomy and consideration of reconstruction is a sensible approach. At the same time as sentinel lymph node biopsy is performed, it is also possible to remove the central subareolar ducts, and this can assist in a decision about whether the patient is suitable for nipple sparing during the mastectomy [29].

6.8 Choosing Options

6.8.1 Implants and Expanders

Breast implants and expanders are best suited for breast reconstruction in women with smaller breasts with thick mastectomy flaps and minor degrees of ptosis [30]. For women who wish to avoid major surgery involving donor sites and scars on other parts of their body, breast reconstruction using implants may be the option of choice. This technique is also worthy of consideration in patients considering bilateral mastectomy leading to a good level of post operative symmetry. When this is performed as a delayed procedure, a period of tissue expansion is required prior to the placement of the definitive implant. In the immediate setting, however, a skin-sparing approach during mastectomy improves the quality of the final result [31]. Total submuscular implant placement can sometimes lead to upward displacement of the inframammary fold. To address this problem, the site of origin of the pectoralis major muscle should be released or detached and the inferior pole of the implant should be covered with an acellular dermal matrix to achieve enhanced projection in this important area [32]. Good candidates for this technique have small to moderate-sized breasts, good quality skin and show an absence of established glandular ptosis. Young patients requesting bilateral risk-reducing surgery are good candidates for implant-based reconstructions using this technique. In older age groups, the technique may still lead to very satisfactory results when combined with symmetrising surgery on the contralateral side. Irradiated tissues rarely do well with implant-based breast reconstructions [32]. During the reconstructive consultation, the limitations of this technique for unilateral reconstruction must be communicated and the patient advised that symmetry is possibly usually only when clothed with the contralateral side supported in a bra.

6.8.2 Use of Tissue Matrices

A variety of tissues have been used to cover the lower pole of implants during breast reconstruction (Fig. 6.1). The problem with total muscular cover has been obtaining satisfactory inferior projection and reconstruction of a satisfactory inframammary fold. The tissue matrices in common use include those derived from human skin (Alloderm®), pig skin (Strattice and Permacol) and bovine skin and pericardium [32, 33]. Both synthetic and absorbable meshes have also been used. De-epithelialised lower mastectomy flaps are another option to improve lower pole fullness and provide sufficient cover of the implant where it sits below

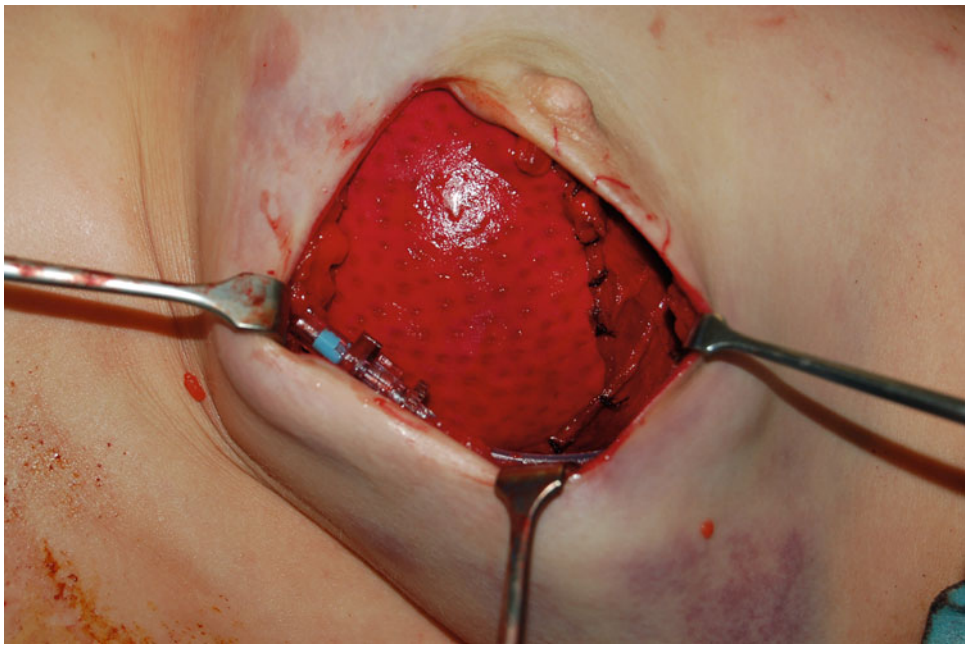

Fig. 6.1 Strattice® used as a sling for breast reconstruction in a patient having a nipple sparing mastectomy

the lower margin of the pectoralis major muscles (Fig. 6.2). When tissue matrices are used meshes or de-epithelialised skin are used, the pectoralis major muscle is lifted from its site of origin and the tissue matrix, mesh or de-epithelialised flap is stitched between the cut edge of the pectoralis major muscle and the new inframammary fold [33]. This provides a sling for the lower part of the implant alone, Becker implant/expander or tissue expander. The option of de-epithelialising the lower flap of the mastectomy and suturing this to the edge of the pectoralis major muscle is less good at creating an inframammary fold than acellular dermal matrix [34]. The two can be combined to good effect when carrying out a skin-sparing mastectomy.

Complication rates with these various techniques can differ widely. Implant and tissue matrix loss rates can be as high as 15 % [33]. Particular care is needed when selecting the most appropriate incision, especially if a nipple-sparing technique is to be used. Any wound edge necrosis particularly over the tissue matrix or mesh is associated with a high rate of implant loss.

6.8.3 LD Flaps

Patients who are ideally suited for LD flaps include thin patients where the infraumbilical tissues are limited, and patients who have undergone previous abdominoplasty or other abdominal operations through abdominal scars that may have compromised the blood supply to the abdominal flap. The LD also appears more resistant to the effects of impaired wound healing in patients who smoke or who have diabetes [35]. Additionally, the LD does not compromise the abdominal wall, which may be an issue for patients considering future pregnancy. In patients considered for secondary reconstruction, the existing mastectomy scar may pose challenges to planning insertion of an LD flap. Compared with an oblique mastectomy scar, a vertical or horizontal scar can be difficult to conceal and may compromise projection of the reconstructed breast. If the flap is placed too high, then satisfactory ptosis and inferior pole projection cannot be obtained [36]. In patients with a very high scar, the flap can be inserted into a new incision placed in the inframammary fold incision. The main bulk of the muscle must be placed where it is required to create a breast mound which matches the opposite normal breast. One study comparing LD breast reconstruction with TRAM reconstruction found the LD flap was associated with fewer complications [37].

Until recently it has been traditional to combine an LD flap in most patients with insertion of breast implants. With the development of extended LD flaps, an increasing number of patients can have autologous breast reconstruction without the use of an implant [38]. The shape evolves over time, and it is important to inform women that the contour and shape will improve with time (Fig. 6.3). It is also possible to augment the volume of an LD flap by later lipofilling [39]. A major drawback of LD flaps is the high rate of seroma formation on the back [40].

6.8.4 TRAM and DIEP Flaps

Surplus tissue in the lower abdomen can be an excellent source of material when considering breast reconstruction. Typically, the reconstruction is performed without the need

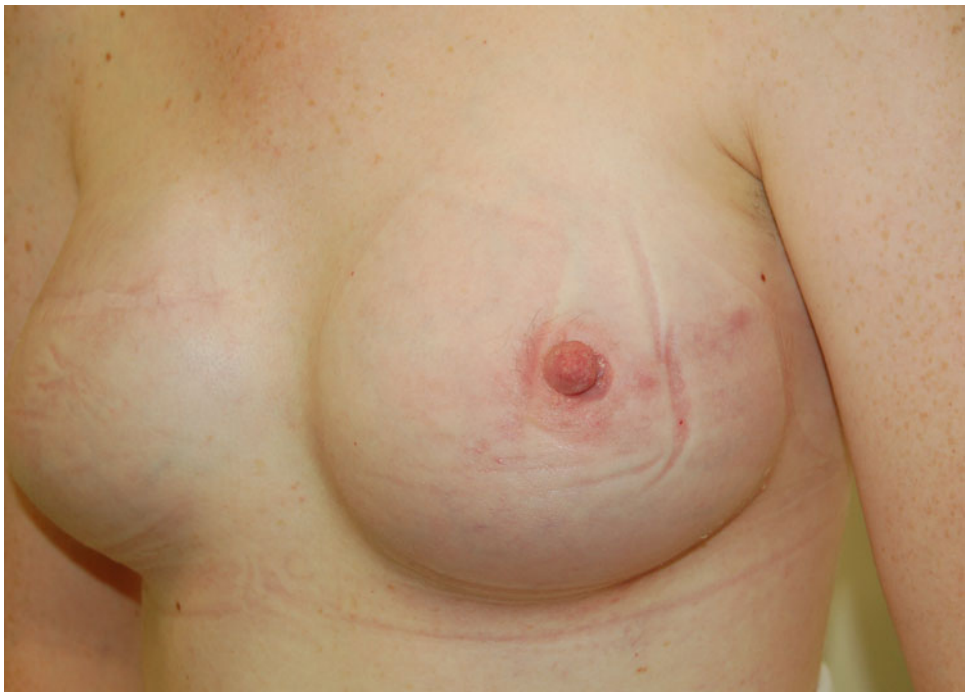

Fig. 6.2 Bilateral breast reconstruction on the right delayed, and the left prophylactic nipple-sparing mastectomy (following diagnosis of mutation in the *BRCA1* gene). Reconstruction was with Strattice®. The patient has a bilateral shaped prosthesis

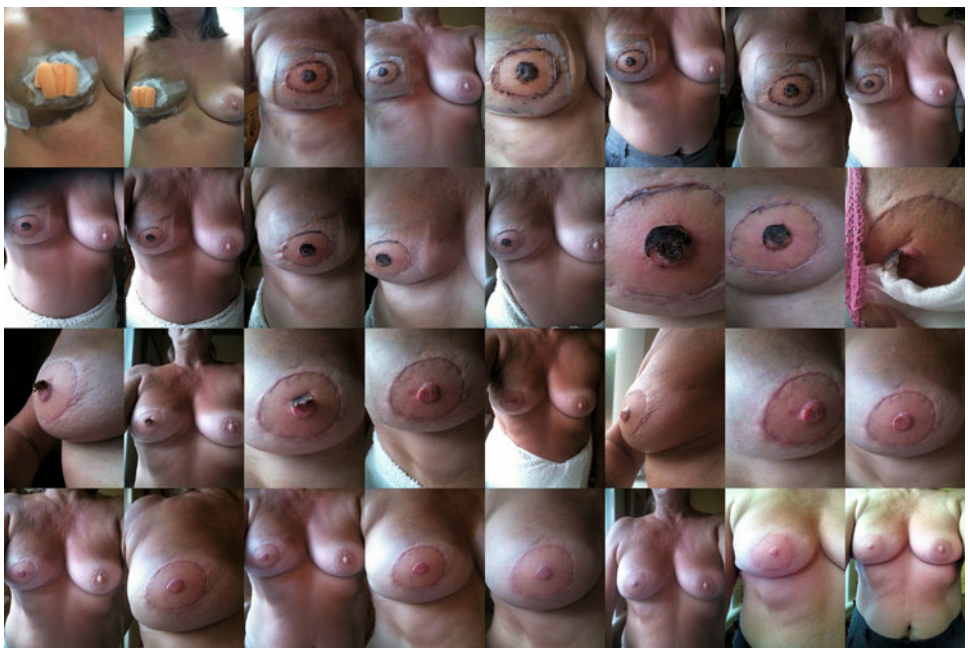

Fig. 6.3 Reconstruction in transition. A patient who underwent a right breast reconstruction with an extended latissimus dorsi (LD) flap. Photograph were taken regularly by the patient over a 3-month period after surgery

for breast implants, and the final result may be indistinguishable from the native breast when reconstruction is performed in ideal circumstances. The transfer may be achieved as a pedicled muscle flap or as a free tissue transfer either incorporating part of the rectus abdominis muscle (TRAM) or based purely on the perforating branches of the deep inferior epigastric artery (DIEP) [33, 41, 42]. Prior abdominal operations require careful evaluation to ensure the axial vessels are likely to be intact and that pre-existing scars will not impact adversely on the abdominal closure or interfere with successful wound healing. The patient's general health should be good and cigarette smokers should be advised to stop smoking for at least 3 months prior to surgery where circumstances allow [15]. Cigarette smoking significantly increases the risk of complications, and these patients may be served better by a procedure with a lower risk profile. There is also a well-recognised risk of total flap failure of around 3–5 %, which

again is higher in smokers, and of abdominal wall bulging or herniation, and these factors when combined with a longer recovery period compared with other techniques may significantly influence a patient's decision to proceed with this surgery. Where circumstances are favourable, however, fully autologous lower abdominal breast reconstructions produce durable results with high levels of patient satisfaction in both immediate and delayed settings [3].

6.8.5 Other Free Flaps

There are a range of other free flaps that have been described as options for breast reconstruction . These include superior and inferior gluteal artery perforator flaps and the transverse upper gracilis flap [33].

These flaps are usually offered only by specialist plastic surgeons and are used mostly in patients who are not suitable for other options [33].

6.8.6 Skin-Sparing Mastectomy

The goal of breast reconstruction is to achieve an aesthetically pleasing breast resembling as closely as possible the native organ, or at the very least to achieve a result that can be matched by the minimum of additional surgery to the contralateral side. The preservation of as much native breast skin as possible at the time of mastectomy brings significant advantages in terms of both final breast shape and overall aesthetic appearance when combined with immediate breast reconstruction [43, 44]. A body of evidence now exists supporting the oncological safety of this technique [45–50]. These data show skin-sparing mastectomy can be performed without compromising local disease control. Carlson et al. [51] have provided a 10 year retrospective review of 539 patients treated for 565 cases of breast cancer by skin-sparing mastectomy and immediate breast reconstruction. The local recurrence rate with an average 65 month follow-up was 5.5 %, and the local recurrence rates increased as the disease stage at presentation increased. These rates of local recurrence are comparable to those for total mastectomy and nipple excision [52]. In an earlier publication, Medina-Franco et al. [47] reported a local recurrence rate of 4.5 % with median follow-up of 6 years in 173 consecutive patients undergoing skin-sparing mastectomy and breast reconstruction. A skin-sparing approach to mastectomy is therefore both desirable and safe and should be considered whenever breast reconstruction is planned. Nipple-sparing mastectomy is also possible in patients with cancers, and is discussed later.

6.8.7 The Opposite Breast

Symmetry is the primary focus of breast reconstruction . This is often difficult to achieve in many patients. Selection of one or another technique for breast reconstruction is influenced not only by the amount of skin that very occasionally needs to be removed during the surgery to excise the breast cancer but also by the appearance of the remaining breast, including any possible procedures that may be advised on the opposite breast to achieve shape and/or volume symmetry (Table 6.2).

It is of upmost importance to consider the opposite breast in the initial breast reconstruction plan. For this reason it is important to discuss with the patient, prior to any operation, what the options are for the opposite breast if symmetry is to be obtained. The reconstructive surgeon should, however, appreciate that most patients prefer to leave their opposite breast unscarred and untouched if possible. If the breast that is to be matched is well shaped without excessive ptosis, the goal of breast reconstruction should be to match it. If the opposite breast is large or small in relation to the patient's body habitus, then the options of enlarging or reducing the opposite breast should be considered and discussed. Even if the opposite breast is of adequate volume, it may be necessary to consider a mastopexy if one is going to obtain symmetry of contour as well as symmetry of volume.

One option for the opposite breast is prophylactic mastectomy. Such an operation attempts to reduce the possibility of breast cancer developing in the opposite breast in women at high risk and it can ease some patients' fears that they have about cancer development in the opposite breast (Fig. 6.2). The patient must, however, be guided in this by discussions and input from the multidisciplinary team before this approach is selected. Of concern is that studies have shown a recent dramatic increase in the number of woman having prophylactic contralateral mastectomy [53]. Studies of women having such procedures have shown that most of these women are not at significantly heightened risk of developing a contralateral breast cancer [54]. Significant risk factors for having a prophylactic contralateral mastectomy include having a breast MRI and having a breast reconstruction [55, 56] (Table 6.3). Although it is true that it is easier to obtain symmetry when similar procedures are performed on both breasts, this in itself is not sufficient reason to remove a normal contralateral breast which is not at significant risk of breast cancer development. With adjuvant hormone therapy the rate of contralateral breast cancer development is less than 4 per 1,000 per year, although that risk persists over a 20–30 year period [54]. Even for those patients who develop a contralateral breast cancer, mastectomy is not always necessary. Only in patients with a strong family history with or without the

Table 6.3 Predictors of contralateral prophylactic mastectomy by multivariate analysis

	Odds ratio	*P* value
Age < 50 years vs age ≥ 50 years	2.3	<0.0001
Race (white vs other)	3.6	<0.0001
Family history of BC	2.9	<0.0001
DCIS vs IDC	1.9	0.0003
ILC vs IDC	0.9	0.6465
Reconstruction vs no reconstruction	3.2	<0.0001
MRI at diagnosis	2.2	<0.0001
Breast-conserving surgery attempted	1.7	0.0014

Source From King T, Sakr R, Gurevich et al. (2009) Clinical management factors contribute to the decision for contralateral prophylactic mastectomy (CPM). San Antonio Breast Cancer Symposium. abstract 38. Odds ratios were adjusted for the surgeon
BC breast cancer, *DCIS* ductal carcinoma in situ, *IDC* infiltrating ductal carcinoma, *ILC* infiltrating lobular carcinoma

knowledge that the patient is carrying a mutated *BRCA1* or *BRCA2* gene and in patients with atypical hyperplasia affecting a breast together with a significant family history should prophylactic mastectomy be considered as essentially a therapeutic procedure. There is some information that suggests patients who have a contralateral mastectomy at diagnosis have a better outcome than those who have a unilateral mastectomy [57]. This information is not from randomised studies, and is inconsistent with the number of women who die from contralateral breast cancer [54]. Providing appropriate surveillance of the other breast is continued on a regular basis as development and treatment of a contralateral breast cancer does not appear to compromise outcome [54].

6.9 Revisional Surgery Consultation

A number of patients who have had reconstructions which were initially symmetrical and satisfactory attend consultations to discuss revisional reconstructive surgery. The untreated breast increases in size and in develops increasing ptosis over time, whereas the reconstructed breast, with the exception of autologous reconstruction, tends to remain the same size or even shrinks if the patient has had radiotherapy. The same range of reconstructive options are available to these patients as to patients who have had an immediate reconstruction. Options may be limited, depending on what procedures they have had previously and whether the patient has received prior radiotherapy. Revising and improving a patient's reconstruction can be more complex than a primary breast reconstruction. Considerable expertise in this area is required if an individual surgeon is to offer such an option. To obtain symmetry it is usually necessary to consider surgery to both breasts and assess the need for reduction or mastopexy of the opposite breast together with revisional surgery on the previously reconstructed breast (Fig. 6.4). Patients who have had previous implant surgery before the use of tissue matrices often do not have well-defined inframammary folds. If the patient has sufficient skin inferiorly, then simply dividing the lower part of the capsule and placing a tissue matrix to define the inframammary fold and to provide a sling provides much enhanced lower pole projection and allows placement of a shaped prosthesis and can produce satisfactory results in many patients. Alternatively, autologous tissue transfer with or without lipofilling can be offered. Each patient requires careful assessment by the reconstructive team with sufficient time for the patient to consider all options.

6.9.1 Partial Breast Reconstruction

For patients who have significant degrees of asymmetry following breast-conserving surgery there are a range of options. If the treated breast is small but of satisfactory contour, then the simplest option is to perform a contralateral breast reduction and mastopexy. Most patients, however, have distortion at the wide excision site, often with displacement of the nipple. Lipofilling can improve distortion and contour, but the problem of nipple displacement remains. Following two or three episodes of lipofilling, it is possible to mobilise the skin of the breast and recentralise the nipple on the residual larger volume of breast mound. Where there is distortion, lipofilling usually needs to be combined with either scar release or open scar revision, excising the scar tissue at the wide excision site and reshaping the residual breast mound to get rid of the defect at the wide excision site. Placement of a prosthesis under the treated breast, or even in both breasts, has been used to good effect in carefully selected patients [58]. The implants can be placed underneath the breast or underneath the chest wall muscle. Although it was previously considered that implants in breasts treated by radiotherapy had a

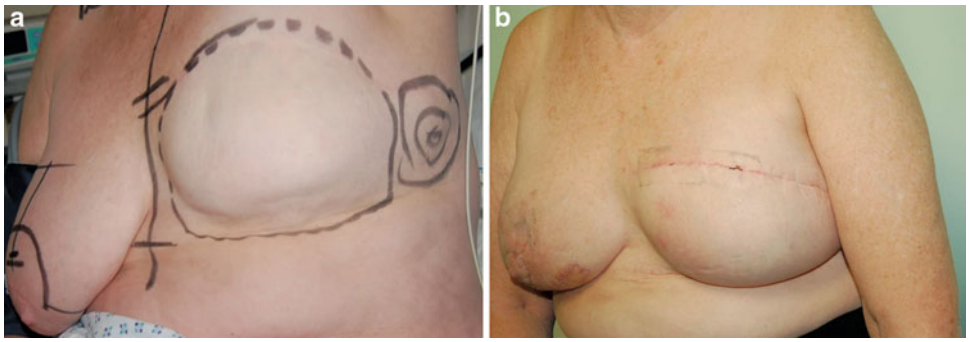

Fig. 6.4 **a** Patient who had a left breast mastectomy with an implant 10 years earlier. Revision surgery involved placing Strattice® in the left breast to replace the prosthesis and doing a right mastopexy with a small reduction. **b** Result 2 weeks postoperatively

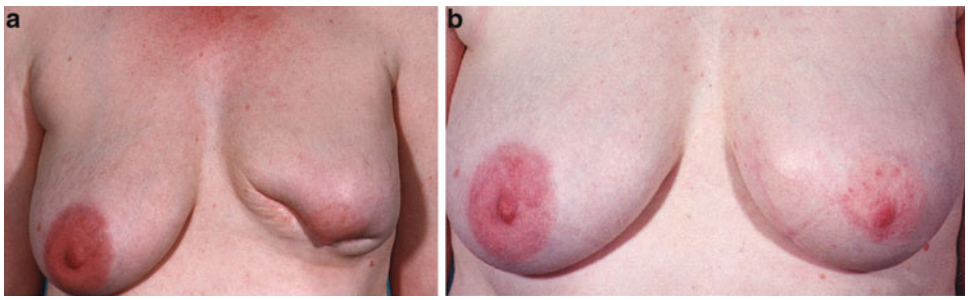

Fig. 6.5 **a** Patient with a poor cosmetic result before and after LD flap partial reconstruction. **b** Postoperative result

high rate of capsular contraction and unsatisfactory cosmetic outcomes, in selected patients the results achieved have been excellent. However, with the recent improvement in the volumes of fat that can be harvested and with the increasing use of lipofilling, the number of patients who are either suitable for or require breast implants to gain satisfactory symmetry is small. In some patients there is a need to replace skin and volume, so the use of myocutaneous or even lipocutaneous flaps is the only option to obtain symmetry. The LD flap is the most widely used flap in this situation (Fig. 6.5).

When patients are attending consultations for consideration of procedures to achieve symmetry, then it is important to discuss all the appropriate and relevant options with the patient and give the patient time to come to an informed decision. Some patients with asymmetry attend consultations for advice on the best way to achieve symmetry when clothed. This can be achieved very effectively by wearing a shell over the treated breast in the bra rather than by more complex reconstructive surgical procedures. Provision of these shells increases women's confidence and their ability to wear a wider range of clothes. Surgery is thus not the only option for such women, and all such women should be given access to a properly trained prosthesis fitter and should be given advice by an appropriately trained reconstructive surgeon.

6.10 Reconstruction of One or Both Breasts

6.10.1 Bilateral Prophylactic Mastectomy in High-Risk Women

In the Mayo study of prophylactic mastectomy in high-risk women, 1,065 women underwent prophylactic mastectomy over 32 years [59]. Two-thirds were classified as having an increased breast cancer risk on the basis of their family history. The remainder had a variety of conditions, including breast pain, cystic disease and difficult mammograms. Ninety per cent had a subcutaneous mastectomy which was skin-sparing. In these patients, prophylactic mastectomy resulted in an over 90 % reduction in subsequent breast cancer development. Eighty per cent of the subcutaneous skin-sparing mastectomies were actually nipple-sparing. In this study of 425 low-risk women, ten deaths would have been expected from breast cancer, but none were observed, which is a 100 % risk reduction. In the 214 high-risk women, between 11 and 31 deaths from breast cancer were expected, whereas two occurred, which is an 81 94 % reduction in death rate.

Although nipple-sparing mastectomies are now widely used for prophylaxis, they can also be used in the treatment of women with invasive and in situ breast cancer. They

have an acceptable risk of recurrence of less than 2 % in T1 cancers [31, 60–62]. Selection of patients for nipple-sparing mastectomies has been based on the distance of the cancer from the nipple: the greater the distance, the less likely is nipple involvement of cancer. Where there are concerns there may be nipple involvement, this can be checked prior to surgery either by using a mammotome to remove the subareolar ducts [62] or by biopsying the ducts at the time of sentinel node biopsy prior to the mastectomy or during the operations by frozen section [63–66].

6.11 Timing of Breast Reconstruction

Immediate breast reconstruction is an increasingly appealing option offering women the option of waking up after their mastectomy with a reconstructed breast. This has obvious psychological advantages, and patients who request immediate reconstruction are usually pleased with this decision and the outcomes. Despite the psychological benefits of immediate reconstruction, there are some potential drawbacks, including being uncertain of the need for postoperative radiotherapy at the time the decision to choose the type of reconstruction is made.

Delayed reconstruction can be performed from several days to many years after mastectomy. Contrary to what some believe, many women do not become adjusted to breast loss. Some surgeons wait 3–6 months after mastectomy or 3–6 months after radiotherapy for the flaps to heal and for the skin reaction to settle. This allows time for seromas to resolve and for the patient to have time to consider the various options that may be suitable to reconstruct her breast. Results for both can be satisfying (Table 6.4).

There is a third way. In patients where it not clear whether they need radiotherapy or not, it is possible to place a tissue expander under the chest wall. The expander is inflated and this stretches the residual skin [64, 65]. If the patient does not need radiotherapy, there is the option of maintaining tissue expansion and replacing this with an implant later. For those who require radiotherapy, the expander can be reduced in volume to allow radiotherapy. A few weeks after completion of radiotherapy the expander is reinflated and 3 months later, the patient undergoes a further procedure usually bringing in vascularised tissue as an LD or abdominal flap. There is some evidence that the new tissue brought in rejuvenates skin which has been irradiated and results in an overall better result than doing a straightforward mastectomy, giving radiotherapy and then performing a standard delayed breast reconstruction.

Table 6.4 Patient's rating of the results of their surgery at 18 months postoperatively

Overall, how would you describe the results of your operation?	Mastectomy only	Immediate reconstruction	Delayed reconstruction
Excellent	1,513 (36)	520 (34)	368 (47)
Very good	1,565 (37)	505 (33)	242 (31)
Good	786 (19)	288 (19)	101 (13)
Fair	304 (7)	145 (9)	43 (5)
Poor	74 (2)	74 (5)	28 (4)

6.12 Patient Preferences and Breast Reconstruction

There are a variety of studies which have looked at patient preferences in relation to breast reconstruction. In one study 309 women who underwent a therapeutic mastectomy, 79 who underwent a prophylactic mastectomy and 247 women who had also undergone a breast reconstruction were asked to express opinions in relation to a number of options, including materials used for reconstruction, the number and duration of operations, short-term complication rate, long-term complication rate, aesthetic results and the time they might spend waiting for the operation [66]. In all 71 % agreed to participate in this study. Autologous tissue was preferred by these patients to implants, and shorter operations were preferred to longer operations. Patients wished for excellent results, with low rates of complications, but patients were willing to trade an excellent result for a good result for a 10 % reduction in short-term complications. On the basis of what women thought was important, an autologous LD flap with a good aesthetic result providing it only had a 10 % complication rate was the highest ranked option. Second was an autologous DIEP flap with a 10 % complication rate and a good result. Third was an autologous DIEP flap with an excellent result but a complication rate of up to a 25 %.

Patients select a reconstructive technique which suits their wishes after the initial discussion. Generally, simpler techniques which produce acceptable aesthetic results are preferred by most women, but more complex procedures generally give better results [3, 67] (Table 6.4). Interestingly, a study of female plastic surgeons found a strong desire for them to pursue implant-based reconstructions, with invasiveness of the procedure and recovery time cited as the most important reasons [68]. Patients' understanding of exactly what is involved in breast reconstructive surgery was investigated in one study where questions were asked in relation to the operation itself, the recognised complications and how breast reconstruction may influence the detection of recurrence. The study found that only 37.9 % of patients

answered the questions correctly [69]. Communicating options and providing informed choice is therefore a huge and ongoing problem [70].

Finally, body image and the impact of breast reconstruction change over time (see Fig. 6.3). Body image may initially be worse in patients who have had reconstruction but improves over time, and by 2 years it is as good as for patients who have had mastectomy or breast-conserving surgery [70]. Surgical issues even at 2 years may still be significantly greater in patients who have had reconstruction than in patients who have had breast-conserving surgery. Given the continued fall in local recurrence rates after breast-conserving surgery, the most important decision in breast reconstruction remains whether there are options to retain the patients own breast safely. However good a reconstruction is, it is rarely ever as good as a well-performed breast-conserving procedure.

References

1. Knottenbelt A, Spauwen PHM, Wobbes TH (2004) The oncological implications of immediate breast reconstruction. Eur J Surg Oncol 30:829–833
2. Kronowitz SJ, Hunt KK, Kuerer HM et al (2004). Delayed-immediate breast reconstruction. Plast Reconstr Surg 113(6): 1617–1628
3. The NHS Information Centre (2010) Third annual report of the national mastectomy and breast reconstruction audit. Available via http://www.ic.nhs.uk/services/national-clinical-audit-support-programme-ncasp/audit-reports/mastectomy-and-breast-reconstruction
4. Morrow M, Goldstein L. (2006) Surgery of the primary tumor in metastatic breast cancer: closing the barn door after the horse has bolted? J Clin Oncol 24(18):2694–2696
5. Untch M, von Minckwitz G (2009) Recent advances in systemic therapy. Advances in neoadjuvant (primary) systemic therapy with cytotoxic agents. Breast Cancer Res 11(2):203
6. El-Tamer MB, Ward BM, Schifftner T et al (2007) Morbidity and mortality following breast cancer surgery in women: national benchmarks for standards of care. Ann Surg 245(5): 665–671
7. Beahm EK, Walton RL, Chang DW (2006) Breast reconstruction in the obese patient. Plast Reconstr Surg 118 Supplement(4):15–16
8. Krueger JK, Rohrich RJ (2001) Clearing the smoke: The scientific rationale for tobacco abstention with plastic surgery. Plast Reconstr Surg 108(4):1063–1073
9. Chang LD, Buncke G, Slezak S et al (1996) Cigarette smoking, plastic surgery, and microsurgery. J Recontr Microsurg 12(7):467–474
10. Sarin CL, Austin JC, Nickel WO (1974) Effects of smoking on digital blood-flow velocity. JAMA 229(10):1327
11. Manassa EH, Hertl CH, Olbrisch RR (2003) Wound healing problems in smokers and nonsmokers after 132 abdominoplasties. Plast Reconstr Surg 111(6):2082–2087
12. Rees TD, Liverett DM, Guy CL (1984) The effect of cigarette smoking on skin-flap survival in the face lift patient. Plast Reconstr Surg 73(6):911–915
13. Sorensen LT, Horby J, Friis E et al (2002) Smoking as a risk factor for wound healing and infection in breast cancer surgery. Eur J Surg Oncol 28(8):815–820
14. Spear SL, Ducic I, Cuoco F et al (2005) The effect of smoking on flap and donor-site complications in pedicled TRAM reconstruction. Plast Reconstr Surg 116(7):1872–1880
15. Padubidri AN, Yetman R, Browne E et al (2001). Complications of postmastectomy breast reconstructions in smokers, ex-smokers and nonsmokers 107(2):2374–2380
16. Chang DW, Reece GP, Wang B et al (2000) Effect of smoking on complications in patients undergoing free TRAM flap breast reconstruction. Plast Reconstr Surg 105(7):2374–2380
17. Gill PS, Hunt JP, Guerra AB et al (2004). A 10-year retrospective review of 758 DIEP flaps for breast reconstruction. Plast Reconstr Surg 113(4):1153–1160
18. McCarthy CM, Mehara BJ, Riedel E et al (2008). Predicting complications following expander/implant breast reconstruction: an outcomes analysis based on preoperative clinical risk. Plast Reconstr Surg 121(6):1886–1892
19. Moller AM, Villebro N, Pederson T et al (2002) Effect of preoperative smoking intervention on postoperative complications: a randomized clinical trial. Lancet 359(9301):114–117
20. Hultman CS, Daiza S (2003). Skin-sparing mastectomy flap complications after breast reconstruction: review of incidence, management and outcome. Ann Plast Surg 50(3):249–255
21. Lee BT, Adesiyun T, Colakoglu S et al (2010) Postmastectomy radiation therapy and breast reconstruction: an analysis of complications and patient satisfaction. Ann Plast Surg 64(5):679–683
22. Cordeiro PG, McCarthy CM (2006) A single surgeon's 12-year experience with tissue expander/implant breast reconstruction. II. An analysis of long-termcomplications, aesthetic outcomes, and patient satisfaction. Plast Reconstr Surg 118:832–839
23. Behranwala KA, Dua RS, Ross GM et al (2006) The influence of radiotherapy on capsule formation and aesthetic outcome after immediate breast reconstruction using biodimensional anatomical expander implants. J Plast Reconstr Aesthet Surg 59:1043–1051
24. Pomahac B, Recht A, May JW et al (2006) New trends in breast cancer management: is the era of immediate breast reconstruction changing? Ann Surg 244:282–288
25. Chang HR (2010) Trastuzumab-based neoadjuvant therapy in patients with HER2-positive breast cancer. Cancer 116(12):2856–2867
26. Dixon JM, Renshaw L, Dixon J et al (2011) (2011) Invasive lobular carcinoma: response to neoadjuvant letrozole therapy. Breast Cancer Res Treat 130(3):871–877
27. Macaskill EJ, Dixon JM (2012) Preoperative endocrine therapy: preferred therapy for whom? Curr Breast Cancer Rep 4(1):39–47
28. Musgrave KJ, Bochner M, Kollias J (2010) Surgical decision-making in immediate breast reconstruction. World J Surg 34(12):3029–3035
29. Govindarajulu S, Narreddy S, Shere MH et al (2006). Preoperative mammotome biopsy of ducts beneath the nipple areola complex. Eur J Surg Oncol 32(4):410–412
30. Fan J, Raposio E, Wang J et al (2002) Development of the inframammary fold and ptosis in breast reconstruction with textured tissue expanders. Aesthetic Plast Surg 26(3):219–222
31. Benediktsson KP, Perbeck L (2008) Survival in breast cancer after nipple-sparing subcutaneous mastectomy and immediate reconstruction with implants: A prospective trial with 13 year median follow-up in 216 patients. Eur J Surg Oncol 34:143–148
32. Chun YS, Verma K, Rosen H et al (2010 Implant-based breast reconstruction using acellular dermal matrix and the risk of postoperative complications. Plast Reconstr Surg 125(2):429–36
33. Rossen GD, Magarakis M, Shridharani SM et al (2010) A review of the surgical management of breast cancer: plastic reconstructive techniques and timing implications. Ann Surg Oncol 17: 1890–1900

34. Goyal A, Wu JM, Chandran VP et al (2011) Outcome after autologous dermal sling-assisted immediate breast reconstruction. Br J Surg 98:1267–1272
35. Hamdi M, Van LAnduyt K, Hijjawi JB et al (2008) Surgical technique in pedicled thoracodorsal artery perforator flaps: a clinical experience with 99 patients. Plast Reconstr Surg: 121:1632–1641
36. Delay E, Gounot N, Bouillot A et al (1998) Autologous latissimus breast reconstruction: a 3-year clinical experience with 100 patients. Plast Reconstr Surg 102:1461–1478
37. Kroll SS, Baldwin B (1992) A comparison of outcomes using three different methods of breast reconstruction. Plast Reconstr Surg 90(3):455–462
38. Barnett GR, Gianoutsos MP (1996) The latissimus dorsi added fat flap for natural tissue breast reconstruction: report of 15 cases. Plast Reconstr Surg 97:63–70
39. Sinna R, Delay E, Garson S, et al (2010) Breast fat grafting (lipomodelling) after extended latissimus dorsi flap breast reconstruction: a preliminary report of 200 consecutive cases. J Plast Reconstr Aesthet Surg 63(11):1769–1777
40. Burgic M, Bruant Rodier C, Wilk A et al (2010) Complications following autologous latissimus flap breast reconstruction. Bosn J Basic Med Sci 10(1):65–67
41. Nahabedian NY, Tsangaris T, Momen B (2005) Breast reconstruction with the DIEP flap or the muscle-sparing (MS-2) free TRAM flap: is there a difference? Plast Reconstr Surg 115:436–444
42. Nahabedian MY, Momen B, Galdino G et al (2002) Breast reconstruction with the free TRAM or DIEP flap: patient selection, choice of flap, and outcome. Plast Reconstr Surg 110:466–475
43. Hudson DA (2004) Factors determining shape and symmetry in immediate breast reconstruction. Ann Plast Surg 52(1):15–21
44. Shaikh-Naidu N, Preminger BA, Rogers K, et al (2004) Determinants of aesthetic satisfaction following TRAM and implant breast reconstruction. Ann Plast Surg 52(5):465–470 (discussion 470)
45. Carlson GW, Losken A, Moore B et al (2001) Results of immediate breast reconstruction after skin-sparing mastectomy. Ann Plast Surg 46(3):222–228
46. Rivadeneira DE, Simmons RM, Fish SK et al (2000) Skin-sparing mastectomy with immediate breast reconstruction: a critical analysis of local recurrence. Cancer J 6(5):331–335
47. Medina-Franco H, Vasconez LO, Fix RJ et al (2002) Factors associated with local recurrence after skin-sparing mastectomy and immediate breast reconstruction for invasive breast cancer. Ann Surg 235(6):814–819
48. Ho CM, Mak CK, Lau Y et al (2003) (2003) Skin involvement in invasive breast carcinoma: safety of skin-sparing mastectomy. Ann Surg Oncol 10(2):102–107
49. Singletary SE, Robb GL (2003) Oncologic safety of skin-sparing mastectomy. Ann Surg Oncol 10(2):95–97
50. Spiegel AJ, Butler CE (2003) Recurrence following treatment of ductal carcinoma in situ with skin-sparing mastectomy and immediate breast reconstruction. Plast Reconstr Surg 111(2):706–711
51. Carlson GW, Styblo TM, Lyles RH et al (2003) Local recurrence after skin-sparing mastectomy: tumor biology or surgical conservatism? Ann Surg Oncol 10(2):108–112
52. Fisher B, Anderson S, Redmond CK et al (1995) Reanalysis and results after 12 years of follow-up in a randomized clinical trial comparing total mastectomy with lumpectomy with or without irradiation in the treatment of breast cancer. N Engl J Med 333(22):1456–1461
53. King TA, Sakr R, Patil S et al (2011) Clinical management factors contribute to the decision for contralateral prophylactic mastectomy. J Clin Oncol 29(16):2158–2164
54. Robertson C, Arcot Ragupathy SK, Boachie C et al (2011) The clinical effectiveness and cost effectiveness of different surveillance mammography regimens after the treatment for primary breast cancer: systematic reviews, registry database analyses and economic evaluation. Health Technol Assess 15(34):
55. Houssami N, Ciatto S, Macaskill P et al (2008) Accuracy and surgical impact of MRI in breast cancer staging: systematic review and meta-analysis in detection of multifocal and multicentric cancer. J Clin Oncol 26(19):3248–3258
56. Brennan ME, Houssami N, Lord S et al (2009) Magnetic resonance imaging screening of the contralateral breast in women with newly diagnosed breast cancer: systematic review and meta-analysis of incremental cancer detection and impact on surgical management. J Clin Oncol 27(33):5640–5649
57. Bedrosian I, Hu CY, Chang GJ (2010) Population-based study of contralateral prophylactic mastectomy and survival outcomes of breast cancer patients. J Natl Cancer Inst 102(6):401–409
58. Schaverien MV, Stutchfield BM, Raine C et al (2012) Implant-based augmentation mammaplasty following breast conservation surgery. Ann Plast Surg (in press)
59. Hartmann LC, Schaid DJ, Woods JE et al (1999) Efficacy of bilateral prophylactic mastectomy in women with a family history of breast cancer. N Engl J Med 340(2):77–84
60. Petit Y, Veronesi U, Orecchia R et al (2005) Nipple-sparing mastectomy in association with intra operative radiotherapy (ELLIOT): a new type of mastectomy for breast cancer treatment. Breast Cancer Res Treat 27:1–5
61. Caruso F, Ferrara M, Gastiglione G et al (2006) Nipple sparing subcutaneous mastectomy: sixty-six month follow up. Eur J Surg Oncol 32:937–940
62. Petit, JY, Veronesi U, Rey P et al (2009) Nipple-sparing mastectomy: risk of nipple-areolar recurrences in a series of 579 cases. Breast Cancer Res Treat 114(1):97—101
63. Petit JY, Veronesi U, Lohsiriwat V et al (2011) Nipple-sparing mastectomy—is it worth the risk? Nat Rev Clin Oncol. 8(12):742–747
64. Kronowitz SJ (2010) Delayed-immediate breast reconstruction: technical and timing considerations. Plast Reconstr Surg 125(2):463–474
65. Kronowitz SJ, Lam C, Terefe W (2011). A multidisciplinary protocol for planned skin-preserving delayed breast reconstruction for patients with locally advanced breast cancer requiring postmastectomy radiation therapy: 3-year follow up. Plast Reconstr Surg 127(6):2154–2166
66. Damen TH, de Bekker-Grob EW, Mureau MA et al (2011) Patients' preferences for breast recosntruction: a discrete choice experiment. J Plast Reconstr Aesthet Surg 64(1):75–83
67. Winters ZE, Benson JR, Pusic AL (2010) A systematic review of the clinical evidence to guide treatment recommendations in breast reconstruction based on patient-reported outcome measures and health-related quality of life. Ann Surg 252(6):929–942
68. Sbitany H, Amalfi AN, Langstein HN (2009) Preferences in choosing between breast reconstruction options: a survey of female plastic surgeons. Plast Reconstr Surg 124(6):1781–1789
69. Lee CN, Belkora J, Chang Y et al (2011) Are patients making high-quality decisions about breast reconstruction after mastectomy? Plast Reconstr Surg 127(1):18–26
70. Collins KK, Liu Y, Schootman M et al (2011) Effects of breast cancer surgery and surgical side effects on body image over time. Breast Cancer Res Treat 126(1):167–176

Principles for Breast Reconstruction: Indications and Limits

7

Jennifer L. Marti and Virgilio Sacchini

7.1 Introduction

Breast cancer occurs in one of eight American women. Although many patients are candidates for breast-conservation therapy, the rates of mastectomy and of contralateral risk-reducing mastectomy have risen in recent years in the USA [1]. The vast majority of patients undergoing mastectomy are candidates for breast reconstruction. Accordingly, the number of breast reconstruction operations has also increased [2].

Extensive literature clearly supports the advantages and oncologic safety of reconstruction after mastectomy. Reconstruction after mastectomy has been shown to be effective in restoring body image, improving quality of life, and reducing the psychological distress of mastectomy [3, 4]. At the same time, immediate reconstruction has been found to be oncologically safe after mastectomy, even in cases of advanced breast cancer [5–7]. This has been conclusively demonstrated in multiple studies, including a meta-analysis by Gieni et al. [8], which confirmed no increased risk of local recurrence with immediate breast reconstruction after mastectomy. However, despite its advantages and oncologic safety, fewer than 25 % of American patients undergo immediate or delayed reconstruction after mastectomy [9].

Options for reconstruction include reconstruction with autologous tissue, or with a tissue expander and implant. For unilateral reconstruction, symmetry is more easily obtained with a tissue flap than with an implant [2]. Autologous flap options include latissimus dorsi myocutaneous flaps, transverse rectus abdominus myocutaneous (TRAM) flaps, deep inferior epigastric perforator flaps, and gluteal artery perforator flaps [3]. Implants contain either saline or silicone. An immediate one-stage reconstruction with an implant may be feasible; however, most patients undergo a staged procedure with a tissue expander to allow for interval expansion, followed by an exchange to a permanent implant.

Autologous reconstruction may be difficult or complicated in patients who have undergone prior surgery at potential donor sites, or who have medical comorbidities such as hypertension, diabetes, and chronic obstructive pulmonary disease, who are smokers, or who are at the extremes of body mass index [3].

7.2 Immediate Versus Delayed Reconstruction

Most patients undergoing mastectomy are candidates for immediate reconstruction. Immediate reconstruction offers multiple advantages, including one-stage surgery, better cosmetic outcome, and improved psychological state. In the only randomized controlled trial to date comparing immediate and delayed breast reconstruction, Dean et al. [10] reported increased psychological well-being with immediate reconstruction [3]. Immediate reconstruction often achieves a better aesthetic result than delayed reconstruction, owing to preservation of the skin envelope and inframammary fold [11]. For patients who undergo delayed reconstruction, use of an autologous flap is preferable to use of an implant, as the process of tissue expansion required for an implant is difficult owing to skin stiffness, resulting in a suboptimal cosmetic result [2]. A combination of a tissue expander and an implant with a latissimus dorsi flap is another option for breast reconstruction.

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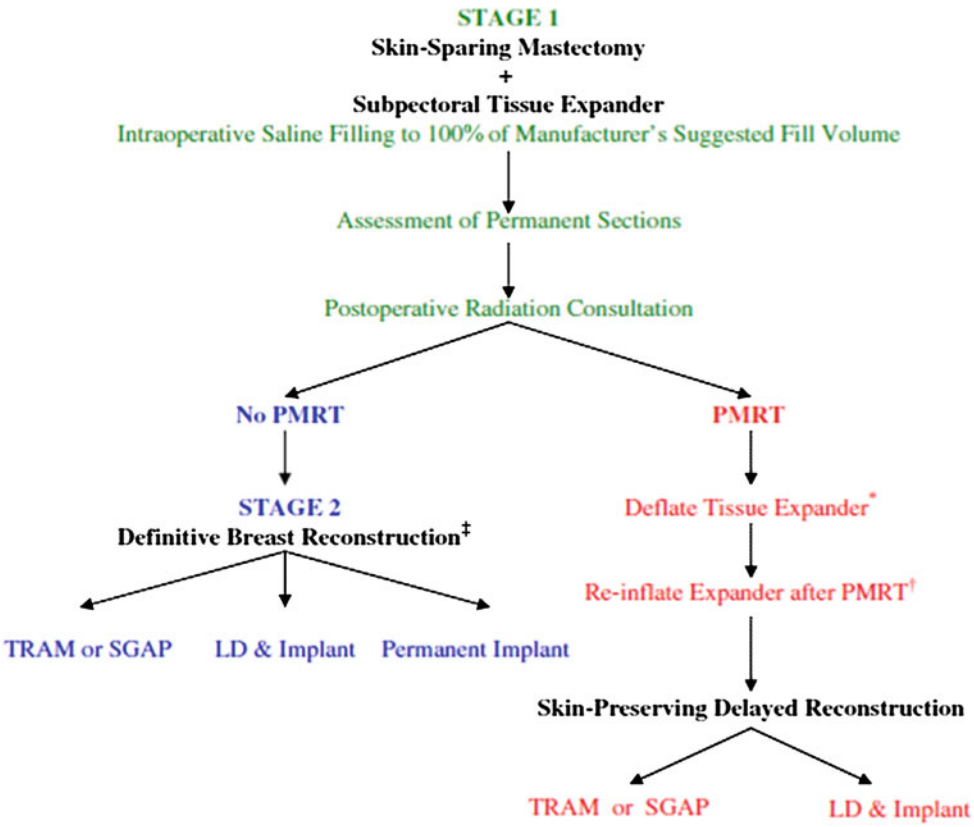

Fig. 7.1 MD Anderson Cancer Center delayed–immediate breast reconstruction protocol. *LD* latissimus dorsi flap, *PMRT* postmastectomy radiation therapy, *SGAP* superior gluteal artery perforator flap, *TRAM* transverse rectus abdominus myocutaneous flap. (Reprinted with permission from Kronowitz et al. [62])

7.2.1 Breast Reconstruction Considerations with Anticipated Postmastectomy Radiotherapy

Immediate reconstruction in patients who will undergo anticipated postmastectomy radiotherapy (PMRT) is controversial. The two main issues that raise concern are compromised delivery of radiotherapy in the face of a reconstructed breast, and the impact of radiotherapy on the long-term cosmetic result of the reconstruction [12].

7.2.2 Oncologic Safety of Reconstruction Prior to PMRT

Historically, delayed reconstruction has been recommended when PMRT is planned. Some still advocate this approach, owing to concerns of compromised delivery of radiotherapy in the presence of a reconstructed breast, whether a tissue flap or an implant [12–16]. Concerns include compromised delivery to the internal mammary lymph nodes, nonuniform radiotherapy delivery, underdosing of the chest wall, and increased radiotherapy dose to normal tissues with a breast reconstruction in place [12]. The evidence is conflicting. On the one hand, Motwani et al. [15] reported compromised delivery of radiotherapy in 52 % of patients who had undergone immediate reconstruction, compared with 7 % of controls. However, Koutcher et al. [17] found no compromised delivery of radiotherapy to the chest wall in most patients, with an excellent 30-month actuarial locoregional control rate of 97 %.

Owing to concerns of compromised radiotherapy delivery attributable to the reconstructed breast, a "delayed–immediate" reconstruction algorithm is advocated at the MD Anderson Cancer Center for patients who will receive PMRT [2]. With this approach, a tissue expander is placed at the time of mastectomy, and is deflated during adjuvant radiotherapy (protocol outlined in Fig. 7.1). Tissue expansion is performed after the completion of radiotherapy, and reconstruction with an autologous flap is performed 4–6 months thereafter [18]. In this series, the approach resulted in low complication rates, with tissue expander loss in 14 % of patients. The recurrence rate at 32 months of follow-up was low, at 3 % [18]. The complication rate with a "delayed–immediate" approach with subsequent flap reconstruction may be lower than that for a standard delayed flap reconstruction (26 % vs. 38 %, $p = 0.40$) [18].

Despite the concerns about radiation delivery that prompted development of the "delayed–immediate approach," many authors have reported acceptable recurrence rates and cosmetic outcomes with immediate reconstruction followed by PMRT [17]. In one retrospective

review of 191 patients requiring PMRT who underwent TRAM flap reconstruction in either an immediate or a delayed fashion, the risk of locoregional recurrence was not significantly increased in the group undergoing immediate reconstruction (3.7 % vs. 1.8 %, $p = 0.65$) at 40 months of follow-up [19]. Similarly, Wright et al. [20] retrospectively reviewed 104 patients who underwent exchange for a permanent implant prior to PMRT. Local control rates were excellent, 0 % at 5 years, and immediate reconstruction was not associated with an elevated risk of distant metastases or death.

In contrast to these data, others have reported higher rates of locoregional recurrence among patients undergoing immediate reconstruction. Nahabedian et al. [21] retrospectively analyzed 146 patients who underwent immediate or delayed reconstruction after PMRT. Locoregional recurrence rates were higher in patients who underwent immediate versus delayed reconstruction (27 % vs. 15 %, $p = 0.04$). These data should be interpreted with caution because of the higher than expected rates of recurrence [21, 22]. As a result of these conflicting data, the safety of immediate reconstruction prior to PMRT remains controversial.

7.2.3 Effects of Radiotherapy on the Cosmetic Outcome of the Reconstructed Breast

In addition to conflicting data about oncologic safety, there is also debate about the impact of reconstruction prior to PMRT on cosmetic outcomes. The main complications caused by radiation on the reconstructed breast include fat necrosis, impaired wound healing, contracture, fibrosis, volume loss, and architectural distortion [23]. There are data to support superior cosmetic results with delayed reconstruction compared with immediate reconstruction. Javaid et al. [23] in a systematic review of ten published reports of patients undergoing immediate and delayed reconstruction and PMRT found a higher incidence of breast fibrosis and contracture with immediate reconstruction. Similarly, Kronowitz et al. [16], in a systematic review of 49 articles, reported high rates of contracture and implant loss among patients undergoing immediate reconstruction prior to PMRT.

Other groups have also reported lower rates of complications after delayed reconstruction. Adesiyun et al. [24], in a review of 113 patients who underwent immediate or delayed breast reconstruction with PMRT, reported a lower rate of complications in the delayed-reconstruction group (32 % vs. 44 %, $p = 0.18$), although this difference was not statistically significant. The patients' general satisfaction with their cosmetic outcome was similar in the two groups (68 %) [24]. Another group found no significant difference in complication rates with immediate or delayed reconstruction with TRAM flaps in patients who received PMRT, but the authors ultimately recommended delayed reconstruction because of possible low power of the study [25].

Compared with the aforementioned studies, other groups have reported acceptable cosmetic results and complication rates with immediate reconstruction. A meta-analysis of 11 studies by Barry et al. [26] concluded that postoperative outcomes did not differ depending on whether reconstruction was performed before or after PMRT. Autologous flaps appeared to have superior outcomes. Postoperative complications such as fibrosis, contracture, infection, fat necrosis, and reoperation were lower with autologous flap reconstruction than with implant reconstruction [26]. Thus, if immediate reconstruction is pursued, many authors advocate reconstruction with an autologous flap over a tissue expander/implant to enhance cosmetic results [6].

Although many authors have reported superior outcomes with flap reconstruction compared with implant reconstruction prior to PMRT, this does not necessarily imply that successful outcomes cannot be achieved with implant reconstruction. For example, Cordeiro et al. [27, 28] reported satisfactory aesthetic results with immediate tissue expander placement, followed by exchange for a permanent implant prior to radiotherapy. Aesthetic results were categorized as "good to excellent" in 80 % of patients, with an implant loss rate of 11 % [27].

7.2.4 Inflammatory Breast Cancer

In patients with inflammatory breast carcinoma, delayed reconstruction is recommended because of extensive skin involvement and a high risk of local recurrence [29]. The required resection of skin precludes a skin-sparing mastectomy. Furthermore, timely administration of radiotherapy is imperative, making the delay for healing after reconstruction undesirable. Therefore, reconstruction should be delayed in patients undergoing mastectomy for inflammatory breast cancer. This recommendation is reflected in the 2012 National Cancer Comprehensive Network guidelines [30].

There are two small series that have reported success with immediate reconstruction. Chin et al. [31] performed a retrospective analysis of 23 patients with inflammatory breast cancer who underwent immediate or delayed reconstruction. They reported similar rates of locoregional recurrence (29 % vs. 33 %, p not significant), suggesting no compromised oncologic outcome with immediate reconstruction. Another small series found no overall survival difference in patients who underwent immediate reconstruction, although six of ten patients did develop local recurrence [32]. Importantly, these small studies do not

offer sufficient statistical power to conclusively demonstrate the safety of immediate breast reconstruction for patients with inflammatory breast cancer.

In conclusion, for patients who will likely require PMRT, immediate reconstruction remains controversial, owing to concerns of compromised radiotherapy delivery and impaired cosmetic outcome of the reconstructed breast. However, many authors have reported acceptable cosmetic outcomes and comparable rates of locoregional recurrence with immediate reconstruction. Immediate reconstruction is not recommended in patients with inflammatory breast cancer.

7.2.4.1 Nipple-Sparing Mastectomy

After a traditional skin-sparing mastectomy, patients may subsequently undergo nipple reconstruction. This requires an additional surgical procedure and tattooing, and ultimately, many patients may never pursue this. Furthermore, results may be disappointing. Jabor et al. [33] reported a 14 % rate of patient dissatisfaction after nipple–areola complex (NAC) reconstruction owing to loss of nipple projection and the overall appearance and texture of the reconstructed NAC. Therefore, preservation of the NAC with a nipple-sparing mastectomy (NSM) may be desirable in some patients.

Subcutaneous mastectomy with NAC preservation and breast reconstruction was first described by Freeman [34] in 1962. Preservation of the NAC may enhance cosmetic outcome and offer psychological benefit, as the NAC plays an important role in the identification of a woman's body image [35]. Indeed, Boneti et al. [36] reported higher patient cosmetic satisfaction in patients who had undergone NSM as compared with skin-sparing mastectomy. There is theoretical concern about the oncologic safety of this procedure owing to an inability to resect all of the retroareolar ductal tissue.

7.2.5 Candidates for NSM

When selecting a candidate for NSM, one must consider the risk of cancer involvement of the NAC, and the size and degree of ptosis of the breast [37]. Candidates for NSM include patients undergoing risk-reducing mastectomy. Patients may pursue risk-reducing mastectomy because of high-risk factors such as a strong family history, the presence or history of a contralateral breast tumor, lobular carcinoma in situ, or previous radiation for Hodgkin lymphoma [38]. Selected patients with ductal carcinoma in situ (DCIS) or invasive breast cancer may also be candidates for NSM [38]. In appropriately selected patients, only 12 % will have tumor involvement at the NAC, precluding preservation [39, 40].

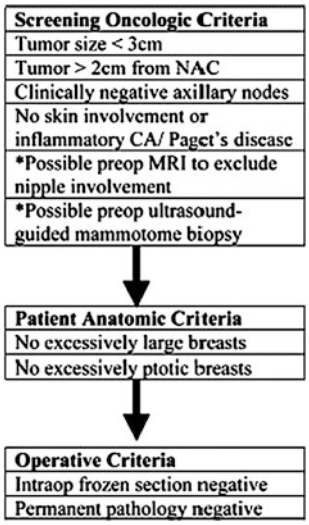

Fig. 7.2 Patient selection criteria for nipple-sparing mastectomy. *CA* cancer, *NAC* nipple–areola complex. (Reproduced with permission from Spear et al. [50])

The factors associated with nipple involvement include tumors larger than 2–4 cm, a tumor–nipple distance of less than 2 cm, breast tumors overlapping more than one quadrant, grade 3 or undifferentiated cancers, stage III disease, human epidermal growth factor receptor 2 (HER2)/neu positivity, and an extensive intraductal component of greater than 25 % [41–43].

For patients with invasive cancer, small tumors located in the periphery of the breast have the lowest risk of NAC involvement. The lowest risk of NAC involvement occurs in tumors smaller than 2 cm, located at least 2.5 cm from the NAC [44]. Tumors located within 2 cm of the NAC, or larger than 4 cm, were found in one report to have occult tumor present at the nipple in 50 % of cases [44]. A pathologic analysis of 140 mastectomy specimens reported a 16 % rate of NAC involvement with cancer. In all cases, the primary tumor was located within 2.5 cm of the NAC [45].

Many series of carefully selected patients have reported low rates of NAC involvement, ranging from 6 to 10 % [37, 38, 46–49]. In one series of patients with peripheral tumors and clinically node-negative disease, a low rate (less than 2 %) of NAC involvement was reported [48]. Therefore, the risk of NAC involvement is lower in patients with low-grade, unicentric, small, peripheral tumors, with clinically uninvolved axillary lymph nodes, who have not undergone neoadjuvant chemotherapy [39, 48, 50, 51]. Patients who will likely undergo radiotherapy are not ideal candidates, as they have advanced disease that portends a higher probability of NAC involvement. Furthermore, radiotherapy may result in distortion and asymmetric displacement of the NAC. A proposed algorithm for patient selection is illustrated in Fig. 7.2.

7.2.6 Intraoperative Assessment of NAC Tumor Involvement

Identification of NAC tumor involvement precludes NAC preservation. Intraoperative pathologic assessment with frozen section of the retroareolar ducts can be useful to identify the presence of NAC tumor involvement at the initial surgery [39, 42, 52]. Dissection of the retroaerolar ducts should be done sharply, as cautery can cause thermal damage to the NAC [52]. Coring of the nipple ducts may be facilitated by everting the nipple [52].

Frozen-section analysis is 91 % sensitive and 99 % specific for assessing tumor involvement of the NAC [53]. Reported rates of positive frozen section range from 2.5 to 12 % in well-selected patients [36, 39, 54, 55]. With careful patient selection and the use of preoperative MRI, Wijayanayagam et al. [56] reported a low rate of NAC involvement of 3 %. NAC tumor involvement may not be identified until final surgical pathologic analysis, necessitating NAC resection at a second surgery. When the NAC is involved with tumor, the histologic finding is usually DCIS, although atypical ductal hyperplasia and invasive breast carcinoma may also be identified [39, 43, 54, 57].

7.2.7 Rates of Recurrence After NSM

Multiple series with less than 3 years of follow-up have reported recurrence rates of 5 % or less after NSM, comparable to rates of recurrence after skin-sparing mastectomy [36, 40, 55, 58]. Voltura et al. [55] reported a 5 % recurrence rate at 24 months in patients with aggressive triple-negative tumors. Sacchini et al. [58] reported recurrences in only two of 123 patients undergoing NSM, with a median follow-up of 25 months. Recurrences did not occur at the NAC [58]. Breast cancer occurred in two patients who underwent risk-reducing mastectomies, located in peripheral locations [58]. In another series of 96 patients who underwent NSM with a median follow-up of 34 months, only one patient developed a locoregional recurrence, and two patients developed distant metastases [40].

The reported recurrence rates of longer-term studies, with follow-up of at least 3 years, range from 5 to 28 % [39, 42, 59, 60]. In a review of 112 patients who underwent NSM and had tumors located at least 2 cm from the nipple, 5 % of patients has recurrence at a mean follow-up of 59 months [42]. Recurrences occurred in the chest wall, upper breast, and inframammary fold, with only one recurrence in the NAC [42]. The location of these recurrences highlights the importance of considering the potential for elevated risk at the periphery of the breast after NSM, as access to the peripheral breast may be more difficult if a small periareolar incision is used.

Studies with long-term follow-up of patients who undergo NSM are limited, and have not definitively demonstrated the long-term oncologic safety of NSM. In a series with a follow-up of 5.5 years, Caruso et al. [59] reported a recurrence rate of 12 % in 50 patients. Recurrences occurred at the NAC in one patient, and distant metastases developed in four patients. In a prospective trial with a median follow-up of 13 years, Benediktsson and Perbeck [53] reported a high overall locoregional recurrence rate of 28 %. This may suggest that NSM is not oncologically safe in the long term, but this high rate may have been due to patient selection. Patients at high risk of recurrence were included, with tumors larger than 3 cm or multicentric disease [53]. Patients in this study who received PMRT had a local recurrence rate of 8.5 %, similar to reported rates after skin-sparing mastectomy [53].

Petit et al. [60] recently published an update of their experience with 934 patients who underwent NSM with a median follow-up of 50 months. These investigators routinely treat the NAC intraoperatively with electron intraoperative treatment if the frozen section is negative, and preserve the NAC even if final pathologic investigation reveals tumor involvement [60]. For patients with invasive ductal cancer, 3.6 % had recurrence in the breast at 5 years, and 0.8 % had recurrence at the NAC [60]. Of the patients who had recurrence at the NAC, most had an extensive intraductal component and had HER2/neu positivity [60]. For patients with DCIS, the rate of locoregional recurrence at 5 years was high: 8 % [60]. The rate of recurrence was 4.9 % in the breast and 2.9 % at the NAC [60]. These high recurrence rates may cause one to pause before offering this procedure to patients with DCIS. Predictors of breast recurrence among patients with DCIS included age under 40 years, positive retroareolar margins, estrogen receptor negativity, progesterone receptor negativity, high-grade histologic findings, HER2/neu positivity, and Ki-67 index greater than 20 % [60].

In conclusion, several studies support the short-term oncologic safety of NSM, with locoregional recurrence rates similar to those of skin-sparing mastectomy, and rare recurrences occurring at the NAC. However, the long-term oncologic safety of this procedure has not been determined, and the recent data of Petit et al. [60] may be a reason for caution in patients with DCIS. More studies with longer-term follow-up are needed, as the literature to date is not yet definitive on the oncologic safety of NSM in the long term.

7.2.8 NSM in BRCA Mutation Carriers

The oncologic safety of NSM in BRCA mutation carriers is controversial, as breast tissue connects with the nipple and cannot be completely resected with NAC preservation [61].

One pathologic analysis of mastectomy specimens of BRCA patients revealed that terminal ductal lobular units were present in 24 % of the NACs and 8 % of nipples [61]. The long-term potential of this retained tissue developing a cancer is unknown [61]. In this study, occult NAC tumor involvement was 0 % in risk-reducing specimens, and 10 % in therapeutic specimens. These rates are similar to those for non-BRCA mutation carriers [61]. Long-term studies are needed before we can say with absolute certainty that NSM is an oncologically sound procedure in BRCA patients.

7.2.8.1 Postoperative Outcomes of the NAC

Patients should be counseled that the NAC preservation in NSM is mainly of cosmetic, not functional benefit. Most patients will not experience sustained preservation of nipple sensation or erectile ability [39]. There is a risk of approximately 12 % of occult tumor involvement at the NAC, requiring resection [39, 40]. Furthermore, there is a risk of partial or complete necrosis of the NAC in approximately 4–11 % of patients [38, 39, 42, 54, 58]. Preservation of the blood supply to the NAC may be maximized by use of a lateral incision, without a circumareolar extension. Also, the NAC may ultimately settle in a displaced or asymmetric position, with lateral displacement occurring in 67 % of cases in one series [54].

Numerous studies have demonstrated the short-term oncologic safety of NSM in risk reduction, and in patients with early-stage breast cancer. Larger studies with longer follow-up are needed to definitely demonstrate that NSM has locoregional recurrence rates comparable to those of skin-sparing mastectomy. Ideal candidates for NSM should have small tumors (less than 3 cm), located at least 2 cm from the nipple, with clinically uninvolved axillary lymph nodes, and without skin involvement [50]. Patients with extensive DCIS are not good candidates for NSM because of reported high rates of locoregional recurrence [60]. Use of intraoperative frozen section can identify most patients with occult NAC involvement. Preservation of the NAC may enhance cosmetic outcome and overall patient satisfaction.

7.3 Conclusions

Most patients are candidates for immediate breast reconstruction after mastectomy. For patients who will require PMRT, immediate reconstruction is controversial, but many authors have reported acceptable cosmetic results and locoregional recurrence rates with immediate reconstruction. NSM may be an attractive option for women for risk reduction, or in selected patients with early-stage breast cancer.

References

1. Tuttle TM, Habermann EB, Grund EH, Morris TJ, Virnig BA (2007) Increasing use of contralateral prophylactic mastectomy for breast cancer patients: a trend toward more aggressive surgical treatment. J Clin Oncol 25:5203–5209
2. Serletti JM, Fosnot J, Nelson JA, Disa JJ, Bucky LP (2011) Breast reconstruction after breast cancer. Plast Reconstr Surg 127:124e–135e
3. D'Souza N, Darmanin G, Fedorowicz Z (2011) Immediate versus delayed reconstruction following surgery for breast cancer. Cochrane Database Syst Rev CD008674
4. Miller MJ (1998) Immediate breast reconstruction. Clin Plast Surg 25:145–156
5. Langstein HN, Cheng MH, Singletary SE, Robb GL, Hoy E, Smith TL, Kroll SS (2003) Breast cancer recurrence after immediate reconstruction: patterns and significance. Plast Reconstr Surg 111:712–720(discussion 721–712)
6. Newman LA, Kuerer HM, Hunt KK, Ames FC, Ross MI, Theriault R, Fry N, Kroll SS, Robb GL, Singletary SE (1999) Feasibility of immediate breast reconstruction for locally advanced breast cancer. Ann Surg Oncol 6:671–675
7. O'Brien W, Hasselgren PO, Hummel RP, Coith R, Hyams D, Kurtzman L, Neale HW (1993) Comparison of postoperative wound complications and early cancer recurrence between patients undergoing mastectomy with or without immediate breast reconstruction. Am J Surg 166:1–5
8. Gieni M, Avram R, Dickson L, Farrokhyar F, Lovrics P, Faidi S, Sne N (2012) Local breast cancer recurrence after mastectomy and immediate breast reconstruction for invasive cancer: A meta-analysis. Breast 21(3):230–236
9. Agarwal S, Pappas L, Neumayer L, Agarwal J (2011) An analysis of immediate postmastectomy breast reconstruction frequency using the surveillance, epidemiology, and end results database. Breast J 17:352–358
10. Dean C, Chetty U, Forrest AP (1983) Effects of immediate breast reconstruction on psychosocial morbidity after mastectomy. Lancet 1:459–462
11. Drucker-Zertuche M, Robles-Vidal C (2007) A 7 year experience with immediate breast reconstruction after skin sparing mastectomy for cancer. Eur J Surg Oncol 33:140–146
12. Buchholz TA, Strom EA, Perkins GH, McNeese MD (2002) Controversies regarding the use of radiation after mastectomy in breast cancer. Oncologist 7:539–546
13. Schechter NR, Strom EA, Perkins GH, Arzu I, McNeese MD, Langstein HN, Kronowitz SJ, Meric-Bernstam F, Babiera G, Hunt KK, Hortobagyi GN, Buchholz TA (2005) Immediate breast reconstruction can impact postmastectomy irradiation. Am J Clin Oncol 28:485–494
14. Kronowitz SJ, Robb GL (2004) Breast reconstruction and adjuvant therapies. Semin Plast Surg 18:105–115
15. Motwani SB, Strom EA, Schechter NR, Butler CE, Lee GK, Langstein HN, Kronowitz SJ, Meric-Bernstam F, Ibrahim NK, Buchholz TA (2006) The impact of immediate breast reconstruction on the technical delivery of postmastectomy radiotherapy. Int J Radiat Oncol Biol Phys 66:76–82
16. Kronowitz S, Hunt K, Kuerer H, Strom E, Buchholz T, Ensor J, Koutz C, Robb G (2009) Immediate versus delayed repair of partial mastectomy defects in breast conservation. Breast Cancer Res 11(Suppl 1):S8
17. Koutcher L, Ballangrud A, Cordeiro PG, McCormick B, Hunt M, Van Zee KJ, Hudis C, Beal K (2010) Postmastectomy intensity modulated radiation therapy following immediate expander-implant reconstruction. Radiother Oncol 94:319–323

18. Kronowitz SJ (2010) Delayed-immediate breast reconstruction: technical and timing considerations. Plast Reconstr Surg 125:463–474
19. Huang CJ, Hou MF, Lin SD, Chuang HY, Huang MY, Fu OY, Lian SL (2006) Comparison of local recurrence and distant metastases between breast cancer patients after postmastectomy radiotherapy with and without immediate TRAM flap reconstruction. Plast Reconstr Surg 118:1079–1086 (discussion 1087–1078)
20. Wright JL, Cordeiro PG, Ben-Porat L, Van Zee KJ, Hudis C, Beal K, McCormick B (2008) Mastectomy with immediate expander-implant reconstruction, adjuvant chemotherapy, and radiation for stage II-III breast cancer: treatment intervals and clinical outcomes. Int J Radiat Oncol Biol Phys 70:43–50
21. Nahabedian MY, Momen B (2008) The impact of breast reconstruction on the oncologic efficacy of radiation therapy: a retrospective analysis. Ann Plast Surg 60:244–250
22. Anavekar NS, Rozen WM, Le Roux CM, Ashton MW (2011) Achieving autologous breast reconstruction for breast cancer patients in the setting of post-mastectomy radiotherapy. J Cancer Surviv 5:1–7
23. Javaid M, Song F, Leinster S, Dickson MG, James NK (2006) Radiation effects on the cosmetic outcomes of immediate and delayed autologous breast reconstruction: an argument about timing. J Plast Reconstr Aesthet Surg 59:16–26
24. Adesiyun TA, Lee BT, Yueh JH, Chen C, Colakoglu S, Anderson KE, Nguyen MD, Recht A (2011) Impact of sequencing of postmastectomy radiotherapy and breast reconstruction on timing and rate of complications and patient satisfaction. Int J Radiat Oncol Biol Phys 80:392–397
25. Spear SL, Ducic I, Low M, Cuoco F (2005) The effect of radiation on pedicled TRAM flap breast reconstruction: outcomes and implications. Plast Reconstr Surg 115:84–95
26. Barry M, Kell MR (2011) Radiotherapy and breast reconstruction: a meta-analysis. Breast Cancer Res Treat 127:15–22
27. Cordeiro PG, Pusic AL, Disa JJ, McCormick B, VanZee K (2004) Irradiation after immediate tissue expander/implant breast reconstruction: outcomes, complications, aesthetic results, and satisfaction among 156 patients. Plast Reconstr Surg 113:877–881
28. McCarthy CM, Pusic AL, Disa JJ, McCormick BL, Montgomery LL, Cordeiro PG (2005) Unilateral postoperative chest wall radiotherapy in bilateral tissue expander/implant reconstruction patients: a prospective outcomes analysis. Plast Reconstr Surg 116:1642–1647
29. Singletary SE (2008) Surgical management of inflammatory breast cancer. Semin Oncol 35:72–77
30. National comprehensive cancer network (2012). NCCN clinical practice guidelines in oncology. Breast Cancer (Version 3. 2012):1–167
31. Chin PL, Andersen JS, Somlo G, Chu DZ, Schwarz RE, Ellenhorn JD (2000) Esthetic reconstruction after mastectomy for inflammatory breast cancer: is it worthwhile? J Am Coll Surg 190:304–309
32. Slavin SA, Love SM, Goldwyn RM (1994) Recurrent breast cancer following immediate reconstruction with myocutaneous flaps. Plast Reconstr Surg 93:1191–1204 (discussion 1205–1197)
33. Jabor MA, Shayani P, Collins DR, Jr., Karas T, Cohen BE (2002) Nipple-areola reconstruction: satisfaction and clinical determinants. Plast Reconstr Surg 110:457–463 (discussion 464–455)
34. Freeman BS (1962) Subcutaneous mastectomy for benign breast lesions with immediate or delayed prosthetic replacement. Plast Reconstr Surg Transplant Bull 30:676–682
35. Wellisch DK, Schain WS, Noone RB, Little JW 3rd (1987) The psychological contribution of nipple addition in breast reconstruction. Plast Reconstr Surg 80:699–704
36. Boneti C, Yuen J, Santiago C, Diaz Z, Robertson Y, Korourian S, Westbrook KC, Henry-Tillman RS, Klimberg VS (2011) Oncologic safety of nipple skin-sparing or total skin-sparing mastectomies with immediate reconstruction. J Am Coll Surg 212:686–693 (discussion 693–685)
37. de Alcantara Filho P, Capko D, Barry JM, Morrow M, Pusic A, Sacchini VS (2011) Nipple-sparing mastectomy for breast cancer and risk-reducing surgery: the Memorial Sloan-Kettering Cancer Center experience. Ann Surg Oncol 18:3117–3122
38. Chen CM, Disa JJ, Sacchini V, Pusic AL, Mehrara BJ, Garcia-Etienne CA, Cordeiro PG (2009) Nipple-sparing mastectomy and immediate tissue expander/implant breast reconstruction. Plast Reconstr Surg 124:1772–1780
39. Crowe JP, Patrick RJ, Yetman RJ, Djohan R (2008) Nipple-sparing mastectomy update: one hundred forty-nine procedures and clinical outcomes. Arch Surg 143:1106–1110 (discussion 1110)
40. Paepke S, Schmid R, Fleckner S, Paepke D, Niemeyer M, Schmalfeldt B, Jacobs VR, Kiechle M (2009) Subcutaneous mastectomy with conservation of the nipple-areola skin: broadening the indications. Ann Surg 250:288–292
41. Lambert PA, Kolm P, Perry RR (2000) Parameters that predict nipple involvement in breast cancer. J Am Coll Surg 191:354–359
42. Gerber B, Krause A, Reimer T, Muller H, Kuchenmeister I, Makovitzky J, Kundt G, Friese K (2003) Skin-sparing mastectomy with conservation of the nipple-areola complex and autologous reconstruction is an oncologically safe procedure. Ann Surg 238:120–127
43. Brachtel EF, Rusby JE, Michaelson JS, Chen LL, Muzikansky A, Smith BL, Koerner FC (2009) Occult nipple involvement in breast cancer: clinicopathologic findings in 316 consecutive mastectomy specimens. J Clin Oncol 27:4948–4954
44. Cense HA, Rutgers EJ, Lopes Cardozo M, Van Lanschot JJ (2001) Nipple-sparing mastectomy in breast cancer: a viable option? Eur J Surg Oncol 27:521–526
45. Vyas JJ, Chinoy RF, Vaidya JS (1998) Prediction of nipple and areola involvement in breast cancer. Eur J Surg Oncol 24:15–16
46. Spear SL, Willey SC, Feldman ED, Cocilovo C, Sidawy M, Al-Attar A, Hannan C, Seiboth L, Nahabedian MY (2011) Nipple-sparing mastectomy for prophylactic and therapeutic indications. Plast Reconstr Surg 128:1005–1014
47. Petit JY, Veronesi U, Orecchia R, Rey P, Martella S, Didier F, Viale G, Veronesi P, Luini A, Galimberti V, Bedolis R, Rietjens M, Garusi C, De Lorenzi F, Bosco R, Manconi A, Ivaldi GB, Youssef O (2009) Nipple sparing mastectomy with nipple areola intraoperative radiotherapy: one thousand and one cases of a five years experience at the European institute of oncology of Milan (EIO). Breast Cancer Res Treat 117:333–338
48. Laronga C, Kemp B, Johnston D, Robb GL, Singletary SE (1999) The incidence of occult nipple-areola complex involvement in breast cancer patients receiving a skin-sparing mastectomy. Ann Surg Oncol 6:609–613
49. Petit JY, Veronesi U, Rey P, Rotmensz N, Botteri E, Rietjens M, Garusi C, De Lorenzi F, Martella S, Bosco R, Manconi A, Luini A, Galimberti V, Veronesi P, Ivaldi GB, Orecchia R (2009) Nipple-sparing mastectomy: risk of nipple-areolar recurrences in a series of 579 cases. Breast Cancer Res Treat 114:97–101
50. Spear SL, Hannan CM, Willey SC, Cocilovo C (2009) Nipple-sparing mastectomy. Plast Reconstr Surg 123:1665–1673
51. Lagios MD, Gates EA, Westdahl PR, Richards V, Alpert BS (1979) A guide to the frequency of nipple involvement in breast cancer. A study of 149 consecutive mastectomies using a serial subgross and correlated radiographic technique. Am J Surg 138:135–142
52. Chung AP, Sacchini V (2008) Nipple-sparing mastectomy: where are we now? Surg Oncol 17:261–266

53. Benediktsson KP, Perbeck L (2008) Survival in breast cancer after nipple-sparing subcutaneous mastectomy and immediate reconstruction with implants: a prospective trial with 13 years median follow-up in 216 patients. Eur J Surg Oncol 34:143–148
54. Wagner JL, Fearmonti R, Hunt KK, Hwang RF, Meric-Bernstam F, Kuerer HM, Bedrosian I, Crosby MA, Baumann DP, Ross MI, Feig BW, Krishnamurthy S, Hernandez M, Babiera GV (2012) Prospective evaluation of the nipple-areola complex sparing mastectomy for risk reduction and for early-stage breast cancer. Ann Surg Oncol 19:1137–1144
55. Voltura AM, Tsangaris TN, Rosson GD, Jacobs LK, Flores JI, Singh NK, Argani P, Balch CM (2008) Nipple-sparing mastectomy: critical assessment of 51 procedures and implications for selection criteria. Ann Surg Oncol 15:3396–3401
56. Wijayanayagam A, Kumar AS, Foster RD, Esserman LJ (2008) Optimizing the total skin-sparing mastectomy. Arch Surg 143:38–45 (discussion 45)
57. Cheung KL, Blamey RW, Robertson JF, Elston CW, Ellis IO (1997) Subcutaneous mastectomy for primary breast cancer and ductal carcinoma in situ. Eur J Surg Oncol 23:343–347
58. Sacchini V, Pinotti JA, Barros AC, Luini A, Pluchinotta A, Pinotti M, Boratto MG, Ricci MD, Ruiz CA, Nisida AC, Veronesi P, Petit J, Arnone P, Bassi F, Disa JJ, Garcia-Etienne CA, Borgen PI (2006) Nipple-sparing mastectomy for breast cancer and risk reduction: oncologic or technical problem? J Am Coll Surg 203:704–714
59. Caruso F, Ferrara M, Castiglione G, Trombetta G, De Meo L, Catanuto G, Carillio G (2006) Nipple sparing subcutaneous mastectomy: sixty-six months follow-up. Eur J Surg Oncol 32:937–940
60. Petit JY, Veronesi U, Orecchia R, Curigliano G, Rey PC, Botteri E, Rotmensz N, Lohsiriwat V, Cassilha Kneubil M, Rietjens M (2012) Risk factors associated with recurrence after nipple-sparing mastectomy for invasive and intraepithelial neoplasia. Ann Oncol 23(8):2053–2058
61. Reynolds C, Davidson JA, Lindor NM, Glazebrook KN, Jakub JW, Degnim AC, Sandhu NP, Walsh MF, Hartmann LC, Boughey JC (2011) Prophylactic and therapeutic mastectomy in BRCA mutation carriers: can the nipple be preserved? Ann Surg Oncol 18:3102–3109
62. Kronowitz SJ, Hunt KK, Kuerer HM, Babiera G, McNeese MD, Buchholz TA, Strom EA, Robb GL (2004) Delayed-immediate breast reconstruction. Plast Reconstr Surg 113:1617–1628

8 Aesthetic Principles for Breast Reconstruction: Breast Aesthetic Units and Evaluation of Late Aesthetic Results

Marcelo M. C. Sampaio and Murillo Fraga

8.1 Introduction

Aesthetics (*aisthésis*) is a branch of philosophy dealing with the study of nature and beauty. Several philosophers have encountered great difficulty when attempting to define beauty, or even ugliness, and even more when attempting to quantify this property. Kant, a respected philosopher whose aesthetic notions were quoted by his peers, asserted that it was impossible to establish theoretical rules to build beautiful things.

Upon attempting to establish aesthetic notions, physicians face difficulties in scientifically validating their results. Individual criteria are invariably attributed to judgment.

Because it is a subjective matter, aesthetic assessment imposes limitations on science's attempts to measure it. In breast reconstruction, a result is deemed good when it pleases most people, especially the patient. Questionnaires on quality of life can be applied as a scientific method to assess results, although quite often they were developed for other medical areas and later adapted for plastic surgery. Another possibility is to apply a statistically validated specific questionnaire to the assessment of results.

Recently, one such questionnaire, BREAST-Q, was validated. After application to 817 women, it proved to be an efficient instrument to assess aesthetic or reconstructive surgery of the breast. The development of standardized questionnaires is important because these instruments allow comparisons among publications by different institutions and thus represent a powerful scientific tool [1]. This questionnaire was used in several clinical studies. McCarthy et al. [2] applied it to 672 mastectomy patients and concluded that those who underwent reconstruction with silicone implants were more satisfied than those who underwent reconstruction with saline implants. Another group of researchers applied this questionnaire to 219 women who underwent reconstruction with implants and autologous tissue and found that the group with the transverse rectus abdominis myocutaneous (TRAM) flap was more satisfied with their new breasts [3].

In recent years, there has been increasing concern with judging the effectiveness of plastic surgery procedures by means of questionnaires. Despite its biases, this method supports the consolidation of surgical procedures based on the improvement of the quality of life. BREAST-Q might become an effective instrument for this purpose because it was developed specifically for plastic surgery and allows for the standardization of the assessment of results in future literature.

Are quality-of-life questionnaires able to assess aesthetic results? This question is the subject of long-standing debate because, even if it were proven that plastic surgery positively impacts quality of life, it is very difficult to quantify aesthetics. Despite these shortcomings, questionnaires represent an important tool for the validation of surgical techniques and may eventually compel health insurance companies to fund these procedures.

Owing to the difficulties in establishing a scientific method of assessing aesthetic results in plastic surgery, many of the notions discussed in this study are purely empirical and thus offer a low level of scientific evidence.

8.2 Breast Reconstruction

Breasts are viewed by many as a fundamental indicator of femininity or as an element of sexual attraction, and they represent a very important factor in the psychosocial balance of women.

Since 1980, postmastectomy breast reconstruction has become an integral part of the therapeutic plan in breast cancer. Evidence of the oncologic safety of this procedure and developments and advancements in several surgical techniques allow satisfactory reconstruction of the shape and size of breasts.

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The first decision to be made concerns the most appropriate time to perform the reconstruction, namely, whether during the same surgery as mastectomy or delayed by several months or years.

In ideal circumstances, immediate is preferred to delayed reconstruction. Patients are thus spared the trauma caused by breast amputation and have better odds of good aesthetic results because the anatomical elements are better preserved and less susceptible to the effects of late wound healing.

The choice of the reconstruction technique involves a complex assessment that must begin at the preoperative evaluation. The clinical history and physical examination allow not only the estimation of the anesthetic and surgical risks, but also prediction of the viability of certain reconstruction techniques. Ideally, reconstruction must be individualized, and no priority should be attributed a priori to any of the several available possibilities.

There are several techniques for breast reconstruction and they differ in the amount of tissue to be removed in the mastectomy, its localization, and the possibility of autologous tissue donor sites.

The anatomical elements that might require replacement include skin, glandular tissue, and the areolar–papillary complex. The extent and localization of the replaced tissue depend on the oncologic surgical treatment.

Breast reconstruction historically passed through several evolutionary phases as a function of its results. Initially, surgeons sought only to create a mammary volume. Next, the challenge was to give a proper shape to the reconstructed breast. Currently, it is possible to reconstruct symmetric breasts, aiming at attaining better balance. However, the search for perfection continues, and recently, an aesthetic concern arose regarding reconstruction. The challenge of applying aesthetic notions to reconstruction has become a trend, and the description of the anatomical units of the breasts and the chest wall motivates the discussions.

The assessment of the aesthetic results of reconstructions focuses on the attainment of symmetry in the volume, shape, and position of the breasts. This symmetry is a primordial, universally accepted notion, which is the goal of all patients. A new aesthetic criterion to consider was recently described, and concerns the anatomical units of the breast. According to this principle, instead of repairing only the damage caused by the oncologic-surgical treatment, the total reconstruction of these units might afford better aesthetic results [4, 5].

8.3 Breast Aesthetic Units

Burget and Menick [6] described the aesthetic subunits in nose reconstruction. The idea that the replacement of a full unit was better than partial reconstruction induced an extraordinary improvement in results. Similarly to nose reconstruction, the principle of aesthetic subunits in the planning of reconstructive breast surgery might result in better quality of the final results.

One of the aims is to restore the tissue in the most similar and natural manner possible with minimal scarring trauma.

In aesthetic breast surgery, surgeons choose to perform the incisions on the skin folds and anatomical sulci (axillary fold, inframammary fold, and areolar margin), thus reducing the stigma of a surgical intervention. In reconstructive surgery, this principle might not be followed owing to the oncologic priority of treatment. The localization and extent of the neoplasm determine the position of the scars. Nevertheless, the current approach still considers the aesthetic side without interfering in the local–regional treatment of disease [7].

On these grounds, in recent years, the concept of breast oncoplastic surgery emerged, which might be defined as the balance between the maximal local–regional control of breast cancer and the minimal possible trauma.

In the literature on breast cancer, the breasts were described as geometric circles divided into quadrants (“mammary mass”), without taking into account the natural and anatomical shape (of a drop) or the aesthetic demarcation lines. Surgical incisions on uncovered areas of the skin are aesthetically unpleasant. One of the main stigmas associated with the full process of breast reconstruction is the scar resulting from the catheter inserted to infuse chemotherapy agents, which remains visible on the upper chest area in the vast majority of patients [5].

In 1999, Restifo [8] applied the concept of breast aesthetic units in delayed reconstructions with a TRAM flap. In those cases where the lower flap was affected, the full lower pole was replaced by the skin island derived from the abdominal flap (TRAM flap).

A similar principle was applied by Coutinho et al. [9], who observed that it is often preferable to sacrifice a part of the preserved tissue and replace the full anatomical unit to attain more harmonious results. These same authors also reported their preference for single horizontal or oblique scars that do not encroach on the upper medial quadrant.

8.4 Langer’s Lines

Karl Langer, an Austrian anatomist, studied the skin of nonembalmed corpses and found that, although the bundles of dermal collagen fibers are placed in all directions, thus resulting in a resistant tissue, in any particular location, most fibers follow the same direction. He noticed that boring wounds produced by an ice pick on the skin of a corpse are slit-shaped rather than rounded because the ice pick divides the dermis according to the prevailing direction of the collagen fibers and thus allows the wound to open.

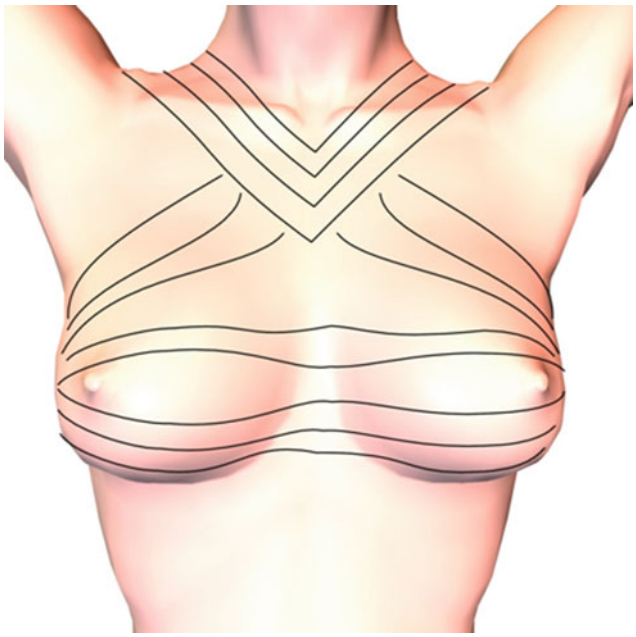

Fig. 8.1 Breast Langer's lines

The prevailing pattern of the collagen fibers determines the characteristic tension and wrinkles of the skin. The cleavage lines (also known as lines of minimum tension or Langer's lines) tend to be longitudinal spirals in the limbs and transverse in the neck and trunk [10].

Whenever possible, surgeons choose to follow the cleavage lines because they afford better-looking scars (Fig. 8.1).

8.5 The Subunit Principle

On the grounds of the breast subunit principle, two major approaches to reconstruction are described:

1. Reconstructions with flaps respecting the aesthetic subunits and thus producing good results.
2. Reconstructions not respecting the aesthetic subunits and thus giving a patch-like appearance to the anterior chest area.

The aesthetic subunits are characterized by the type of the skin, including its hue, texture, and thickness. These characteristics convey a uniform visual impression. The anatomical transitions between the breast and its boundaries, mainly the skin of the chest and the upper abdomen, demarcate clear transitional areas. Differences in the skin hue determine the characterization of the subunits and are crucial for the aesthetics of reconstruction.

Transitions are perceptible between the following locations:

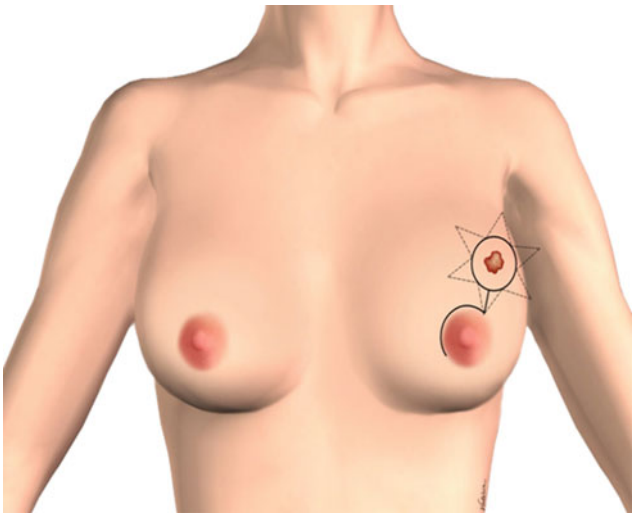

Fig. 8.2 The skin resection should be performed concentrically to the tumor, thus allowing the appropriate orientation of scars toward the better-camouflaged areas of the breasts

- Breast skin and areola
- Areola and nipple
- Breast skin and sternum skin
- Breast skin and upper abdomen skin
- Breast skin and lateral chest wall skin

Spear and Davison [11], in a 2003 review covering 10 years, assessed 264 patients who underwent reconstruction with autogenous tissue and concluded that the main breast subunits to be reconstructed and that afforded the best results in terms of appearance and scar camouflage were the areolar–papillary complex and the periareolar area. Once again, they emphasized the importance of taking these structures into account in surgical planning to achieve good results.

8.6 Reconstruction in Partial Mastectomies

The main goal of partial reconstruction is to preserve the cone shape of the breasts with the areolar–papillary complex centered on the breast projection apex. Scars must be linear or oblique and follow the lines of force (Langer's lines). Whenever possible, it is advisable to place the scars in the lower quadrants, inframammary fold, and periareolar area. The most difficult areas, which result in more visible scars, are the upper medial quadrants, which are not covered by the clothes.

The skin resection should be performed concentrically to the tumor, thus allowing the appropriate orientation of scars toward the better-camouflaged areas of the breasts (Fig. 8.2).

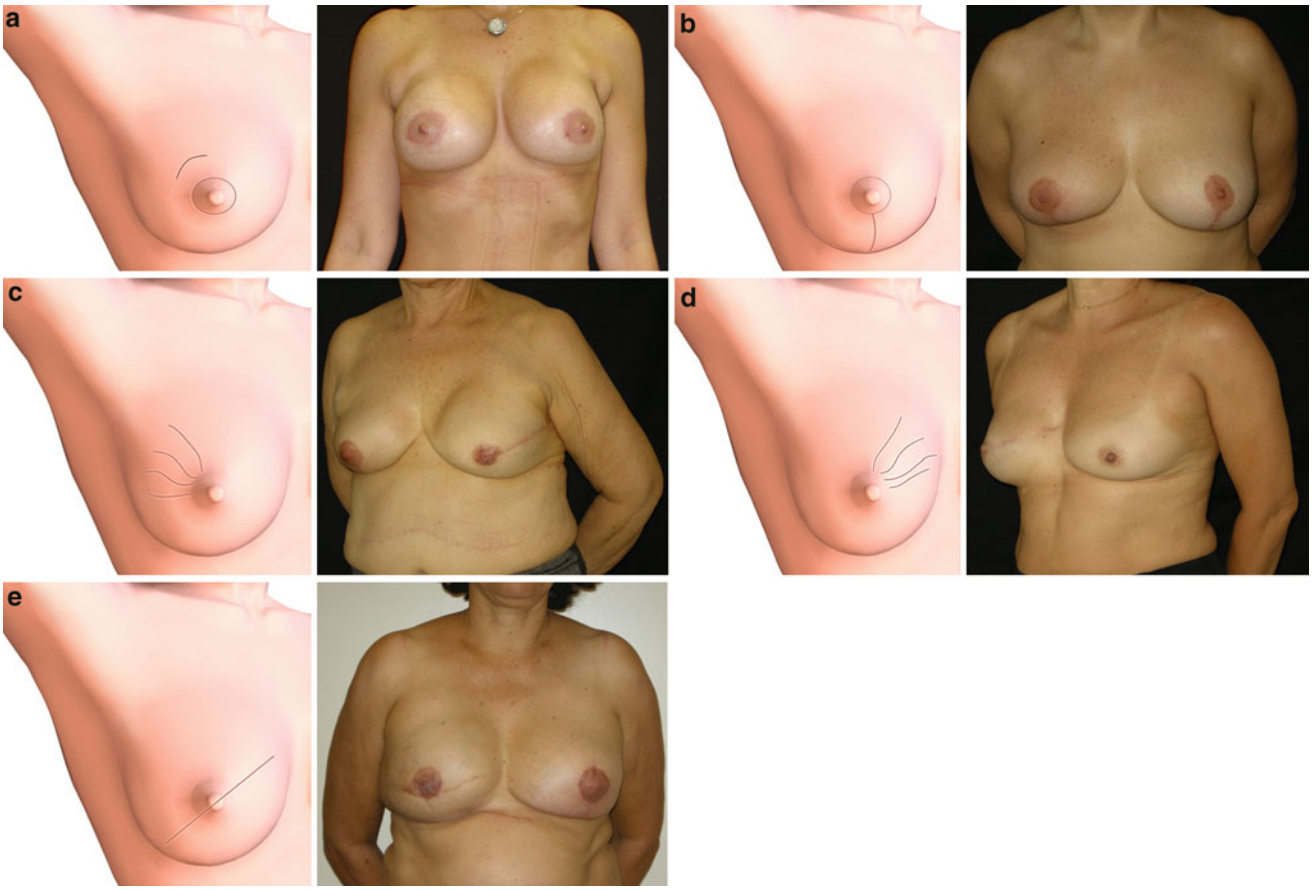

Fig. 8.3 Scar types: **a** type 1–periareolar scar; **b** type 2—scar on the lower pole; **c** type 3—scar on the upper lateral quadrant; **d** type 4—scar on the upper medial quadrant; **e** type 5—scar crossing over quadrants

8.7 Classification of Aesthetic Results According to the Position of Scars (Sampaio and Fraga)

According to the principles of the position and quality of scars in breast reconstruction, the scars may be classified into five types in decreasing order as a function of the aesthetic results (Fig. 8.3):

1. Periareolar scar (most favorable)
2. Scar on the lower pole
3. Scar on the upper lateral quadrant
4. Scar on the upper medial quadrant
5. Scar crossing over quadrants (least favorable)

8.8 Reconstruction in Total Mastectomies

Attention to the breast subunits favors the aesthetic results of reconstruction. Scars on the inframammary fold and lateral wall of the chest have better quality than scars on the medial and upper pole.

The total reconstruction of one breast segment affords better results than the reconstruction of one quadrant because it avoids the patch-like appearance.

The approach to reconstruction that emphasizes the importance of the breast aesthetic units affords surgeons the possibility of choosing the best surgical technique and of offering patients differentiated and more attractive results.

8.9 Classification of Breast Reconstruction Results According to the Position of the Flap (Sampaio and Fraga)

According to the principles of flap position and scar quality in mastectomies, we may classify the reconstruction types from the aesthetic point of view into four types in decreasing order (Fig. 8.4):

1. Flap in the lower pole (most favorable)
2. Flap in the upper pole
3. Full breast reconstruction
4. Central flap crossing over quadrants (least favorable)

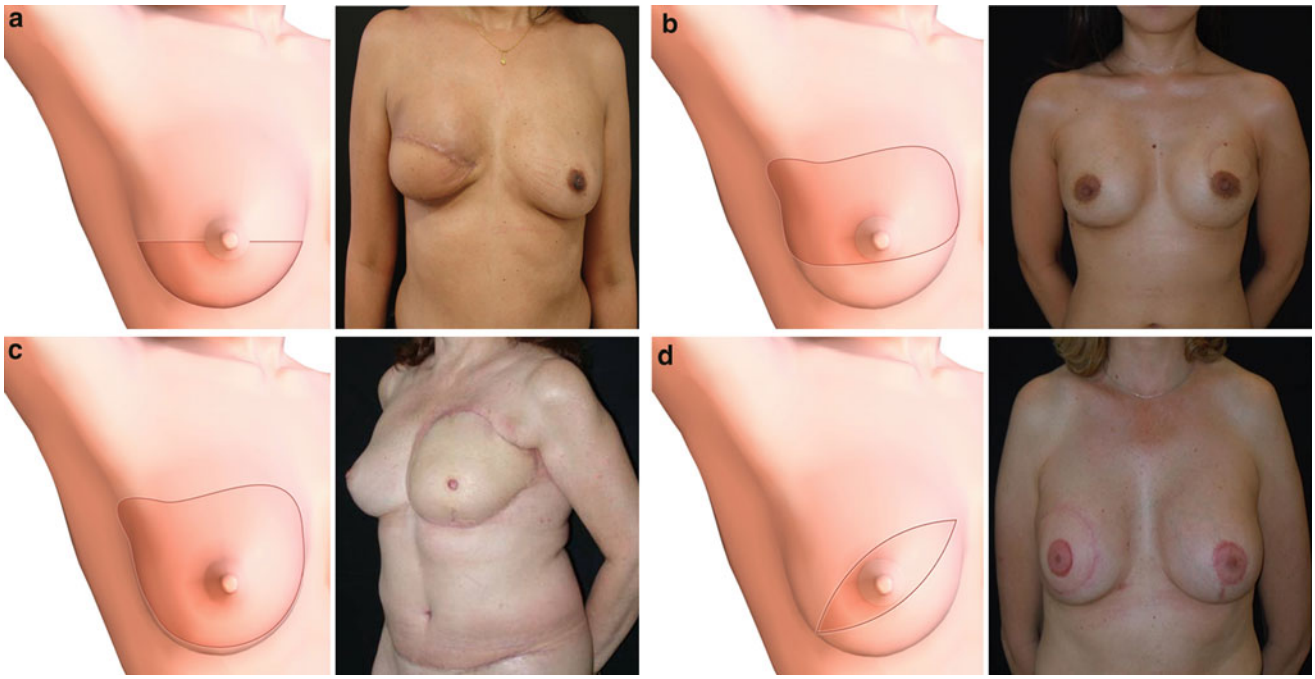

Fig. 8.4 Reconstruction types: **a** type I—flap in the lower pole; **b** type II—flap in the upper pole; **c** type III—full breast reconstruction; **d** type IV—central flap crossing over quadrants

8.10 Long-Term Results of Breast Reconstructions

8.10.1 Psychological Aspects

A series of studies performed in the last 25 years considered the psychological aspects of patients who underwent mastectomy.

The earliest reports described a wide range of disorders, ranging from depression to the loss of the body image and eventually to suicide attempts.

Recently, more thorough studies have defined the psychosocial traumas related to mastectomies, which include loss of femininity and mood, and interpersonal and conjugal disorders.

Breast reconstruction acts as a "reverse mastectomy," and it provides the most effective means of restoring biopsychosocial well-being.

The most frequently performed types of breast reconstruction are expanders, implants, expander prostheses, and autogenous flaps (TRAM and latissimus dorsi flaps).

In 2000, Wilkins et al. [12] compared the psychological benefits of breast reconstruction on the basis of the time and type of procedure. They concluded that both immediate and delayed reconstruction promote substantial psychological benefits and that the type of reconstruction (expander/implants versus pedicled or free TRAM flap) in immediate reconstruction does not significantly affect the psychological status [12].

In delayed reconstruction, the use of expanders/implants promotes greater improvement of vitality and well-being, whereas the use of autogenous flaps is associated with more remarkable improvement of the body image [12].

8.11 Complications of Postmastectomy Breast Reconstructions

In 2002, Alderman et al. [13] assessed, the complications associated with the time and type of reconstructions as well as other variables, such as body mass index, radiotherapy, chemotherapy, age, and smoking. A total of 326 patients were analyzed, and the complications were classified as total or partial [13].

The results showed that immediate reconstructions are associated with a higher (statistically significant) rate of both total and partial complications compared with delayed reconstructions [13].

The body mass index is a variable associated with higher (statistically significant) rates of complications independently of the time and type of reconstruction [13].

No significant differences were observed in the rate of complications for the remaining variables or the type of procedure. However, certain evidence suggests higher rates of total and partial complications with the use of implants combined with radiotherapy and in patients who undergo reconstruction with a TRAM flap and have chemotherapy [13].

References

1. Cano SJ, Klassen AF, Scott AM, Cordeiro PG, Pussic AL (2012) The BREAST-Q: further validation in independent clinical samples. Plast Reconstr Surg 129(2):293–302
2. McCarthy C, Klassen A, Cano S et al (2010) Patient satisfaction with postmastectomy breast reconstruction: A comparison of saline and silicone implants. Cancer 116:5584–5591
3. Hu E, Pusic A, Waljee J et al (2009) Patient-reported aesthetic satisfaction with breast reconstruction during the long-term survivorship period. Plast Reconstr Surg 124:1–8
4. Kroll SS, Baldwin B (1992) A comparison of outcomes using three different methods of breast reconstruction. Plast Reconstr Surg 90:455–462
5. Hudson DA (2004) Factors determining shape and symmetry in immediate breast reconstruction. Ann Plast Surg 52(1):15–21
6. Burget GG, Menick FJ (1985) Subunit principle in nasal reconstruction. Plast Reconstr Surg 76:239–247
7. Spear SL (2009) Oncoplastic surgery. Plast Reconstr Surg 124(3):993–994
8. Restifo RJ (1999) The aesthetic subunit principle in late TRAM flap breast reconstruction. Ann Plast Surg 43(3):235–239
9. Coutinho M, Southern S, Ramakrishnan V et al (2001) The aesthetic implications of scar position in breast reconstruction. Br J Plast Surg 54(5):326–330
10. Falanga V, Zitelli J, Eaglestein W (1998) Wound healing. J Am Acad Derm 19(3):559–563
11. Spear SL, Davison SP (2003) Aesthetic subunits of the breast. Plast Reconstr Surg 112(2):440–447
12. Wilkins E, Cederna P, Lowery J et al (2000) Prospective analysis of psychosocial outcomes in breast reconstruction: one year postoperative results from the Michigan breast reconstruction outcome study. Plast Reconstr Surg 106(5):1014–1025
13. Alderman AK, Wilkins EG, Kim HM, Lowery JC (2002) Complications in postmastectomy breast reconstruction: two-year results of the Michigan breast reconstruction outcome study. Plast Reconstr Surg 109(7):2265–2274

Systemic Treatment of Breast Cancer and Breast Reconstruction

9

Sergio D. Simon

9.1 Introduction

Since the early 1970s the concept that breast cancer is a systemic disease—and therefore needs systemic treatment—gained wide acceptance among the oncologic community. The pioneering clinical trials by Fisher et al. [1] and Bonadonna et al. [2] confirmed that the adjuvant treatment of women with breast cancer improves disease-free survival and overall survival. Four decades later, systemic treatment has become an integral part of the treatment of women with invasive breast cancer and has been responsible in great part for an impressive decrease in mortality over the last 25 years.

Recent understanding of the complexities of the molecular biology of breast cancer has shed new light on the systemic treatment of breast cancer. Although the presence of estrogen receptor (ER) and progesterone receptor (PR) has been regularly studied in tumor specimens since the 1970s and the presence of human epidermal growth factor receptor 2 (HER2) has been measured since the 1990s, it was only after seminal works in the early years of this century [3, 4] that gene expression profiles of breast cancer ("gene signatures") were identified through microarray techniques. Since then, breast cancer has been subdivided in the so-called molecular subtypes. Studies have demonstrated that "breast cancer" is indeed a heterogeneous group of diseases that have in common their origin in the mammary gland but have wide variations in biology, clinical presentation, prognosis, and treatment. It is now accepted that breast cancer is subdivided into five major molecular subtypes, of which four subtypes are of clinical relevance:

1. *Luminal A tumors*: These tumors have high expression of steroid-hormone-mediated signaling pathways, resulting in high expression of ER. Luminal A tumors tend to be of low grade, have low proliferation markers, and usually have a very indolent clinical course and therefore good survival. They tend to respond well to endocrine manipulation (tamoxifen, aromatase inhibitors, ovarian ablation, etc.) and less well to conventional chemotherapy. About 40 % of the cases of breast cancers fall into this subtype. Adjuvant treatment of these tumors is frequently done with hormonal treatment alone, although chemotherapy can also be used.
2. *Luminal B tumors*: Despite the presence of ER, these tumors are different from luminal A tumors owing to less defined gene expression and genomic alterations. They tend to be of higher grades and to have relatively high expression of proliferation genes and cell-cycle-related genes. The expression of ER and PR is usually less exuberant than in luminal A tumors. Mutation of p53 is not infrequent in this group, and many tumors overexpress HER2. The prognosis for luminal B tumors is distinctly poorer than that for luminal A tumors and they are usually associated with some degree of endocrine resistance. They comprise about 25 % of cases of breast cancer. Adjuvant treatment of these tumors usually comprises chemotherapy and endocrine treatment, with trastuzumab therapy reserved for HER2-positive patients.
3. *HER2-enriched tumors*: Some 20 % of breast tumors belong to this subtype, which is characterized by amplification of the *ERBB2* gene (formerly *HER2* or *HER2/neu*) in the long arm of chromosome 17. This gene amplification results in overexpression of HER2 at the cell membrane, which can be detected by routine immunohistochemistry (IHC). These tumors tend to be of high grade and a high proportion of them present p53 mutations. The prognosis for HER2-enriched tumors is poor, with a short disease-free interval after initial diagnosis and with aggressive visceral metastases (liver, lung, brain) developing through the clinical course of

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these patients. With the introduction of anti-HER2 agents (the monoclonal antibody trastuzumab and the oral tyrosine kinase inhibitor lapatinib), the disease-free survival and the overall survival of these patients has improved dramatically. Typically, adjuvant treatment of these tumors combines chemotherapy and trastuzumab therapy.

4. *Basal-like tumors* ("triple-negative breast cancer" or TNBC): About 15 % of breast tumors fall into this category. These tumors have high expression of basal epithelial markers, such as cytokeratins 5/6, c-KIT, laminin, and p-cadherin. Some express epidermal growth factor receptor. These tumors do not express ER, PR, or HER2 on IHC (hence the name "triple negative"). They are usually high-grade tumors, with a high proliferation index (as measured by the Ki67 antigen) and frequent p53 mutations. TNBC is usually an aggressive disease, with high incidence of visceral and brain metastasis and a very poor prognosis. Patients with familial breast cancer with *BRCA1* germline mutations usually present with this subtype of breast cancer. TNBC tumors are sensitive to chemotherapy, especially to DNA-damaging agents such as anthracyclines and platinum salts. Adjuvant treatment of these tumors is usually done with aggressive and intensive chemotherapy.

A fifth molecular subtype, called "normal breast-like," has been less well characterized and its clinical correlations are not clear at this time.

Although initially defined by DNA microarray techniques, the molecular subtypes of breast cancer are usually classified through the use of routine IHC, which is readily available to most pathology laboratories. It has been demonstrated that IHC is a reasonable surrogate marker for subtype classification and the results for ER, PR, HER2, and Ki67 are routinely used for this classification by most clinical oncologists.

On the basis of these considerations, the systemic treatment of breast cancer has been tailored to each individual patient, according to anatomical IHC (and/or gene expression patterns) of their specific tumors. Therefore, treatment of luminal A and luminal B tumors will include endocrine therapy, whereas treatment of HER2-enriched or TNBC tumors will not involve hormonal therapy. Typically, hormonal therapy is done for 5 years, with some patients receiving endocrine treatment for up to 10 years. Anti-HER2 therapy (in the form of the monoclonal antibody trastuzumab and sometimes the oral inhibitor lapatinib) has been reserved for patients whose malignant cells overexpress this protein in the cell membrane. Adjuvant trastuzumab therapy has typically been used for 1 year. Chemotherapy, on the other hand, has been applied to most cases of breast cancer irrespective of their molecular subtypes although, as mentioned before, some subtypes are more resistant and other types are more sensitive to this type of treatment. Typically, adjuvant chemotherapy will last between 3 and 6 months.

In many cases, however, inoperable/locally advanced breast tumors are treated initially with neoadjuvant (also called "primary") chemotherapy. The purpose of this type of treatment is to render these tumors operable or, in some cases, to make breast-conserving surgery possible in a case initially treatable only by radical mastectomy. The same principles that guide the choice of adjuvant treatment are applied in the choice of neoadjuvant treatment: chemotherapy, trastuzumab therapy, and hormonal manipulation can be used, depending on the molecular subtype of the tumor.

Each of these forms of systemic treatment s, causing changes in the cell cycle and the hormonal milieu of the patients, can potentially influence the final outcome of plastic surgery. Furthermore, chemotherapy is known to increase the chance of developing infection by means of causing leukopenia and decreased immune function. Therefore, the systemic treatment of breast cancer can potentially have direct implications on breast reconstruction by impairing wound healing, by increasing the risk of microthrombotic events, and by facilitating local infection.

9.2 Tamoxifen and Breast Reconstruction

Tamoxifen is a nonsteroidal selective modulator of ER. Its active metabolites, 4-hydroxytamoxifen and endoxifen, bind to ER in tumor cells, normal breast tissues, and other target tissues, blocking the activation of the estrogen-dependent genes. Because of its strong antiestrogenic and antitumoral effect, tamoxifen has been used since the 1970s in the treatment of breast cancer.

In the adjuvant setting, tamoxifen has been used mostly in premenopausal patients, since several studies have shown that aromatase inhibitors (anastrozol, letrozol, and exemestane) are more effective in postmenopausal women. When used in the adjuvant setting for 5 years, tamoxifen significantly diminishes the risk of recurrence and improves overall survival in patients with luminal A and luminal B tumors [5].

Side effects of tamoxifen include hot flashes, amenorrhea, sexual dysfunction, endometrial hyperplasia, and increased risk of endometrial cancer. In addition, there is an increased risk of thromboembolic events, especially during and immediately after major surgical procedures or periods of immobility. Women with previous history of varicose veins, deep vein thrombosis, pulmonary thromboembolism, myocardial infarction, and cerebral vascular accidents should be given tamoxifen with great caution.

History of hypercoagulability is also a contraindication for the use of tamoxifen, especially during surgical procedures. Factor V Leiden, a mutation of factor V, which

affects about 5 % of the Caucasian population in the USA, is the most frequent cause of hypercoagulability. Cases of flap loss following microsurgical perforator flap breast reconstruction have been reported, with cases of recurrent arterial thrombosis both intraoperatively and postoperatively in patients with factor V Leiden using tamoxifen [6].

Tamoxifen has also been associated with increased the risk of microvascular flap complications in patients undergoing breast reconstruction. Preclinical studies [7] in Wistar rats demonstrated that animals receiving tamoxifen for 2 weeks and submitted to terminoterminal anastomoses of the femoral artery had significantly greater thickness of intimal and total arterial wall when compared with animals not receiving tamoxifen, although no significant differences in thrombotic complications were noted. Kelley et al. [8] retrospectively compared rates of microvascular complications and pulmonary thromboembolism in patients who were and were not receiving adjuvant tamoxifen therapy at the time of microvascular breast reconstruction. Among 670 patients, 205 were taking tamoxifen before breast reconstruction and 465 were not. Of note, patients taking tamoxifen were significantly younger, had lower body mass index, and had fewer comorbidities than those not receiving the drug. Despite this, microvascular flap complications were significantly commoner in patients taking tamoxifen (21.5 vs 15 %, $p = 0.04$). Patients taking tamoxifen had more immediate and delayed complications, both as cardiovascular events and as surgical flap complications. Immediate total flap loss and a lower rate of flap salvage were significantly more frequent in the tamoxifen group. The authors recommend stopping use of the drug 28 days before microsurgical breast reconstruction.

As a practical consideration, it seems reasonable to screen candidates for microsurgical reconstruction for a history of hypercoagulability for consideration of prophylactic anticoagulation and to stop taking tamoxifen 28 days prior to surgery for all patients.

9.3 Chemotherapy and Surgical Outcomes

Several authors have examined the influence of chemotherapy on surgical outcomes of reconstructive surgery as well as the eventual delay in starting chemotherapy caused by immediate reconstructive surgery.

Furey et al. [9] evaluated retrospectively the rate and severity of wound complications in 112 patients who received adjuvant chemotherapy after mastectomy with immediate breast reconstruction (IBR). The rate of wound complications (20.8 % in the entire group) was similar in patients receiving chemotherapy when compared with a group of patients not receiving systemic treatment. No patient had a delay in the initiation of adjuvant therapy because of wound complications secondary to IBR. There was no correlation between age, type of operation, tumor pathology, stage, number of lymph nodes harvested, type of prosthesis or chemotherapy, and wound complications. The frequency of wound complications was not increased in patients receiving adjuvant chemotherapy after mastectomy and IBR. The authors concluded that administration of adjuvant chemotherapy does not need to be delayed in patients who have IBR following mastectomy for breast cancer.

Caffo et al. [10] examined the concurrent use of adjuvant chemotherapy and IBR with skin expanders after mastectomy and the short-term toxicity of these treatments. Evaluating 52 consecutive patients receiving IBR with skin expanders after mastectomy and adjuvant chemotherapy, and comparing them with patients undergoing IBR without adjuvant chemotherapy and with another group of patients undergoing mastectomy and chemotherapy but no IBR, Caffo et al. concluded that the interval between surgery and the start of expander inflation was similar in the groups with or without chemotherapy (median of 5 days) and that there were no statistically significant differences in complications between the groups receiving chemotherapy or not receiving it. The planned chemotherapy dose was delivered equally to both groups. They concluded that concurrent breast reconstruction and chemotherapy is safe and feasible and that no reduction in dose intensity is required.

Warren Peled et al. [11] studied the impact of chemotherapy and the timing of chemotherapy on postoperative outcomes in patients undergoing mastectomy and IBR. This retrospective study reviewed data on 163 consecutive patients undergoing mastectomy and IBR, of which 57 had received neoadjuvant chemotherapy, 41 had received postoperative adjuvant chemotherapy, and 65 had received no chemotherapy. Although the adjuvant chemotherapy group had a higher rate of postoperative infections as compared with the neoadjuvant and no chemotherapy groups, the unplanned return to the operating room and the rate of implant/expander removal was the same in the three groups. Of patients who underwent expander/implant reconstruction, implant removal was not different among women in the neoadjuvant chemotherapy cohort, the adjuvant cohort, and the no chemotherapy cohort (26 %, 22 %, 18 %, $p = 0.70$).

Evaluating the delay in starting adjuvant chemotherapy caused by breast reconstructive surgery, Alderman et al. [12] examined 3,643 patients with stage I–III breast cancer who were treated at eight different National Comprehensive Cancer Network (NCCN) institutions who followed similar treatment guidelines. Breast-conserving surgery, mastectomy with immediate reconstruction, and mastectomy with delayed reconstruction were studied, and Cox regression analysis was used to evaluate the type of surgery and the timing of chemotherapy. Of all the patients, a significant

delay (more than 8 weeks after surgery) was observed in 5.1 % of cases. Factors that favored early start of chemotherapy were younger age, lower body mass index, absence of comorbidities, and non-African-American ethnicity. For patients below the age of 60 years, mastectomy and immediate reconstruction was the only modality where a significant proportion of patients had a delay to the start of chemotherapy of more than 8 weeks. For women above the age of 60 years, a greater proportion had a delay in starting chemotherapy when compared with younger patients, especially in the group undergoing breast-conserving surgery. Overall, mastectomy with IBR caused a modest but statistically significant delay in initiating systemic treatment. The clinical significance of this finding is unknown.

In a prospective pilot study, Giacalone et al. [13] compared the feasibility, oncological safety, and esthetic outcome of skin-sparing mastectomy plus IBR with a latissimus dorsi flap after neoadjuvant chemotherapy and radiotherapy ($N = 26$) with the more standard approach of mastectomy followed by adjuvant chemotherapy and radiotherapy and a delayed latissimus dorsi flap reconstruction after completion of the systemic treatment ($N = 78$). With prolonged follow-up (median 4.1 years, range 1–8 years), early complications were seen in 61 % of patients undergoing immediate reconstruction versus 56 % of patients undergoing delayed reconstruction. Early implant loss was 0 % in the immediate reconstruction group versus 12 % in the delayed reconstruction group. Capsular contracture, reconstruction failure, local recurrence, and cosmetic results were similar in both groups, suggesting that IBR is safe and effective even when performed after neoadjuvant chemotherapy and radiotherapy.

Similar findings were reported in a retrospective study by Monrigal et al. [14], who reviewed 210 patients treated at the same institution over a period of 18 years. These patients had received neoadjuvant chemotherapy and radiotherapy prior to undergoing mastectomy with IBR (107 patients had a latissimus dorsi flap with an implant, 56 patients had a transverse rectus abdominis musculocutaneous flap, 25 patients had an autologous latissimus dorsi flap, and 22 patients had a retropectoral implant). Forty-six events were seen (20 necrosis events, nine surgical site infections, and six hematomas), leading to a second surgical procedure in 23 patients. Necrosis was especially more frequent with the transverse rectus abdominis musculocutaneous flap technique. Late complications (capsular contracture, infection, dislocation, deflation) were recorded in 23.6 % of patients, leading to 14 new interventions. The 5 year overall survival and disease-free survival were excellent (86.7 and 75.6 %, respectively), and 30.5 % of patients had recurrent disease (five local, nine locoregional, and 54 distant relapses). Despite the small numbers of these series of patients and the lack of randomized studies (which would probably be impossible to run), the evidence points toward satisfactory results of IBC after neoadjuvant chemotherapy and radiotherapy.

IBR after neoadjuvant chemotherapy was also recently reported by Azzawi et al. [15]. They studied the influence of neoadjuvant chemotherapy on surgical outcomes of patients operated on by the same surgeon in a 7-year period. They were compared with patients undergoing breast reconstruction without prior neoadjuvant chemotherapy. A total of 171 patients received 198 IBR procedures with different types of reconstructions (free tissue transfers, pedicled flaps, and implant-only procedures). Fifty-three patients received neoadjuvant therapy and 118 patients received no primary chemotherapy. IBR was unsuccessful in 2 % of each group, and the rate of reoperation for major complications was 9 % in each group. Differences in minor complications were not statistically different and the delay in the time to commencement of adjuvant radiotherapy was the same in both groups.

Finally, Gouy et al. [16] reviewed the experience of a single institution in order to determine whether reconstruction after neoadjuvant chemotherapy and mastectomy can affect the interval between surgery and adjuvant treatment and if survival was in any way affected by this sequence of treatment. They concluded that IBR does not delay the start of adjuvant therapy, has no significant effect on local or distant relapse-free interval, and does not delay the commencement of radiotherapy.

In conclusion, several series of patients reported in the literature raise no major concern regarding the association of chemotherapy and breast reconstruction. The time to starting chemotherapy has not been significantly delayed by reconstructive surgery, there have been no reports of increased risk of infectious or surgical complications caused by neoadjuvant chemotherapy, and survival end points do not seem to be affected by the association of chemotherapy and reconstructive surgery. However, care needs to be taken when chemotherapy and major breast surgery are performed at close intervals, since both treatments have potentially dangerous complications for patients with breast cancer.

References

1. Fisher B, Carbone P, Economou SG et al (1975) L-Phenylalanine mustard (L-PAM) in the management of primary breast cancer. A report of early findings. N Engl J Med 292(3):117–122
2. Bonadonna G, Brusamolino E, Valagussa P et al (1976) Combination chemotherapy as an adjuvant treatment in operable breast cancer. N Engl J Med 294(8):405–410
3. Perou CM, Sørlie T, Eisen MB et al (2000) Molecular portraits of human breast tumours. Nature 406(6797):747–752
4. Sørlie T, Perou CM, Tibshirani R et al (2001) Gene expression patterns of breast carcinomas distinguish tumor subclasses

with clinical implications. Proc Natl Acad Sci USA 98(19): 10869–10874
5. Early Breast Cancer Trialists' Collaborative Group (EBCTCG) (2011) Relevance of breast cancer hormone receptors and other factors to the efficacy of adjuvant tamoxifen: patient-level meta-analysis of randomised trials. Lancet 378(9793):771–84
6. Khansa I, Colakoglu S, Tomich DC et al (2011) Factor V Leiden associated with flap loss in microsurgical breast reconstruction. Microsurgery 31(5):409–412. doi:10.1002/micr.20879
7. De Pinho Pessoa BB, Menezes Cavalcante BB, Maia MP et al (2007) Effect of tamoxifen on arterial microvascular anastomosis. Microsurgery 27(4):286–288
8. Kelley BP, Valero V, Yi M, Kronowitz SJ (2012) Tamoxifen increases the risk of microvascular flap complications in patients undergoing microvascular breast reconstruction. Plast Reconstr Surg 129(2):305–314
9. Furey PC, Macgillivray DC, Castiglione CL, Allen L (1994) Wound complications in patients receiving adjuvant chemotherapy after mastectomy and immediate breast reconstruction for breast cancer. J Surg Oncol 55(3):194–197
10. Caffo O, Cazzolli D, Scalet A et al (2000) Concurrent adjuvant chemotherapy and immediate breast reconstruction with skin expanders after mastectomy for breast cancer. Breast Cancer Res Treat 60(3):267–275
11. Warren PA, Itakura K, Foster RD et al (2010) Impact of chemotherapy on postoperative complications after mastectomy and immediate breast reconstruction. Arch Surg 145(9):880–885
12. Alderman AK, Collins ED, Schott A et al (2010) The impact of breast reconstruction on the delivery of chemotherapy. Cancer 116(7):1791–1800
13. Giacalone PL, Rathat G, Daures JP et al (2010) New concept for immediate breast reconstruction for invasive cancers: feasibility, oncological safety and esthetic outcome of post-neoadjuvant therapy immediate breast reconstruction versus delayed breast reconstruction: a prospective pilot study. Breast Cancer Res Treat 122(2):439–451
14. Monrigal E, Dauplat J, Gimbergues P et al (2011) Mastectomy with immediate breast reconstruction after neoadjuvant chemotherapy and radiation therapy. A new option for patients with operable invasive breast cancer. Results of a 20 years single institution study. Eur J Surg Oncol 37(10):864–870
15. Azzawi K, Ismail A, Earl H et al (2010) Influence of neoadjuvant chemotherapy on outcomes of immediate breast reconstruction. Plast Reconstr Surg 126(1):1–11
16. Gouy S, Rouzier R, Missana MC et al (2005) Immediate reconstruction after neoadjuvant chemotherapy: effect on adjuvant treatment starting and survival. Ann Surg Oncol 12(2):161–166

Principles and Consequences of Radiotherapy for Breast Reconstruction

10

Roberto Orecchia, Maria Cristina Leonardi, and Veronica Dell'Acqua

10.1 Postmastectomy Radiotherapy Indications

Since clear evidence of a survival advantage by adding locoregional radiotherapy (RT) to the treatment of high-risk postmastectomy patients emerged toward the end of the 1990s, the number of patients who require postmastectomy RT (PMRT) has increased over time. There is a worldwide recommendation that chest wall and supraclavicular RT be administered to patients with T3/T4 tumors and to patients with a tumor of any size with four or more positive axillary lymph nodes. For women at intermediate risk of recurrence, the role of PMRT is unclear, but PMRT is increasingly used, mainly when some aggressive features are present, such as grade III, vascular, or lymphatic invasion and young age. Several specifically addressed trials broadening the indications for PMRT are ongoing and the percentage of patients who require adjuvant RT following mastectomy is expected to increase in the coming years [1].

The optimum integration of breast reconstruction and PMRT has not yet been well established. The best strategy is for each case to be discussed within the context of a multidisciplinary team in order to offer the best management option according to the physicians' and patients' points of view [2].

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10.2 Physiopathology of Radiation

Radiation side effects are classified as acute and chronic, according to the time at which they occur. Acute effects become manifest within days to weeks and usually involve cellular death in rapidly proliferating cells. The most typical acute reactions consist of erythema, dry desquamation, edema, and epilation. Later, skin becomes hyperpigmented owing to stimulation of epidermal melanocytes. These initial reactions can progress into severer reactions such as moist desquamation, characterized by exposure of the dermis, secreting exudates, which results from eradication of stem cells from the basal layer. Chronic side effects may occur after several months or years and usually manifest themselves as atrophy and fibrosis. Clinically, fibrosis causes hardening and thickening of the dermis. Dyschromic changes consist of either hyperpigmentation or hypopigmentation, due to abnormal stimulation or depletion of melanocytes, respectively. Telangiectasia consists in dilatation of superficial vessels. The mechanisms of radiation-induced damage are explained by either the microvascular occlusion theory or the chromosomal alteration theory [3]. Recent evidence supports the latter theory, showing permanent damage to fibroblasts and to stem cells, which are inhibited from replicating and producing new vessels [4].

10.3 Delayed Versus Immediate Breast Reconstruction

The choice of the type of reconstruction (allogeneic versus autologous) and the timing (immediate versus delayed) depends on several variables, such as tumor stage, need for postoperative therapies, body habits, breast size, and personal preference. Recommendations range from delaying breast reconstruction until after PMRT to using a delayed–immediate approach, placing a temporary tissue expander (TE) before definitive breast reconstruction, to performing immediate breast reconstruction followed by PMRT. Breast

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reconstruction is considered oncologically safe in terms of local recurrence or any survival end point compared with patients who only received RT following mastectomy without breast reconstruction [5, 6].

The use of immediate breast reconstruction has markedly increased in recent years, owing to the positive psychological impact, the ease of operating with nonirradiated tissue, and the great cost-effectiveness [7, 8]. The potential drawbacks are a more complicated RT technique and an increased postoperative complication rate with adverse cosmetic outcome [9–11]. Immediate breast reconstruction can be adversely affected by PMRT and may compromise the radiation field design, leading to suboptimal radiation delivery [10]. On the other hand, delayed breast reconstruction after PMRT may be technically challenging because of chronic inflammation, which increases the risk of perioperative complications, delayed healing, wound infection, and anastomotic failure [12]. The main points emerging from a comprehensive review including 11 studies [13] are that immediate breast reconstruction and PMRT is more likely to cause morbidity than immediate breast reconstruction alone; use of autologous tissue is the superior reconstruction technique in terms of postoperative morbidity in the case of PMRT after breast reconstruction; delaying breast reconstruction until the completion of PMRT had no significant effect on outcome.

Most studies addressing the issue of sequencing do not find any increase in overall complication rates between immediate breast reconstruction and delayed breast reconstruction [14, 15], but point out the different nature of the complications [16]. Early complications (vessel thrombosis, partial or total flap loss, infection, nonhealing open wounds) tend to develop in patients having PMRT first, whereas patients having breast reconstruction first have a higher risk of late complications (fat necrosis, flap volume loss, and flap contracture) [17, 18]. Javaid et al. [19] conducted a systematic review including ten studies on the optimum timing of RT in relation to autologous breast reconstruction. All studies but one described an increased complication rate when breast reconstruction is combined with PMRT compared with breast reconstruction alone, from 0–21 % to 16–33 %. The general recommendation is to delay the breast reconstruction with autologous tissue until after the end of RT in order to avoid an adverse cosmetic outcome [20–22].

There is no consensus in the literature regarding the appropriate timing of delayed breast reconstruction after PMRT. In one dedicated study, an interval of 12 months between the completion of PMRT and delayed abdominal free flap breast reconstruction was shown to minimize complications and optimize outcomes [23].

The most frequent complication of breast reconstruction using a prosthesis is capsular contracture. Although both previous and postoperative RT are strongly involved in capsule formation [24], for patients irradiated after immediate breast reconstruction the risk increases dramatically [25]. In the study conducted by Behrawala et al. [26], capsule formation was three times more likely to occur after immediate breast reconstruction in association with an RT field. Regarding the appropriate timing of PMRT after breast reconstruction with a TE/permanent implant (PI), Tallet et al. [27] found that the complication rate was not influenced by the RT delivered either 1 month or 5 months after breast reconstruction with a TE. However, using an animal model, Goodman et al. [28] demonstrated that a time interval of 2–3 weeks after complete filling of the TE increased tissue tolerance to radiation. In previously irradiated patients, delaying breast reconstruction for at least 12 months after the completion of RT seems to reduce the incidence of capsular contracture [29, 30]. Kronowitz et al. [31] reported on a two-stage delayed–immediate breast reconstruction approach to optimize outcomes in those patients for whom the need for PMRT is unknown at the time of mastectomy. The first stage consists in placing a saline-filled TE, followed by immediate breast reconstruction if RT is not required, according to the final histopathology report. Conversely, if RT is required, the TE is deflated and patients undergo delayed breast reconstruction after the completion of RT using an autologous tissue flap. This approach appears to be both technically feasible and safe.

10.4 Type of Reconstruction and Radiation Side Effects

For women having breast reconstruction there are a variety of reconstructive options available, each with its own pros and cons. The four commonest types of breast reconstruction performed today are TE/PI, latissimus dorsi (LD) flap, transverse rectus abdominis myocutaneous (TRAM) flap, and deep inferior epigastric perforator (DIEP) flap. The decision regarding which type of breast reconstruction should be used is determined by a number of variables related to disease, he patient's characteristics, and the surgeon's expertise [32]. Autologous breast reconstruction is always the preferred choice when a patient is a candidate for RT. In a study conducted by Jhaveri et al. [33], the impact on cosmesis, functional outcome, and daily life activity was significantly greater for TE/PI compared with autologous breast reconstruction. A group from Massachusetts General Hospital [20] reported complication rates of 53 % and 12 %, respectively, with TE/PI and autologous breast reconstruction. Besides, none of the autologous breast reconstruction patients required corrective surgery. A retrospective review of patients who underwent mastectomy plus autologous or TE/PI breast reconstruction at the

Cleveland Clinic was performed by Berry et al. [34]. In the TE/PI population, there was a total complication rate of 31.8 % and an overall major complication rate of 24.8 %. RT increased the major complication rate from 21.2 % to 45.4 %. The commonest complications were implant extrusion and capsular contracture. However, TE/PI breast reconstruction was successful in 70.1 % of patients receiving RT. In the autologous breast reconstruction group, there was a total complication rate of 31.5 %, and 19.7 % of patients had major complications. There was no statistically significant difference between the irradiated and nonirradiated autologous tissue breast reconstruction, with major complication rates of 17.9 % and 20.5 %, respectively. Different autologous flap types provided similar complication rates. Berry et al. found that preoperative and postoperative RT led to higher major complication rates compared with no RT ($p < 0.001$) and autologous breast reconstruction had significantly fewer major complications compared with TE/PI breast reconstruction for both preoperative RT ($p = 0.005$, odds ratio 0.22) and postoperative RT ($p = 0.05$, odds ratio 0.35).

Conversely, in the study conducted by Anderson et al. [35], the type of breast reconstruction with irradiation made no difference to the complication rate and both breast reconstruction with a TRAM flap and breast reconstruction with TE/PI had a very low rate of major complications (0–5 %), probably due to a more sophisticated RT.

10.4.1 Allogeneic Reconstruction

The reconstructive technique with TE/PI is a faster and less complex operative procedure than autologous tissue breast reconstruction, in spite of its having a greater bearing on complication rates [13]. Long-term complications include capsular contracture, infection, pain, skin necrosis or inadequate healing, fibrosis and progressive asymmetry, implant rupture, extrusion, and malpositioning (Figs. 10.1, 10.2). Capsular contracture is by far the commonest complication: the cause of capsular contracture is probably multifactorial, where subclinical infections, patient sensitivity to the inflammatory response, and hematomas may also play a role [36]. Some authors have hypothesized that RT may activate the wingless signaling pathway implicated in regulating fibroproliferation in capsular tissue around the allogeneic reconstructions. Abnormal levels of proteins involved in the fibroproliferative processes have been described in irradiated capsules compared with nonirradiated capsules [37]. Clinically, from examinations of patients with bilateral TE/PI breast reconstruction and unilateral RT, a clear difference in capsular contracture between irradiated and nonirradiated breasts was observed in 60 % of cases [38].

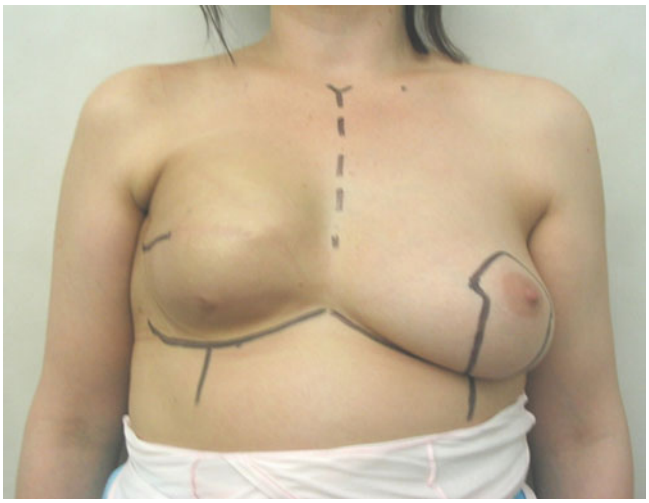

Fig. 10.1 Photograph of a patient with a radiation-induced deformity of the tissue expander after immediate breast reconstruction

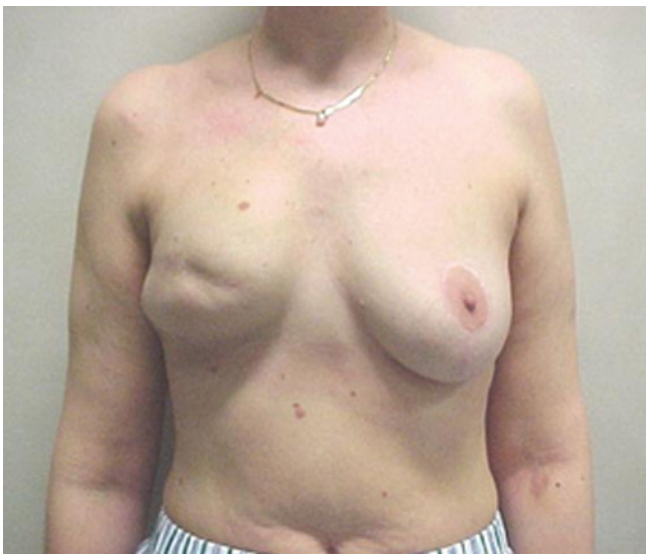

Fig. 10.2 Photograph taken after completion of radiotherapy showing capsular contracture of the permanent implant of the right breast

The rate of complications and unfavorable aesthetic results ranges from 3 % to 40 % in the absence of RT [39] and might rise to 17–80 % by adding RT [40]. Tallet et al. [27] reported a three times higher complication rate (14 % vs 51 %) and prosthesis loss rate (9 % vs 24 %), when RT was applied, whereas a sixfold higher odds of complications with an odds ratio of 6.4 (95 % confidence interval, 1.6–25.0) was observed in the Michigan Breast Reconstruction Outcomes prospective study [41]. In that series, the use of RT was significantly associated with breast reconstruction failure, and complications occurred in 68 % of the irradiated group compared with 31 % of the nonirradiated group ($p = 0.006$).

The overall complication rate in the irradiated group was 52.5 %, with 32.5 % of capsular contractures, as compared with 10 % in a nonirradiated control group in a study including 40 patients [14]. Ascherman et al. [15] reported on 27 patients reconstructed with TE/PI, where the irradiated group had a higher overall complication rate compared with a control group (40.7 % vs 16.7 %), requiring a more frequent removal of the implant (18.5 % vs 4.2 %). In the study by Drucker-Zertuche et al. [42], the irradiated group, with a greater complication rate (45.9 % vs 11.6 %), also had a higher percentage (54 %) of major or minor correction surgical procedures as compared with the nonirradiated group (5 %) and had a greater breast reconstruction failure rate (16.2 % vs 0 %).

Despite the fact that RT increases the rate of complications, TE/PI remains for many investigators an acceptable option for reconstruction. The group from the Memorial Sloan–Kettering Cancer Center continues to use immediate breast reconstruction with TE/PI for women who are not ideal candidates for autologous tissue reconstruction [39], despite finding in their series 68 % of patients had capsular contractions after RT, which was significantly higher than for nonirradiated patients (40 %, $p = 0.025$). Complications aside, the overall success rate for implant breast reconstruction was 90 % among irradiated patients compared with 99 % among nonirradiated patients and 80 % of the irradiated women demonstrated acceptable aesthetic results versus 88 % of the nonirradiated women. Hazard et al. [6] reached the same conclusions in a small retrospective study, with an acceptable rate of capsular contraction and good or excellent cosmetic outcomes in 85 % of cases. Modern RT with the alternate use of customized-bolus RT and intensity-modulated RT (IMRT) in one-third of cases allows the achievement of a very low incidence of complications as observed in the series conducted by Anderson et al. [35], which might be promising for future studies.

The combined use of an autologous flap and an implant did not prevent higher complication rates when breast reconstruction was performed before PMRT (67 %) as compared with PMRT being administered first (30 %), which was of borderline significance ($p = 0.093$) [16]. However, immediate breast reconstruction with an implant in conjunction with a flap shows a rate of capsular contracture which is threefold lower than that with an implant alone (6.8 % vs 25 %) [25]. With regard to patients who have previously undergone PMRT, breast reconstruction with TE/PI alone is considered a relative contraindication because of the risk of bone deformity and rib fractures [43]. However in a selected group of women who did not develop severe skin changes nor induration with initial PMRT, delayed TE/PI reconstructions have been considered as an option, as shown in one study [44].

10.4.2 Autologous Reconstruction

The two most commonly used autologous tissue flaps for breast reconstruction are the LD and TRAM flaps. Recent studies have reported on the use of the DIEP flap, whereas with regard to the superficial inferior epigastric artery flap and other flaps based on gluteal and thigh regions, the ability to withstand RT is still unknown. The free flap version of the TRAM flap appears to be more resistant to RT changes than a pedicled TRAM flap because of the different blood supply [45]. However, the fewer complications and flap losses after irradiation of free TRAM flaps as compared with pedicled TRAM flaps observed in several studies are not confirmed by others [46].

The commonest complications after autologous breast reconstruction are fat necrosis, flap and mastectomy skin loss, fibrosis, and contracture. Even in the absence of RT, complication rates range from 5 % to 41 % [11, 47]. The addition of RT increases this incidence and current literature reports complication rates in the range from 7 % to 87.5 % [18, 48, 49]. Complications occur irrespective of whether an immediate or delayed breast reconstruction is performed [50], but a trend toward an increase in complications (overall aesthetic appearance, symmetry, flap contracture and hyperpigmentation) was evident for immediate breast reconstruction and PMRT [51].

The TRAM flap is one of the most commonly studied flaps in the literature for breast reconstruction. When the need for PMRT is unknown at the time of surgery, the TRAM flap [52] is a good option to provide good tolerance and aesthetically acceptable results (Fig. 10.3). Apart from fat necrosis, a recent study from Emory University did not find any difference either in the complication rate or in the need for revision surgery among patients with immediate breast reconstruction alone as compared with patients receiving PMRT, although cosmesis was worse [49]. On the other hand, studies from the MD Anderson Cancer Center [24, 59] indicate that RT after autologous breast reconstruction clearly increased morbidity and worsened the cosmetic results, supporting the delay of breast reconstruction until after RT. No flap loss was reported, but fat necrosis was observed in 34 % of cases, atrophy and loss of symmetry in 78 % of cases, and hyperpigmentation in 37 % of cases. These changes required multiple revisions and additional flaps to correct deformities. Williams et al. [22] compared the outcomes of patients who had preoperative RT and then TRAM flap breast reconstruction with those of patients who did not undergo preoperative RT. Overall complication rates were comparable between the two groups, with the exception of fat necrosis, which was seen in 17 % of the irradiated group versus 10 % of the nonirradiated patients. Jacobsen et al. [53] reported on a series

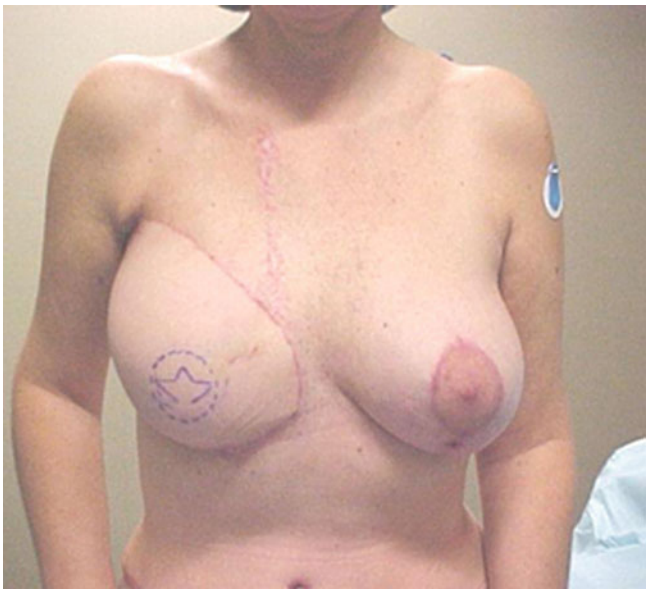

Fig. 10.3 Cosmetic results after postmastectomy radiotherapy to the right side and delayed breast reconstruction with a transverse rectus abdominis myocutaneous flap

from the Mayo Clinic and confirmed no increase in complication rates in patients who received preoperative RT compared with patients who received breast reconstruction alone.

In the study conducted by Albino et al. [54] among 76 women who underwent autologous breast reconstruction, complications occurred in 70 % of cases after RT and 47 % of these required surgery for postoperative RT effects. Fat necrosis or fibrosis was noted in 19.7 % of patients, skin complications (retraction or hypertrophic scarring) were recorded in 30.3 % of patients, and 27.6 % of patients were generally dissatisfied.

Previous published series of LD flap breast reconstruction have shown capsular contracture affecting between 0 and 56 % of patients [25, 55, 56]. This great variability is attributable to the variation in sample size, follow-up, technique, and population involved.

The LD muscle is considered a useful flap in the previously irradiated chest, and no increase in flap loss has been documented, although prior RT negatively affects the aesthetic results [57]. Nevertheless, patient satisfaction was similar between patients who underwent immediate breast reconstruction with PMRT and patients who underwent delayed breast reconstruction [58]. Apffelstaedt et al. [59] found no significant difference in the complication rate between preoperative irradiated and nonirradiated women.

More recently, some studies have focused on DIEP flap breast reconstruction. The general recommendation remains that of delaying breast reconstruction until after the completion of PMRT. A case–control study from the Memorial Medical Center in New Orleans comparing a small series of patients receiving PMRT after breast reconstruction with patients having DIEP flap breast reconstruction alone found substantially higher rates of fat necrosis (23 % vs 0 %), fibrosis or shrinkage (57 % vs 0 %), and contracture (17 % vs 0 %) in the irradiated patients, but no difference in the rate of flap revisions or dehiscence [60]. However, a recent study by Chatterjee et al. [61] found that postoperative RT did not significantly affect breast volume after immediate DIEP flap breast reconstruction and that there was no difference in the rates of other complications between irradiated and nonirradiated patients.

10.4.3 Impact of Reconstruction on Delivery and Quality of PMRT

Conventional RT doses reported in the literature are around 50 Gy in 1.8–2 Gy daily (five times a week) fractions using tangential beams, with a variable proportion of patients receiving boost doses to the scar of typically around 10–16 Gy. Altered fractionated schemes are less used owing to concern they may be associated with a higher risk of late side effects. However, Whitfield et al. [62] reported that the rates of severe capsular contracture in patients receiving the common UK fractionation of 40 Gy in 15 fractions over 3 weeks appeared comparable to those for patients receiving the conventional 5 week schedule, achieving a crude rate of 19.5 %.

Modern RT modalities using an immobilization device and computed tomography to plan RT delivery are bound to minimize the risk of complications [63, 64]. In older series in which the RT technique was not optimal, patients experienced higher complication rates [65]. An important issue in breast reconstruction is whether the immediate reconstruction impairs the delivery of PMRT. In fact, the reconstructed breast is different in size, shape, and firmness compared with the natural one and may cause technical problems related to the design of the radiation fields. The thickness of the chest wall in a reconstructed breast may not be nonuniform, causing dosimetric inhomogeneities of dose within the treatment field, which might translate into higher risk of complications [66]. Because of the steep contour caused by the TE or prosthesis, the junction between the radiation fields can be less precise, leading to regions of underdosage and overdosage (Fig. 10.4).

In two follow-up studies from the MD Anderson Cancer Center, the authors examined the impact of an immediate breast reconstruction on optimal coverage of the targeted areas including the chest wall and internal mammary nodes and avoidance of the lung and heart. In the first report published in 2005, only four of the 18 plans met the criteria for optimal treatment [67]. In 2006, a further report on 110 patients with immediate breast reconstruction who were

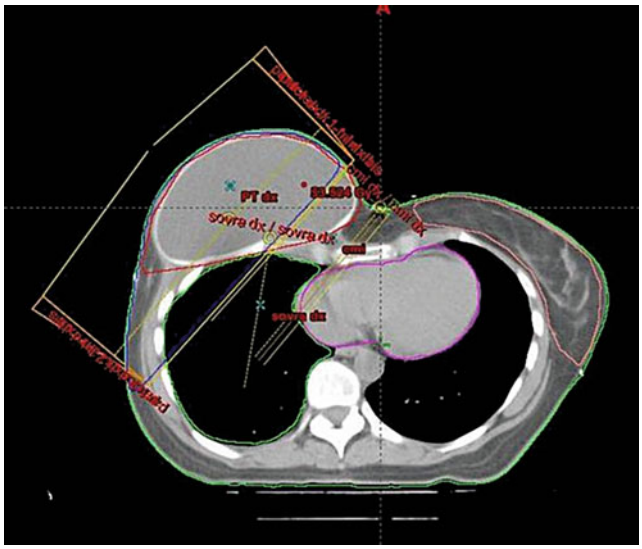

Fig. 10.4 Axial computed tomography slice showing the geometrical match between the medial electron beam field and the lateral photon tangential fields occurring over the steeply sloping contour of the reconstructed breast with a permanent implant

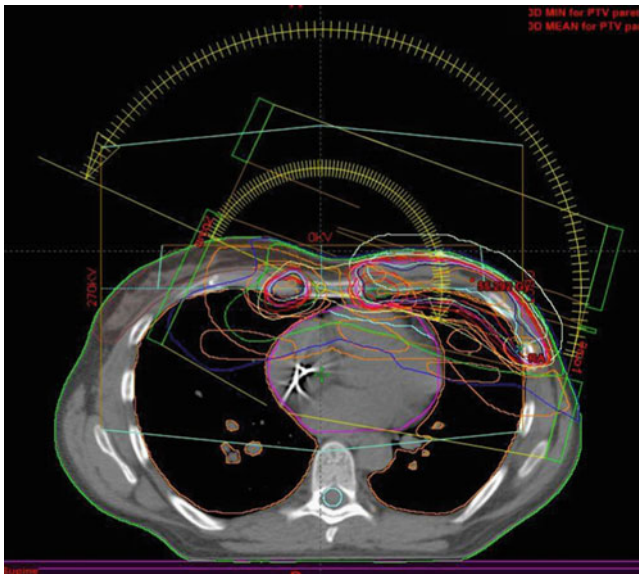

Fig. 10.5 Intensity-modulated radiotherapy plan on an axial computed tomography image using the inverse-planned multisegmental technique to treat the left chest wall and bilateral internal mammary nodes

compared with a group of 108 patients without breast reconstruction was published. The treatment plan was compromised in 52 % of the patients with immediate breast reconstruction compared with just 7 % of the control group, 20 % of them having a major compromise [10]. The largest compromises were observed in those with left-sided cancers. Delaying breast reconstruction makes it easy to deliver RT and to spare the organs at risk, allowing the use of electrons [68]. By use of the more sophisticated approach of IMRT, patients with immediate breast reconstruction can achieve excellent local control with acceptable heart and lung doses, even when internal mammary nodes are being treated, although doses to the heart and lung will be higher (Fig. 10.5). IMRT allows one to adequately cover the target volume in almost three quarters of patients [69]. The overall complication rate was extremely low in a group of patients where IMRT was used in one-third of the cases, owing to the improved dose homogeneity [35].

Regarding the compatibility of radiation and TE/PI reconstructions, prostheses do not interfere with dosimetric distribution as they are essentially tissue-equivalent [70]. Similarly, no dosimetric effects of saline filling in the TEs with consecutively relevant changes in the prescribed dose were seen in dedicated studies [65, 71]. The TE should be kept at a constant volume during RT to avoid treatment setup changes and deviation from the prescribed radiation dose. With repeated dosimetric evaluations during the course of treatment, the TEs appear to go through minimal anatomical changes without any interference with the prescribed dose distribution [72]. The quantification of the radiation dose distribution in the vicinity of the metallic port of the TE and the determination of its potential contribution of the high complication rate is controversial and debated (Fig. 10.6). Two studies measuring the dosimetric changes around the metallic port showed an increased dose in the immediate vicinity of the metallic port owing to the scattering of secondary electrons. As this increased dose does not reach the surface of the TE, it can hardly contribute to increasing the complication rate [73, 74]. On the other hand, the metallic port can attenuate the radiation beam and decrease the dose to the tissue which lies in its direct shadow. However in clinical situations, both the small size of the metallic port and the use of tangential opposed beams make the chance of underdosage quite small and acceptable [75].

Risk factors for increased complications related to radiation treatment have been identified throughout the studies.

The use of a bolus is associated with severer intensity of acute side effects and impaired cosmesis [76]. The choice of a customized bolus rather than a standard one may lead to a significantly better outcome [35].

The subpectoral placement of the implant may be preferable over a subcutaneous placement because of the lower propensity for capsular contracture due to RT [36, 77]. Textured implants are less likely to develop capsular contracture than smooth ones, since they allow minimal abnormal collagen deposition on their surface [78].

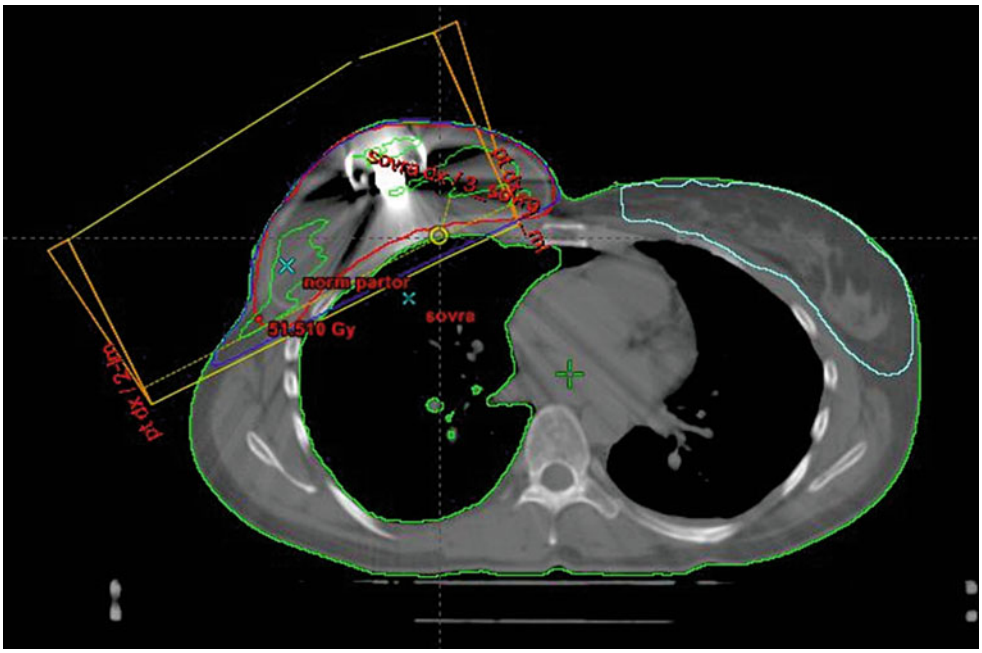

Fig. 10.6 Axial computed tomography slice showing the interference of a high-*Z* metallic port with photon tangent beams of radiation fields in the tissue expander reconstruction

10.5 Reconstruction in Previously Irradiated Fields

Breast reconstruction in the case of salvage mastectomy for local recurrence after breast conservative surgery and RT (QUART) faces the difficulty of being performed on previously irradiated and manipulated tissue. Prior RT to the chest may have a negative impact on the recipient vessels and predispose to vascular complications. In a study reviewing the outcome of flaps placed in an irradiated field, there was a significantly higher rate of intraoperative vascular complications (7.6 % vs 14.2 %, $p = 0.003$) in the irradiated group (9.5 % vs 17.3 %, $p = 0.001$) and a trend toward higher anastomotic revision rates [79].

More recent studies show that the combination of flaps alongside a breast prosthesis offers greater advantages in previously irradiated patients [30, 55]. In fact, several studies demonstrated that when an autologous flap is used with an implant for reconstruction of previously irradiated breast, the flap may protect the implant from the negative effects of RT [56].

An interesting study by Michy et al. [80] reported a series of patients treated with neoadjuvant RT in which immediate breast reconstruction accomplished by a LD flap with a prosthesis showed a lower complication rate and fewer additional surgical revisions than either a TRAM flap alone or a simple prosthetic implant. Similar results were recorded in small series of patients undergoing salvage mastectomy plus LD-flap-based immediate breast reconstruction, where the incidence of capsular contracture was acceptable, being as high as 12–17 % [81].

The use of TE alone is generally considered a contraindication in the case where RT has previously been administered. Few reports of abnormal concave and painful deformity of the chest wall were reported using a TE after QUART [82]. Conversely, the feasibility of implant reconstruction after QUART was described by Persichetti et al. [83]. No significant difference in the total number of capsular contractures was observed between previously irradiated patients undergoing immediate breast reconstruction with two-stage TE/PI and the nonirradiated group, but major complications occurred more frequently if RT had been delivered.

10.6 Aesthetic and Satisfaction Considerations

The cosmetic outcome of all breast reconstructions deteriorates over time even though RT is not performed [84]. In fact, the irradiated reconstructed breasts show the worst aesthetic outcome, which can be evident even after a long time. A worsened aesthetic result is observed with increasing tumor stage, bolus application, and earlier delivery of RT after the reconstructive procedure [85]. Several authors agree that the sequencing of PMRT did not affect the level of satisfaction [16, 49], whereas others observed a trend toward improved cosmetic outcomes when breast reconstruction is delayed [19, 58]. Recent evidence demonstrated that autologous tissue flaps provide greater levels of aesthetic satisfaction relative to TE/PI reconstruction. Excellent/good cosmetic outcome is generally reported in more than 80 % of patients undergoing PMRT

and autologous breast reconstruction [45, 52], although aesthetic appearance and satisfaction were generally worse than in nonirradiated patients [18, 22, 51].

References

1. MacDonald SM, Harris EE, Arthur DW et al (2011) ACR Appropriateness Criteria® locally advanced breast cancer. Breast J 17:579–585
2. Kaufmann M, Morrow M, von Minckwitz G et al (2010) Locoregional treatment of primary breast cancer: consensus recommendations from an international expert panel. Cancer 116:1184–1191
3. Robinson DW (1975) Surgical problems in the excision and repair of radiated tissue. Plast Reconstr Surg 55:41–49
4. Rudolph R (1982) Complications of surgery for radiotherapy skin damage. Plast Reconstr Surg 70:179–185
5. Soong IS, Yau TK, Ho CM, Lim et al (2004) Post-mastectomy radiotherapy after immediate autologous breast reconstruction in primary treatment of breast cancers. Clin Oncol (R Coll Radiol) 16:283–289
6. Hazard L, Miercort C, Gaffney D et al (2004) Local-regional radiation therapy after breast reconstruction: what is the appropriate target volume? A case-control study of patients treated with electron arc radiotherapy and review of the literature. Am J Clin Oncol 27:555–564
7. Al-Ghazal SK, Sully L, Fallowfield L et al (2000) The psychological impact of immediate rather than delayed breast reconstruction. Eur J Surg Oncol 26:17–19
8. Khoo A, Kroll SS, Reece GP et al (1998) A comparison of resource costs of immediate and delayed breast reconstruction. Plast Reconstr Surg 101:964–968
9. Buchholz TA, Kronowitz SJ, Kuerer HM (2002) Immediate breast reconstruction after skin-sparing mastectomy for the treatment of advanced breast cancer: radiation oncology considerations. Ann Surg Oncol 9:820–821
10. Motwani SB, Strom EA, Schechter NR et al (2006) The impact of immediate breast reconstruction on the technical delivery of postmastectomy radiotherapy. Int J Radiat Oncol Biol Phys 66:76–82
11. Alderman AK, Wilkins EG, Kim HM et al (2002) Complications in postmastectomy breast reconstruction: two-year results of the Michigan Breast Reconstruction Outcome Study. Plast Reconstr Surg 109:2265–2274
12. Temple CL, Strom EA, Youssef A et al (2005) Choice of recipient vessels in delayed TRAM flap breast reconstruction after radiotherapy. Plast Reconstr Surg 115:105–113
13. Barry M, Kell MR (2011) Radiotherapy and breast reconstruction: a meta-analysis. Breast Cancer Res Treat 127:15–22
14. Spear SL, Onyewu C (2000) Staged breast reconstruction with saline-filled implants in the irradiated breast: recent trends and therapeutic implications. Plast Reconstr Surg 105:930–942
15. Ascherman JA, Hanasono MM, Newman MI et al (2006) Implant reconstruction in breast cancer patients treated with radiation therapy. Plast Reconstr Surg 117:359–365
16. Adesiyun TA, Lee BT, Yueh JH et al (2011) Impact of sequencing of postmastectomy radiotherapy and breast reconstruction on timing and rate of complications and patient satisfaction. Int J Radiat Oncol Biol Phys 80:392–397
17. Lee BT, A Adesiyun T, Colakoglu S, et al (2010) Postmastectomy radiation therapy and breast reconstruction: an analysis of complications and patient satisfaction. Ann Plast Surg 64:679–683
18. Tran NV, Chang DW, Gupta A et al (2001) Comparison of immediate and delayed free TRAM flap breast reconstruction in patients receiving postmastectomy radiation therapy. Plast Reconstr Surg 108:78–82
19. Javaid M, Song F, Leinster S et al (2006) Radiation effects on the cosmetic outcomes of immediate and delayed autologous breast reconstruction: an argument about timing. J Plast Reconstr Aesthet Surg 59:16–26
20. Chawla AK, Kachnic LA, Taghian AG et al (2002) Radiotherapy and breast reconstruction: complications and cosmesis with TRAM versus tissue expander/implant. Int J Radiat Oncol Biol Phys 54:520–526
21. Rogers NE, Allen RJ (2002) Radiation effects on breast reconstruction with the deep inferior epigastric perforator flap. Plast Reconstr Surg 109:1919–1924
22. Williams JK, Carlson GW, Bostwick J 3rd et al (1997) The effects of radiation treatment after TRAM flap breast reconstruction. Plast Reconstr Surg 100:1153–1160
23. Baumann DP, Crosby MA, Selber JC et al (2011) Optimal timing of delayed free lower abdominal flap breast reconstruction after postmastectomy radiation therapy. Plast Reconstr Surg 127:1100–1106
24. Contant CM, van Geel AN, van der Holt B et al (2000) Morbidity of immediate breast reconstruction (IBR) after mastectomy by a subpectorally placed silicone prosthesis: the adverse effect of radiotherapy. Eur J Surg Oncol 26:344–350
25. Pinsolle V, Grinfeder C, Mathoulin-Pelissier S et al (2006) Complications analysis of 266 immediate breast reconstructions. J Plast Reconstr Aesthet Surg 59:1017–1024
26. Behranwala KA, Dua RS, Ross GM et al (2006) The influence of radiotherapy on capsule formation and aesthetic outcome after immediate breast reconstruction using biodimensional anatomical expander implants. J Plast Reconstr Aesthet Surg 59:1043–1051
27. Tallet AV, Salem N, Moutardier V et al (2003) Radiotherapy and immediate two-stage breast reconstruction with a tissue expander and implant: complications and esthetic results. Int J Radiat Oncol Biol Phys 57:136–142
28. Goodman CM, Miller R, Patrick CW Jr et al (2002) Radiotherapy: effects on expanded skin. Plast Reconstr Surg 110:1080–1083
29. Barnsley GP, Sigurdson LJ, Barnsley SE (2006) Textured surface breast implants in the prevention of capsular contracture among breast augmentation patients: a meta-analysis of randomized controlled trials. Plast Reconstr Surg 117:2182–2190
30. Spear SL, Boehmler JH, Bogue DP et al (2008) Options in reconstructing the irradiated breast. Plast Reconstr Surg 122:379–388
31. Kronowitz SJ (2010) Delayed-immediate breast reconstruction: technical and timing considerations. Plast Reconstr Surg 125:463–474
32. Nahabedian MY (2009) Breast reconstruction: a review and rationale for patient selection. Plast Reconstr Surg 124:55–62
33. Jhaveri JD, Rush SC, Kostroff K et al (2008) Clinical outcomes of postmastectomy radiation therapy after immediate breast reconstruction. Int J Radiat Oncol Biol Phys 72:859–865
34. Berry T, Brooks S, Sydow N et al (2010) Complication rates of radiation on tissue expander and autologous tissue breast reconstruction. Ann Surg Oncol 17(Suppl 3):202–210
35. Anderson PR, Freedman G, Nicolaou N et al (2009) Postmastectomy chest wall radiation to a temporary tissue expander or permanent breast implant–is there a difference in complication rates? Int J Radiat Oncol Biol Phys 74:81–85
36. Embrey M, Adams EE, Cunningham B et al (1999) A review of the literature on the etiology of capsular contracture and a pilot study to determine the outcome of capsular contracture interventions. Aesthetic Plast Surg 23:197–206

37. Lipa JE, Qiu W, Huang N et al (2010) Pathogenesis of radiation-induced capsular contracture in tissue expander and implant breast reconstruction. Plast Reconstr Surg 125:437–445
38. McCarthy CM, Pusic AL, Disa JJ et al (2005) Unilateral postoperative chest wall radiotherapy in bilateral tissue expander/implant reconstruction patients: a prospective outcomes analysis. Plast Reconstr Surg 116:1642–1647
39. Cordeiro PG, Pusic AL, Disa JJ et al (2004) Irradiation after immediate tissue expander/implant breast reconstruction: outcomes, complications, aesthetic results, and satisfaction among 156 patients. Plast Reconstr Surg 113:877–881
40. Vandeweyer E, Deraemaecker R (2000) Radiation therapy after immediate breast reconstruction with implants. Plast Reconstr Surg 106:56–58
41. Krueger EA, Wilkins EG, Strawderman M et al (2001) Complications and patient satisfaction following expander/implant breast reconstruction with and without radiotherapy. Int J Radiat Oncol Biol Phys 49:713–721
42. Drucker-Zertuche M, Bargallo-Rocha E, Zamora-Del RR (2011) Radiotherapy and immediate expander/implant breast reconstruction: should reconstruction be delayed? Breast J. 17:365–370
43. Tseng J, Huang AH, Wong MS, et al (2010) Rib fractures: a complication of radiation therapy and tissue expansion for breast reconstruction.Plast Reconstr Surg 125:65e–66e
44. Parsa AA, Jackowe DJ, Johnson EW et al (2009) Selection criteria for expander/implant breast reconstruction following radiation therapy. Hawaii Med J 68:66–68
45. Hunt KK, Baldwin BJ, Strom EA et al (1997) Feasibility of postmastectomy radiation therapy after TRAM flap breast reconstruction. Ann Surg Oncol 4:377–384
46. Zimmerman RP, Mark RJ, Kim AI et al (1998) Radiation tolerance of transverse rectus abdominis myocutaneous-free flaps used in immediate breast reconstruction. Am J Clin Oncol 21:381–385
47. Spear SL, Newman MK, Bedford MS et al (2008) A retrospective analysis of outcomes using three common methods for immediate breast reconstruction. Plast Reconstr Surg 122:340–347
48. Tran NV, Evans GR, Kroll SS et al (2000) Postoperative adjuvant irradiation: effects on tranverse rectus abdominis muscle flap breast reconstruction. Plast Reconstr Surg 106:313–317
49. Carlson GW, Page AL, Peters K et al (2008) Effects of radiation therapy on pedicled transverse rectus abdominis myocutaneous flap breast reconstruction. Ann Plast Surg 60:568–572
50. Kroll SS, Robb GL, Reece GP et al (1998) Does prior irradiation increase the risk of total or partial free-flap loss? J Reconstr Microsurg 14:263–268
51. Spear SL, Ducic I, Low M et al (2005) The effect of radiation on pedicled TRAM flap breast reconstruction: outcomes and implications. Plast Reconstr Surg 115:84–95
52. Disa JJ, Cordeiro PG, Heerdt AH et al (2003) Skin-sparing mastectomy and immediate autologous tissue reconstruction after whole-breast irradiation. Plast Reconstr Surg 111:118–124
53. Jacobsen WM, Meland NB, Woods JE (1994) Autologous breast reconstruction with use of transverse rectus abdominis musculocutaneous flap: Mayo clinic experience with 147 cases. Mayo Clin Proc 69:635–640
54. Albino FP, Koltz PF, Ling MN et al (2010) Irradiated autologous breast reconstructions: effects of patient factors and treatment variables. Plast Reconstr Surg 126:12–16
55. Spear SL, Boehmler JH, Taylor NS et al (2007) The role of the latissimus dorsi flap in reconstruction of the irradiated breast. Plast Reconstr Surg 119:1–9
56. Chang DW, Barnea Y, Robb G (2008) Effects of an autologous flap combined with an implant for breast reconstruction: an evaluation of 1000 consecutive reconstructions of previously irradiated breasts. Plast Reconstr Surg 122:356–362
57. Moore TS, Farrell LD (1992) Latissimus dorsi myocutaneous flap for breast reconstruction: long-term results. Plast Reconstr Surg 89:666–672
58. McKeown DJ, Hogg FJ, Brown IM et al (2009) The timing of autologous latissimus dorsi breast reconstruction and effect of radiotherapy on outcome. J Plast Reconstr Aesthet Surg 62:488–493
59. Apffelstaedt J (2002) Indications and complications of latissimus dorsi myocutaneous flaps in oncologic breast surgery. World J Surg 26:1088–1093
60. Rogers NE, Allen RJ (2002) Radiation effects on breast reconstruction with the deep inferior epigastric perforator flap. Plast Reconstr Surg 109:1919–1924
61. Chatterjee JS, Lee A, Anderson W, Baker L (2009) Effect of postoperative radiotherapy on autologous deep inferior epigastric perforator flap volume after immediate breast reconstruction. Br J Surg 96:1135–1140
62. Whitfield GA, Horan G, Irwin MS et al (2009) Incidence of severe capsular contracture following implant-based immediate breast reconstruction with or without postoperative chest wall radiotherapy using 40 Gray in 15 fractions. Radiother Oncol 90:141–147
63. Mehta VK, Goffinet D (2004) Postmastectomy radiation therapy after TRAM flap breast reconstruction. Breast J 10:118–122
64. McDonald MW, Godette KD, Butker EK et al (2008) Long-term outcomes of IMRT for breast cancer: a single-institution cohort analysis. Int J Radiat Oncol Biol Phys 72:1031–1040
65. Kuske RR, Schuster R, Klein E et al (1991) Radiotherapy and breast reconstruction: clinical results and dosimetry. Int J Radiat Oncol Biol Phys 21:339–346
66. Buchholz TA, Strom EA, Perkins GH et al (2002) Controversies regarding the use of radiation after mastectomy in breast cancer. Oncologist 7:539–546
67. Schechter NR, Strom EA, Perkins GH et al (2005) Immediate breast reconstruction can impact postmastectomy irradiation. Am J Clin Oncol 28:485–494
68. Overgaard M, Hansen PS, Overgaard J et al (1997) Postoperative radiotherapy in high-risk premenopausal women with breast cancer who receive adjuvant chemotherapy. Danish Breast Cancer Cooperative Group 82b Trial. N Engl J Med 337:949–955
69. Koutcher L, Ballangrud A, Cordeiro PG et al (2010) Postmastectomy intensity modulated radiation therapy following immediate expander-implant reconstruction. Radiother Oncol 94:319–323
70. Krishnan L, Krishnan EC (1986) Electron beam irradiation after reconstruction with silicone gel implant in breast cancer. Am J Clin Oncol 9:223–226
71. Piroth MD, Piroth DM, Pinkawa M et al (2009) Immediate reconstruction with an expander/implant following ablatio mammae because of breast cancer : side effects and cosmetic results after adjuvant chest wall radiotherapy. Strahlenther Onkol 185:669–674
72. Shankar RA, Nibhanupudy JR, Sridhar R et al (2003) Immediate breast reconstruction-impact on radiation management. J Natl Med Assoc 95:286–295
73. Moni J, Graves-Ditman M, Cederna P et al (2004) Dosimetry around metallic ports in tissue expanders in patients receiving postmastectomy radiation therapy: an ex vivo evaluation. Med Dosim 29:49–54
74. Thompson RC, Morgan AM (2005) Investigation into dosimetric effect of a MAGNA-SITE tissue expander on post-mastectomy radiotherapy. Med Phys 32:1640–1646
75. Damast S, Beal K, Ballangrud A et al (2006) Do metallic ports in tissue expanders affect postmastectomy radiation delivery? Int J Radiat Oncol Biol Phys 66:305–310

76. Hanks SH, Lyons JA, Crowe J et al (2000) The acute effects of postoperative radiation therapy on the transverse rectus abdominis myocutaneous flap used in immediate breast reconstruction. Int J Radiat Oncol Biol Phys 47:1185–1190
77. Halpern J, McNeese MD, Kroll SS et al (1990) Irradiation of prosthetically augmented breasts: a retrospective study on toxicity and cosmetic results. Int J Radiat Oncol Biol Phys 18:189–191
78. Collis N, Coleman D, Foo IT et al (2000) Ten-year review of a prospective randomized controlled trial of textured versus smooth subglandular silicone gel breast implants. Plast Reconstr Surg 106:786–791
79. Fosnot J, Fischer JP, Smartt JM Jr et al (2011) Does previous chest wall irradiation increase vascular complications in free autologous breast reconstruction? Plast Reconstr Surg 127:496–504
80. Michy T, Gimbergues P, Le Bouëdec G et al (2007) What surgical procedure for immediate breast reconstruction after preoperative radiotherapy and chemotherapy? J Chir 144:511–515
81. Freeman ME, Perdikis G, Sternberg EG et al (2006) Latissimus dorsi reconstruction: a good option for patients with failed breast conservation therapy. Ann Plast Surg 57:134–137
82. de Wildt RP, Tuinder S, van der Hulst RR (2009) Substantial chest-wall deformity following tissue expansion after radiotherapy. Eur J Plast Surg 32:337–340
83. Persichetti P, Cagli B, Simone P et al (2009) Implant breast reconstruction after salvage mastectomy in previously irradiated patients. Ann Plast Surg 62:350–354
84. Thomson HJ, Potter S, Greenwood RJ et al (2008) A prospective longitudinal study of cosmetic outcome in immediate latissimus dorsi breast reconstruction and the influence of radiotherapy. Ann Surg Oncol 15:1081–1091
85. Victor SJ, Brown DM, Horwitz EM et al (1998) Treatment outcome with radiation therapy after breast augmentation or reconstruction in patients with primary breast carcinoma. Cancer 82:1303–1309

Part II

Partial Breast Reconstruction

Preoperative Planning for Oncoplastic Surgery 11

Cicero Urban and Mario Rietjens

11.1 Introduction

Oncoplastic surgery represents an important evolution in breast cancer surgery. It allows better aesthetic–functional outcomes and consequently an improvement of the psychological aspects of patients with breast cancer, as it broadens the range of indications for breast-conserving treatment (BCT). The various techniques for immediate reconstruction must be dealt with case by case so the best results concerning the aesthetic–functional aspects can be achieved. For delayed reconstruction, the results are generally inferior to those obtained in immediate surgery, and in many cases major surgical procedures are required. Therefore, the emphasis of this new phase in breast surgery must be on immediate reconstruction associated with the integration of oncologic and aesthetic concepts by the surgery team and by the single surgeon [1–18].

However, it is hard to eliminate completely the risk of local recurrence after BCT. A local failure might reflect a disease with more aggressive biological characteristics, as well as a new primary tumor or even a failure of the treatment. These failures may occur as a consequence of selection of patients or inadequate treatment, but they tend to reduce after the use of high-quality imaging, postoperative radiotherapy, appropriate adjuvant systemic treatment, and surgical excision with negative margins [19, 20]. Concerning this last point, the surgeon daily faces the dilemma of performing resections with wide margins, aiming to reach ideal oncologic control, and at the same time, not removing so much breast tissue, which could result in major deformities or asymmetry between the breasts. If local–regional control represents the main target of oncologic surgery, the aesthetic result is the basic principle of breast conservation from the very beginning.

A way to soften this conflict is to apply plastic surgery techniques to breast cancer surgery. This new concept, which has been spreading in some centers for treatment of cancer in Europe, is based on three fundamental points: ideal cancer surgery, homolateral reconstruction, and immediate contralateral remodeling applying plastic surgery techniques [1–18]. Therefore, it allows more extensive resections in BCT and it does not negatively affect the final aesthetic results [21, 22]. The focus of oncoplastic surgery, as well of other techniques such as sentinel node biopsy, with regard to breast surgery is to improve quality of life of patients through treatments that can be more effective and less aggressive.

This chapter will deal with planning oncoplastic surgery in early breast cancer, which is as important as the operating time for this surgery, in order to achieve the best oncologic and aesthetic outcomes and to reduce errors.

11.2 Patient Selection

Oncoplastic surgery is more complex and time-consuming than lumpectomy and quadrantectomy. Thus, the selection of patients from the oncologic, aesthetic, and psychological point of view is critical. All attempts should be made to minimize the risk of positive margins, which are difficult and sometimes impossible to reassess in a second surgical procedure, and to reduce and prevent complications that may delay adjuvant treatments. Patients strongly motivated to preserve their breasts better tolerate this kind of surgery. Therefore, there are some established indications for oncoplastic surgery in BCT. The main one is for patients with a mammary resection volume of more than 20 %, and especially in the case of macromastia, where results from

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Table 11.1 Indications and relative contraindications for oncoplastic surgery in breast-conserving surgery

Indications	Relative contraindications
Resections over 20 % of breast volume	Extensive tumors located in medial regions
Macromastia	Low-volume breasts, and without ptosis
Severe ptosis and asymmetry	Previously irradiated breasts
Need for large skin resections inside the mammoplasty area	Large skin resections beyond the mammoplasty area
Central, medial, and inferior tumors	Tobacco addiction and uncontrolled diabetes
Previous plastic surgery of the breast	Exaggerated patient expectations with aesthetic results

skin-sparing or nipple-sparing mastectomy are usually unsatisfactory and the oncoplastic approach may also favor radiotherapy planning [23].

Current indications and relative contraindications for oncoplastic surgery in BCT are given in Table 11.1.

11.3 Preoperative Planning

It is essential that the choice of the technique for oncoplastic surgery in breast-conserving surgery depends on elements related to the tumor location, size, and multifocality/muticentricity, characteristics of the breast, and clinical evaluation of the patient. Although the only significant element mentioned as an aesthetic risk in breast-conserving surgery in the Cochrane evaluation was a mammary resection volume over 20 %, in clinical practice there are other individualized risk factors that should be observed [23]:

- Tumor size/breast size
- Multicentricity and multifocality
- Location of tumor and proximity to skin
- Distance between the tumor and the nipple–areola complex (NAC)
- Previous and future radiotherapy
- Previous mammoplasty
- Volume and shape of the breast
- Level of mammary ptosis and breast asymmetry.
- Liposubstitution level.

In some circumstances, associated clinical conditions may influence the choice of the most appropriate technique. Diabetic patients, obesity, tobacco addicts, those with collagen diseases, and those above 70 years old are subject to risks concerning unsatisfactory aesthetic results and skin-healing complications are greater. Major resections and wide NAC dislocations may bring additional risks of fat necrosis and partial or total NAC losses [23].

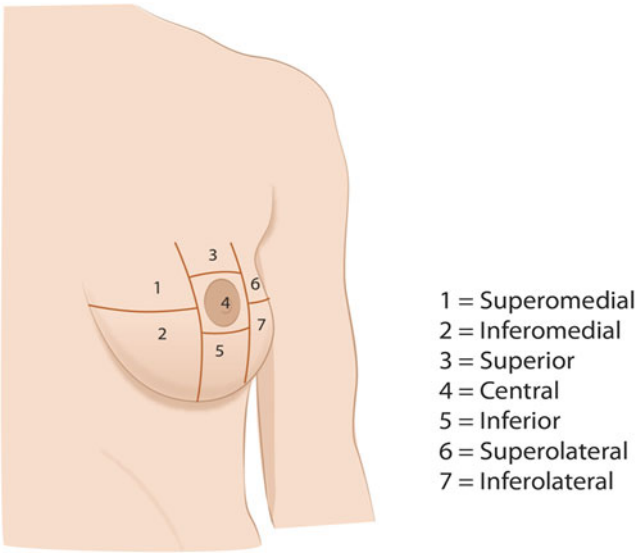

Fig. 11.1 Breast quadrants for oncoplastic surgery

The ideal location for a tumor is within the wide resection area, or inside the mammoplasty area. When the tumor is close to the skin and outside this area, the oncoplastic procedure may be more complex and it may require combined techniques, whose results are not always satisfactory. In such cases, skin-sparing or nipple-sparing mastectomy should be considered as an option, as well as in cases where a major resection of the skin is needed. Flaps such as latissimus dorsi flap, which has a different color and texture compared with the breast, usually lead to unsatisfactory results, and therefore should be considered as an exception [23].

A high-volume breast with severe ptosis allows surgical procedures with wider margins and usually leads to more satisfactory results. Patients with macromastia represent a formal indication for oncoplastic surgery owing to better radiotherapy planning. In cases of previous breast augmentation plastic surgery, it is necessary to take into consideration that the breast volume is not the real one, and consequently some considerable deformities may result. The biggest problem concerning oncoplastic surgery is dealing with young patients, with a conic breast, without mammary ptosis, and with low or medium volume. In such cases, according to the location or tumor size, local flaps offer little chance of good results, so skin-sparing or nipple-sparing mastectomy with immediate reconstruction may be the best choice [23].

The decision for oncoplastic surgery is based on oncologic and aesthetic concepts and principles, so a structured guideline is not possible to assist in all cases with all involved variables, but it can help the decision-making process. Basically, the flowchart for planning oncoplastic surgery should take into consideration the features of the patient's breast and the tumor size (Figs. 11.1 and 11.2) [23].

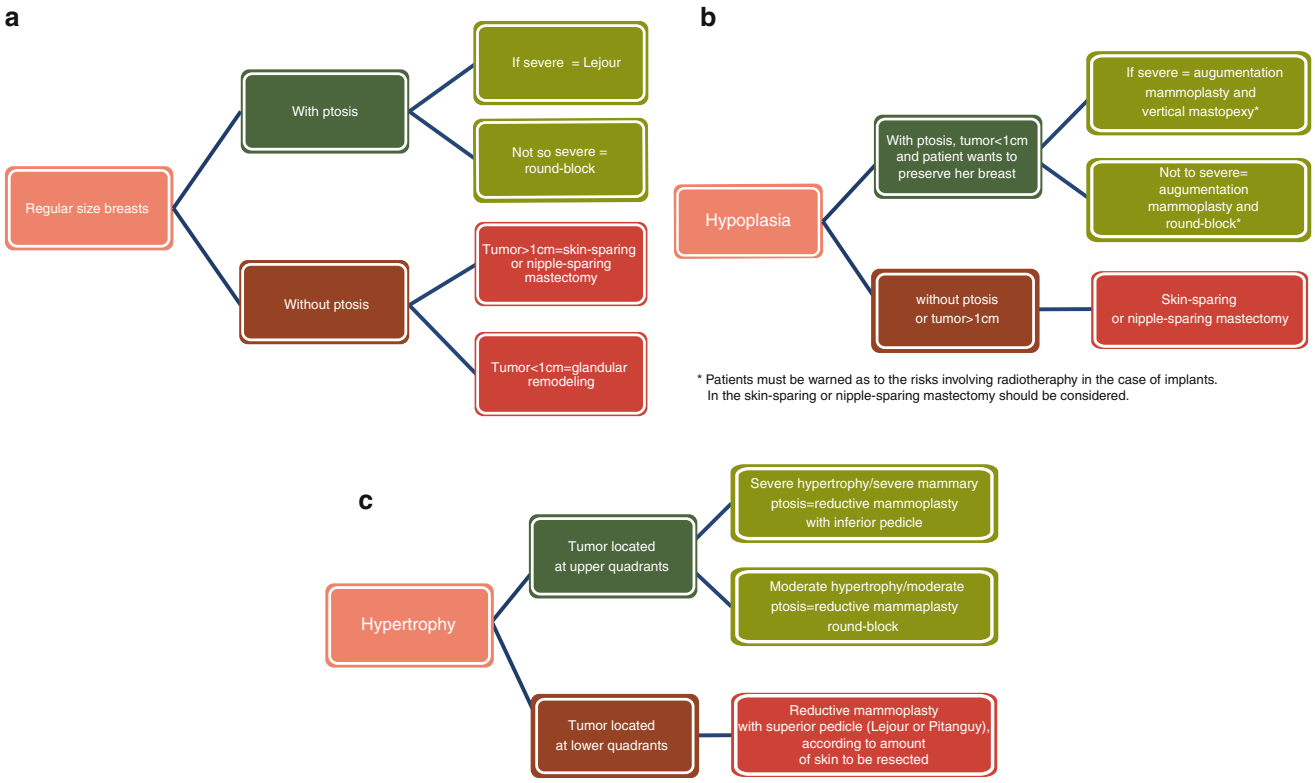

Fig. 11.2 Decision flowchart for planning oncoplastic surgery (Modified from Urban et al. [23])

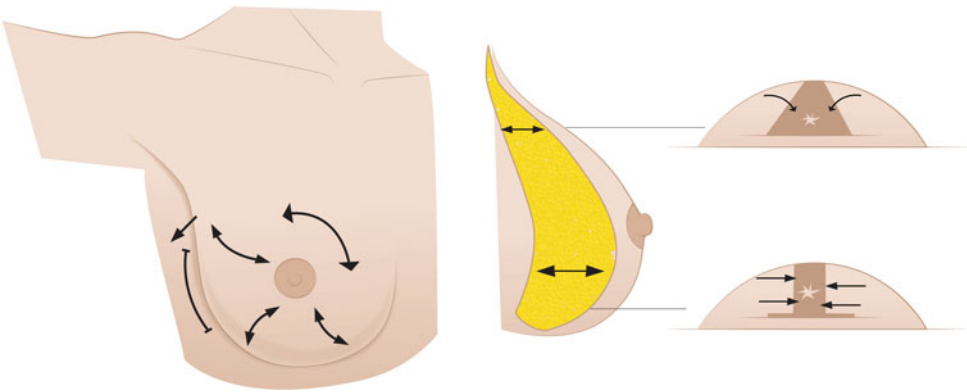

Fig. 11.3 Class I glandular flaps: skin incisions and plan for glandular reshaping

11.4 Immediate Partial Breast Reconstruction Techniques

11.4.1 Class I Techniques

11.4.1.1 Planning for Glandular Flaps

This class I technique consists of moving glandular flaps around the defect caused by classic quadrantectomy or lumpectomy resections, in an attempt to cover it completely. It is preferentially indicated for premenopausal patients, when the glandular component of the breast is greater, therefore reducing the risk of liponecrosis in the postoperative period. This technique is also indicated in cases of tumors located in the upper quadrants, where the mammary gland is less thick; and even if there is a small filling defect, such a defect is not so visible. The opposite effect happens in the lower quadrants, where the mammary gland thickness is more important to consider, and if an adapted technique is not applied, the resulting aesthetic defect may be disastrous. Glandular reshaping in lower portions of the breast is possible for small tumors, and in a vertical or oblique way. Planning for the position of the incisions should consider the quadrant of tumor location (Figs. 11.3 and 11.4).

Fig. 11.4 Class I glandular reshaping for superior quadrants

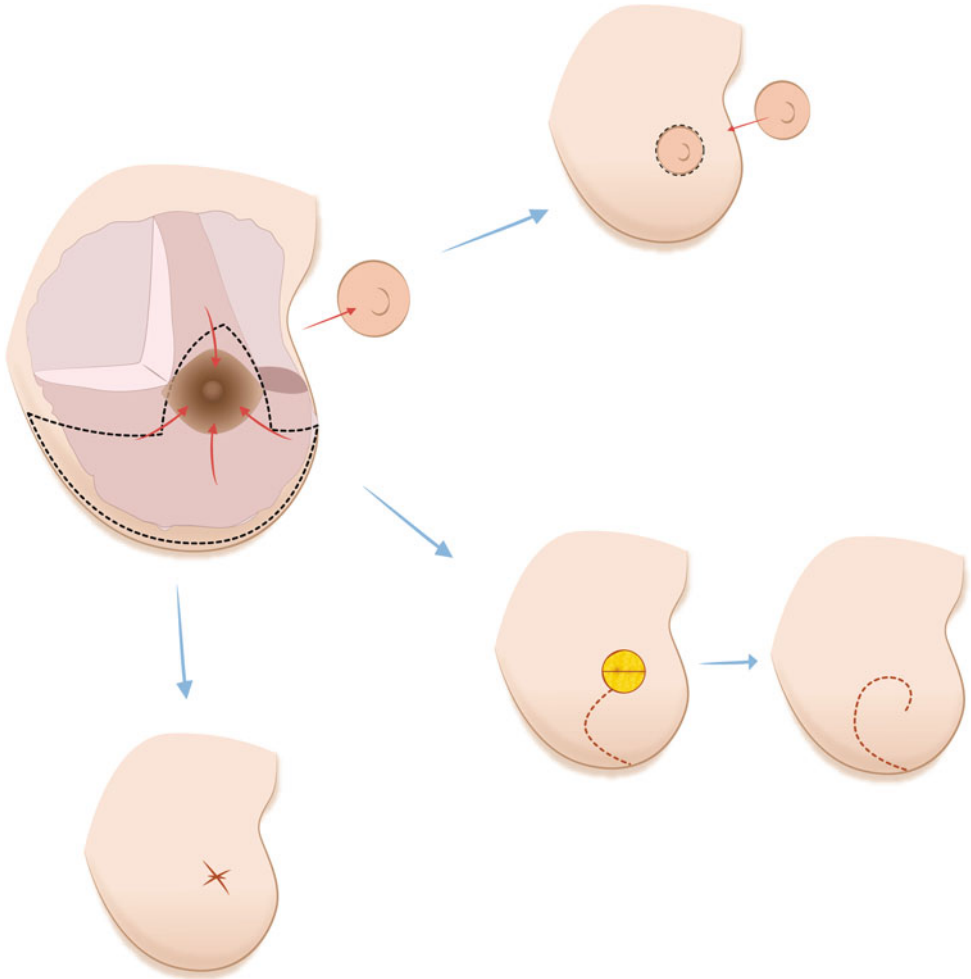

Fig. 11.5 Central quadrant plan for reconstruction with the tobacco purse string technique and a cutaneous–glandular flap

11.4.1.2 Planning for Central Quadrant Techniques

This represented a great innovation in the early days of BCT, as up to some years ago having a retroareolar neoplasia was synonymous of mastectomy. Immediate breast reconstruction techniques for central quadrant resections may differ according to breast volume, level of ptosis, and shape of ptosis (either vertical or lateral). For a breast without ptosis or with slight ptosis, it is possible to use the glandular suture in a tobacco pouch. Two or three layers of glandular suture in a tobacco pouch allow one to obtain the central projection of the mammary cone, and the cutaneous

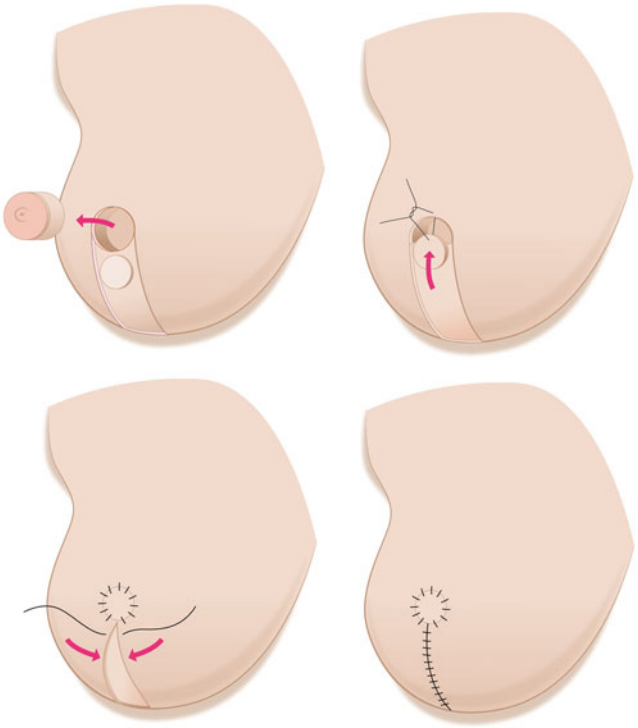

Fig. 11.6 Plan for Grisotti's flap for the central quadrant

suture also in a tobacco pouch would produce a residual scar within the area where the future areola will be reconstructed, therefore causing the scar to disappear almost completely (Fig. 11.5). The disadvantage of this technique is that there is no good connection with the cutaneous edge and consequently there might be delay in the healing process. A cutaneous–glandular flap can be an alternative and can also result in a good outcome in these cases.

For large breasts with oblique ptosis, it is possible to use a technique described by Galimberti et al. [24], derived from the reductive mammoplasty technique based on the rotation of the inferolateral glandular pedicle, preserving a cutaneous island that replaces the areolomammillary complex (Fig. 11.6). This might be the first oncoplastic technique described in the literature, as it was a direct adaptation of the plastic surgery technique to BCT.

11.4.2 Class II Techniques

11.4.2.1 Planning for Periareolar Techniques

These class II techniques are inspired by reductive mammoplasty techniques proposed by Góes [25] and Benelli [26], in which a major glandular cutaneous undermining procedure for remodeling through a periareolar scar is performed. It is indicated for small or medium-volume breasts with little or average ptosis. The great advantage of these techniques is mainly oncologic, as they allow for a tumorectomy or either a simple or a double quadrantectomy in any part of the breast, except for the central quadrant.

The preoperative drawing is done with the patient standing up, and basically it is necessary to calculate only two points (A and B). Point A represents the position of the upper edge of the areola, which can be calculated by different methods. The simplest method is that this point corresponds to the transition from the upper two-thirds of the arm to the lower third. Another method, proposed by Pitanguy [27], is to calculate initially the future position of the nipple, which will be the projection of the tip of a finger placed at the level of the inframammary sulcus. Bearing in mind that the diameter of a normal areola is about 45 mm, one can calculate the radius of 23 mm superiorly to mark point A. Point B will be the inferior point of the areola, the calculation of which is based on the distance between the lower point of the areola and the inframammary sulcus, around 40 mm for a small breast and about 60 mm for a large breast without ptosis (Fig. 11.7). Once these two points are obtained, it is necessary to trace an ellipsis, which will indicate the area for skin removal.

11.4.2.2 Planning for Superior Pedicle Techniques

These techniques are based on superior areolar vascular pedicles such as those proposed by Pitanguy [27] or Lejour [28]. They may be useful in cases of tumors situated in the lower quadrants and are appropriate for large breasts or medium-volume breasts with minimal ptosis. The technique is similar to one used in aesthetic surgical procedures. The upper point of the areola (point A) is calculated as in the preceding technique. Point B can be obtained by drawing an inverted "T" of 5-4-4 cm, which creates an areola whose diameter is approximately 45 mm. The superior drawing is made in a "mosque roof" shape in order to reduce the tension at point B. A vertical pillar design is made through superior-internal and superior-external mobilization of the breast as described by Lejour [28]. The decision on whether to perform only a vertical scar or an inverted "T" scar will depend on the level of hypertrophy and the level of ptosis. For small breasts and those with less ptosis, it is possible to perform only a vertical scar, and for large breasts with major ptosis an inverted "T" scar will avoid the cutaneous excess such as the skin fold produced in the vertical scar. The position of the scar as vertical or an inverted "T" can be central (more frequent), medial, or lateral, according to the location of the tumor and the need for skin removal on the nodule aiming to obtain better surgical radicalization (Fig. 11.8).

11.4.2.3 Planning for Inferior Pedicle Techniques

These techniques are based on inferior-posterior areolar vascular pedicles, as described by Ribeiro et al. [29] and Robbins [30], and they may be applied in cases of tumors situated in the upper quadrants of the breast. The

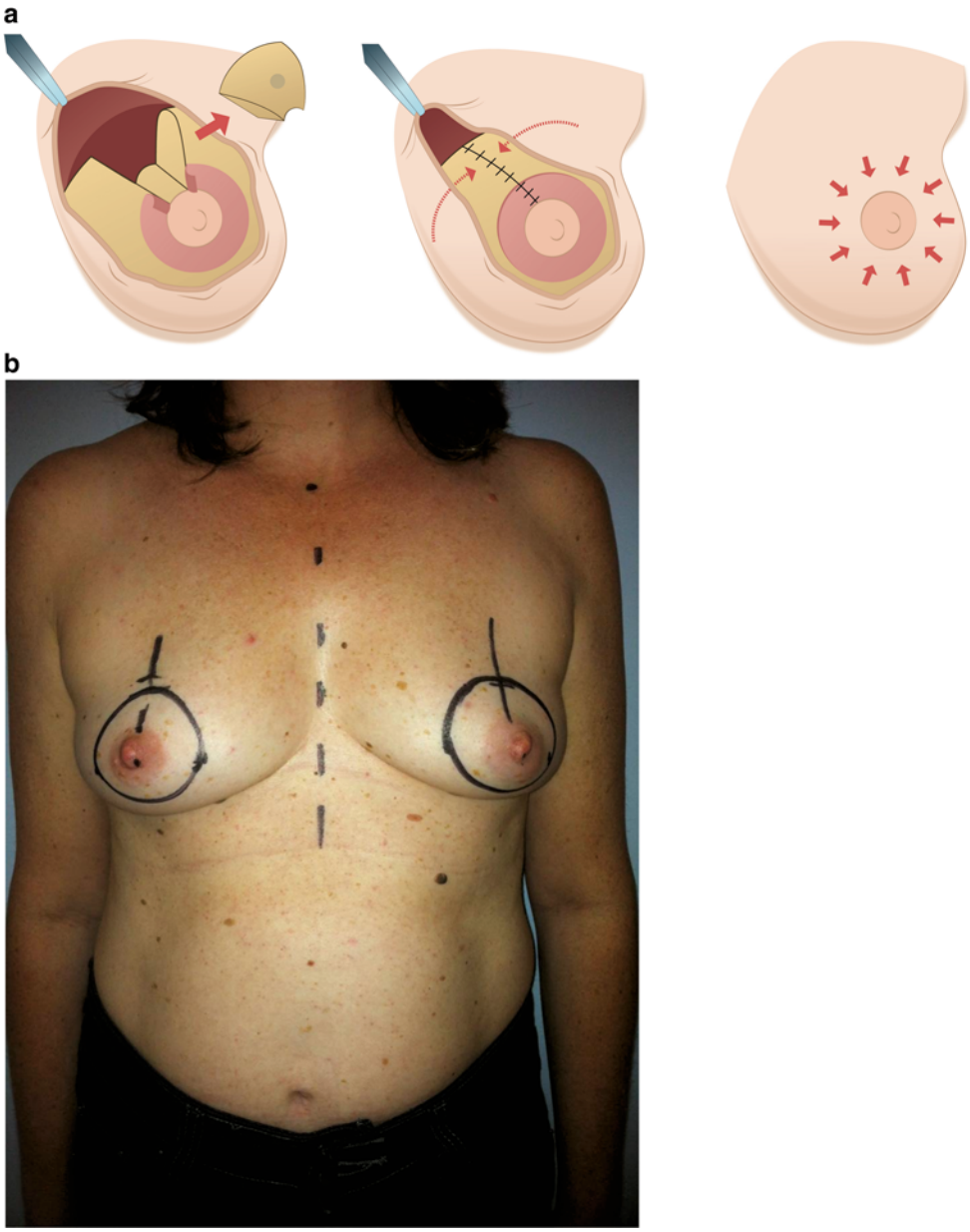

Fig. 11.7 Plan for the round block technique

preoperative drawing and measurements can be made in the same way as with the Pitanguy and Lejour techniques, with a periareolar scar and an inverted "T", or a vertical/oblique inferior line. The areolar pedicle is inferior-posterior and should be drawn with an inferior base of at least 6–8 cm. This measurement is important to preserve the posterior vessels located in the lateral edge of the pectoralis major muscle, which penetrate the pedicle (Fig. 11.9).

11.5 Conclusions

It is not exaggerated to state that planning is the most important time in this surgery. There are two fundamental aims in planning oncoplastic surgery : anticipation of the surgical steps to follow in the operating theater, and reduction of surgical risks. In planning oncoplastic surgery it is essential to anticipate the size and location of future glandular and skin defects, and the relation of the NAC to them. Symmetry is a big challenge in oncoplastic surgery, and it is clear that with good preoperative planning it is possible to achieve better oncologic and aesthetic–functional outcomes. On must also plan how correct possible previous asymmetries too, and to combine this with the oncologic approach. And, of course, the preoperative planning stage is the last time for the surgeon to detect any patient misconceptions about this kind of surgery and its limitations, which are greater than those for aesthetic surgery.

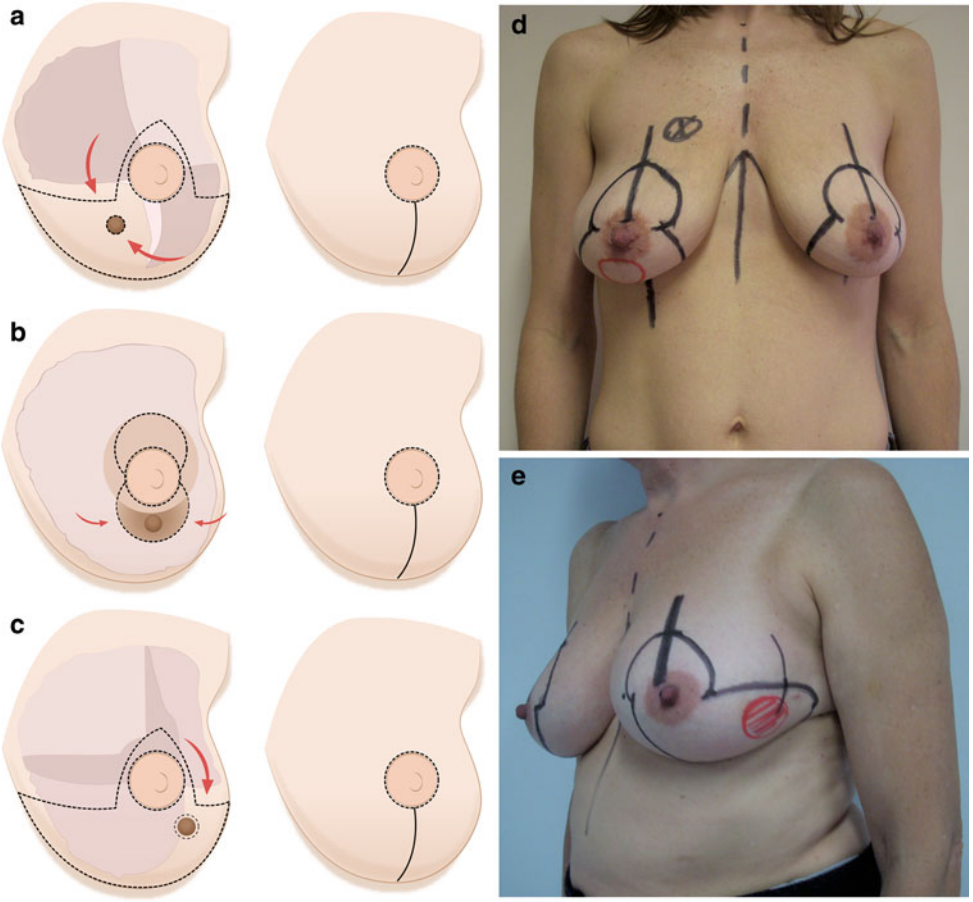

Fig. 11.8 Plan for superior pedicle techniques with tumor in different inferior quadrants

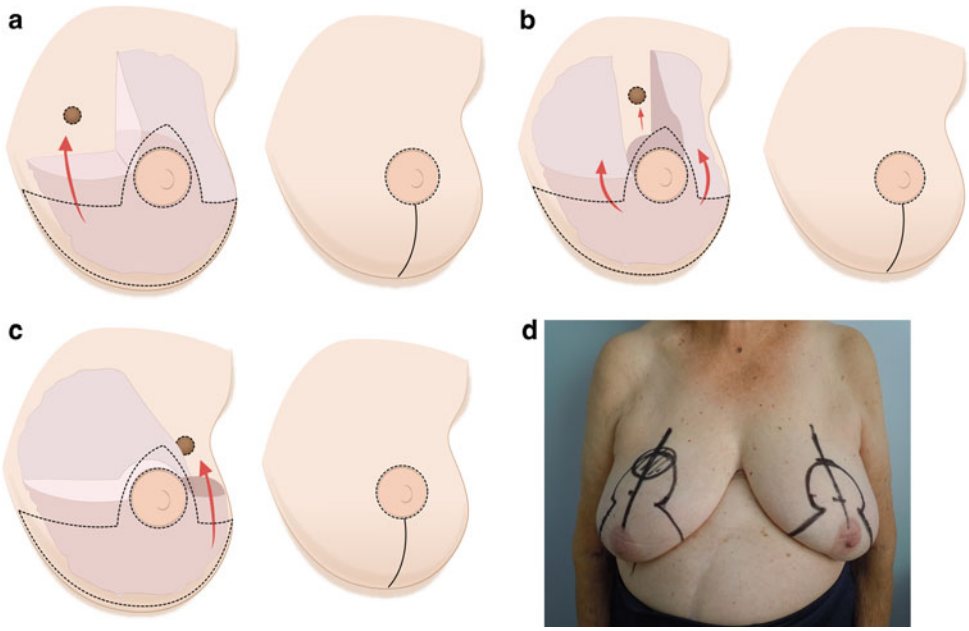

Fig. 11.9 Plan for inferior pedicle techniques with tumor in different superior quadrants

References

1. Clough KB, Kroll SS, Audretsch W (1999) An approach to the repair of partial mastectomy defects. Plast Reconstr Surg 104(2):409–420
2. Baildam AD (2002) Oncoplastic surgery of the breast. Br J Surg 89(5):532–533
3. Clough KB, Lewis JS, Couturaud B, Fitoussi A, Nos C, Falcou MC (2003) Oncoplastic techniques allow extensive resections for breast-conserving therapy of breast carcinomas. Ann Surg 237(1):26–34
4. Clough KB, Cuminet J, Fitoussi A, Nos C, Mosseri V (1998) Cosmetic sequelae after conservative treatment for breast cancer: classification and results of surgical correction. Ann Surg Oncol 41(5):471–481
5. Sacchini V, Luini A, Tana S, Lozza L, Galimberti V, Merson M et al (1991) Quantitative and qualitative cosmetic evaluation after conservative treatment for breast cancer. Eur J Cancer 27(11):1395–1400
6. Al-Ghazal SK, Blamey RW, Stewart J, Morgan AA (1999) The cosmetic outcome in early breast cancer treated with breast conservation. Eur J Surg Oncol 25(6):566–570
7. Al-Ghazal SK, Blamey RW (1999) Cosmetic assessment of breast-conserving surgery for primary breast cancer. Breast 8(4): 162–168
8. Olivotto IA, Rose MA, Osteen RT, Love S, Cady B, Silver B et al (1989) Late cosmetic outcome after conservative surgery and radiotherapy: analysis of causes of cosmetic failure. Int J Radiat Oncol Biol Phys 17(4):747–753
9. Bulstrode NW, Shrotria S (2001) Prediction of cosmetic outcome following conservative breast surgery using breast volume measurements. Breast 10:124–126
10. Berrino P, Campora E, Santi P (1987) Post quadrantectomy breast deformities: classification and techniques of surgical correction. Plast Reconstr Surg 79(4):567–572
11. Clough KB, Cuminet J, Fitoussi A, Nos C, Mosseri V (1998) Cosmetic sequelae after conservative treatment for breast cancer: classification and results of surgical correction. Ann Plast Surg 41(5):471–481
12. Petit JY, Garusi C, Greuse M, Rietjens M, Youssef O, Luini A et al (2002) One hundred and eleven cases of breast conservation treatment with simultaneous reconstruction at the European institute of oncology (Milan). Tumori 88(1):41–47
13. Rietjens M, Petit JY, Contesso G, Bertin F, Gilles R (1997) The role of reduction mammaplasty in oncology. Eur J Plast Surg 20(5):245–250
14. Smith ML, Evans GR, Gurlek A, Bouvet M, Singletary SE, Ames FC et al (1998) Reduction mammaplasty: its role in breast conservation surgery for early-stage breast cancer. Ann Plast Surg 41(3):234–239
15. Losken A, Elwood ET, Styblo TM, Bostwick J 3rd (2002) The role of reduction mammaplasty in reconstructing partial mastectomy defects. Plast Reconstr Surg 109(3):968–975
16. Spear SL, Pelletiere CV, Wolfe AJ, Tsangaris TN, Pennanen MF (2003) Experience with reduction mammaplasty combined with breast conservation therapy in the treatment of breast cancer. Plast Reconstr Surg 111(3):1102–1109
17. Stolier A, Allen R, Linhares L (2003) Breast conservation therapy with concomitant breast reduction in large-breasted women. Breast J 9(4):269–271
18. Spear SL, Burke JB, Forman D, Zuurbier RA, Berg CD (1998) Experience with reduction mammaplasty following breast conservation surgery and radiation therapy. Plast Reconst Surg 102(6):1913–1916
19. Fisher B, Anderson S, Bryant J, Margolese RG, Deutsch M, Fisher ER et al (2002) Twenty-year follow-up of a randomized trial comparing total mastectomy, and lumpectomy plus irradiation for the treatment of invasive breast cancer. N Engl J Med 347(16):1233–1241
20. Veronesi U, Cascinelli N, Mariani L, Greco M, Saccozzi R, Luini A et al (2002) Twenty-year follow-up of a randomized study comparing breast-conserving surgery with radical mastectomy for early breast cancer. N Engl J Med 347(16):1227–1232
21. Kaur N, Petit JY, Rietjens M, Maffini F, Luini A, Gatti G et al (2005) Comparative study of surgical margins in oncoplastic surgery and quadrantectomy in breast cancer. Ann Surg Oncol 12(7):539–545
22. Rietjens M, Urban CA, Petit JY et al (2007) Long-term oncologic results of breast conservation treatment with oncoplastic surgery. Breast 16:387–395
23. Urban C, Lima R, Schunemann E, Spautz C, Rabinovich I, Anselmi K (2011) Oncoplastic principles in breast conserving surgery. Breast 20(Suppl 3):S92–S95
24. Galimberti V, Zurrida S, Zanini V, Callegari M, Veronesi P, Catania S et al (1993) Central small size breast cancer: how to overcome the problem of nipple and areola involvement. Eur J Cancer 29A(8):1093–1096
25. Góes JC (2003) Periareolar mastopexy: double skin technique with mesh support. Aesthet Surg J 23(2):129–135
26. Benelli L (1990) A new periareolar mammaplasty: the "round block" technique. Aesthet Plast Surg 14(2):93–100
27. Pitanguy I (1967) Surgical treatment of breast hypertrophy. Br J Plast Surg 20(1):78–85
28. Lejour M (1999) Vertical mammaplasty: early complications after 250 personal consecutive cases. Plast Reconstr Surg 104(3):764–770
29. Ribeiro L, Accorsi A Jr, Buss A, Marçal-Pessoa M (2002) Creation and evolution of 30 years of the inferior pedicle in reduction mammaplasties. Plast Reconstr Surg 110(3):960–970
30. Robbins TH (1977) A reduction mammaplasty with the areola-nipple based on an inferior dermal pedicle. Plast Reconstr Surg 59(1):64–67

Oncoplastic Surgery: Central Quadrant Techniques

12

Kristine E. Calhoun and Benjamin O. Anderson

12.1 Introduction

Breast-conserving therapy was introduced as an alternative to breast sacrifice for women affected by breast cancer beginning in the 1970s and clinical trials have since demonstrated equivalency in terms of overall survival between lumpectomy plus radiation and mastectomy [1, 2]. Although there are clear contraindications to lumpectomy, for the appropriately selected individual, breast-conserving therapy offers both effective treatment and the psychological benefit of retention of the breast.

In a traditional lumpectomy, there is no specific effort to obliterate the internal resection cavity. In fact, closing fibroglandular tissue can result in unsightly defects if alignment of the breast tissue is suboptimal. Fibroglandular tissue that is sutured closed at middle depth in the breast while the patient is supine on the operating table can result in a dimpled, irregular appearance when the patient stands up. Given this potential, most surgeons choose to close the skin of a lumpectomy without approximation of the underlying tissue. Although the simple "scoop and run" approach to lumpectomy may work well for small tumors, declivity of the skin and/or displacement of the nipple–areola complex (NAC) may occur if the lesion removed from the breast is sizable and may create especially troubling defects for central lesions.

For breast conservation to be effective, the primary tumor must be resected with adequate surgical margins while simultaneously maintaining the breast's shape and appearance, goals which may prove challenging and in some settings seem to be conflicting [3, 4]. In 1994, Audretsch [5] was one of the first to advocate the use of "oncoplastic surgery" for repair of partial mastectomy defects by combining the techniques of volume reduction with immediate flap reconstruction. Although initially used to describe partial mastectomy combined with large myocutaneous flap reconstruction using the latissimus dorsi or the rectus abdominis muscles, "oncoplastic surgery" now more commonly describes numerous surgical techniques that utilize partial mastectomy and breast-flap advancement to address tissue defects following wide resection. Compared with breast reconstruction using a myocutaneous flap, breast-flap advancements are easily learned and implemented by breast surgeons, even those lacking formal plastic surgery training.

A comprehensive understanding of normal ductal anatomy is critical to planning an oncoplastic partial mastectomy [3, 6]. The modern anatomic analysis of ductal anatomy suggests that the number of major ductal systems is probably fewer than ten [7]. The size of ductal segments is variable and whereas some ducts pass radially from the nipple to the periphery of the breast, others travel directly back from the nipple toward the chest wall. In contrast, well-defined breast vasculature allows the surgeon to remove and remodel large amounts of fibroglandular tissue without major risk of breast devascularization and/or tissue necrosis. The commonest sources of arterial blood supply in the human breast arise from the axillary and internal mammary arteries. By maintaining communication with one of these two arterial connections, one maintains an adequate blood supply for the breast parenchyma during tissue advancement and mastopexy closure.

The use of oncoplastic surgical techniques for breast conservation allows wider resections without subsequent tissue deformity, and thereby allows surgeons to achieve wide surgical margins while preserving the shape and appearance of the breast [8]. Such techniques can be especially useful for more centrally located lesions, which when resected with standard surgical techniques may result

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in suboptimal cosmetic outcomes. Although specific oncoplastic techniques differ from one another, all of the approaches involve fashioning the tissue resection to the anatomic shape of the cancer while ensuring that wide margins, ideally more that 1 cm, are achieved in an optimal number of patients [3, 6]. The indications and contraindications for oncoplastic surgery are the same as those for traditional breast-conserving surgery, and such techniques should only be offered to those otherwise believed to be breast-preservation candidates on the basis of size and centricity.

The techniques described in this chapter include those used for central segmental resections that utilize breast-flap advancement (so-called tissue displacement techniques) and include central lumpectomy, batwing mastopexy lumpectomy, donut mastopexy lumpectomy, and variations on reduction mastopexy lumpectomy which utilize a pedicle flap to restore the NAC.

12.2 Preoperative Planning

Patients undergoing central quadrant resections should undergo standard preoperative history taking and physical examination, with the elements of gynecologic, family, and social history, including smoking, emphasized. Special attention should be given to any prior breast surgical history, including the placement of breast implants. Needle sampling should be performed to provide tissue diagnosis of malignancy. At our institution, internal review of all external pathology slides is required to confirm that we agree with the histopathologic diagnosis.

Those being considered for oncoplastic resections should undergo a standard preoperative breast imaging workup, which typically includes some combination of mammography, ultrasonography, and in selected circumstances breast MRI. Although mammography may underestimate the extent of ductal carcinoma in situ by as much as 1–2 cm, it is still warranted and is often the initial diagnostic study [9].

Although controversial, the use of MRI may contribute to the surgeon's ability to preoperatively determine the extent of disease, especially for mammographically subtle and/or occult cancers, and to conceptualize the location of the tumor more three-dimensionally than allowed on mammography. Compared with mammographic and ultrasonographic images, the extent of disease seen on MRI may correlate best with the extent of tumor found on pathologic evaluation. In addition, MRI has the lowest false-negative rate in detecting invasive lobular carcinoma [10]. Although its sensitivity for detection of invasive breast cancer is high, MRI unfortunately has a low specificity of 68 % in the diagnosis of breast cancer before biopsy [11]. Up to one-third of MRI studies will show some area of enhancement that needs further assessment that ultimately proves to be histologically benign breast tissue [3]. A consensus statement from the American Society of Breast Surgeons [12] updated in 2010 supports the use of MRI for determining the extent of ipsilateral tumor or the presence of contralateral disease in patients with a proven breast cancer (especially those with invasive lobular carcinoma) when dense breast tissue precludes an accurate mammographic assessment. For cancers containing both invasive and noninvasive components, a combination of imaging methods may yield the best estimate of overall tumor size [13].

12.3 Perioperative Planning

Once a central oncoplastic approach has been selected, decisions regarding the use of preoperative wire localization for nonpalpable malignancies must be made. In planning oncoplastic resections, the surgeon needs to accurately identify the area requiring removal. Silverstein et al. [14] suggested the preoperative placement of two to four bracketing wires to delineate the boundaries of a single lesion. In a study by Liberman et al. [15], wire bracketing of 42 lesions allowed complete removal of suspicious calcifications in 34 patients (81.0 %). It has been suggested that single wire localization of large breast lesions is likelier to result in positive margins, because the surgeon lacks landmarks to determine where the true boundaries of nonpalpable disease are located. For such scenarios, multiple bracketing wires may assist the surgeon in achieving complete excision at the initial intervention. For more palpable lesions, such wire localizations may be a moot point.

Skin landmarks should be marked with the patient sitting up in the preoperative area, including the inframammary crease, the anterior axillary fold at the pectoralis major muscle, the posterior axillary fold of the latissimus dorsi muscle, the sternal border of the breast, and the periareolar circle. Identifying these entities with the patient in the upright position is very important for the final cosmetic outcome, because these anatomic sites may prove challenging to accurately locate once the patient is anesthetized and lying supine on the operating room table. Generally, for reduction-type procedures, markings will be placed on both breasts.

For all oncoplastic techniques, the patient should be supine on the operating room table and with both arms abducted on arm boards and secured. It is preferable to have both breasts prepared and draped into the field so that visual comparison with the patient in a beach chair position is possible as the wound is closed. Such an approach allows the surgeon to identify any areas of unnecessary tugging or dimpling which are inadvertently created so that they can be corrected.

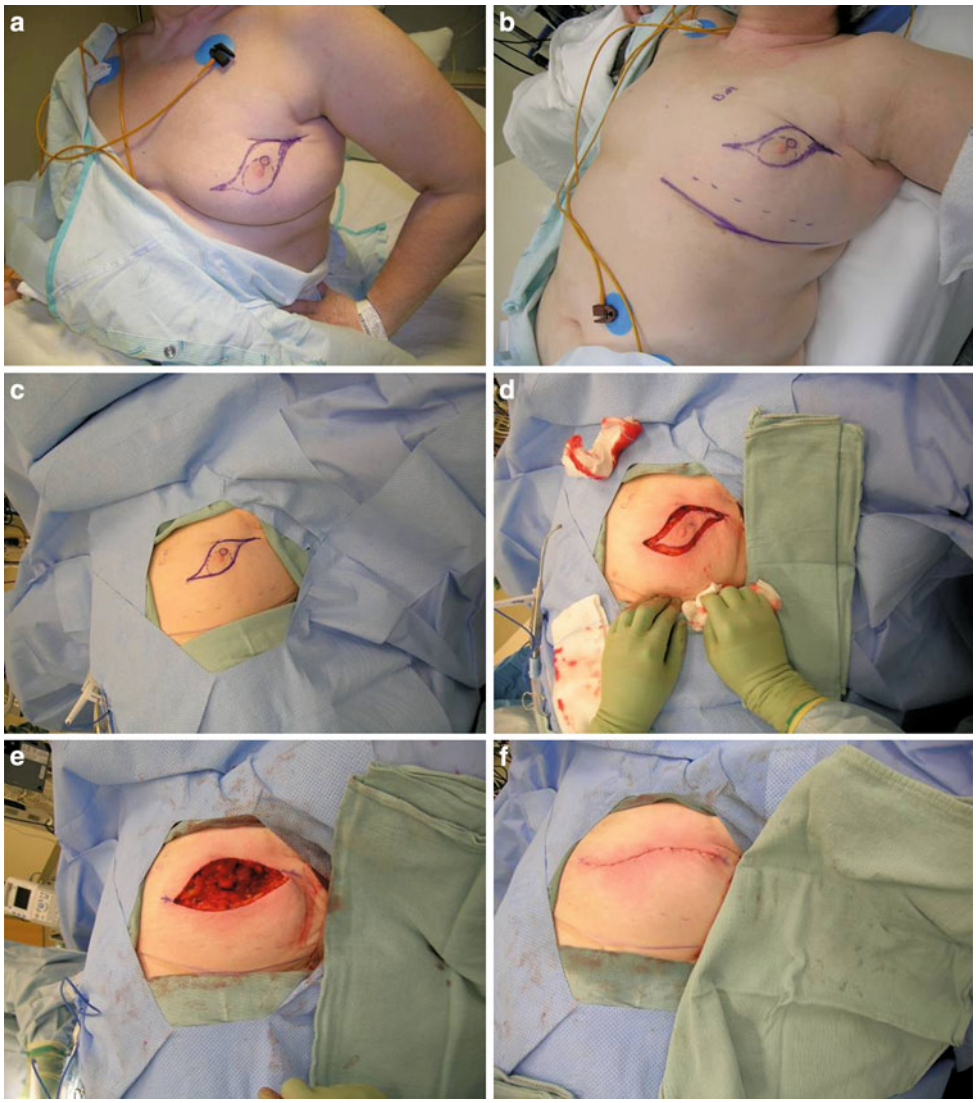

Fig. 12.1 Central lumpectomy. **a** Preoperative marking with the patient in the upright position. **b** Intraoperative marking with the patient in the supine position illustrating positional shift of the breast landmarks. **c** Initial skin incision revealing wide exposure over the target lesion. **d** Central resection. **e** Postexcision cavity. **f** Final closure

12.4 Central Quadrant Techniques

12.4.1 Central Lumpectomy

For those cancers involving the NAC, including Paget's disease of the nipple, the cosmetic impact of nipple removal with central lumpectomy typically accounts for the common use of mastectomy in this situation. In recent years, with improved NAC reconstructive capabilities, central lumpectomies have been utilized more. Although central lumpectomy removes the NAC and underlying central tissues, it typically leaves behind a significant breast mound, especially for those with larger breasts at the baseline. The cosmetic outcome with central lumpectomy can range from good to outstanding, depending on the woman's body habitus, and is likely to be better tolerated than reconstruction of an entire breast [3]. Central lumpectomy can be particularly valuable in women with large breasts where loss of the entire breast with mastectomy may create prominent asymmetry. Surgical issues of NAC reconstruction in an irradiated field, including wound-healing issues and NAC loss, must be considered, so early referral for plastic surgery is warranted.

In central lumpectomy, the incision can be made in the pattern of a large parallelogram that encompasses the entire NAC, or can be more circular in nature (Fig. 12.1a–f). After excision of the skin island/NAC, short-distance mastectomy-type skin flaps are raised along both sides of the wound. The dissection is carried down to the chest wall and the breast gland is lifted off the pectoralis muscle. After full-thickness excision of the tumor, four to six marking clips are typically placed at the base of the defect within the surrounding fibroglandular tissue for future imaging and radiation oncology purposes. A small drain may also be placed in the lumpectomy wound in cases where the

dissection is more extensive and fear of seroma is increased. For adequate evaluation of margin status by the pathologist, sharp rather than cautery dissection should be considered, as sharp dissection will not alter the histological margins of the resected tissues with the so-called cautery effect. Larger intraparenchymal vessels can be ligated or coagulated during the dissection, and cautery can then be used on the exposed fibroglandular tissue faces to control bleeding.

Once tissue specimens have been resected and hemostasis has been obtained, the fibroglandular tissue at the level of the pectoralis fascia is undermined so that breast-tissue advancement can be performed over the muscle. Once the fibroglandular tissues have been sufficiently mobilized and hemostasis has been confirmed, the margins of the residual cavity are shifted together by the advancement of breast tissue over muscle and the defect is sutured at the deepest edges using 3-0 absorbable sutures. The direction of tissue advancement can be adjusted depending upon the location of the fibroglandular defect and the excess tissue that can be shifted to close it. The goal of the mastopexy is to perform as complete a closure over the pectoralis muscle as possible to discourage communication between the anterior skin and the deeper tissues. Side to side comparisons with the patient in an upright position are warranted to ensure that no unusual retractions of the tissues or unsightly cosmetic results have occurred.

The superficial tissue layer is next closed with an interrupted subdermal 3-0 absorbable suture, and the skin is closed with 4-0 absorbable subcuticular sutures in routine fashion. Two variations on closure exist. The first, which is more typical, involves closure in a manner which results in a scar that is a horizontal, straight line, and the second involves closing the wound utilizing a purse-string closure to facilitate areolar tattooing.

12.4.2 Batwing Mastopexy Lumpectomy

For cancers adjacent to or deep to the NAC, but without direct involvement of the nipple, lumpectomy can successfully be performed without sacrifice of the nipple itself. The batwing approach preserves the viability of the NAC while preserving the breast mound by using mastopexy closure to close the resulting fibroglandular defect of the full-thickness resection. This procedure may result in lifting of the nipple into the upper breast, and a contralateral lift may need to be performed to achieve symmetry, especially when the native breast is large and pendulous.

Two similar semicircle incisions are made with angled "wings" on each side of the areola (Fig. 12.2a–e). The two half-circles are positioned so they can be reapproximated to each other at wound closure. Removal of these skin wings allows the two semicircles to be shifted together without creating redundant skin folds at closure. Fibroglandular tissue dissection is carried down deep to the known cancer, with the depth in relation to the chest wall dictated by the position of the lesion within the breast. In most situations, the dissection is carried down to the chest wall and the breast gland is lifted off the pectoralis muscle in a fashion similar to that for central lumpectomy. The principles of sharp dissection and the placement of marking clips are also similar to those utilized in central lumpectomy.

Following full-thickness resection of the target, mobilization of the fibroglandular tissue for mastopexy closure will likely be required. The breast tissue is elevated off of the chest wall at the plane between the pectoralis muscle and breast gland, and the fibroglandular tissue is advanced to close the resulting defect. The deepest parts are approximated by interrupted sutures. We typically secure the fibroglandular tissue to fibroglandular tissue and do not place anchoring stitches into the chest wall, thereby allowing the approximated breast tissues to move along the chest wall. The superficial layer is closed in the same fashion as in central lumpectomy. As this procedure can cause some lifting of the nipple, it may create asymmetry compared with the noncancerous breast. A contralateral lift can be performed after adjuvant radiation therapy has been completed and the treated breast has "declared" its new size and shape to achieve symmetry, although some plastic surgeons may choose to perform this symmetry procedure concurrent with the oncologic surgery.

12.4.3 Donut Mastopexy Lumpectomy

For segmentally distributed cancers located in the upper or lateral breast that approach the NAC, donut mastopexy lumpectomy can be used to achieve effective resection of long, narrow segments of breast tissue. Donut mastopexy avoids a visible long radial scar which is against Kraissl's line or Langer's line. In this procedure (Fig. 12.3a–f), two concentric lines are placed around the areola and a periareolar "donut" skin island is excised, with only a periareolar scar visible after this operation. Deepithelialization by separating this skin island from the underlying tissues is done, taking care to avoid full devascularization of the areolar skin. The width of the "donut" skin island should be approximately 1 cm, but is somewhat dependent on the size of the areola and the expected extent of excision. Removal of this tissue ring is required, as it allows both adequate access to and exposure of the breast tissue and closure of the skin envelope around the remaining fibroglandular tissue that will reduce tissue volume overall.

A skin envelope is created in all directions around the NAC. The quadrant of breast tissue containing the target lesion is fully exposed utilizing the same dissection used for

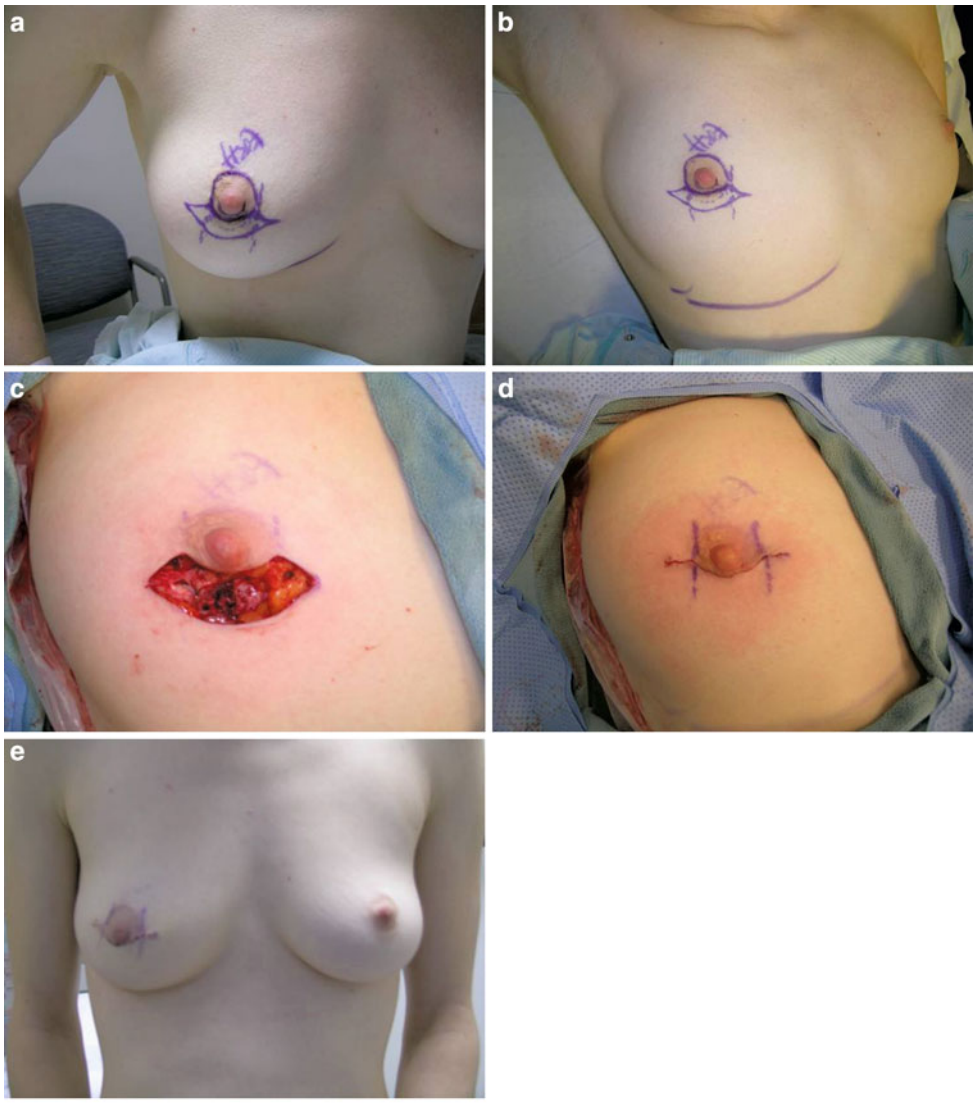

Fig. 12.2 Batwing mastopexy lumpectomy. **a** Preoperative marking with the patient in the upright position. **b** Intraoperative marking with the patient in the supine position. **c** Resection cavity. **d** Final closure. **e** Postoperative result with the patient in the upright position

a skin-sparing mastectomy. The full-thickness breast gland is then separated from the underlying pectoralis muscle and delivered through the circumareolar incision. The segment of breast tissue with the tumor is resected in a wedge-shaped fashion, with the width of tissue excision required to achieve adequate surgical margins balanced against the difficulty that will be created by virtue of an oversized segmental defect.

The remaining fibroglandular tissue is returned to the skin envelope and the peripheral apical corners of the fibroglandular tissue are secured to each other and then anchored to the chest wall. This anchoring step maintains proper orientation of the mobilized fibroglandular tissue within the skin envelope during the initial phases of healing. A purse string using a 3-0 absorbable suture is placed around the areola opening, and is clamped at a size that reapproximates the original NAC. Interrupted inverted 3-0 absorbable sutures are placed subdermally around the NAC, at which time the purse-string suture is tied and then 4-0 subcuticular sutures are used to close the wound. Uplifting of the NAC may create mild asymmetry in comparison with the untreated breast. If desired, a contralateral lift can be performed to achieve symmetry.

12.4.4 Reduction Mastopexy Lumpectomy Modifications

Initially used in women with macromastia and excessive breast ptosis, this procedure is currently used for resection of lesions in the lower hemisphere of the breast between the 4 o'clock and 8 o'clock positions, where "scoop and run" lumpectomy using circumareolar incision would result in unacceptable down-turning of the nipple owing to scar

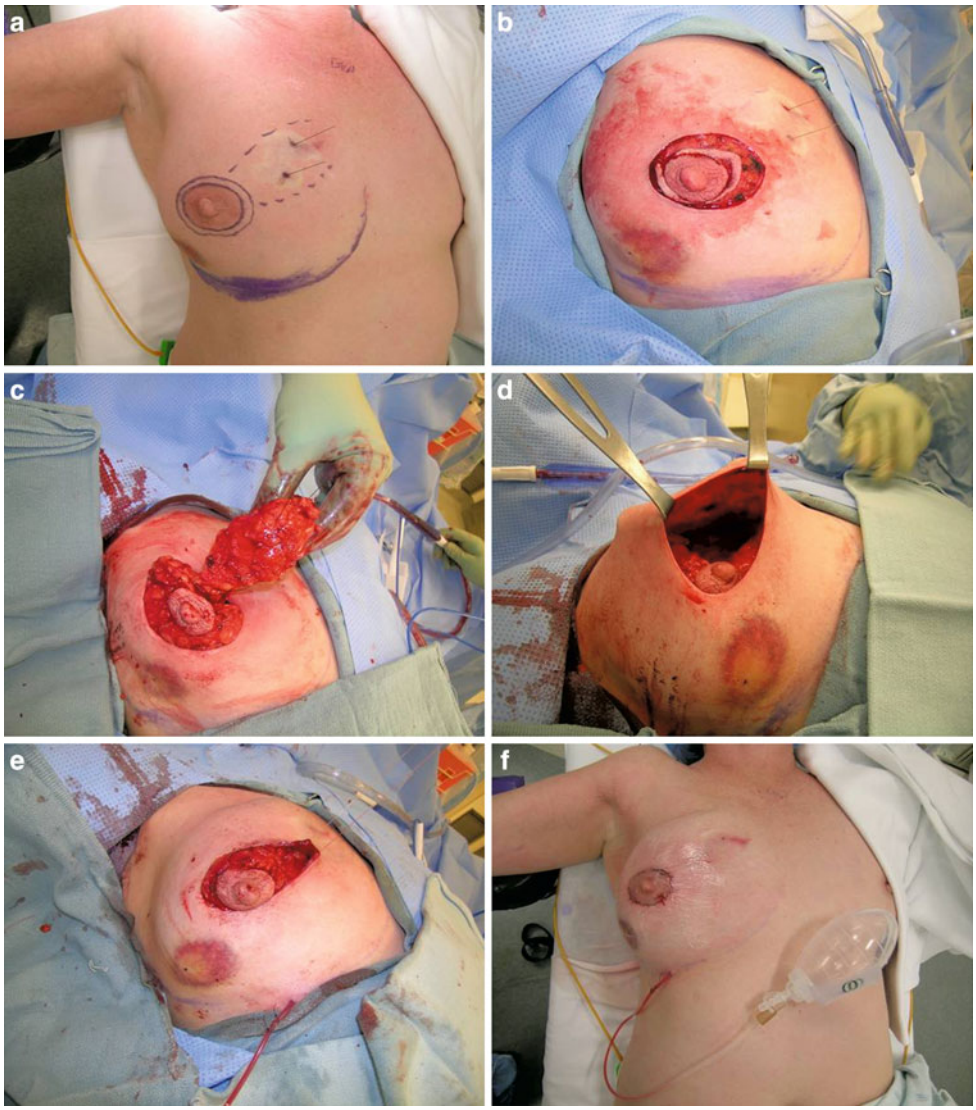

Fig. 12.3 Donut mastopexy lumpectomy. **a** Preoperative marking including marking of the region to be removed based on preoperative bracketing wires and concentric circles for skin donut excision. **b** Initial skin incision. **c** Delivery of tissue segment through the periareolar incision. **d** Remaining cavity after resection. **e** Purse-string closure. **f** Final operative result

contracture after radiotherapy. This unpleasant cosmetic outcome can be prevented by using the technique of reduction mastopexy lumpectomy (Fig. 12.4a–f). Recently, the indications for using reduction techniques have been expanded to include women with centrally located tumors faced with NAC loss. In these situations, the reduction is coupled with a deepithelialized pedicle flap with an overlying skin island to recreate the NAC, ultimately resulting in a Wise-type scar and a neo-nipple [16].

In traditional reduction mammoplasty, a keyhole pattern incision is made and the skin above the areola is deepithelialized in preparation for skin closure. A superior pedicle flap is created by inframammary incision and undermining of the breast tissue off the pectoral fascia to mobilize the NAC and underlying tissues. Mobilization of the breast tissue allows palpation of both the deep and the superficial surfaces of the tumor, which can aid the surgeon in determining the lateral margins of excision around the target lesion. When it is used for a central lesion, the primary tumor and overlaying NAC are resected down to the chest wall. The principle of sharp dissection and the placement of marking clips are the same as those for parallelogram mastopexy lumpectomy. A caudally located inferior flap is then deepithelialized, except for an appropriately sized skin island that will function as the neo-nipple. Following this, redundant medial, lateral, and superior tissues are then resected while preserving the pedicle tissue. An incision at the inframammary crease facilitates mobilization and assists in restoration of normal breast shape and contour.

Once all tissues have been resected, the central, inferior pedicle is mobilized, brought cephalad, and utilized to occupy the defect created by removal of the prior NAC. The neo-nipple is sutured to the margins of NAC resection. The medial and lateral breast flaps are undermined and sutured together to fill the excision defect, leaving a typical

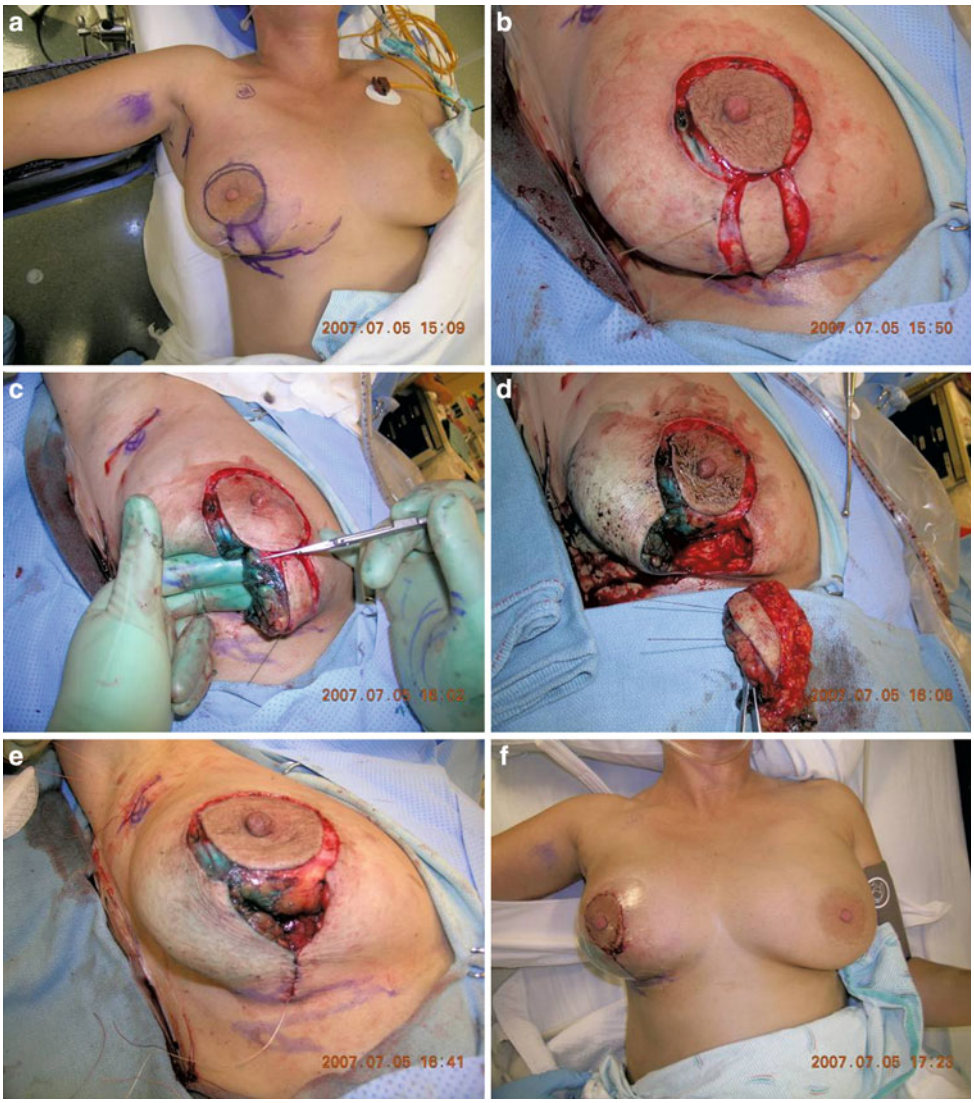

Fig. 12.4 Reduction mastopexy lumpectomy. **a** Preoperative skin markings showing the keyhole incision pattern. **b** Initial skin incision. **c** Full-thickness resection. **d** Excised specimen and residual cavity. **e** Closure. **f** Final result

inverted-T scar. Variations of this technique have been reported, including the Grisotti flap, which extends the pedicle laterally and results in an inferior and laterally sweeping incision [16], and free nipple graft from the skin of the contralateral reduction tissue [17]. Finally, some choose to utilize the reduction flap without creation of a neo-nipple, leaving the patient with a Wise-type incision and the choice of NAC in a delayed fashion [16].

12.5 Postoperative Management

Although drains are rarely required in standard partial mastectomy cases, with more extensive dissections, such as donut mastopexy lumpectomy, fluid accumulation can become more pronounced and require postoperative aspiration. In recent years, we have started to place small, 15F drains overnight to avoid excessive fluid accumulation in the dissected breast that might distort the oncoplastic closure. These drains are typically removed either prior to discharge or on the first postoperative day in the clinic.

12.6 Complications

When using central oncoplastic approaches, surgeons without formal plastic surgery training must determine which procedures they are comfortable performing without plastic surgery consultation or intraoperative collaboration [3]. Although these techniques appear to be relatively safe in the immediate postoperative period, issues such as wound infection, fat necrosis, and delayed healing with the more advanced techniques are all potential, reported complications [18–20]. Despite more extensive resections, hematomas requiring reoperation appear to be infrequent, occurring roughly 2–3 % of the time in two recent studies [19, 20]. The

blood supply of the external nipple arises from underlying fibroglandular tissue using major lactiferous sinuses rather than the collateral circulation from surrounding areolar skin, so nipple necrosis may occur if dissection extends high up behind the nipple, but is also fortunately rare [3]. Finally, in a review of 84 women who underwent partial mastectomy and radiation therapy, Kronowitz et al. [21] showed that immediate repair of partial mastectomy defects with local tissues results in fewer complications (23 vs. 67 %) and better aesthetic outcomes (57 vs. 33 %) than that with a latissimus dorsi flap, which some surgeons used for delayed reconstructions [22].

12.7 Results

The main goal of oncoplastic lumpectomy remains negative surgical margin resection. Complete excision of calcified lesions and masses should be confirmed with specimen radiography during surgery. Additional oriented margins can be resected prior to mastopexy closure when the radiograph suggests inadequate resection may have occurred, hopefully eliminating the need for a delayed re-excision. Although some centers use intraoperative analysis with a frozen section to aid in decisions regarding the resection of additional segments of tissue, thus is not our policy.

Multicolored inking performed by the surgeon in the operating room helps to improve margin identification. Inking kits are now available with six colors (black, blue, yellow, green, orange, and red), which are very useful for labeling all of the surgical margins (superior, inferior, medial, lateral, superficial, and deep) (Fig. 12.5). Clear uniformity between the surgeon and the pathologist in terms of what color means what margin is required, especially when inadequate margins are identified that require reoperation.

Although the historical gold standard for a negative surgical margin has been 10 mm, what constitutes a true "negative margin" differs widely from center to center, with 3 mm or greater accepted at our institution. Low local recurrence rates after breast conservation therapy, especially in the era of postlumpectomy irradiation, can be achieved with an intermediate surgical margin width between 1 and 10 mm [1, 2]. If re-excision is needed for inadequate surgical margins following the initial resection, both the surgical approach and the timing of the operation must be considered [3]. When the positive margin involves a minority of the specimen, the entire biopsy cavity does not need to be re-excised, and instead can be directed toward the inadequate region. If re-excision is delayed for 3–4 weeks, the previous seroma cavity may be nearly reabsorbed, which leaves a fibrous biopsy cavity that can be easily located by intraoperative palpation. With noninvasive cancer, Silverstein et al. [14] have suggested that it is feasible to delay re-excision for up to 3 months, at which point the seroma cavity has been fully reabsorbed.

Fig. 12.5 Specimen inked by the surgeon to designate anterior, posterior, medial, lateral, inferior, and superior margins

When all the resection margins are positive, mastectomy may be needed to attain satisfactory surgical clearance. In this instance, it may be technically challenging to include both the initial oncoplastic incision and the NAC in a subsequent total mastectomy, and consultation with the plastic surgeon in the event of immediate postmastectomy reconstruction is mandatory. Despite a clear ability to resect widely with these central oncoplastic techniques, inadequate margins remain an issue. Although reports remain sparse, reported rates of inadequate margins following initial resection range from 8 to 22 % [19, 20, 23–28]. The decision between a re-excision and a mastectomy must be based on the operating surgeon's ability to appropriately localize the involved region, and with more advanced resections this may only be possible with breast sacrifice.

Although large studies of long-term outcomes specifically addressing oncoplastic approaches in breast conservation are lacking, the limited available results continue to look promising. One investigation from Europe followed 148 women for a median of 74 months (range 10–108 months) and only two were lost to follow-up. Among the 146 individuals available for analysis, there were only five women (3 %) who had an ipsilateral in-breast cancer recurrence after 5 years and all had either T2 or T3 tumors at presentation. Rietjens et al. [29] argued that recurrence rates for women with oncoplastic resections and concurrent radiation therapy were comparable to the in-breast recurrence rates reported with standard breast conservation techniques. Studies of more limited follow-up recently reported no in-breast local recurrences at 26 months [19], 38 months [20], and 34 months [16],

although some distant recurrences were reported. These results appear equivalent to those for women treated with traditional lumpectomy and should serve to allay any fears of cosmesis being favored over cancer control.

12.8 Conclusions

Although shown to be a reasonable alternative to mastectomy for the appropriately selected breast cancer patient, traditional "scoop and run" lumpectomy may result in poor cosmesis. Central oncoplastic techniques, including central lumpectomy, batwing mastopexy lumpectomy, donut mastopexy lumpectomy, and variations of reduction mastopexy lumpectomy have been developed to address this issue. By combining large-volume tumor removal with breast-flap advancements, the oncoplastic approaches allow wider margins of resection and better breast shape and contour preservation. Candidates are those felt to be standard lumpectomy candidates and include those with no evidence of multicentric disease.

Standard preoperative workup, including dedicated breast imaging, and preoperative wire localization are necessary to aid the surgeon in successful resection. Complications of tissue necrosis are fortunately rare, despite sometimes significant remodeling of the fibroglandular tissues due to the breast's rich blood supply. Outcomes appear at least equivalent to those for standard breast conservation techniques, although large case series are lacking. Despite this paucity of long-term results, oncoplastic lumpectomy can be learned by individuals familiar with breast surgical techniques and generally results in better cosmesis and equivalent oncologic outcomes.

References

1. Veronesi U, Cascinelli N, Mariani L, Greco M, Saccozzi R, Luini A et al (2002) Twenty-year follow-up of a randomized study comparing breast-conserving surgery with radical mastectomy for early breast cancer. N Engl J Med 347(16):1227–1232
2. Fisher B, Anderson S, Bryant J, Margolese RG, Deutsch M, Fisher ER et al (2002) Twenty-year follow-up of a randomized trial comparing total mastectomy, lumpectomy, and lumpectomy plus irradiation for the treatment of invasive breast cancer. N Engl J Med 347(16):1233–1241
3. Anderson BO, Masetti R, Silverstein MJ (2005) Oncoplastic approaches to partial mastectomy: an overview of volume-displacement techniques. Lancet Oncol 6(3):145–157
4. Masetti R, Pirulli PG, Magno S, Franceschini G, Chiesa F, Antinori A (2000) Oncoplastic techniques in the conservative surgical treatment of breast cancer. Breast Cancer 7(4):276–280
5. Audretsch WP (2006) Reconstruction of the partial mastectomy defect: classification and method. In: Spear SL (ed) Surgery of the breast: principle and art, 2nd edn. Lippincott Williams & Wilkins, Philadelphia, pp 179–216
6. Chen CY, Calhoun KE, Masetti R, Anderson BO (2006) Oncoplastic breast conserving surgery: a renaissance of anatomically-based surgical technique. Minerva Chir 61(5):421–434
7. Love SM, Barsky SH (2004) Anatomy of the nipple and breast ducts revisited. Cancer 101(9):1947–1957
8. Silverstein MJ (2003) An argument against routine use of radiotherapy for ductal carcinoma in situ. Oncology (Huntingt) 17(11):1511–1533; discussion 1533–1534, 1539, 1542 passim
9. Holland R, Faverly DRG (2002) The local distribution of ductal carcinoma in situ of the breast: whole-organ studies. In: Silverstein MJ (ed) Ductal carcinoma in situ of the breast, 2nd edn. Lippincott Williams & Wilkins, Philadelphia, pp 240–254
10. Boetes C, Veltman J, van Die L, Bult P, Wobbes T, Barentsz JO (2004) The role of MRI in invasive lobular carcinoma. Breast Cancer Res Treat 86(1):31–37
11. Bluemke DA, Gatsonis CA, Chen MH, DeAngelis GA, DeBruhl N, Harms S et al (2004) Magnetic resonance imaging of the breast prior to biopsy. JAMA 292(22):2735–2742
12. The American Society of Breast Surgeons Consensus Statement: The use of magnetic resonance imaging in breast oncology, 27 July 2010. http://www.breastsurgeons.org/statements
13. Silverstein MJ, Lagios MD, Recht A, Allred DC, Harms SE, Holland R et al (2005) Image-detected breast cancer: state of the art diagnosis and treatment. J Am Coll Surg 201(4):586–597
14. Silverstein MJ, Larson L, Soni R, Nakamura S, Woo C, Colburn WJ et al (2002) Breast biopsy and oncoplastic surgery for the patient with ductal carcinoma in situ: surgical, pathologic, and radiologic issues. In: Silverstein MJ (ed) Ductal carcinoma in situ of the breast, 2nd edn. Lippincott Williams & Wilkins, Philadelphia, pp 185–204
15. Liberman L, Kaplan J, Van Zee KJ, Morris EA, LaTrenta LR, Abramson AF et al (2001) Bracketing wires for preoperative breast needle localization. AJR Am J Roentgenol 177(3):565–572
16. Huemer GM, Schrenk P, Moser F, Wagner E, Wayand W (2007) Oncoplastic techniques allow breast-conserving treatment in centrally located breast cancers. Plast Reconstr Surg 120(2):390–398
17. Schoeller T, Huemer GM (2006) Immediate reconstruction of the nipple/areola complex in oncoplastic surgery after central quadrantectomy. Ann Plast Surg 57(6):611–616
18. Iwuagwu OC (2005) Additional considerations in the application of oncoplastic approaches. Lancet Oncol 6(6):356
19. Meretoja TJ, Svarvar C, Jahkola TA (2010) Outcome of oncoplastic breast surgery in 90 prospective patients. Am Jour Surg 200(2):224–228
20. Roughton MC, Shenaq D, Jaskowiak N, Park JE, Song DH (2012) Optimizing delivery of breast conservation therapy: a multidisciplinary approach to oncoplastic surgery. Ann Plast Surg 69(3):250–255
21. Kronowitz SJ, Feledy JA, Hunt KK, Kuerer HM, Youssef A, Koutz CA et al (2006) Determining the optimal approach to breast reconstruction after partial mastectomy. Plast Reconstr Surg 117(1):1–11
22. Nahabedian MY (2006) Determining the optimal approach to breast reconstruction after partial mastectomy: discussion. Plast Reconstr Surg 117(1):12–14
23. Bong J, Parker J, Clapper R, Dooley W (2010) Clinical series of oncoplastic mastopexy to optimize cosmesis of large volume resections for breast conservation. Ann Surg Oncol 17(12): 3247–3251
24. Naguib SF (2006) Oncoplastic resection of retroareolar breast cancer: central quadrantectomy and reconstruction by local skin-glandular flap. J Egypt Natl Canc Inst 18(4):334–347
25. Clough K, Lewis J, Couturuad B et al (2003) Oncoplastic techniques allow extensive resections for breast conserving therapy of breast carcinomas. Ann Surg 237(1):26–34

26. Losken A, Elwood E, Styblo T et al (2002) The role of reduction mammoplasty in reconstructing partial mastectomy defects. Plast Reconstr Surg 109(3):968–975
27. McCulley S, Macmillan R (2005) Therapeutic mammoplasty-analysis of 50 consecutive cases. Br J Plast Surg 58(7): 902–907
28. Caruso F, Catanuto G, De Meo L et al (2008) Outcomes of bilateral mammoplasty for early stage breast cancer. Eur J Surg Oncol 34(10):1143–1147
29. Rietjens M, Urban CA, Rey PC et al (2007) Long-term oncological results if breast conservation treatment with oncoplastic surgery. J Breast 16(4):387–395

Periareolar Techniques

13

Alexandre Mendonça Munhoz

13.1 Introduction

The nipple–areola complex (NAC) is an important component of the breast and its aesthetic outcome is crucial in most patients who have been diagnosed with breast cancer. The technical objectives of breast surgery are resection of the breast tissue with adequate margins while restoring the breast volume. To achieve these goals, numerous approaches have been proposed involving a variety of designs incorporating a periareolar incision, or other variations in the shape around the NAC [1–8]. In our experience, with the periareolar approaches, the aesthetic results can be improved further [9–11]. In breast-conserving surgery (BCS), the final scarring can be kept at the natural border of the NAC with the breast skin. In skin-sparing mastectomy (SSM), the patchlike effect of skin flaps can be avoided, which may be less favorable than the other incisions [9, 10]. Thus, scar reduction and even total camouflage by the future NAC reconstruction are the main positive aspects of the periareolar techniques [9].

Despite its advantages, it is our impression that the periareolar approach is not appropriate for all patients. In our experience, it is more suitable in patients with small/medium-sized breasts with an adequate areola diameter. Restricted surgical exposure and difficulty in skin flap dissection are commonly observed for patients with a small areola and inexperienced breast surgeons.

The importance of obtaining a good aesthetic result, while avoiding visible scars, has led breast and plastic surgeons to shift the location of the incision to an areolar region in selected cases. We believe that the hemicircumareolar or total circumareolar technique with appropriate planning achieves favorable aesthetic results with fewer complications.

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13.2 Indications and Patient Selection

Appropriate patient selection is critical. Thus, patients are usually first seen in the preoperative period by a multidisciplinary team to evaluate the breast volume, ptosis, and tumor size/location. For patients with a large-diameter areola (more than 4 cm) without breast ptosis (Regnault grade I), a hemicircumareolar incision is indicated (Fig. 13.1). Other important indications are the presence of a marked color transition between the NAC and the breast skin, small and medium-volume breasts (cup size A or B), and tumors located near the central quadrant (4–5 cm from the NAC). For patients with a small/medium-diameter areola (less than 4 cm), with some degree of breast ptosis (Regnault grade II), and with small and medium-volume breasts (cup size A or B), a complete circumareolar incision is better indicated (Fig. 13.2).

Relative contraindications include more significant breast ptosis (Regnault grade III or grade III [12]—Table 13.1), very large breasts, and especially a very small NAC (less than 2.0 cm). As the degree of ptosis increases, it is more likely that an L-shaped or inverted-T skin excision will be helpful in consistently achieving the desired result. If the nipple sits well below the inframammary fold or must be elevated more than 4 cm, a periareolar mastopexy becomes riskier. A very small NAC with a well-defined border is more likely to result in an enlarged areola and an unsatisfactory scar, with irreparable loss of the original shape and size of the areola.

13.3 Skin Markings

Usually, the skin markings (the sternum midline, the inframammary folds, and the areola diameters on the vertical lines from the midclavicle) are drawn with the patient in an upright position. If there is a large-diameter areola and no breast ptosis, a semicircular periareolar incision (hemicircumareolar) is usually indicated in BCS or nipple–areola

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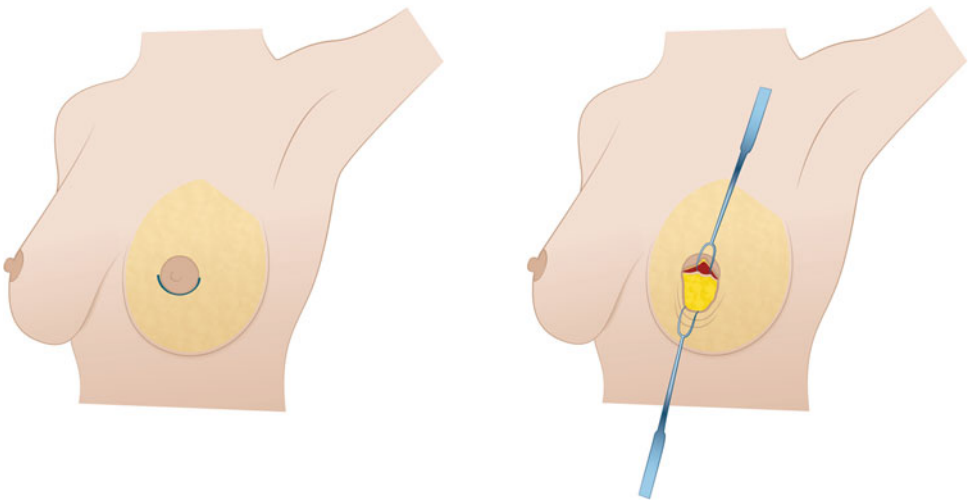

Fig. 13.1 A hemicircumareolar incision approach for patients with a large-diameter areola without breast ptosis

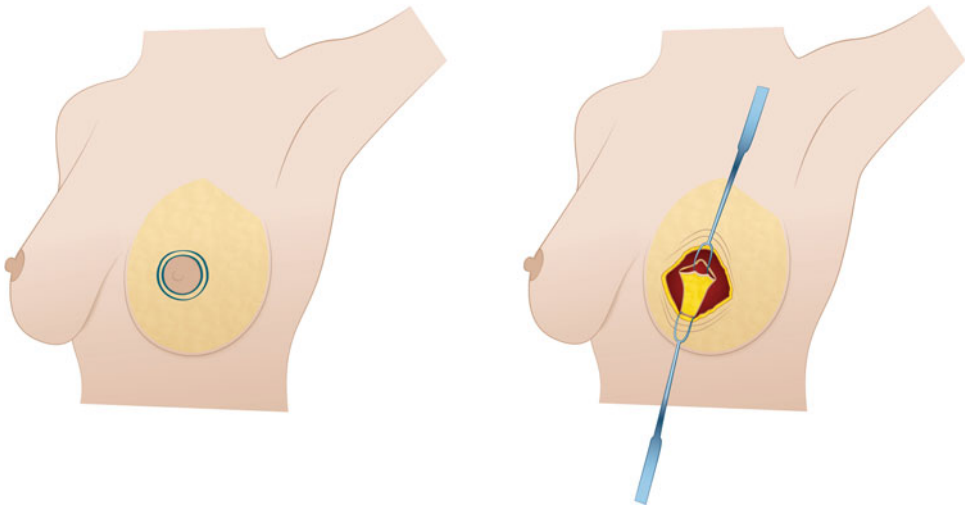

Fig. 13.2 A complete circumareolar incision associated with transdermic access along its inferior border for patients with a small/medium-diameter areola with some degree of breast ptosis

sparing mastectomy (NSM). In these cases no additional skin markings are necessary. To prevent conspicuous scarring within or outside the areola, the incision is performed exactly at the junction of the areola and surrounding skin. If there is a small/medium-diameter areola and breast ptosis, an epidermic decortication of the complete circumareolar marked cutaneous ring and transdermic access along its inferior border are indicated (Figs. 13.2, 13.3). In these cases it is important to make the following marks: Point A, 19–21 cm from the midclavicular line and 10–12 cm from the external line. The ideal diameter of the NAC (25–30 mm) is outlined as a complete circumareolar epidermic ring (maximum width of 20–25 mm) which will be resected to reduce the cutaneous excess. The medial limit of resection coincides with the 10–12 cm of the external line and the same distance is maintained for the lateral limit. These limits of skin resection are confirmed by the medial–lateral and superior–inferior pinch test, ensuring there was no tension after removal of the skin.

13.4 Surgical Technique

The surgical procedure is performed with the patient under general anesthesia and with the patient's the arms supported symmetrically 30° away from the chest. It is important to begin the sharp dissection with a no. 10 blade and the NAC is elevated off the underlying breast parenchyma Care is taken to leave a thickness of the retroareolar glandular tissue of approximately 1–2 cm to avoid nipple retraction. The incision is closed in layers with interrupted subcutaneous Vicryl 4-0 sutures and a continuous intracutaneous Prolene 4-0 suture (Ethicon, Johnson & Johnson, Hamburg, Germany).

Table 13.1 Regnault's classification of ptosis

Degree	Characteristics
Minor (grade I)	Nipple at the level of the inframammary fold
Moderate (grade II)	Nipple below the inframammary fold, but above the lower breast contour
Severe (grade III)	Nipple below the inframammary fold, at the lower breast contour
Glandular ptosis	Nipple above the level of the inframammary fold but the breast hangs below the fold
Pseudoptosis	Nipple above the level of the inframammary fold but the breast is hypoplastic and hangs below the fold

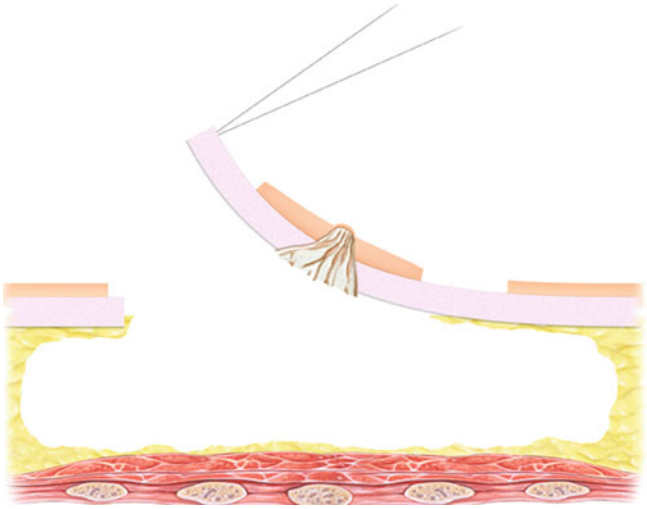

Fig. 13.3 The diameter of the nipple–areola complex (NAC) is outlined, as is the complete circumareolar epidermic ring, which will be resected. After the decortication, full access (transdermic) along its inferior border is performed. The transdermic access along the inferior border of the decorticated ring and glandular resection

In patients with a small/medium-diameter areola with breast ptosis, an epidermic decortication of the complete circumareolar marked cutaneous ring and transdermic access along its inferior border are performed. Thus, the subdermal plexus coming from the medial, lateral, and cephalic side of the areola is spared to ensure vascular supply to the NAC. Glandular excision is completed, leaving an adequate thickness of the subcutaneous tissue and a proper subareolar amount of gland. Skin flaps are handled carefully with the use of delicate hooks in order to maintain the integrity of the subdermal plexus and to avoid excessive skin flap traction. The skin is closed by the triple-layer technique. This technique is achieved by deepithelialization of the periareolar circle and advancement of the remaining areolar edge over this deepithelialized area. The advanced areolar edge is fixed over the deepithelialized area using a deeper layer of sutures anchoring the deepithelialized edge under the advanced areola and a superficial layer of sutures anchoring the edge of the advanced skin to the edge of the skin of the deepithelialized flap. This way, the terminal skin suture only overlies intact dermal and subcutaneous tissues, and all other sutures are not present in only one layer

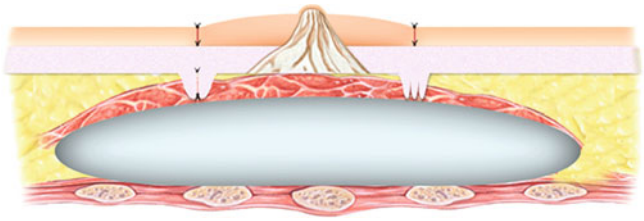

Fig. 13.4 A partial submuscular pocket under the pectoralis major muscle is elevated from the inferior to the superior positions and the pectoralis muscle is partially detached. Closure of the periareolar incision is performed by the triple-layer technique. This technique is achieved by the advancement of the remaining areolar edge over this deepithelialized area. The advanced areolar edge is fixed over the deepithelialized area using a deeper layer of sutures anchoring the deepithelialized edge under the advanced areola and a superficial layer of sutures anchoring the edge of the advanced skin to the edge of the skin of the deepithelialized flap

(Figs. 13.3, 13.4). A 2-0 nylon intradermal circumareolar purse-string suture is then used to limit the periareolar centrifugal tension and to improve areolar symmetry; a continuous 4-0 nylon suture (Ethicon, Johnson & Johnson, Hamburg, Germany) is used on the areolar skin surface to enhance the quality of the skin–areola transition zone.

13.5 Periareolar Technique in Skin-Sparing Mastectomy

SSM has been demonstrated to be an oncologically safe procedure for the treatment of early-stage breast cancer [1–3, 13, 14]. Compared with traditional mastectomy, SSM provides an ideal color and texture of breast skin and enhances the contour of the inframammary crease. To allow for adequate breast skin preservation, the oncoplastic surgeon should preoperatively discuss the periareolar incision and the width of the remaining skin flaps.

A critical survey of the literature shows that SSM is normally performed through numerous techniques, but most involve central breast incisions [1–3, 13, 14]. Habitually, the technique differs from surgeon to surgeon and is dependent on factors such as the type of reconstruction and the size of the breast. Although the type of incision differs, it is our impression that the best aesthetic outcome is related to the total periareolar approach [9]. With this technique,

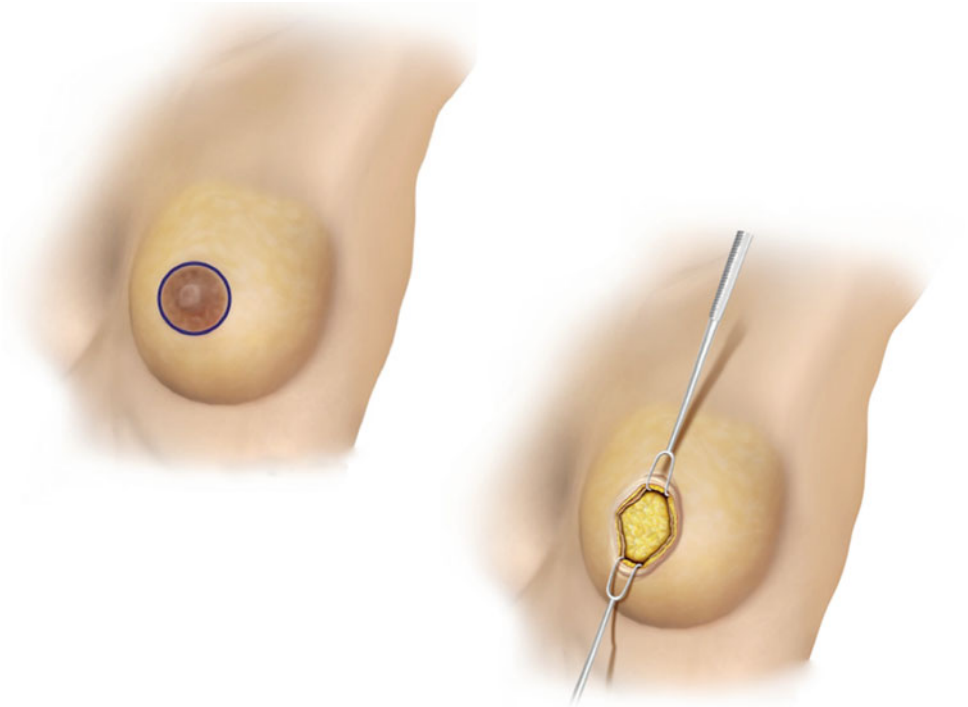

Fig. 13.5 The total periareolar approach for skin-sparing mastectomy (SSM) and immediate reconstruction. With this technique, the final scar can be kept at the transition of the natural border of the future NAC

the final scar can be kept at the transition of the natural border of the future NAC (Fig. 13.5).

In therapeutic SSM, specific areas of skin may in some instances require excision including prior incisions. Our approach to this issue is better performed through a central incision where the previous biopsy scar is excised in continuity with the NAC. Thus, previous communication of the team performing the biopsy/lumpectomy with the oncoplastic surgery team is critical in order to plan the incision as close as possible to the NAC. Usually, a total periareolar incision is performed, and with use of delicate hooks and fiber-optic retractors, the breast tissue dissection is performed in the same subcutaneous layer, reaching the final margins of the breast parenchyma. Skin flaps are handled carefully in order to maintain the integrity of the subdermal plexus and avoid excessive skin flap traction and even dermal exposure. A minimum flap thickness of 3–5 mm is maintained (Fig. 13.6).

The immediate reconstruction can be performed with an implant only, an expander and an implant, an implant associated with a pedicled latissimus dorsi muscle flap (LDMF), a transverse rectus abdominis musculocutaneous flap, or a deep inferior epigastric adipocutaneous free tissue transfer flap. In our experience, the reconstruction technique is frequently performed with a biodimensional implant–expander system associated with an LDMF as described elsewhere [9] (Figs. 13.7, 13.8). This option is usually chosen on the basis of individual aesthetic considerations but taking into account patient choice. This aspect is important since we have noted that some groups of patients prefer less evident breast scars.

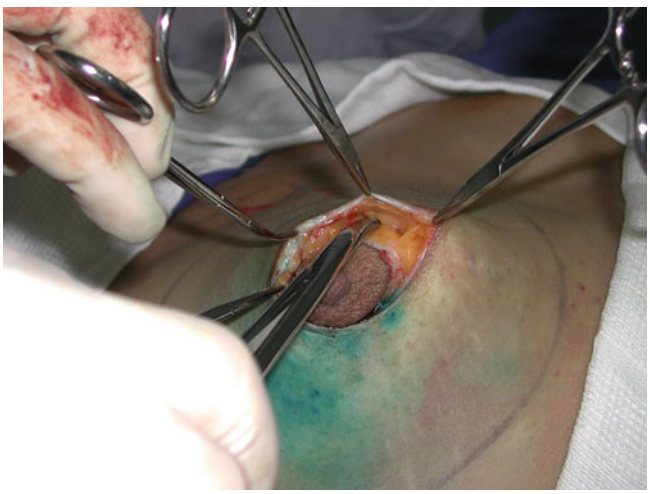

Fig. 13.6 The total periareolar incision is performed, and with use of delicate hooks and fiber-optic retractors, the breast tissue dissection is performed in the same subcutaneous layer, reaching the final margins of the breast parenchyma. Skin flaps are handled carefully in order to maintain the integrity of the subdermal plexus and to avoid excessive skin flap traction. A minimum flap thickness of 3–5 mm is maintained

Thus, patients who are candidates for SSM and who do not want a large horizontal breast scar are the best candidates for SSM through a total periareolar incision. In fact, with the total periareolar incision and reconstruction, the final scar can be kept at the transition of the future NAC border, which may even be camouflaged by the NAC reconstruction. In addition, the latissimus dorsi muscle can be incorporated into the submuscular pocket. The implant–expander is placed in a

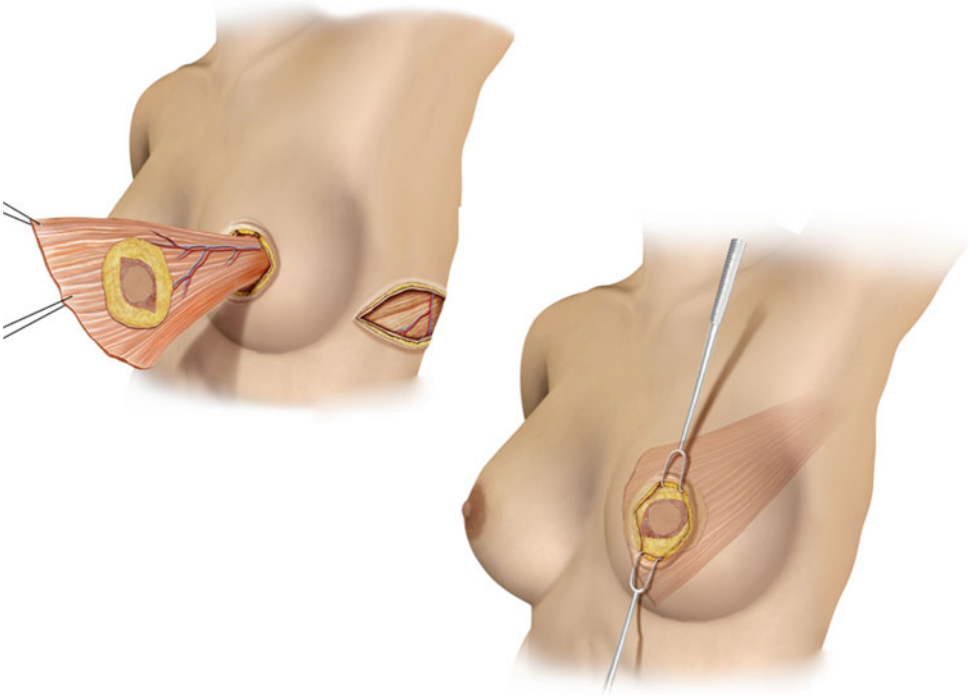

Fig. 13.7 The reconstruction technique is performed with a biodimensional implant–expander system associated with a latissimus dorsi myocutaneous flap. The flap provides adequate skin cover for the resected NAC and the final scar can be kept at the transition of the future NAC border. The latissimus dorsi muscle can be incorporated into the submuscular pocket and the implant–expander is placed in a total submuscular position where a cover is made in its superior two-thirds by the pectoralis muscle and the inferior third by the latissimus dorsi muscle flap

total submuscular position, where a cover is made in its superior two-thirds by the pectoralis muscle and the inferior third by the LDMF. This allows creation of a tension-free muscular pocket while providing adequate tissue coverage for the implant–expander [9]. In cases in which vascularity of the mastectomy flap is unpredictable, the expansion can be initiated with limited fluid, which allows these flaps time to recover vascularity [9, 15, 16]. If there are small areas of skin necrosis, the patient can be treated on an outpatient basis with implant deflation and dressing changes since the implant is located under a healthy muscular pocket [9, 17]. In our experience, native breast skin complications were observed in almost 10 % of patients and represented one-third of all complications. Most cases consisted of partial skin loss and wound dehiscence between the LDMF and the breast skin [9].

In spite of the main advantages, the total periareolar technique has some limitations. The surgical exposure is restricted and dissection can be troublesome if the oncological surgeon is inexperienced [1, 9, 13]. In this situation, more breast skin tension and flap irregularities can be noted and a poor exposure may result in an inadequate oncological resection (Fig. 13.8).

13.6 Periareolar Techniques in Nipple–Areola Sparing Mastectomy

Recently, a debate has developed about the possibility of extending preservation of the skin in SSM to include the NAC [4–8]. Thus, NSM is an alternative to mastectomy which aims at avoiding the removal of the NAC and the positive consequences for immediate reconstruction.

The objectives of NSM reconstruction are resection of the breast tissue while restoring the breast volume, shape, and symmetry. To achieve these goals, numerous incisions have been proposed (Fig. 13.9). However, the decision of the access incision with no complications has attracted attention in the literature [4, 5, 7, 8]. Besides the restricted access, the conventional periareolar approach can potentially result in vascular impairment to collateral flow, which can induce partial or total NAC necrosis. In fact, Regolo et al. [5], in a series of 32 consecutive NSM using the conventional periareolar approach observed a high rate of necrotic complications of the NAC (60 %). Consequently, we have developed an approach to improve surgical access for patients who are candidates for NSM based on a total circumareolar incision similar to that previously described for gynecomastia treatment [10, 18, 19].

Usually, the diameter of the NAC (3–4 cm) is outlined, as is the complete circumareolar epidermic ring (maximum of 4–5 cm width), which will be resected to improve surgical access. An epidermic decortication of the complete circumareolar marked cutaneous ring and full access along its inferior border are performed. The skin closure is performed by the triple-layer technique described previously [10]. This last aspect is crucial in some circumstances, since the pectoralis major muscle is usually not long enough to cover the implant totally. Thus, extending the deepithelialization around the areolar

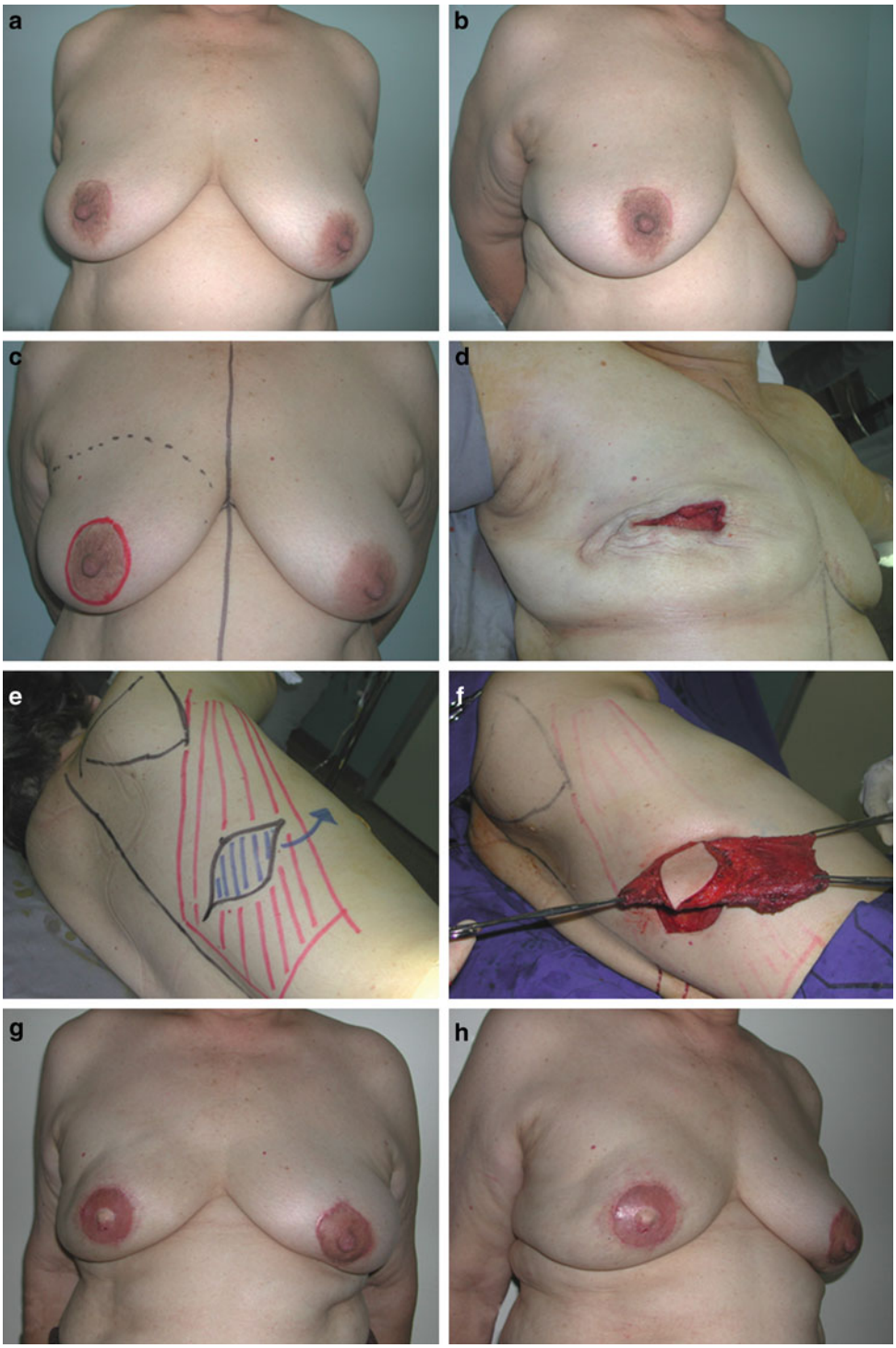

Fig. 13.8 A 54-year-old patient with a 4.8-cm invasive ductal carcinoma located in the right breast (**a**, **b**). The reconstruction markings showing the planned periareolar SSM (**c**). The patient underwent SSM with axillary dissection (**d**). The patient underwent immediate reconstruction with a biodimensional implant–expander (McGhan 150 volume 385–405 cm^3) associated with a latissimus dorsi myocutaneous flap (**e**, **f**). Postoperative appearance at 11 months with a very good outcome after radiation therapy (**g**, **h**)

incision allows complete and secure triple-layer closure of the entire wound. In this fashion, no part of the suture lines are present in only one layer, thus lessening the risk of implant contamination or exposure. In some situations, small potential areas of delayed healing of the incision can be treated conservatively as a consequence of the complete underlying soft-tissue cover over the implant (Fig. 13.10).

There are some limitations of present technique related to breast anatomy and experience. The surgical field is limited and dissection can be difficult. Thus, the procedure is not applicable for all types of breast volume, position, and tumor location.

Partial and full-thickness NAC necrosis has been described following NSM [4–7]. It is our impression that our acceptable incidence of NAC necrosis is probably due

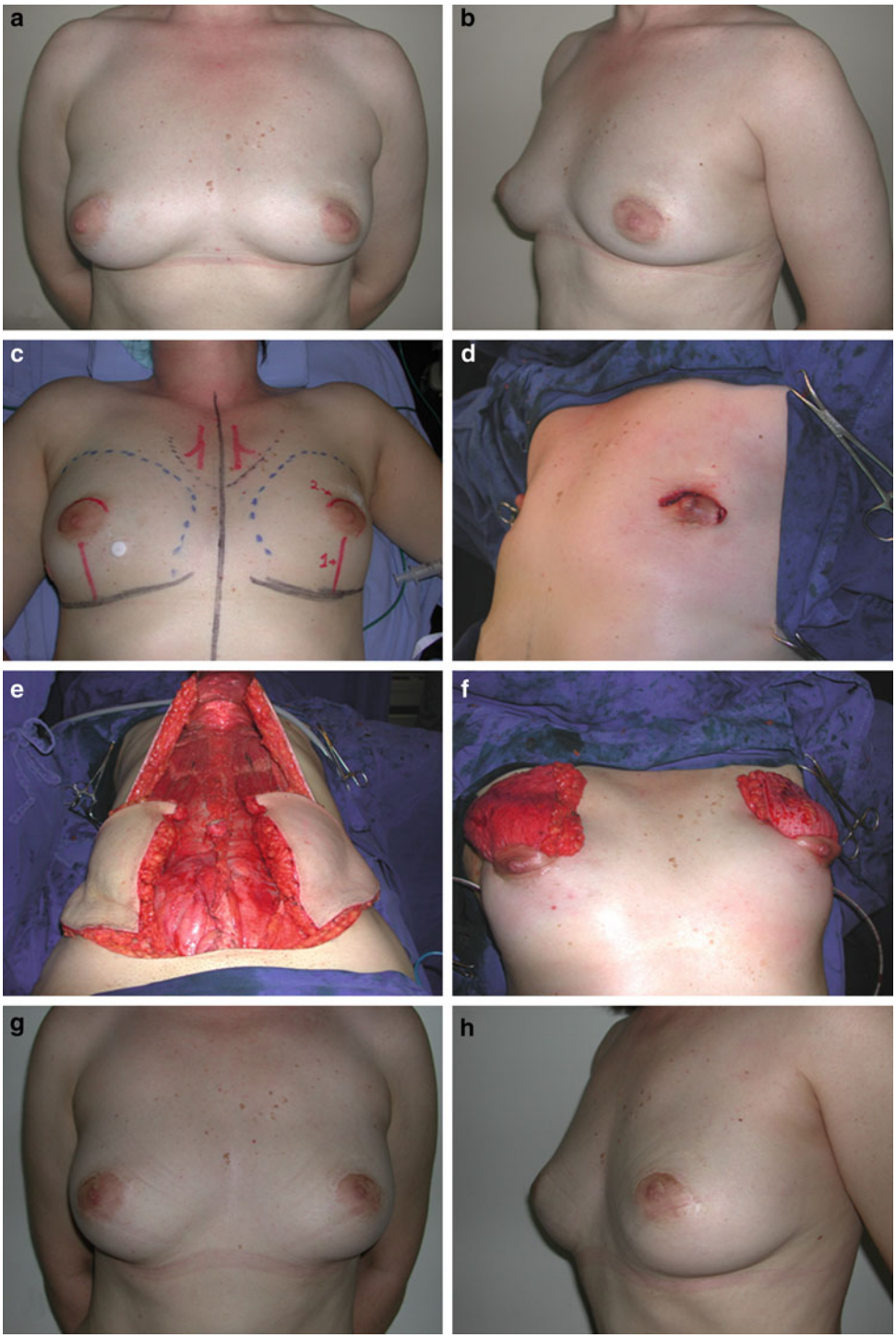

Fig. 13.9 A 51-year-old patient with a strong familial history of breast cancer and a previous biopsy with atypical hyperplasia located in the right breast (**a**, **b**).The reconstruction markings showing the planned hemiperiareolar nipple–areola sparing mastectomy (NSM) (**c**). The patient underwent bilateral NSM (**d**). The patient underwent immediate bilateral reconstruction with a transverse rectus abdominis musculocutaneous flap (**e**, **f**). The postoperative appearance at 10 months with a very good outcome (**g**, **h**)

to several factors. These factors include full access along the inferior border of NAC which seems to allow adequate blood supply to the NAC. In addition, another important aspect is related to the preparation of the skin flaps and the retroareolar tissue. For this reason, it is important to leave an adequate thickness of the subcutaneous tissue and a adequate subareolar amount of gland to avoid postoperative areolar retraction and necrosis [10].

13.7 Periareolar Techniques in Breast-Conserving Surgery

BCS is an important component of early breast cancer treatment, with a survival outcome comparable to that of radical procedures [20]. On the other hand, for BCS to be successful, breast surgeons must resect tumors with

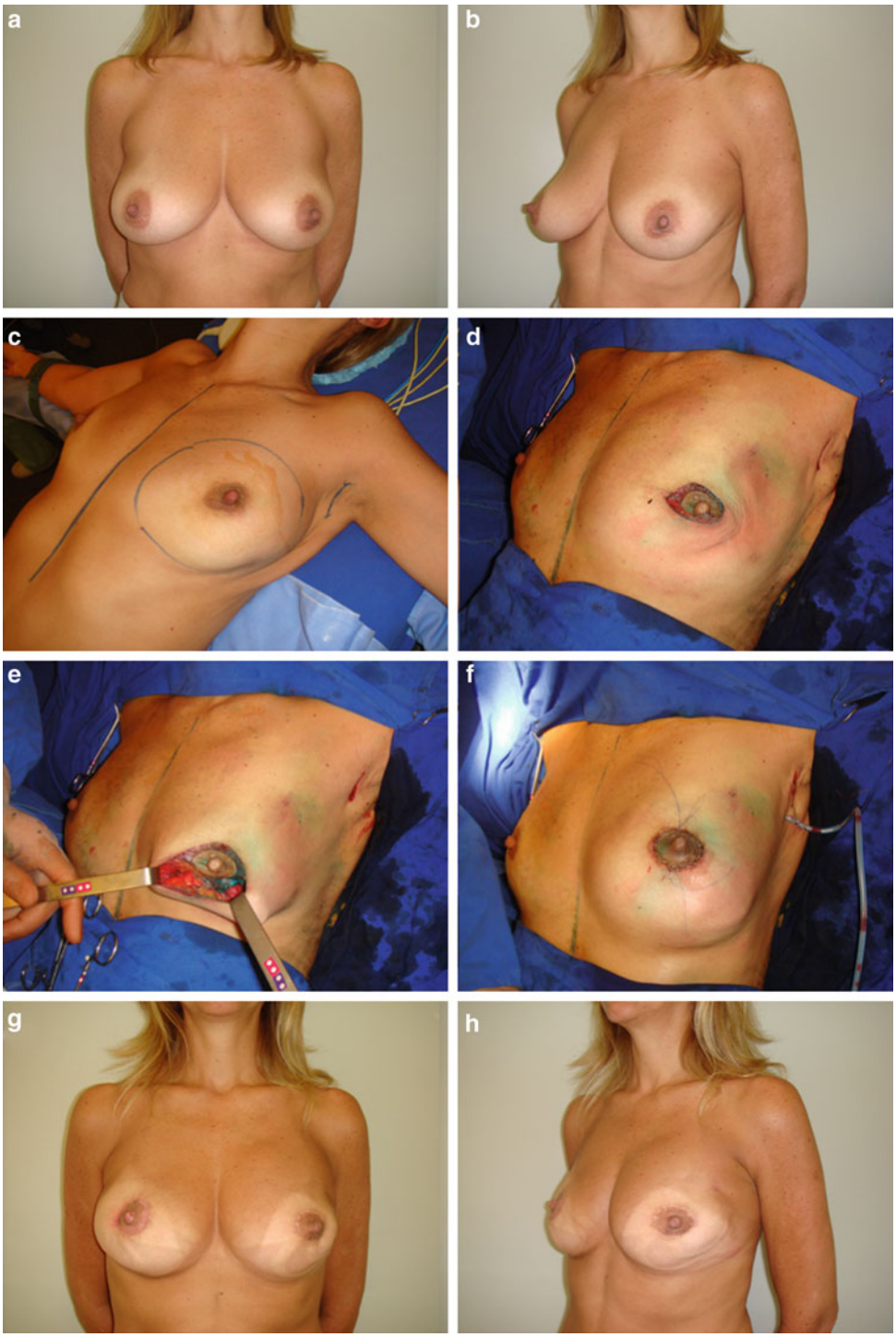

Fig. 13.10 A 40-year-old patient with 2.8-cm ductal carcinoma in situ located in the left breast (**a**, **b**). The reconstruction markings showing the planned total periareolar NSM (**c**). The patient underwent left-sided NSM (**d**). The patient underwent immediate reconstruction with a biodimensional implant–expander (McGhan 150 volume 295–315 cm^3) (**e**, **f**). Postoperative appearance at 1 year with a very good outcome (**g**, **h**)

adequate surgical margins and yet preserve the breast's form and shape [21–27]. In BCS for T1 and T2 tumors, we have increasingly adopted the periareolar approach for lumpectomy. In these cases, incisions can be made semicircularly or total circularly concentric to the NAC similar to the incisions used for NSM. These approaches make it possible to remove lesions that are close to the NAC, up to 4–5 cm away. In most cases, we prefer to use separate incisions for sentinel lymph node biopsy or axillary clearance. Because of rich breast tissue vascularization, it is possible to plan the incision and the pedicle for the NAC according to the tumor location. Thus, the location of the NAC pedicle may be medial, superior, inferior, and lateral and usually results in a total periareolar scar pattern [25].

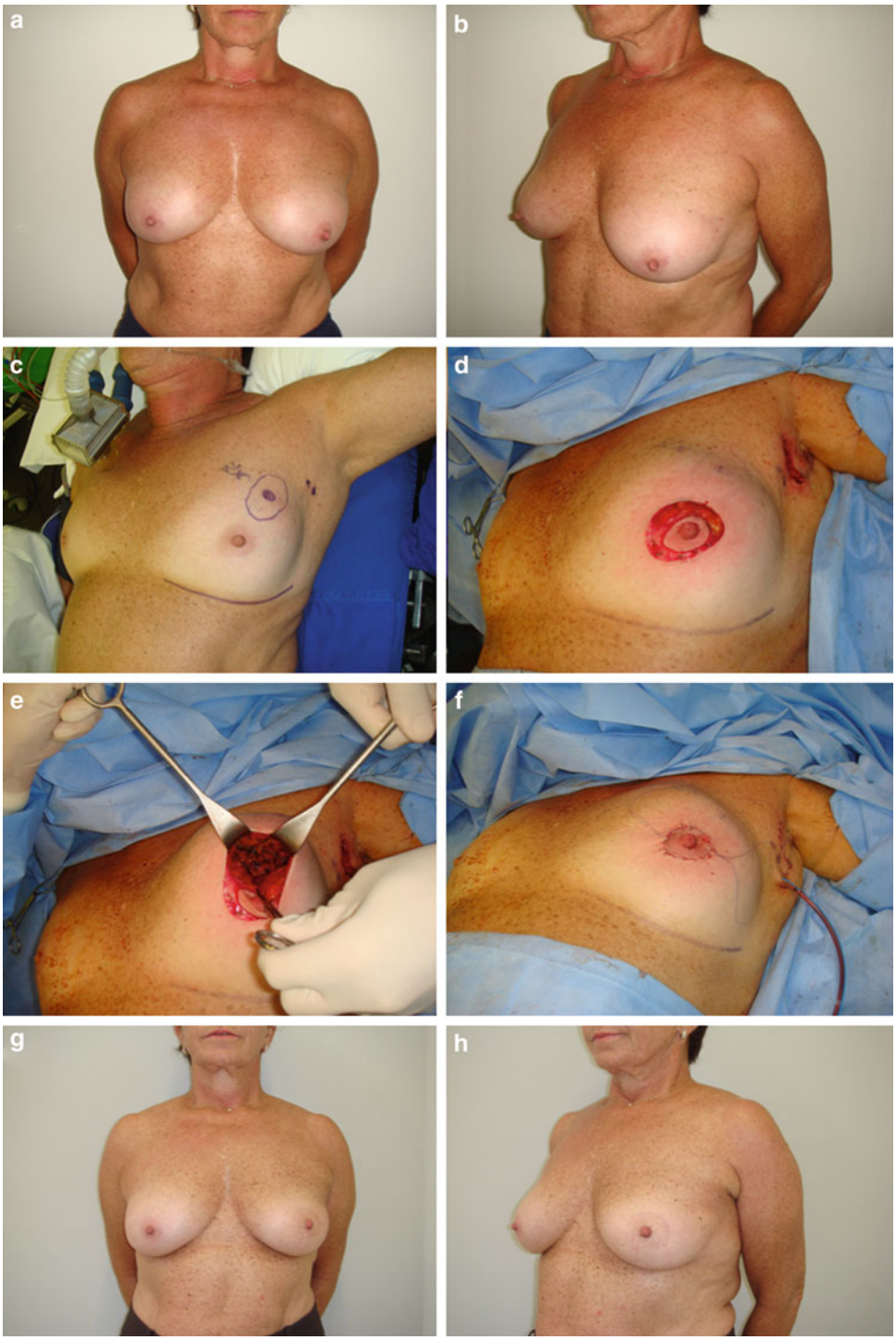

Fig. 13.11 A 55-year-old patient with 2.0-cm invasive ductal carcinoma located in the left breast (**a**, **b**). The reconstruction markings showing the planned total periareolar breast-conserving surgery (**c**). The patient underwent upper-left quadrantectomy (**d**). The patient underwent immediate reconstruction with local glandular flaps similar to Benelli's "round-block" procedure (**e**, **f**). Postoperative appearance at 1.5 years with a very good outcome after radiotherapy (**g**, **h**)

In patients with a small/medium-diameter areola and deeply located tumors, the total periareolar incision can be advantageous as an alternative to radial-segmental BCS. Described elsewhere as donut mastopexy lumpectomy, this technique has the benefit of a unique breast resection in which a tissue segment is removed through a periareolar incision [28]. Another similar option is the Benelli mastopexy technique as a variation of donut mastopexy [29]. In Benelli's "round-block" procedure, the periareolar outer circle is extended superiorly, first to excise the skin over the lesions and second to lift up the breast. The inner circle is at the circumareolar margin. The skin between the circles is deepithelialized, and a wedge resection of the superior segment of the breast is performed. The remaining

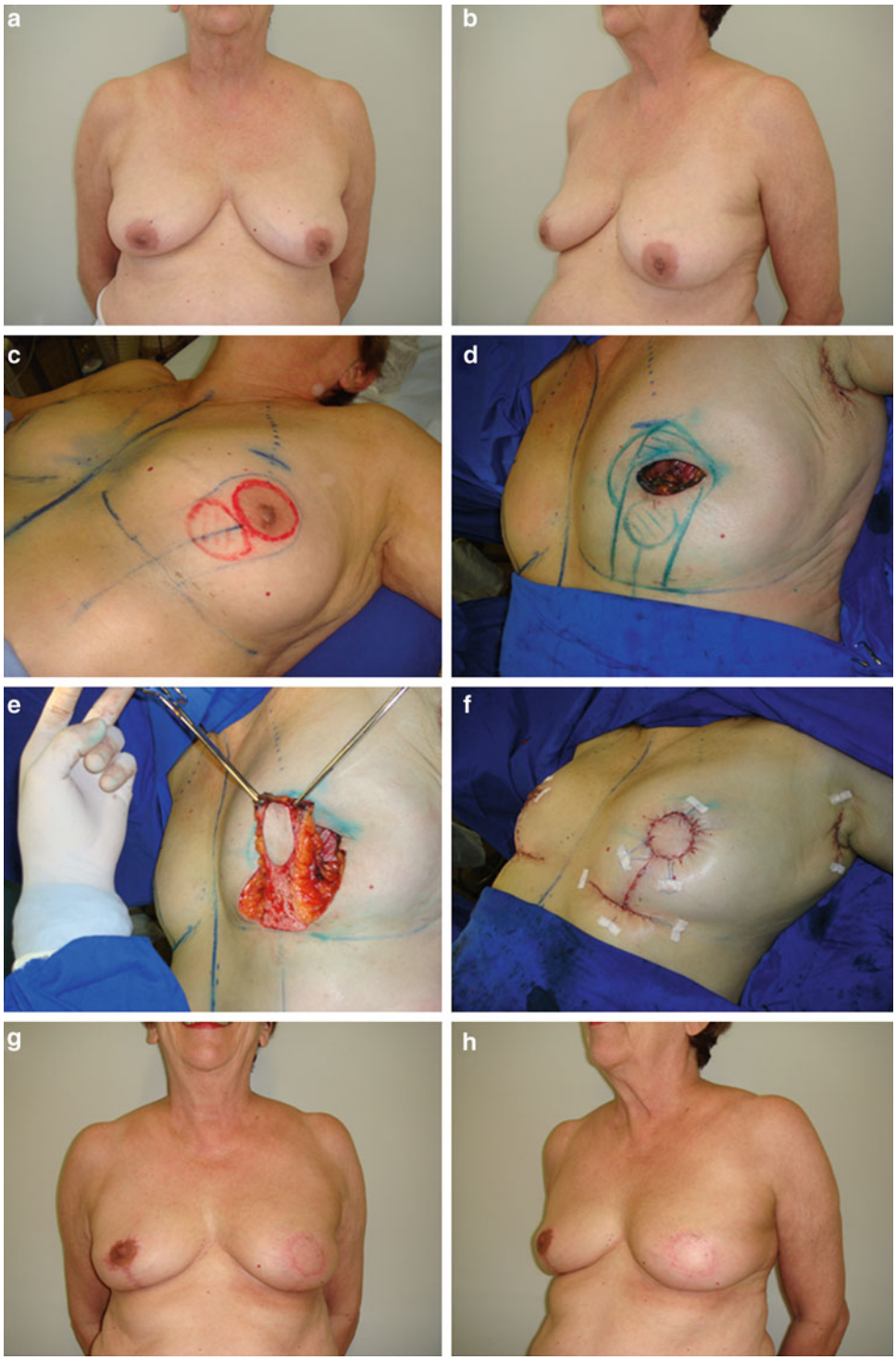

Fig. 13.12 A 64-year-old patient with 2.0-cm invasive ductal carcinoma located in the left breast (**a**, **b**). The reconstruction markings showing the planned total periareolar breast-conserving surgery (**c**). The patient underwent central quadrantectomy (**d**). The patient underwent immediate reconstruction with an inferior pedicle dermoglandular flap (**e**, **f**). Postoperative appearance at 1 year with a very good outcome after radiotherapy (**g**, **h**)

breast is detached from the pectoral fascia, and the skin flap of the upper half of the breast is undermined and detached from the gland. The posterior aspect of the breast at the level of the areola is sutured to the pectoralis fascia at the level of the third intercostal space to lift up the breast and fill part of the defect. The superior breast pillars are wrapped around each other and sutured to the pectoral fascia to further fill the defect and reshape the gland and the lumpectomy defect [29].

In spite of the benefits previously described, total periareolar incision is more technically challenging and time-consuming than the radial approach, with a wide skin undermining in which only a segment of the breast is removed. As we emphasized for the NSM techniques,

resection of the skin ring (double circle incision) is necessary to allow both adequate access to the breast tissue and closure of the skin envelope around the remaining breast tissue. This tissue is returned to the skin envelope and sutured at deep and superficial margins to close the resulting defect as a breast-flap advancement. In the case of breast ptosis, a purse-string closure around the NAC completes the procedure, leaving only a periareolar incision (Fig. 13.11).

Another important point is related to centrally located breast cancer. Traditionally, these tumors have been treated with radical surgery (SSM). However, recent studies have demonstrated that BCS is an adequate treatment for selected patients with central or retroareolar breast cancers when compared with SSM [30–32]. In this group, a primary association of oncological and reconstructive techniques can improve the final scar outcome and breast symmetry, especially for women who may need contralateral breast reduction [33]. In this field, an increasing number of studies have reported different approaches and various techniques for achieving satisfactory results, ranging from local advancement glandular flaps and reduction mammaplasty/mastopexy procedures to LDMF reconstruction [24, 30, 31, 33]. In our experience, for tumors located in the central breast region, the superior NAC pedicle is frequently injured by the tumor resection. Thus, the remaining lower breast tissue may be moved into the defect as a dermoglandular flap and an inferior pedicle mammaplasty technique can be used [33] (Fig. 13.12). In fact, Courtiss and Goldwyn [34] demonstrated by cadaver dissections that the principal sources of blood flow to the inferior pedicle are the perforating and intercostal branches of the internal mammary artery and the external mammary branches of the lateral thoracic artery. This anatomical characteristic permits a suitable pedicle vascularization and minimizes vascular pedicle complications when the procedure is planned and performed effectively.

13.8 Conclusions

The main objectives of oncological breast surgery are to control the tumor locally and achieve a satisfactory aesthetic outcome with acceptable scars. It is our experience that with the periareolar techniques the aesthetic results can be improved further. Scar reduction and even total camouflage by the future NAC reconstruction are the main positive aspects of these techniques. For this purpose careful preoperative planning and intraoperative care is crucial, as consideration must be given not only to tumor location, prior biopsy incisions, and the reconstruction technique, but also to NAC vascularization.

References

1. Carlson GW (1996) Skin sparing mastectomy: anatomic and technical considerations. Am Surg 62:151–158
2. Singletary SE (1996) Skin sparing mastectomy with immediate breast reconstruction: the M. D. Anderson Cancer Institute experience. Ann Surg Oncol 3:411–416
3. Simmons RM, Adamovich TL (2003) Skin-sparing mastectomy. Surg Clin North Am 83:885–894
4. Cense HA, Rutgers EJTh, Lopes Cardozo M et al (2001) Nipple-sparing mastectomy in breast cancer: a viable option? Eur J Surg Oncol 27:521–526
5. Regolo L, Ballardini B, Gallarotti E et al (2008) Nipple sparing mastectomy: an innovative skin incision for an alternative approach. Breast 17:8–11
6. Crowe JP Jr, Kim JA, Yetman R et al (2004) Nipple-sparing mastectomy: technique and results of 54 procedures. Arch Surg 139:148–150
7. Garcia-Etienne CA, Borgen PI (2006) Update on the indications for nipple-sparing mastectomy. J Support Oncol 4:225–230
8. Caruso F, Ferrara M, Castiglione G et al (2006) Nipple sparing subcutaneous mastectomy: sixty-six months follow-up. Eur J Surg Oncol 32:937–940
9. Munhoz AM, Aldrighi C, Montag E et al (2007) Periareolar skin-sparing mastectomy and latissimus dorsi flap with biodimensional expander implant reconstruction: surgical planning, outcome, and complications. Plast Reconstr Surg 119:1637–1645
10. Munhoz AM, Aldrighi C, Montag E et al (2009) Optimizing the nipple-areola sparing mastectomy with double concentric periareolar incision and biodimensional expander-implant reconstruction: aesthetic and technical refinements. Breast 18:356–367
11. Munhoz AM, Arruda E, Montag E et al (2007) Immediate skin-sparing mastectomy reconstruction with deep inferior epigastric perforator (DIEP) flap. Technical aspects and outcome. Breast J 13:470–478
12. Spear SL, Giese SY, Ducic Y (2001) Concentric mastopexy revisited. Plast Reconstr Surg 107:1296–1302
13. Slavin SA, Schnitt SJ, Duda RB et al (1998) Skin-sparing mastectomy and immediate reconstruction: oncologic risks and aesthetic results in patients with early-stage breast cancer. Plast Reconstr Surg 102:49–54
14. Simmons RM, Fish SK, Gayle L et al (1999) Local and distant recurrence rates in skin-sparing mastectomies compared with non-skin-sparing mastectomies. Ann Surg Oncol 6:676–681
15. Maxwell GP (2003) Immediate breast reconstruction using biodimensional anatomical permanent expander implants: a prospective analysis of outcome and patient satisfaction. Plast Reconstr Surg 111:139–145
16. Gui GP, Tan SM, Faliakou EC et al (2003) Immediate breast reconstruction using biodimensional anatomical permanent expander implants: a prospective analysis of outcome and patient satisfaction. Plast Reconstr Surg 111:125–132
17. Cicchetti S, Leone MS, Franchelli S, Santi PL (2006) One-stage breast reconstruction using McGhan Style 150 biodimensional expanders: a review of 107 implants with six years experience. J Plast Reconstr Aesthet Surg 59:1037–1044
18. Huang TT, Hidalgo JE, Lewis SR (1982) A circumareolar approach in surgical management of gynecomastia. Plast Reconstr Surg 69:35–42
19. Persichetti P, Berloco M, Casadei RM et al (2001) Gynecomastia and the complete circumareolar approach in the surgical management of skin redundancy. Plast Reconstr Surg 107:948–954
20. Fisher B, Anderson S, Bryant J et al (2002) Twenty-year follow-up of a randomized trial comparing total mastectomy, lumpectomy,

and lumpectomy plus irradiation for the treatment of invasive breast cancer. N Engl J Med 347:1233–1240
21. Clough KB, Cuminet J, Fitoussi A, Nos C, Mosseri V (1998) Cosmetic sequel after conservative treatment for breast cancer: classification and results of surgical correction. Ann Plast Surg 41:471–480
22. Kroll S, Singletary SE (1998) Repair of partial mastectomy defects. Clin Plast Surg 25:303–310
23. Kronowitz SJ, Feledy JA, Hunt KK et al (2006) Determining the optimal approach to breast reconstruction after partial mastectomy. Plast Reconstr Surg 117:1–10
24. Munhoz AM, Montag E, Arruda EG et al (2005) Outcome analysis of breast-conservation surgery and immediate latissimus dorsi flap reconstruction in patients with T1 to T2 breast cancer. Plast Reconstr Surg 116:741–752
25. Munhoz AM, Montag E, Fels KW et al (2006) Critical analysis of reduction mammaplasty techniques in combination with conservative breast surgery for early breast cancer treatment. Plast Reconstr Surg 117:1091–1103
26. Munhoz AM, Montag E, Arruda EG et al (2006) Superior-medial dermoglandular pedicle reduction mammaplasty for immediate conservative breast surgery reconstruction. Ann Plast Surg 57: 502–513
27. Losken A, Elwood ET, Styblo TM, Bostwick J 3rd (2002) The role of reduction mammaplasty in reconstructing partial mastectomy defects. Plast Reconstr Surg 109:968–977
28. Amanti C, Regolo L, Moscaroli A et al (2003) Total periareolar approach in breast-conserving surgery. Tumori 89:169–172
29. Benelli L (1990) A new periareolar mammaplasty: the "round block" technique. Aesthet Plast Surg 14:93–100
30. McCulley SJ, Durani P, Macmillan RD (2006) Therapeutic mammaplasty for centrally located breast tumors. Plast Reconstr Surg 117:366–375
31. Huemer GM, Schrenk P, Moser F et al (2007) Oncoplastic techniques allow breast-conserving treatment in centrally located breast cancers. Plast Reconstr Surg 120:390–398
32. Simmons RM, Brennan MB, Christos P et al (2001) Recurrence rates in patients with central or retroareolar breast cancers treated with mastectomy or lumpectomy. Am J Surg 182:325–330
33. Munhoz AM, Montag E, Arruda E et al (2007) Reliability of inferior dermoglandular pedicle reduction mammaplasty in reconstruction of partial mastectomy defects: surgical planning and outcome. Breast 16:577–589
34. Courtiss EH, Goldwyn RM (1977) Reduction mammaplasty by the inferior pedicle technique. Plast Reconstr Surg 59: 500–511

Superior Pedicle Techniques

14

Muriel Greuse

14.1 Introduction

Breast conservation therapy (BCT) for cancer is a great advantage for women because it preserves their body image integrity and is considered to be as safe as mastectomy in early-stage breast cancer [1, 2]. However, poor cosmetic outcomes of BCT are more frequent in hypertrophic and/or ptotic breasts than in small breasts [3]. Techniques of breast reduction coupled with BCT, oncoplastic surgery, help to improve this aesthetic result [4]. Oncoplastic surgical techniques are associated with BCT when the tumor resection is too important in order to avoid breast distortion and/or breast asymmetry. Oncoplastic surgical techniques also improve the oncologic outcome by allowing larger resection to obtain clear margins, reducing the local recurrence rate compared with BCT alone [5]. The increase of the amount of resection (lumpectomy < quadrantectomy 117 cm^3 < oncoplastic surgery 200 cm^3) offers the possibility to treat a larger number of patients with larger invasive tumors or ductal carcinoma in situ. The efficacy of postoperative radiotherapy is also improved by reducing the size of the breast since a larger dose of radiation is necessary in larger breasts, with the related adverse effect of fibrosis [6]. Oncoplastic techniques have resulted in survival and local recurrence rates that are essentially equal to those for modified radical mastectomy [7].

Oncoplastic surgery with the superior pedicle breast reduction technique is useful for the treatment of tumor of the inferior quadrant of the breast from the 3 o'clock to the 9 o'clock position.

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14.2 Indications

Obtaining clear margins (the larger, the better) is an essential step in the procedure in order to reduce the cancer recurrence rate. The rates are influenced by the size of the tumor, the type of tumor, vascular invasion, multicentric disease, and the age of the patient [7].

The size of the tumor is the first criterion: small tumors (T1, T2) are well treated by BCT, but indications are now extended to larger tumors when the breast size allows larger resection, or if they are first treated by neoadjuvant chemotherapy to reduce the size of the tumor prior to surgery. Preoperative radiotherapy to diminish the size of the tumor increases the surgical complication rate and its use has been abandoned [8].

The tumor to breast size ratio is the second criterion. Oncoplastic surgery is very suitable for larger breasts. Breasts with cup size D or greater are ideal candidates, as discomfort from breast weight is resolved with the cure of the cancer. Breasts with cup size A or B will be disfigured by the tumorectomy/quadrantectomy, and are probably better treated by mastectomy and immediate reconstruction; moreover, the adverse effect of the radiotherapy is also avoided. Breasts with cup size C without nipple–areola complex (NAC) ptosis are remodeled by displacement of glandular flaps rather than by a breast reduction technique. But when ptosis of the NAC is present, a mastopexy technique is useful to remodel the treated breast.

The location of the tumor determines the type of oncoplastic surgery chosen. The superior pedicle technique is very suitable for tumors of the inferior quadrant of the breast, medial, central, or lateral. The tumorectomy is done inferiorly, at the site of the breast reduction. The superior pedicle conserves vascularization of the NAC, which is plicated higher on the thorax. The vertical scar alone is the first possibility, the inverted-T scar the second. However, to avoid any delay in the administration of adjuvant therapies (radiotherapy and chemotherapy) caused by infection, skin necrosis, or dehiscence, the inverted-T scar is the best

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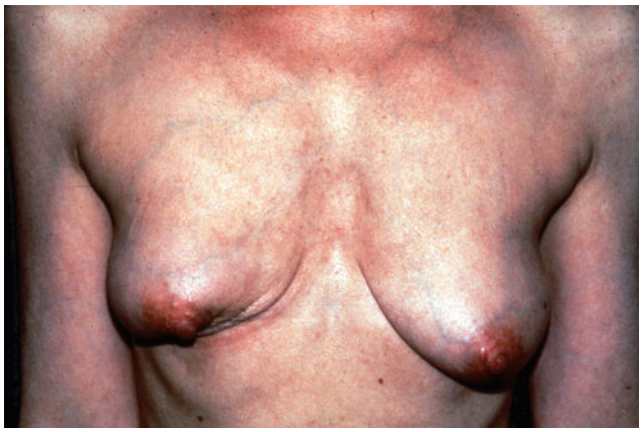

Fig. 14.1 Breast retraction after breast conservation therapy (BCT) and radiotherapy without oncoplastic surgery of the inferior quadrant

option particularly for obese patients, big breasts, smokers, diabetic patients, and major breast ptosis.

The type of the tumor (ductal carcinoma in situ, lobular invasive, multicentric, vascular invasion) and the age of patient influence the positive margin and recurrence rates [9, 10]. Delayed reconstruction after definitive confirmation of the clear margins is an option in these cases. Remodeling is done secondarily, and radiotherapy is applied afterwards as we know that distortion of the inferior quadrant after radiotherapy is frequent without oncoplastic surgery (Fig. 14.1). Furthermore, secondary remodeling of the radiated fibrosis is highly complicated by prolonged edema, tissue necrosis, and persisting deformity [11]. Therefore, oncoplastic surgery is generally discouraged in an already irradiated breast (Fig. 14.2a, b).

14.3 Preoperative Planning

Radiological evaluation (mammography, breast ultrasonography, axillary ultrasonography, biopsy, MRI) of the breasts and distant metastasis research are major steps in the decision regarding which type of treatment to choose during the multidisciplinary counseling. MRI is the best imaging modality to evaluate the size of the tumor preoperatively and to find multifocal/multicentric lesions (which is a contraindication for BCT) and contralateral breast cancer [12, 13]. Thanks to these high-performance and preventive radiological evaluations, a greater number of small tumors are discovered, but 40–50 % of them are nonpalpable. These nonpalpable tumors are marked by ink or multiple hooked wires (harpoons).

Preoperative photographs are taken in front view, three-quarter view right and left, and lateral view right and left. The drawings are done with the patient in a standing position. The midline from the sternal notch until the umbilicus is drawn. The tape measure is placed around the neck of the patient, and the axis of the breast is marked on the clavicle from the sternal notch, around 6.5–8.5 cm (for big patients) down to the abdomen (10–12 cm from the midline) (Fig. 14.3a). The new axis of the breast must not be influenced by the actual position of the NAC, which can be dislocated laterally or medially. The actual position of the NAC in centimeters is written on the patient. The sulcus is marked; it is an important landmark of the breast, and is always well marked during all the intervention as it is the limit of the inferior border of the new breast, the limit of our dissection. The new position of the nipple is marked horizontally on the axis of the breast by placing the index finger in the submammary fold. The superior border of the areola is 2 cm higher (around 18 cm in a short patient and up to 23 cm) (Fig. 14.3b). The position of the new areola is checked on the lateral view of the breast and must be located at the same level as the sulcus. The inner border of the new areola is marked 8–12 cm from the midline depending on the future breast volume desired by the patient (shorter distance for small breasts) (Fig. 14.3c). The outer border is drawn as a mirror image from the vertical axis of the breast (generally 4 cm but up to 5 cm in larger preoperative breasts). All these points are joined by a semicircular line of 8 cm to delimit the famous "mosquito dome" (Fig. 14.3d). The lower vertical limbs of the inferior skin resection are planned by pushing the breast outside and inside, very conservatively, and less than necessary in a breast reduction to avoid tension on the vertical scar and late dehiscence. The inner and outer vertical limbs are drawn as the prolongation of the axis of the breast previously marked on the abdomen (Fig. 14.3e, f). For the vertical scar alone, the two vertical limbs are joined 2 cm above the sulcus. For the inverted-T technique, 6 cm of the vertical limbs is conserved and the horizontal incision for the inverted T is drawn parallel to the inframammary folds. The inferior horizontal incision is made slightly above the sulcus with a triangle flap on the midline to avoid tension at the T. The breasts are examined apart and are pushed together on the midline to check the symmetry of the future inner incision. It is always very instructive to take a photograph with the design finished.

The patient is advised about the possible complications: the risk of immediate or later mastectomy when the margins are positive and if not enough breast is left in place for a cosmetic reconstruction.

14.4 Surgical Technique

The patient is placed in the supine position with the arms abducted for axillary access, with the possibility to seat the patient on the operative table to control the symmetry.

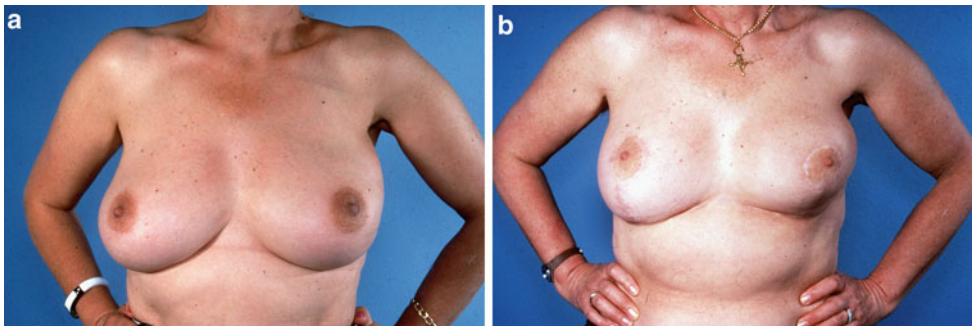

Fig. 14.2 **a** Status after tumorectomy and radiotherapy of the left breast. The patient asked for bilateral remodeling. **b** Fibrosis and retraction of the left irradiated breast with a bad cosmetic result

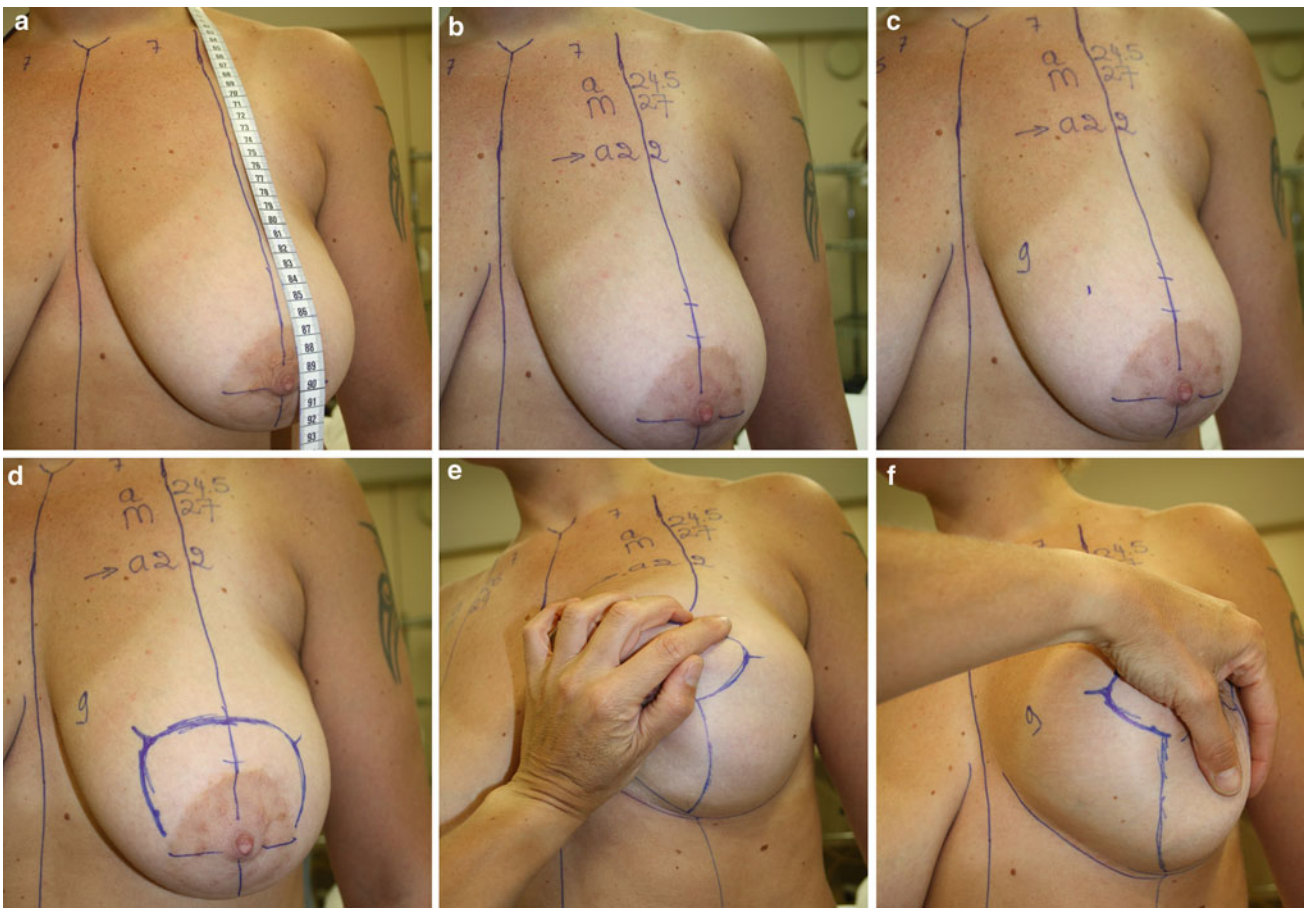

Fig. 14.3 Preoperative design of the superior pedicle technique with the vertical scar: **a** axis of the breast; **b** position of the new areola; **c** inner border of the new areola; **d** mosquito-dome drawing; **e** lateral vertical scar; **f** medial vertical scar

General anesthesia is administrated and no local infiltration is used to prevent distortion of the operative site and tumorous cells spreading. Tumorectomy is performed with an incision/excision of skin in the skin excision of the breast reduction (Fig. 14.4a, b). The best way is to excise the tumor in one piece well oriented by suture materials, to X-ray the fragment to see if the microcalcifications are all included, and finally for the pathologist to evaluate the margins. The axillary dissection is done through a separate incision to avoid the skin and areola external retraction that is often seen with a periareolar incision only. The operative bed of the tumorectomy is clipped to facilitate the postoperative follow-up and orient for the post-operative radiotheraphy. Afterwards the remodeling is performed as a mastopexy or a breast reduction; the shortest pedicle is chosen. First, the tumorectomy specimen is weighed (to

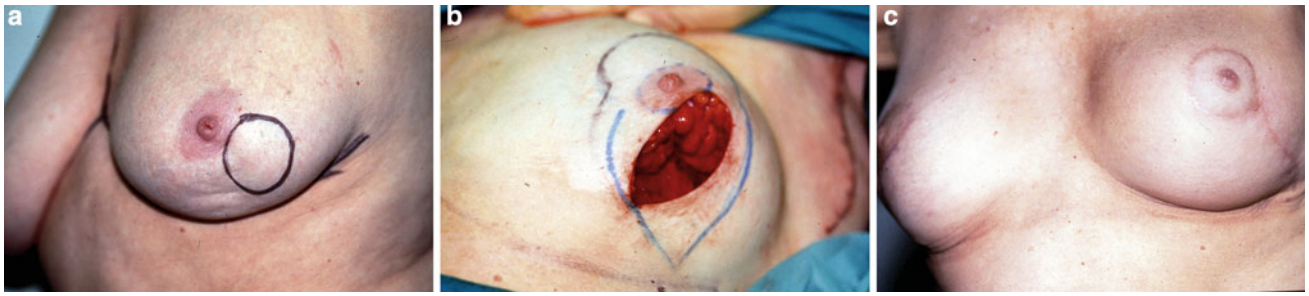

Fig. 14.4 **a** Preoperative image of invasive intraductal carcinoma T2N0M0 in the inferior quadrant of the left breast. **b** Site of tumorectomy before remodeling. **c** Postoperative result 1 year after radiotherapy

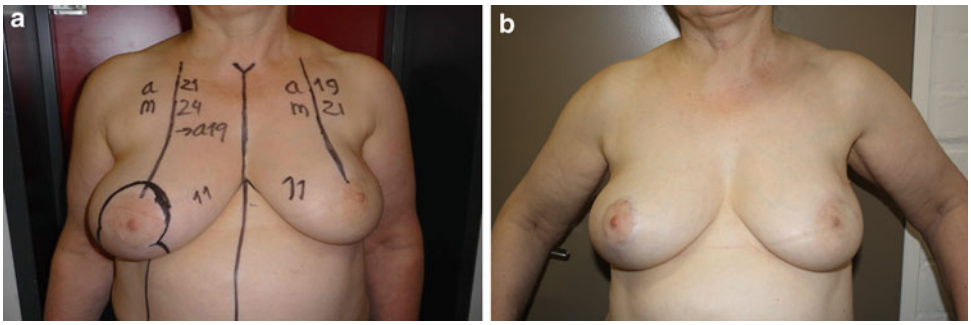

Fig. 14.5 **a** Preoperative image before left BCT plus radiotherapy showing contralateral hypertrophy. **b** Postoperative image after right breast reduction to equalize the two breasts

compare it with the other breast) and the glandular tissue removed is examined to evaluate if a complementary resection of the treated breast is necessary. If this is the case, the complementary piece excised is marked with suture material for further pathologic analysis and the breast reduction is continued classically. The areola is deepithelized following the preoperative design; the vertical and horizontal limbs are cut up to the pectoralis fascia, which is respected; the breast is gently separated from the pectoralis fascia in the superior portion of the breast with care not to devascularize the glandular flaps too much. The gland is palpated in all the plane. If the tumorectomy leaves a hole in the breast, the glandular flap from the opposite limbs is mobilized into the defect. The cardinal points of the areola are sutured with inverted resorbable sutures (Monocryl 3/0). The glandular flaps are softly reapproximated together without any tension (Vicryl 0). Sometimes, some fixation to the pectoralis fascia is necessary to give a nice contour to the breast. A suction drain is placed into the defect. The skin is closed without any tension with resorbable sutures (Fig. 14.4c).

14.5 Contralateral Breast

The same procedure is performed in a mirror-image fashion during the same operation time for the contralateral breast.

The fragment from the breast reduction is marked carefully with suture material and is sent to the pathologist as we know the risk of tumor of the opposite breast is higher than 2–5 %. A suction drain is placed. The patient is frequently placed in a sitting position to evaluate the symmetry. With radiotherapy, the treated breast is always smaller and more fibrosed than the healed breast, so a slight hypercorrection is advised. A slight compressive dressing until healing has occurred is applied as a skin brassiere for 2 months day and night.

Despite the advantage of performing an "all in one" surgery, some surgeons prefer to delay the contralateral breast reduction until after improvement of the side effects of the radiotherapy (after improvement of the fibrosis, the edema, and retraction) to symmetrize the breasts.

After BCT, some patients have breast asymmetry. The easier case to deal with is a nice, comfortable irradiated breast and a bigger and/or more ptotic contralateral breast. The solution is to perform a breast reduction or mastopexy with the drawings already described with the position of the irradiated NAC as a reference for the contralateral breast (Fig. 14.5).

When the irradiated breast is distorted or too heavy, performing a breast reduction on it is highly risky, with the possibility of NAC necrosis, fat necrosis, skin dehiscence, and prolonged edema with, moreover, a poor cosmetic result (Fig. 14.2) [11]. Only small NAC repositioning may be treated with highly conservative manipulation (Fig. 14.6).

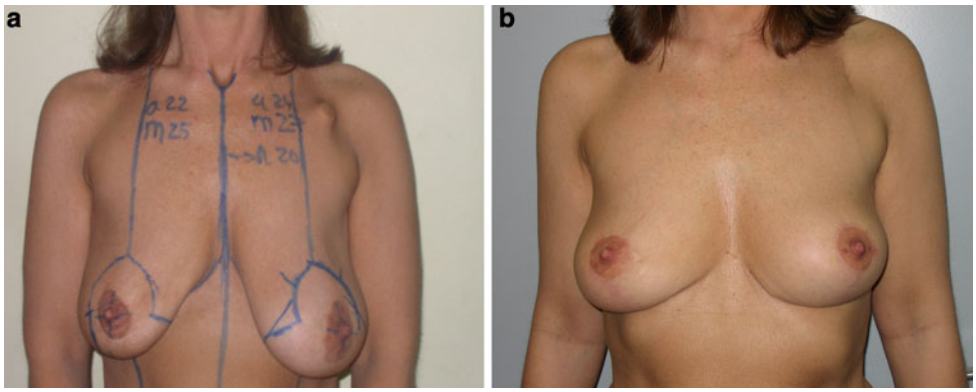

Fig. 14.6 **a** Preoperative image before right BCT plus radiotherapy with bilateral ptosis and left hypertrophy. **b** Postoperative image 1 year after left breast reduction and minimal skin undermining on the right irradiated breast

Lipofilling is not yet well accepted in breast cancer therapy as the role of the stem-cell precursor adipocytes in the stimulation of cancer growth and reappearance is questionable. Lipofilling should be performed only with an oncologic follow-up protocol, and further oncologic series are required [14, 15].

14.6 Postoperative Course

No interference with the follow-up (mammograms) has been demonstrated following oncoplastic surgery compared with BCT alone [16, 17].

A complication rate of 20 % is described, but without delaying the adjuvant therapies: hematoma, seroma, infection, skin dehiscence, fat necrosis (5.6 %), areola necrosis, skin necrosis (7.5 %) [8, 11].

Actuarial 5-year local recurrence rates following oncoplastic surgery of 3 % [7] and 9.4 % [8] have been reported; the corresponding overall survival rates were 92.47 % [7] and 95.7 % [8]. The long-term oncologic results of BCT with oncoplastic surgery are comparable with those of BCT randomized trials [7].

References

1. Fisher B, Anderson S, Bryant J et al (2002) Twenty-year follow-up of randomised trial comparing total mastectomy, lumpectomy and lumpectomy plus irradiation of the treatment of invasive breast cancer. N Eng J Med 347:1233–1241
2. Veronesi U, Casinelly N, Mariani L et al (2002) Twenty-year follow-up of randomized study comparing breast conserving surgery with radical mastectomy for early breast cancer. N Eng J Med 347:1227–1232
3. BrierlyJD, Paterson ICM, Lallemand RC et al (1991) The influence of breast size on the late radiation reaction following excision and radiotherapy for early breast cancer. Clin Oncol 3:6–9
4. Petit JY, Rietjens M, Garusi C et al (1998) Integration of plastic surgery in the course of breast conserving surgery for cancer to improve cosmetic results and radicality of tumor excision. Recent Results Cancer Res 152:202–211
5. Kaur N, Petit JY, Rietjens M et al (2005) Comparative study of surgical margins in oncoplastic surgery and quadrantectomy in breast cancer. Ann Surg Oncol 12(7):539–545
6. Zierhut D, Flentje M, Franck C et al (1994) Conservative treatment of breast cancer: modified irradiation technique for women with large breasts. Radiother Oncol 31:256–261
7. Rietjens M, Urban CA, Rey PC et al (2007) Long-term oncological results of breast-conservative treatment with oncoplastic surgery. Breast 16:387–395
8. Clough KB, Lewis JS, Couturaud B et al (2003) Oncoplastic techniques allow extensive resections for breast-conserving therapy of breast cancer. Ann Surg 237(1):26–34
9. Sakr RA, Poulet B, Kaufman GJ et al (2011) Clear margins for invasive lobular carcinoma: a surgical challenge. Eur J Surg Oncol 37:350–356
10. Kim K, Chie EK, Han W et al (2011) Age < 40 years is an independent prognostic factor predicting inferior overall survival in patients treated with breast conservative therapy. Breast J 17:75–78
11. Munhoz AM, Aldrighi CM, Montag E et al (2011) Outcome analysis of immediate and delayed conservative breast surgery reconstruction with mastopexy and reduction mammaplasty techniques. Ann Plast Surg 67:220–225
12. Boetes C, Mus RD, Holland R et al (1995) Breast Tumors: comparative accuracy of MR imaging relative to mammography and US for demonstrating extent. Radiology 197:743–747
13. Biglia N, Bounous VE, Martincich L et al (2011) Role of MRI (magnetic resonance imaging) versus conventional imaging for breast cancer presurgical staging in young women with dense breast. Eur J Oncol 37:199–204
14. Petit JY, Botteri E, Lohsiriwat V et al (2011) Locoregional recurrence risk after lipofilling in breast cancer patients. Ann Oncol 23(3):582–588
15. Petit JY, Lohsiriwat V, Clough KB et al (2011) The oncologic outcome and immediate surgical complications of lipofilling in breast cancer patients: a multicentric study-Milan-Paris-Lyon experience of 646 lipofilling procedures. Plast Reconstr Surg 128(2):341–346
16. Losken A, Schaefer TG, Newell MS et al (2009) The impact of partial breast reconstruction using reduction techniques on postoperative cancer surveillance. Plast Reconstr Surg 124(1): 9–17
17. Roberts JM, Clark CJ, Campbell MJ et al (2011) Incidence of abnormal mammograms after reduction mammoplasty: implications for Oncoplastic closure. Am J Surg 201(5):608–610

Inferior Pedicle Techniques

15

Albert Losken

15.1 Introduction

Partial breast reconstruction is occasionally required after tumor resection in women who choose breast conservation therapy (BCT) [1]. Various options exist, including rearranging breast tissue, and flap transfer. The oncoplastic reduction or mastopexy technique is very beneficial and seems to be one of the more commonly used approaches [2, 3]. Plastic surgeons are familiar with different breast reduction techniques and pedicles, and will often have preferences in terms of which technique they perform most of the time. The same applies for oncoplastic reduction techniques; however, the location of the tumor defect in addition to breast size and shape will influence the decision.

The inferior pedicle is still one of the most commonly performed breast reduction techniques since it is easy to perform, reliable, and versatile [4]. It makes sense for it to be a commonly used technique in oncoplastic reduction for defects as well, and can essentially be used to reconstruct a partial mastectomy defect in any location except purely inferior [5].

15.2 The Benefits of the Inferior Pedicle Technique

The inferior pedicle can reliably keep the nipple–areola complex well perfused in a breast of almost any size and shape. It is a technique that is easy to learn, and is reproducible. The complications are comparable to other approaches [6]. Although it does require some flap undermining and the Wise pattern in most cases, it can be performed in 2–3 h. Some feel that the inferior pedicle technique has a lower complication rate since the inferior location obliterates dead space in the dependent region of the breast.

15.3 Indications

The indications for an inferior pedicle oncoplastic reduction are women with breast cancer who wish to preserve their breasts and have moderate-sized to large breasts with ptosis. A reduced breast will tolerate radiation therapy better than a large breast, and aesthetic results have been shown to be superior. If the tumor is in the upper or medial pole and there is concern about creating an unfavorable results from a cosmetic standpoint with lumpectomy alone, then this oncoplastic approach is preferable, Other indications for an inferior pedicle oncoplastic procedure are medial, superior, or lateral tumors where the surgeon is concerned about being able to obtain negative margins and anticipates a large resection or if the tumor to breast ratio is greater than 20 %. The ideal patient is one where the tumor can be excised within the expected breast reduction specimen where sufficient breast parenchyma remains following resection to reshape the mound (Fig. 15.1).

15.4 Contraindications

The inferior oncoplastic pedicle technique typically cannot be used if the tumor defect is in the midline lower pole. If the tumor defect is slightly off midline and the inferior pedicle can be based more laterally or medially, then it can still be used for lower-pole tumors. Adequate base width is required and the pedicle cannot be detrimental to shaping the breast mound following resection. If it becomes difficult, then a more superiorly based pedicle is preferable. Central or subareolar tumors that require tumor resection directly beneath the nipple–areola complex could compromise nipple viability with a long inferior pedicle. Choosing

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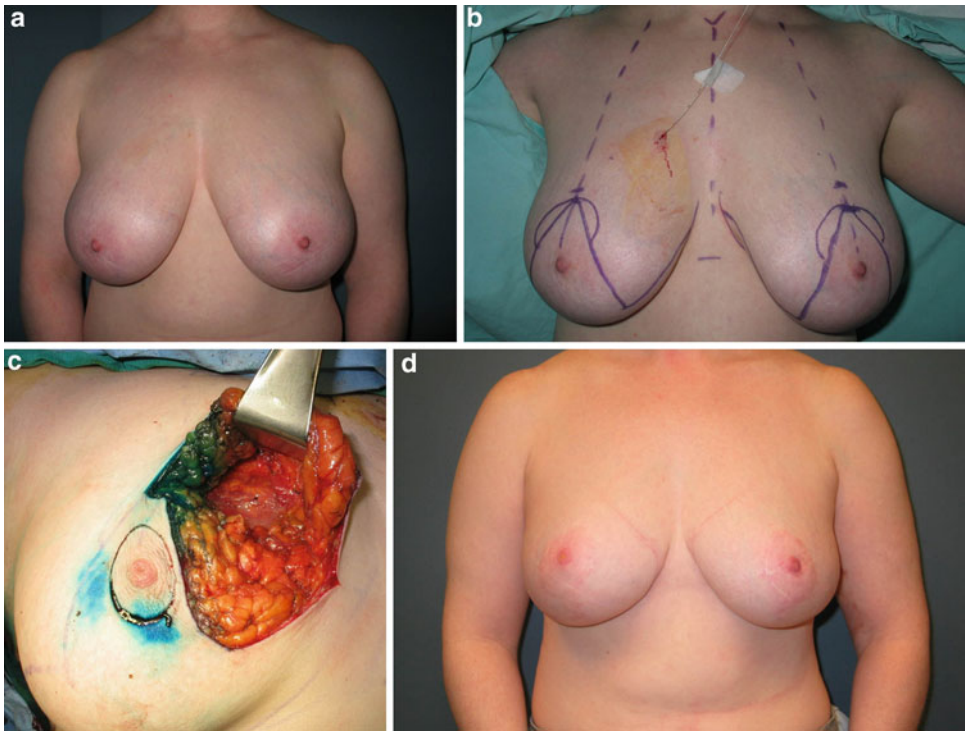

Fig. 15.1 This 33-year-old woman with stage III breast cancer had an excellent response to preoperative chemotherapy, and desired breast conservation. To minimize the potential for a poor cosmetic result with a defect in the upper pole, she underwent a right wire-guided lumpectomy (100 g) with simultaneous bilateral breast reduction (total masses 250 g left and 150 g right). The nipple was moved on the basis of an inferiorly based dermatoglandular pedicle. The pedicle filled the defect and her result is shown at 1 year following completion of radiation therapy for the right breast

a shorter pedicle or even amputation and free nipple graft is safer. Women with a previous infra-areolar biopsy scar or a tumor just inferior to the nipple are not candidates for the inferior pedicle procedure. Appropriate patient selection as always will minimize complications in patients with comorbidities and smokers.

15.5 Timing of Partial Breast Reconstruction

In general, partial breast reconstruction when indicated is best performed at the time of resection (immediate reconstruction). The main concern with immediate reconstruction is the potential for positive margins. When this concern does exist, the reconstruction can be delayed until final confirmation of negative margins (delayed–immediate reconstruction). This then allows the benefits of reconstruction prior to radiation therapy with the luxury of clear margins, although at the expense of a second procedure (Fig. 15.2). Such women at increased risk of positive margins included those under 40 years old, those with extensive ductal carcinoma in situ, those with high-grade tumors, those with a history of neoadjuvant chemotherapy, those with infiltrating lobular carcinoma, and those with human epidermal growth factor receptor 2/neu positivity [3, 7, 8]. The main disadvantage is the need for a secondary procedure, which might be unnecessary in most cases. When a flap reconstruction is required, we prefer to confirm the final margin status prior to partial breast reconstruction.

There are situations where poor results are encountered years following radiation therapy, which then require correction (delayed reconstruction). Reduction techniques should be used with caution in patients who have already been irradiated.

15.6 Surgical Technique

15.6.1 Preoperative Planning

The multidisciplinary team discusses the case and reviews the mammograms. The resective surgeon plans the tumor removal with or without radiographic guidance. The standard Wise pattern markings are then drawn preoperatively marking the nipple in the breast meridian about 19–23 cm from the sternal notch. The tumor defect location is anticipated and an inferior pedicle is drawn out. It should be about 8 cm wide in small breasts, and 10 cm or more in patients with large breasts. The location of the inferior pedicle can be adjusted either medially or laterally to maximize width and blood flow depending on the tumor location and degree of breast ptosis. A similar pattern is drawn on the contralateral breast for symmetry.

15.6.2 Resection

The breast surgeon then performs the tumor resection, ideally below or through the Wise pattern markings and not through the base of the inferior pedicle. If this approach is

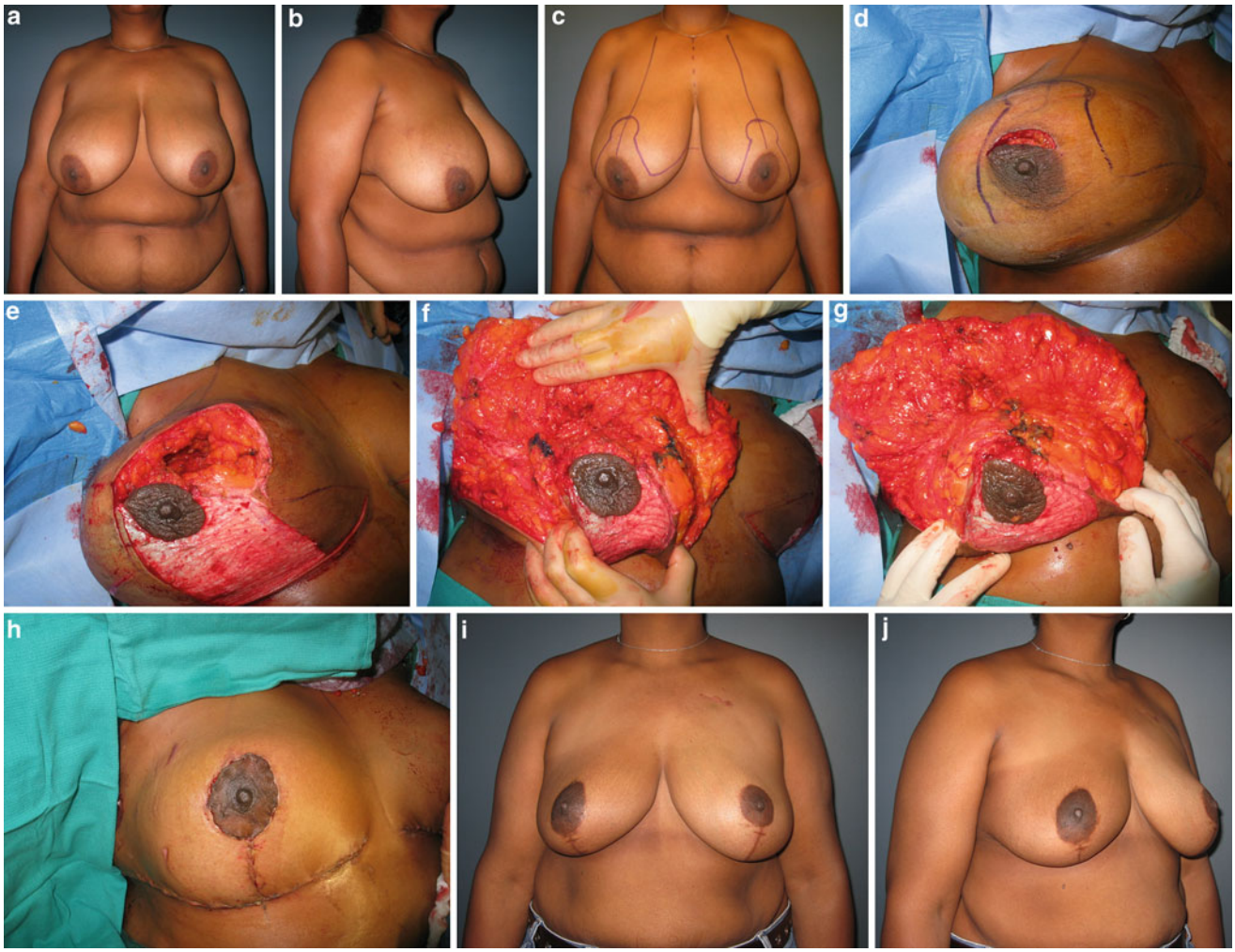

Fig. 15.2 This 49-year-old woman with macromastia had a resection above the nipple–areola complex. Her defect was reconstructed using an inferior pedicle breast reduction. Since there is little tissue on the pedicle above the nipple–areola complex to fill the dead space, the glandular tissue is plicated above the nipple for upper-pole volume. She is shown 1 year following completion of radiation therapy [11]

required for tumor resection, then an alternative pedicle design is required. Skin can be resected along with the tumor if desired as long as it is within the proposed area of dermatoglandular resection. It is important for the reconstructive surgeon to be present at the resection until a comfortable working relationship is achieved. Following tumor resection and intraoperative margin assessment, the cavity is clipped for postoperative surveillance and radiation boosting. The tumor specimen is weighed.

15.6.3 Reconstruction

The remaining breast tissue is examined. The goals are to [1] keep the nipple alive, [2] fill the dead space, and [3] reconstruct or reshape the breast mound. The nipple is incised at the appropriate diameter. The standard Wise pattern is cut if this has not already been done. An inferior pedicle is then deepithelialized. The dermatoglandular pedicle is then created with a wide enough base to maintain nipple viability. Tissue above the nipple–areola complex is also deepithelialized and preserved especially in upper-pole tumors, where the pedicle might be required to fill a defect above the proposed new nipple position. The next step is to fill the dead space (tumor defect). Additional tissue should not be resected until it has been determined that the dead space can be filled with r the inferior pedicle, surrounding breast tissue, or breast flaps. Parenchyma can always be plicated above the nipple if there is need to fill a dead space (Fig. 15.2). Once this has been achieved, the additional dermatoglandular tissue can be resected in the usual reduction fashion, and weighed. The breast mound is then shaped, skin flaps are closed, and the nipple–areola complex is inset. Drains are placed in the tumor cavity. The contralateral reduction is then performed using the same inferior pedicle technique. Ideally, the contralateral

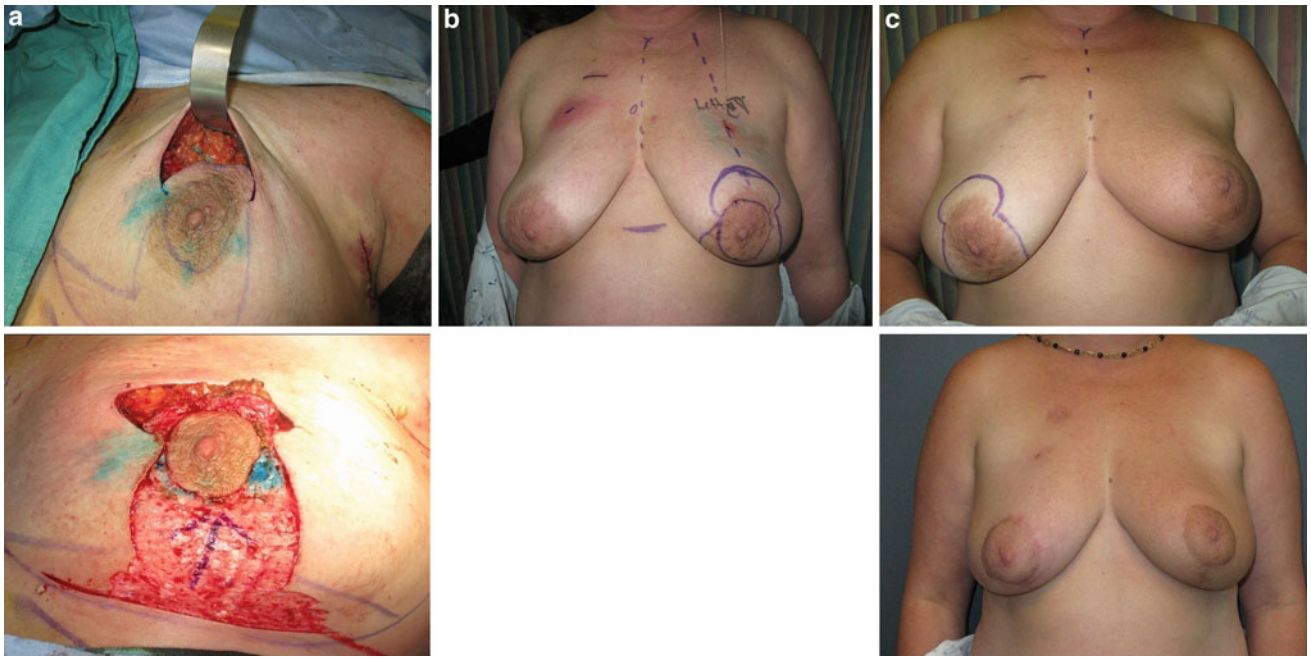

Fig. 15.3 This demonstrates an upper-pole breast cancer resected with a wire-guided biopsy leaving a defect above the nipple. A standard inferior pedicle Wise pattern oncoplastic reduction was chosen at the time of lumpectomy. The right reduction was deferred owing to an infectious process in that breast. The contralateral breast reduction was delayed until completion of radiation therapy (6 months later). There is reasonable shape and symmetry at 1 year following completion of radiation therapy

breast is reduced about 10 % more than the breast with the tumor in anticipation of radiation fibrosis. This will maximize symmetry following completion of radiation therapy. Specimens are then sent separately to the pathology department. Another option with the contralateral breast is to perform the reduction following completion of radiation therapy; however, this approach will necessitate a second procedure in almost everyone (Fig. 15.3).

The inferior pedicle can be adjusted depending on the tumor location (Fig. 15.4) [5]. The medial wedge of parenchyma can be included in the pedicle as an inferomedial design to both enhance blood flow to the nipple and provide additional bulk to fill an upper inner-quadrant defect (Fig. 15.5). An inferolateral pedicle can also be used for lower inner-quadrant defects.

15.7 Surveillance

The three main tools when it comes to postoperative surveillance are the physical examination, radiologic imaging, and tissue sampling. It is important that all members of the team are aware of the various surgical components, since differences in presentation might exist. We have demonstrated that mammography following partial breast reconstruction using reduction techniques is just as sensitive as a screening tool as for patients with BCT alone [9]. Although the qualitative mammographic findings were similar in the two groups over the average 6-year follow-up, there was a slight trend towards longer times to mammographic stability in the oncoplastic reduction group (25.6 vs. 21.2 months in the group with BCT alone). This means that it might take oncoplastic reduction patients slightly longer to reach the point where any change in mammographic findings might be suggestive of malignancy. An accurate interpretation requires familiarity with these temporal changes, and mammograms should be compared over time. Microcalcifications and areas of fat necrosis are easily identified, and no interference in postoperative surveillance has been demonstrated. Other imaging techniques such as ultrasonography and MRI will likely become more popular as technology improves. Although routine tissue sampling is not recommended for screening, any clinical concern necessitates fine-needle aspiration, core-needle biopsy, or surgical biopsy to rule out malignancy. Patients who undergo partial breast reconstruction are expected to have an increase in the amount of tissue sampling required, as demonstrated in our series (53 % in the oncoplastic group compared with 18 % in the group with BCT alone over an average of 7 years).

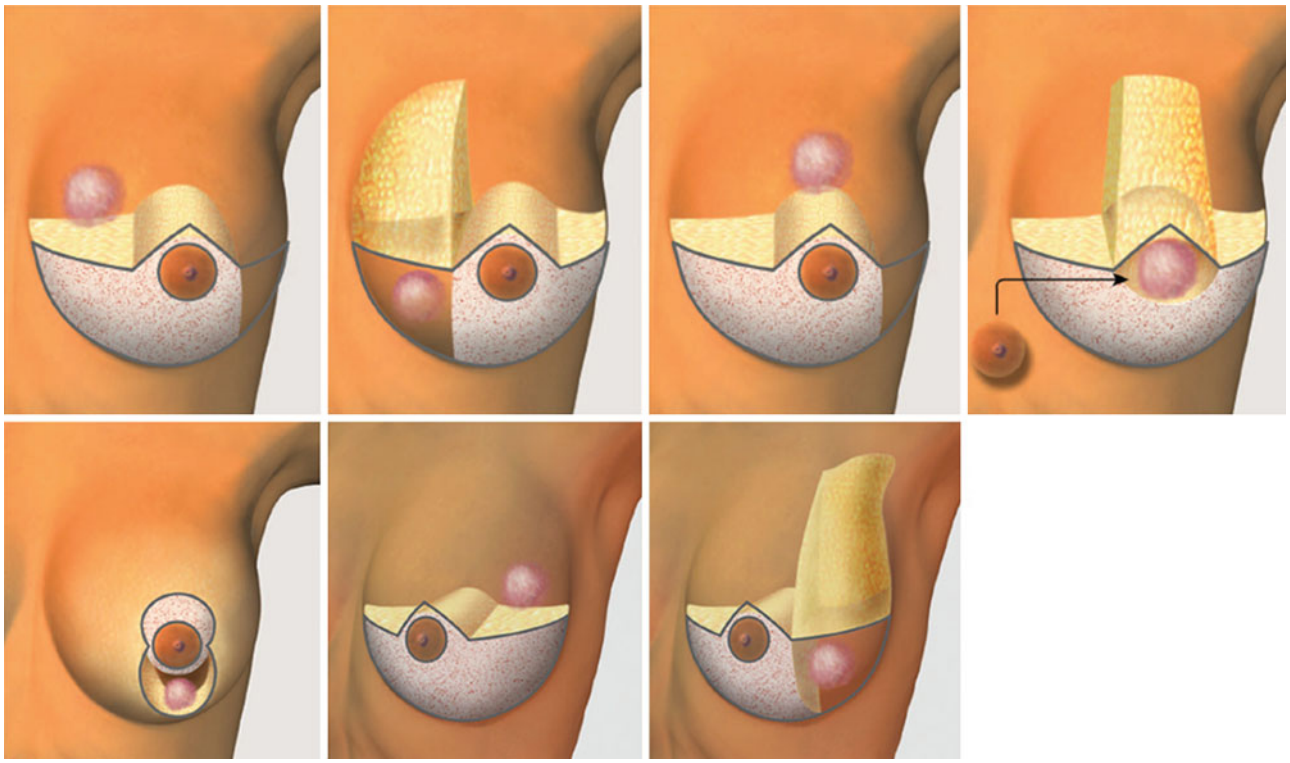

Fig. 15.4 The various modifications to the inferior pedicle based on tumor location [5]

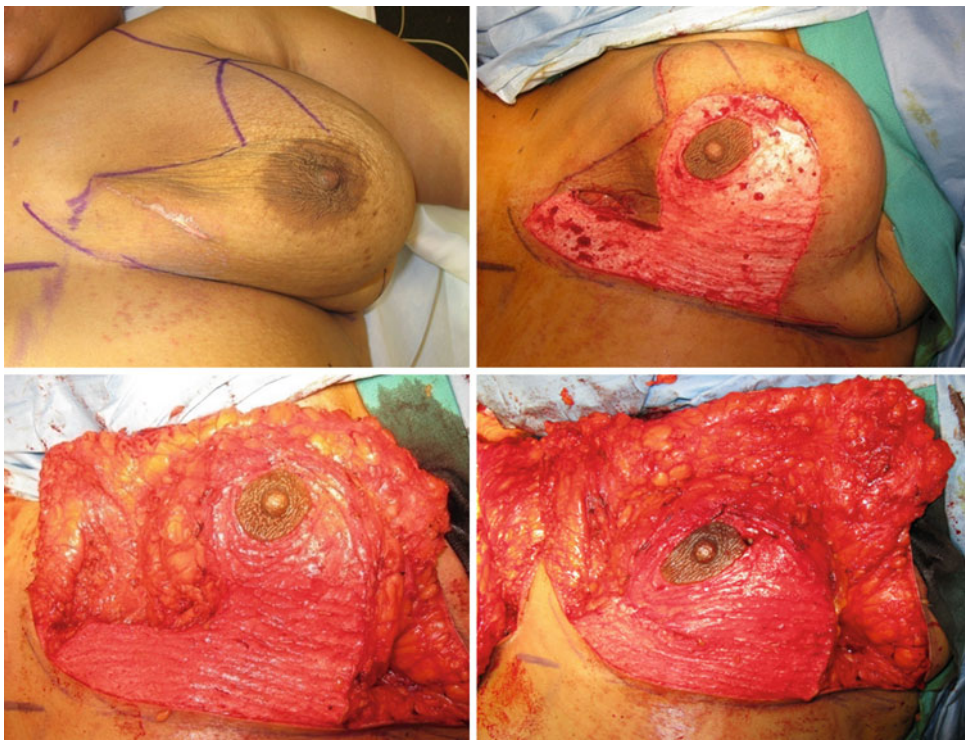

Fig. 15.5 Intraoperative demonstration of retained medial wedge to the inferior pedicle used to fill an inner-quadrant defect following wide excision

15.8 Complications and Outcomes

The inferior pedicle reduction pattern is relatively safe and effective; however, complications can occur. Careful patient selection will minimize the incidence of postoperative complications. Some larger series with volume displacement techniques using a variety of reduction techniques report complications such as delayed wound healing (3–15 %), fat necrosis (3–10 %), and infection (1–5 %) [2, 3, 5]. Loss of nipple is very rare when the pedicle is wide enough and the technique is well designed and executed. Delayed complications with the oncoplastic approach include breast fibrosis and asymmetry. Although the goal of partial breast reconstruction is to prevent the unfavorable cosmetic result, this approach cannot prevent or reverse the effects of radiation therapy. Since these effects will persist, the assessment of shape and symmetry needs to be made in the context of the long term. However, with partial reconstruction, shape is typically preserved and it is easier to adjust the contralateral side secondarily if necessary than reconstruct an irradiated BCT deformity. Asgeirsson et al. [10] reviewed numerous series with intermediate follow-up and demonstrated cosmetic failure rates of 0–18 %. Local recurrence is another important outcome that needs to be evaluated in the oncoplastic patient. Most reviews in the literature are of intermediate follow-up (up to 4.5 years), with local recurrence rates ranging from 0 to 1.8 % per year [10]. Actuarial 5-year local recurrence rates range from 8.5 to 9.4 %. Longer-term studies are required.

15.9 Conclusion

Inferior pedicle oncoplastic reduction is a very reliable and versatile technique for reconstructing the partial mastectomy defects in women with macromastia or ptosis. This technique can be used in a breast of almost any size or shape, as long as sufficient tissue remains following tumor resection. The inferior pedicle oncoplastic reduction technique is indicated for any tumor location except purely inferior. Complication rates and aesthetic results are favorable, and this approach does not interfere with cancer surveillance. We need to critically evaluate results measuring functional, oncological, and aesthetic outcomes in an attempt to establish safe and effective practice guidelines to maximize outcomes.

References

1. Losken A, Hamdi M (2009) Partial breast reconstruction: current perspectives. Plast Reconstr Surg 124(3):722–736
2. Munhoz AM, Montag E, Arruda EG et al (2006) Critical analysis of reduction mammaplasty techniques in combination with conservative breast surgery for early breast cancer treatment. Plast Reconstr Surg 117(4):1091–1107
3. Losken A, Styblo TM, Carlson GW, Jones G, Amerson B (2007) Management algorithm and outcome evaluation of partial mastectomy defects treated using reduction or mastopexy techniques. Ann Plast Surg 59(3):235
4. Rohrich RJ, Gosman AA, Brown SA, Reisch J (2006) Mastopexy preferences: a survey of board-certified plastic surgeons. Plast Reconstr Surg 118:1631
5. Kronowitz SJ, Hunt KK, Kuerer HM et al (2007) Practical guidelines for repair of partial mastectomy defects using the breast reduction technique in patients undergoing breast conservation therapy. Plast Reconstr Surg 120:1755
6. Ribeiro L, Affonso A, Affonso B et al (2004) Creation and evolution of 30 years of the inferior pedicle in reduction mammaplasties. Plast Rec Surg 110(3):960–970
7. Miller AR, Brandao G, Prihoda TJ et al (2004) Positive margins following surgical resection of breast carcinoma: analysis of pathologic correlates. Am J Surg 187(5):647–650
8. Song J, Styblo TM, Calrson G, Losken A (2010) The use of oncoplastic reduction techniques to reconstruct partial mastectomy defects in women with ductal carcinoma in situ. Breast J 16(2):141
9. Losken A, Schaefer TG, Newell MS, Styblo TM (2009) The impact of oncoplastic breast reduction on postoperative cancer surveillance. Plast Reconstr Surg 124(1):9–17
10. Asgeirsson KS, Rasheed T, McCulley SJ, Macmillan RD (2005) Oncological and cosmetic outcomes of oncoplastic breast conserving surgery. Euro J Surg Oncol 31(8):817–823
11. Spear book (2009) Surgery of the breast, principles and art, 3rd edn.

Oncoplastic Reduction Mammoplasty: Incision Patterns, Safety Issues, and Plasticity

16

Mahdi Rezai, Peter Kern, and Stefan Kraemer

16.1 Introduction

Breast conservation therapy, consisting of a margin-negative segmental mastectomy and breast irradiation, is a standard and oncologically safe treatment modality for patients with early-stage breast cancer, and for many patients with locally advanced disease if their tumors can be downstaged sufficiently with induction chemotherapy [1–5]. Multicentric lesions, or a medical contraindication to chest wall irradiation, however, mandate mastectomy for definitive locoregional disease control. The presence of obesity or other body habitus associated with large, pendulous breasts can complicate the efficacy and suitability of both treatment approaches. Delivery of radiation therapy to a bulky and ptotic breast can be very challenging technically and may result in excessive radiation toxicity and worse cosmetic outcomes.

Bilateral reduction mammoplasty in conjunction with tumor-directed segmental partial mastectomy is a surgical technique that can potentially improve the efficacy of radiation therapy in this setting, alleviate the neuropathic symptoms that can accompany macromastia, and increase rates of breast-conserving surgery for breast cancer patients. However, this option is frequently overlooked by surgeons treating newly diagnosed breast cancer patients.

Many different and varied techniques for breast reduction have been described [6–11]. Several of these procedures have come to be known simply on the basis of the name of the physician who described the operation. In addition, many of these procedures have variably overlapping technical details, all of which can create confusion when attempting to evaluate published results. To assist in organizing and evaluating the multiple techniques of breast reduction, it is helpful to realize that any procedure designed to accomplish breast reduction must consist of the following four interrelated elements:

1. Preserving the blood supply to the nipple–areola complex
2. Removing the redundant parenchyma or tumor-adapted segmental partial mastectomy when combining breast conservation therapy with reduction
3. Removing excess skin
4. Shaping the breast.

On the basis of these four cardinal elements, breast reduction techniques can be divided into the following main principles.

The *Wise pattern inverted-T reduction* is the most commonly performed procedure, is based on an inferior pedicle, removes tissue from around the pedicle medially, superiorly, and laterally, removes skin below the medial and lateral breast flaps, including the deepithelialized inferior pedicle, and redraped the skin around the inferior pedicle to shape the breast.

Vertical reduction has gained in popularity as a method to reduce the length of the scars. It is based on a superior [8] or superomedial [10] pedicle, removes tissue from the lower pole of the breast, uses a circumvertical skin resection pattern, and sutures together the medial and lateral pillars for shaping.

Periareolar reduction is based on using a blocked circular dermal suture passed in a purse-string fashion. The round block constitutes a cerclage, fixing a solid circular dermodermal scar block around the areola. The periareolar approach provides easy access to the whole gland, minimizing the extent of the incision required [9].

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Most of the published techniques have different limitations in the amount of removable tissue, vascularization of the nipple–areola complex, and the pedicle design and according to the resulting scars. In 1975, Liacyr Ribeiro [12] published a new method for reduction mammoplasty with an inferior pedicled nipple–areola complex. This inferior pedicle technique has become one of the most popular procedures in reduction mammoplasty among the members of the American Society of Plastic and Reconstructive Surgery [13].

16.2 Development of the Reduction Mammoplasty with Modified Inferior Flap Technique

There are several limitations associated with the principles described in reduction mammoplasty. From the surgical point of view, there is a need for a unique and standardized technique for reduction mammoplasty which can be implemented either in a tumor-adapted reduction strategy in breast conservation treatment or in aesthetic surgery for reduction and mastopexy.

Beside the volume reduction, several other aspects have to be considered when developing a unique reduction mammoplasty technique combining prerequisites from breast conservation treatment and aesthetic surgery.

This technique should have the following aims and possibilities:

- Creation of the desired breast size and shape
- Breast symmetry
- Variation of the width of the breast basis
- Optimization of the projection of the nipple–areola complex
- Reconstruction of the upper breast pole
- Scar-sparing procedure
- Avoidance of secondary ptosis
- Correction of lateral bulging
- Combination with an oncoplastic procedure (segmental resection in breast cancer patients)
- Conversion to skin-sparing mastectomy with reconstruction in the case of positive margins
- Result of good outer and inner aesthetics (breast diagnostics during aftercare)
- Adaptation of the contralateral breast in reconstruction after mastectomy.

For the development of a unique technique in reduction mammoplasty which fulfills these prerequisites, it is important to differentiate two unrelated steps: the inner reduction (volume reduction) and the outer reduction (skin envelope reduction).

Compared with the original technique of Ribeiro with an inferior pedicle, we developed a modified inferior technique with a superior pedicled nipple–areola complex and an inferior dermoglandular flap, which are the two important steps for volume reduction.

For the skin envelope reduction, different scars and incision patterns can be combined with the volume reduction (inverted-T scar, vertical scar, periareolar scar, L scar) depending on the breast size and shape.

16.3 Surgical Technique for Reduction Mammoplasty with a Modified Inferior Flap

With the patient in the half-sitting position, a vertical line is drawn from the hemiclavicular line to the upper edge of the areola (Fig. 16.1). The new position of the nipple is marked on the vertical line corresponding to the projection of the inframammary fold on the upper pole of the breast. By means of a pinching maneuver and the surgeon's judgment, the surgeon determines the lateral lines of 10 cm length. The lower poles of the lines are linked to the inframammary fold with curving lines, as in Pitanguy's technique.

With the breast lifted so that the lower pole can be seen, the drawing of the inferior flap is started at the central portion and is extended to 1–2 cm below the inferior edge of the areola.

16.4 Surgical Principle and Intraoperative Sequence for Tumor-Adapted Reduction Mammoplasty with a Modified Inferior Flap and a Superior Pedicled Nipple–Areola Complex

The outlined flap is decorticated, and an incision is made on its edges downward to the muscular level to allow the shaping of a dermolipoglandular flap, supplied by the fourth, fifth, and sixth intercostal perforating vessels (Fig. 16.2). The nipple–areola complex and the skin in the upper and lateral pole are completely undermined.

When the resection of the remaining tissue of the breast is complete, the flap is attached to the pectoralis fascia with separate stitches.

In the case of a tumor-adapted reduction mammoplasty (Fig. 16.3), the breast cancer is marked preoperatively with wires to achieve segmentally resected tumors for further histopathologic evaluation of tumor-free margins.

The lower edges of the lateral lines are joined at the middle point of the flap base. The new position of the nipple–areola complex is marked at the main projection. After decortication, the superior pedicled nipple–areola complex and the skin are sutured with Monocryl 3-0 sutures.

This surgical principle for a modified inferior flap technique with an inverted-T skin incision can also be combined with vertical, L, and periareolar skin incisions depending on the desired size and shape of the reduced breast.

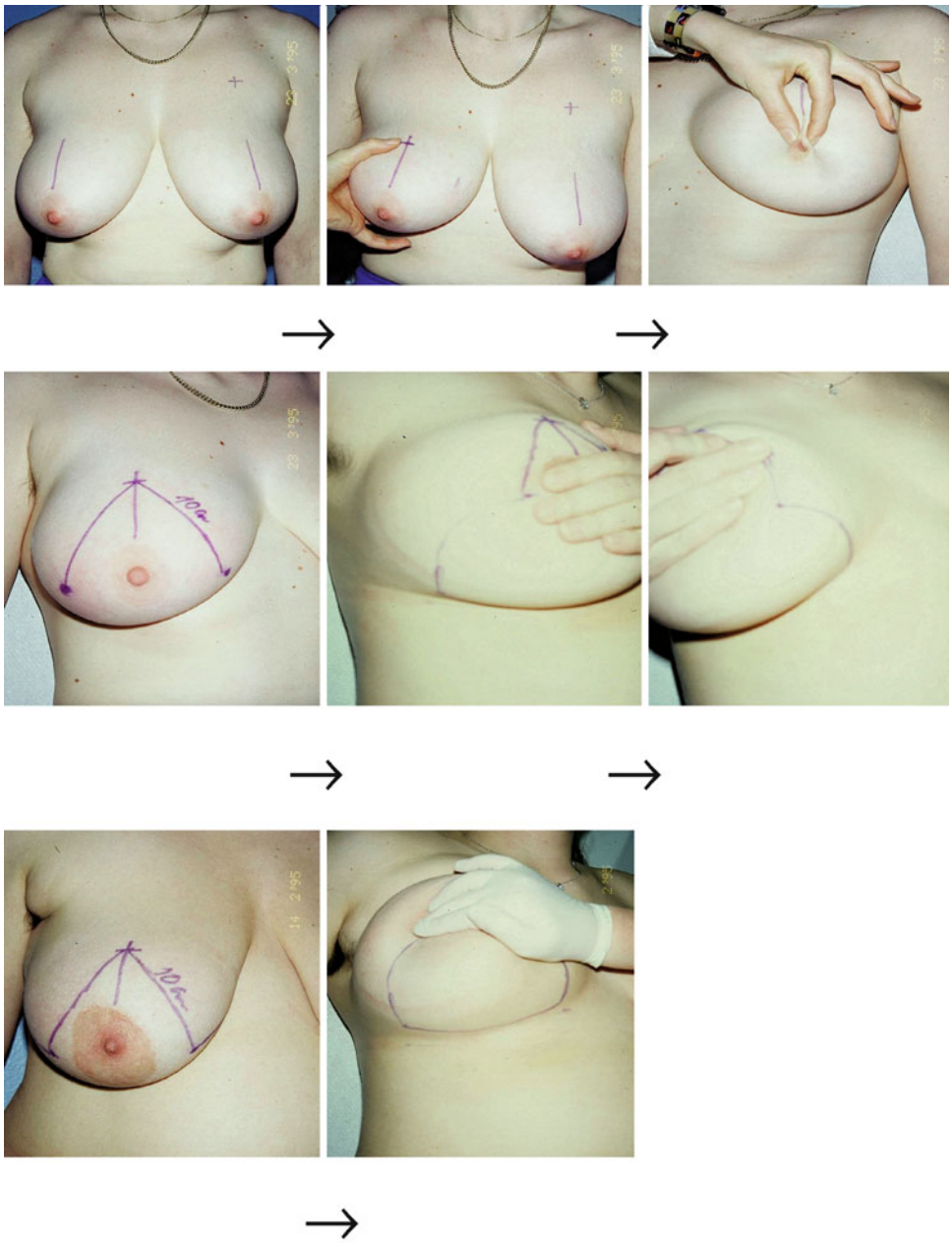

Fig. 16.1 Preoperative marking and planning

Since 1993 we have performed this technique as a routine procedure in aesthetic reduction mammoplasty and in tumor-adapted reduction mammoplasty as the surgical part of breast conservation treatment.

16.5 Timing of Contralateral Breast Alignment

Spear [14] emphasized that an immediate one-step procedure of tumor-adapted reduction mammaplasty and contralateral breast reduction gives the woman an important boost, both physically and psychologically, during management of their breast cancer.

Patel [15] did not find differences in a head-to-head-comparison of quality of life and aesthetic outcomes following immediate, staged-immediate, and delayed oncoplastic reduction mammoplasty . However, with a small number of patients in a 7-year period, we feel that a two-step procedure better avoids differences at mid-term (6 months) and thus provide women with better long-term results. The contralateral alignment of the breast may be exerted after 6 months when the ptosis of the breast that has been operated on is overt.

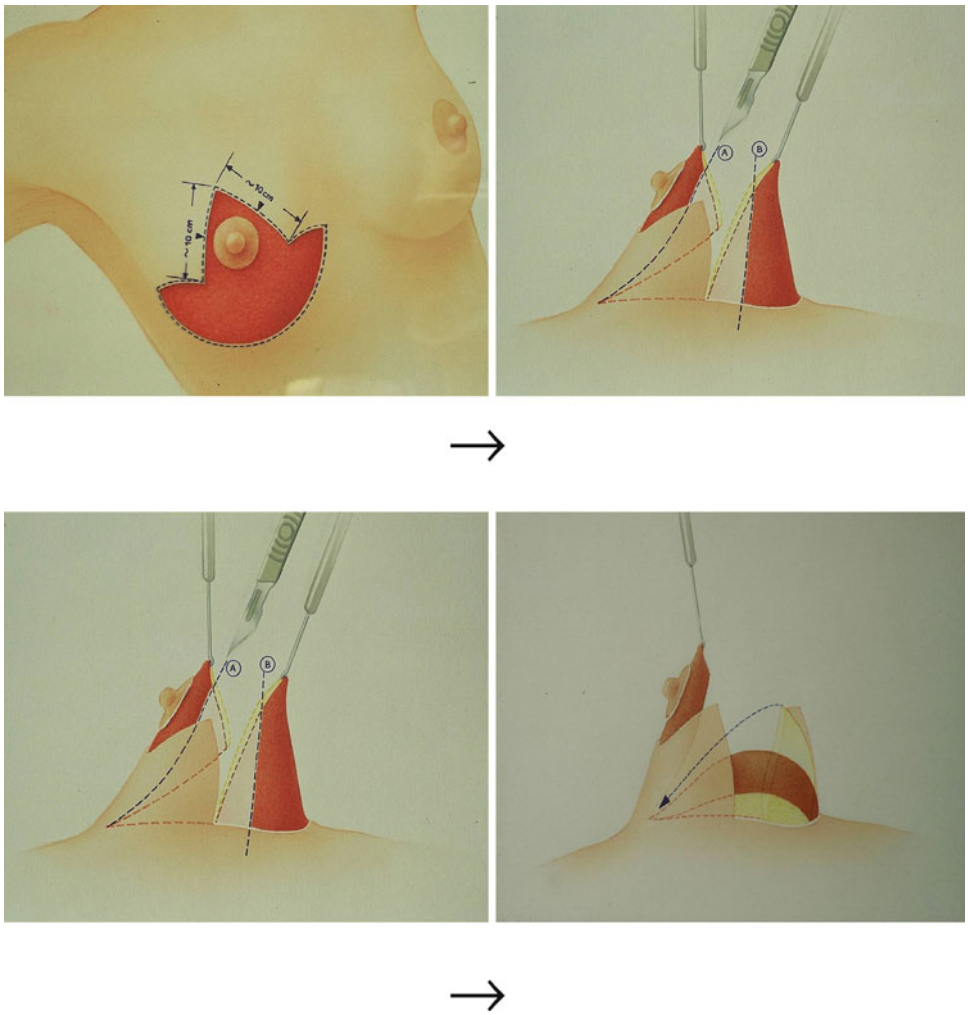

Fig. 16.2 Surgical principle of the reduction mammoplasty — modified inferior flap with superior pedicled nipple–areola complex (according to Rezai)

16.6 Comments and Discussion

Breast conservation therapy for early-stage breast cancer including a segmental partial mastectomy with an attempt to obtain a gross negative margin of at least 1 mm is the treatment of choice for patients with unicentric primary breast cancer. Postoperative breast radiation therapy is an essential component of breast conservation therapy , and results in 12-year local recurrence rates of 10 %, compared with 35 % seen in women who undergo lumpectomy without radiation therapy [3]. For women with locally advanced breast cancer , breast conservation therapy remains an option if the tumor can be appropriately downstaged with induction chemotherapy, and postoperative breast irradiation yields local recurrence rates that are similar to those seen with early-stage disease [2].

Breast cancer patients with macromastia (whether related to obesity or particular body habitus) present particular challenges to the radiation oncologist. The large breast may require higher-energy photons to ensure delivery of radiation to the deeper tissue, and the dose inhomogeneity that can result may lead to significant radiation toxicity with regard to the skin. Significantly worse aesthetic results from breast conservation treatment associated with large, pendulous breasts have been documented in several series [16, 17].

The fairly logical surgical therapeutic modification of reduction mammoplasty has attracted relatively poor attention. Its use as a postradiation procedure to restore symmetry in treated patients with macromastia has been discussed in a few case reports [14]. Employing this technique at the time of the patient's cancer surgery has the clear advantages of a single operative experience, as well as potentially reducing the radiation-related difficulties associated with treating the large, pendulous breast.

With the development of a reduction technique using a superior pedicled nipple–areola complex and the inferior dermoglandular flap, a unique strategy for tumor-adapted reduction mammoplasty and aesthetic breast reduction was implemented in 1993. The modified inferior flap technique

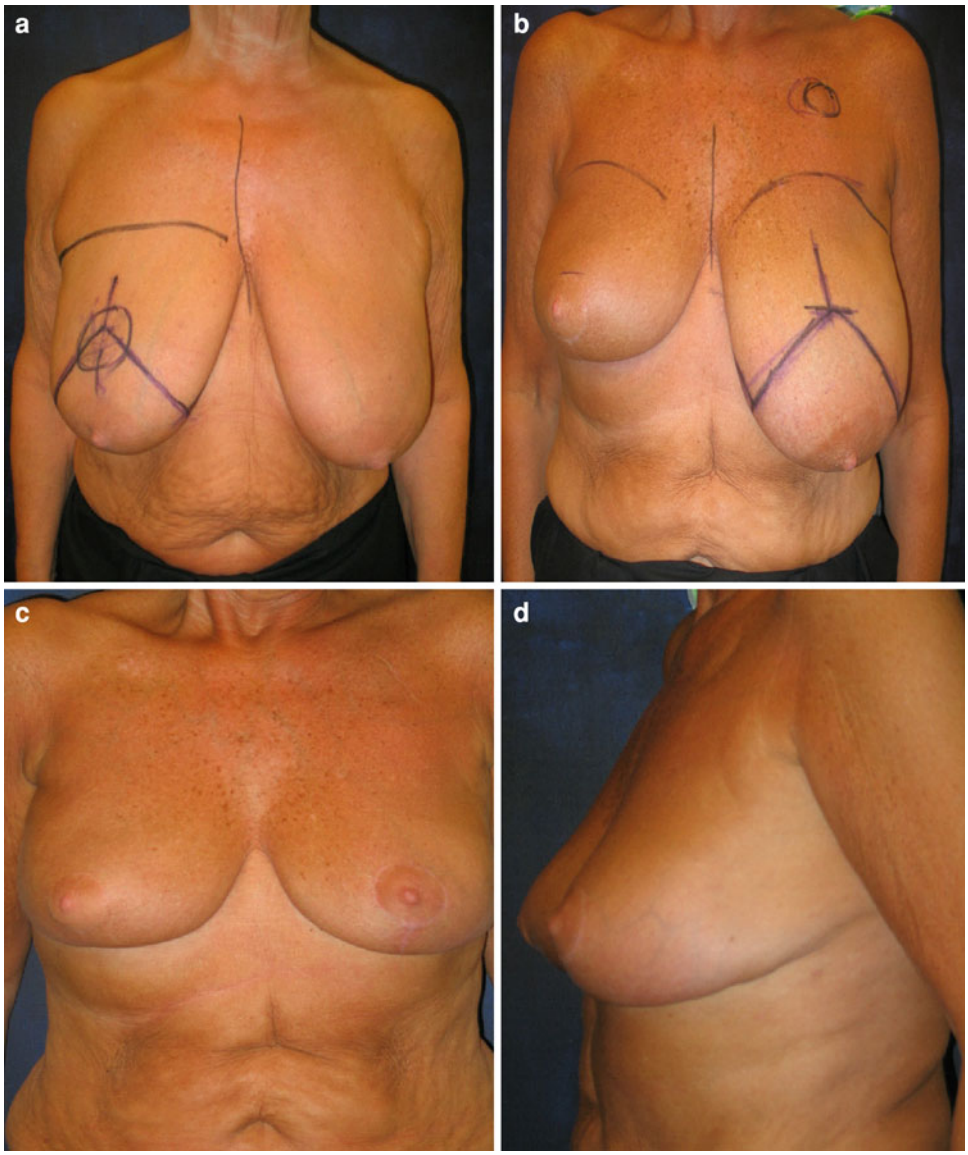

Fig. 16.3 Preoperative drawing and postoperative results. **a** Tumor-adapted reduction mammaplasty (*right side*). **b** Contralateral alignment (*left side*). **c** Postoperative result (*anterior projection*). **d** Postoperative result (*lateral projection*)

can be combined with different skin incision patterns (inverted T, vertical, L, periareolar), depending on the desired size and shape of the breast. The safety of this method is reaffirmed, with only few significant postoperative complications, no major radiation-related complications developing, and excellent patient satisfaction rates. In tumor-adapted reduction mammoplasty, patients received a separate incision for their axillary surgery. In addition, lymphatic mapping with sentinel lymph node biopsy was performed in only a small number of patients, but our results suggest that the identification rate and accuracy of the procedure are not significantly impaired by the reduction mammoplasty.

In summary, we see that bilateral reduction mammoplasty using the modified inferior flap technique can be performed safely at the time of definitive breast cancer surgery and prior to breast irradiation in patients with macromastia. The use of this technique should improve the ability to deliver the radiation component of breast conservation therapy to women with macromastia with acceptably low complication rates.

Even after breast conserving therapy and radiation, the reduction mammaplasty seems feasible with acceptable osmetic results as Spear S et al [18] pointed out. The authors recommended using wider flaps to avoid complications as nipple or flap necrosis, recognizing already in their small series that the healing process was impaired with more and longer induration and swelling than on the nonradiated side. These facts favour the concept of oncoplastic reduction mammaplasty before radiation therapy as we present it here.

Combined segmental mastectomy and breast reduction represents a valuable treatment option for the patient who presents with macromastia and cancer of the breast [19–22].

The ablative procedure is not compromised and the improved symmetry of the breast has resulted in an excellent cosmetic outcomes in these patients.

References

1. Veronesi U, Salvadori B, Luini A (1995) Breast conserving is a safe method in patients with small cancer of the breast. Long-term results of three randomized trials on 1,973 patients. Eur J Cancer 31:1574–1579
2. Veronesi U, Zurrida S (1996) Breast cancer surgery: a century after Halsted. J Cancer Res Clin Oncol 122:74–77
3. Fisher B, Anderson S, Redmond CK (1995) Reanalysis and results of 12 years of follow up in a randomised clinical trial comparing total mastectomy with lumpectomy with or without irradiation in the treatment of breast cancer. N Engl J Med 333:1456–1461
4. Fisher B, Bryant J, Wolmark N (1998) Effect of preoperative chemotherapy on the outcome of women with operable breast cancer. J Clin Oncol 8:2483–2493
5. Veronesi U, Bonadonna G, Zurida S (1995) Conservation surgery after primary chemotherapy in large carcinomas of the breast. Ann Surg 222:612–618
6. Strömbeck JO (1960) Mammaplasty: report of a new technique based on the two-pedicle procedure. Br J Plast Surg 13:79
7. McKissock PK (1972) Reduction mammaplasty with a vertical dermal flap. Plast Reconstr Surg 49:245–252
8. Lejour M (1994) Vertical mammaplasty and liposuction of the breast. Plast Reconstr Surg 94:100–114
9. Benelli L (1990) A new periareolar mammaplasty: the "round block" technique. Aesthet Plast Surg 14:93–100
10. Hall-Findlay EJ (1999) A simplified vertical reduction mammaplasty: shortening the learning curve. Plast Reconstr Surg 104:748–759
11. Hammond DC (1999) Short scar periareolar inferior pedicle reduction (SPAIR) mammaplasty. Plast Reconstr Surg 103:890–901
12. Ribeiro L (1975) A new technique for reduction mammaplasty. Plast Reconstr Surg 55(3):330–334
13. Ribeiro L, Accorsi A, Buss A, Marcal-Pessoa M (2002) Creation and evolution of 30 years of the inferior pedicle in reduction mammaplasties. Plast Reconstr Surg 110:960–970
14. Spear SL (2003) Experience with reduction mammaplasty combined with breast conservation therapy in the treatment of breast cancer. Plast Reconstr Surg 111:1102
15. Patel KM (2011) A head-to-head comparison of quality of life and aesthetic outcomes following immediate, staged-immediate and delayed oncoplastic reduction mammaplasty. Plast Reconstr Surg 127:2167
16. Gray JR, McCormick B, Cox L, Yahalom J (1991) Primary breast irradiation in large-breasted or heavy women: analysis of cosmetic outcome. Int J Radiat Oncol Biol Phys 21:347–354
17. Moody AM, Mayles WP, Bliss JM (1994) The influence of breast size on late radiation effects and association with radiotherapy dose inhomogeneity. Radiother Oncol 33:106–112
18. Spear S, Burke JB, Forman D (1998) Experience with reduction mammoplasty following breast conservation surgery and radiation therapy. Plast Reconstr Surg 102:1913–1916
19. Shestak KC, Johnson RR, Greco RJ, Williams SL (1993) Partial mastectomy and breast reduction as a valuable treatment option for patients with macromastia and carcinoma of the breast. Surg Gynecol Obstet 177:54–56
20. Munhoz AM, Aldrighi CM (2006) Breast reduction as an alternative treatment option for early breast cancer in women with macromastia. Ann Plast Surg 36:26–30
21. Rezai M (2007) Reduktionsplastik mit modifizierter inferiorer Technik. In: Granitzka S, Siebert W (eds) Plastische Operationen an der weiblichen Brust, 2nd edn. Marseille, Munich
22. Rezai M, Nestle-Krämling C (1999) Oncoplastic surgical techniques in breast-conserving therapy for carcinoma of the breast. Gynakologe 32(2):83–90

Distant Volume Flaps for Conservative Surgery 17

Jennifer E. Rusby and Richard M. Rainsbury

17.1 Introduction

The proportion of breast excised in breast-conserving surgery impacts on aesthetic outcome and patient satisfaction [1–3]. Women who are likely to have a poor cosmetic outcome from standard breast-conserving surgery as a result of the volume of excision required to attain clear margins were, historically, advised to have a mastectomy. Oncoplastic surgery has extended the role of breast conservation to allow many patients who would otherwise require a mastectomy to preserve their breasts.

In 2007, approximately 19,500 women underwent breast-conserving surgery for cancer in the UK [4], so postoperative cosmesis is important to a large number of women. Furthermore, as survival following breast cancer improves [5], the long-term appearance after surgery becomes relevant to larger numbers of patients for longer. Finally, patient expectation seems to be increasing as patients are aware that they need not look deformed after breast cancer treatment, and now that visual information is more freely available via the Internet.

Oncoplastic breast-conserving techniques can be classified as volume *displacement* or volume*replacement* . Chapters 12–15 describe the various techniques for volume displacement after partial mastectomy. Volume replacement after total mastectomy (i.e. breast reconstruction) can be provided by an implant, a pedicled flap or a free flap. This is also the case in partial breast reconstruction. The use of implants for volume replacement in partial breast reconstruction is hampered by the need for radiotherapy, hence results are generally poor [6]. Further discussion of implants is beyond the scope of this chapter. Defects in the lower and lateral aspects of the breast can be addressed using local flaps such as abdominal "adipofascial flaps" [7] and lateral tissue flaps [8, 9], respectively. The distant flaps used for volume replacement after partial reconstruction are most commonly pedicled, although some small case series of free flap volume replacement after partial mastectomy have been published [10, 11].

The focus of this chapter is therefore pedicled flaps for volume replacement. Donor options include the latissimus dorsi (LD) muscle (known as an LD miniflap) or skin and subcutaneous tissues of the anterior or lateral chest wall and back in the form of perforator flaps such as intercostal artery perforator (ICAP) and thoracodorsal artery perforator (TDAP) flaps. Pedicled omental flaps can be used to reconstruct inferomedial defects [12]. The superior epigastric artery perforator flap results in very visible donor site scarring. It is therefore best reserved for salvage situations (after recurrent breast cancer, or deep inferior epigastric perforator flap necrosis) [13].

The LD muscle was first used in breast reconstruction by Tansini in 1897. In the recent era of breast reconstruction this has been the workhorse, with significant advantages over implant-only reconstruction for many patients. The use of the LD muscle for volume replacement after breast-conserving surgery was first described by Noguchi et al. [14] in 1990 and was popularised by Rainsbury in the UK in the last decade [15, 16]. With increasing expertise in perforator free flaps for whole breast reconstruction, and well-recognised morbidity from LD muscle transfer, it was a natural extension to consider pedicled perforator flaps for volume replacement after partial mastectomy . In 1995, Angrigiani et al. [17] reported a feasibility study in 40 cadavers and five clinical cases of raising a cutaneous flap as "the latissimus dorsi musculocutaneous flap without muscle". This flap has been used as a free flap for reconstruction of a wide variety of defects (upper and lower limb, neck, etc.). However, it was not until 2004 that Hamdi et al.

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[18] published a series of 31 TDAP flaps used for reconstruction of partial mastectomy defects, and this is now the first choice for repair of partial mastectomy defects by Hamdi [19]. The lateral ICAP (LICAP) and anterior ICAP flaps have also been used for this purpose [20, 21].

17.2 Indications/Patient Selection

Patients with large breasts may accept or even welcome the option of a reduction in breast volume as a result of tumour excision, and the local defect may be best managed with a displacement technique and contralateral symmetrising surgery. But if the patient is keen to avoid contralateral surgery, volume replacement is an option. Smaller-breasted women who wish to avoid local defects and global loss of breast volume are better suited to volume replacement procedures. By choosing this rather than total mastectomy and immediate breast reconstruction, a woman is more likely to preserve the normal shape and sensation of most of her breast [22] but must accept the need for adjuvant breast radiotherapy.

An LD miniflap can readily be used to fill a defect in the lateral aspect of the breast, but also in the central, medial or lower pole of the breast with sufficient mobilisation. Full dissection of the flap inferiorly to the costal margin and posteriorly beyond the scapula, combined with thorough division of all surrounding attachments (see later), is essential in order to capitalise on the full potential of this flap to reconstruct a wide range of resection defects in almost any location. Perforator flaps tend to have less range, although TDAP flap replacement of volume is reported in all quadrants [23]. The ICAP flap is best suited to the lateral aspect of the breast, but defects in the superior pole can be addressed if a pedicle of 3–5 cm can be harvested, as this allows rotation of the flap through 180° without torsion of the perforator [18, 20].

The volume of tissue required also affects choice of flap. Hamdi et al. [18] state that a muscle-sparing LD type III flap (i.e. most of the muscle is included with the flap) is used if the muscle is needed for volume. Most case series of perforator flaps do not provide details of the oncological surgery, but the median specimen weight in a series of LD miniflaps (equivalent to muscle-sparing LD type III flap) was 207 g [24] compared with 164 g in a series of ICAP flaps [21].

Although the importance of *prevention* of cosmetic deformity after breast conservation is emphasised, there will always be a cohort of patients with a suboptimal result who require revisional surgery in the delayed setting [25]. Partial breast reconstruction with volume replacement is a mainstay of management in this situation. Patients must be informed of the full range of options available to them (including completion mastectomy and immediate whole breast reconstruction), and counselled carefully, to allow them to make an informed choice about their treatment in the knowledge of the likely range of outcomes.

17.3 Technique

Whether partial breast volume replacement is performed by a single "oncoplastic" team or separate surgical oncology and plastic surgery teams, it is important that all aspects of the procedure are carefully planned, particularly the oncological resection and the flap design. If two teams are involved, close preoperative collaboration is essential.

17.3.1 Flap Design

Perforators must be assessed preoperatively. Unidirectional (8-Hz) Doppler assessment usually suffices to identify suitable perforators. Duplex is used in difficult cases and multidetector-row CT scanning has also been used [18, 26, 27]. The TDAP usually lies 8 cm below and within 5 cm of the anterior border of the LD muscle [28]. The LICAPs are found an average of 3.5 cm from the anterior border of the LD muscle in the fourth to eighth intercostal spaces and are most likely to be found in the six or seventh intercostal space [19].

17.3.2 Planning and Patient Positioning

Oncological planning involves careful clinical and radiological assessment of tumour size, position and unifocality. The tumour should be marked on the breast, together with an "access tunnel" if required (Fig. 17.1). The borders of the LD muscle should be marked for any case in which muscle harvest is anticipated. For LICAP and TDAP flaps, a pinch test allows assessment of the amount of skin and subcutaneous tissue available while allowing closure without excessive tension (approximately 12 cm perpendicular to the long axis of the flap [20]). The flap is usually horizontally aligned when used for partial breast reconstruction. This allows it to be placed in the relaxed skin tension lines and the donor site scar to be hidden in the bra. The lateral decubitus position is optimal for raising an LD miniflap and lateral chest wall perforator flaps provided the tumour excision can be safely undertaken, the patient in. The shoulder should be abducted to 90° and the elbow should be in 90° of flexion. In addition to providing good access, this makes the perforator course more perpendicular to the skin and the Doppler signal is therefore more discrete. Care must be taken to avoid over abduction or extension as this can lead to a brachial plexopathy.

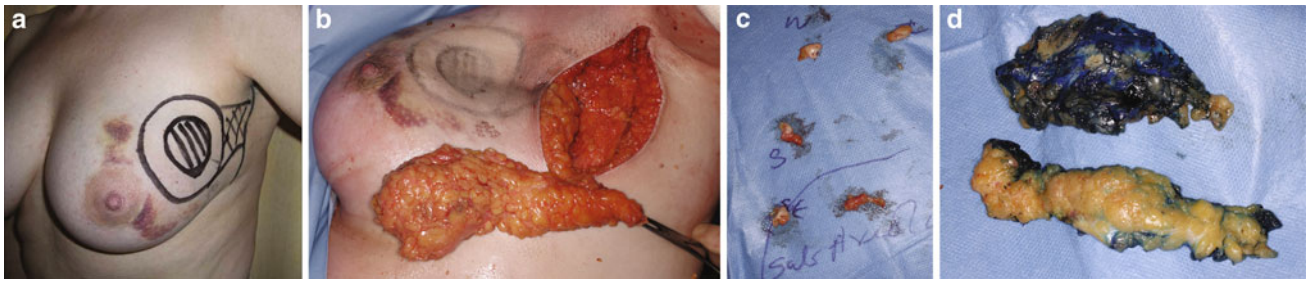

Fig. 17.1 Tumour resection: **a** Preoperative breast markings. **b** A 220-g specimen attached to 'access tunnel' tissue, showing the resulting resection defect and lateral incision used to perform the procedure. **c** Bed biopsy material sent for intraoperative frozen section. **d** 'Re-excision specimens' inked in situ with methylene blue to identify the surface adjacent to the cavity

17.3.3 Incisions and Raising the Flap

The incision depends on whether volume is being replaced in the immediate or delayed setting and which type of flap is planned. In the delayed setting, reopening the previous skin incision on the breast often reveals a skin deficit. The wound may gape, demonstrating that skin replacement is required to allow the remaining breast tissue to return to its presurgical position. This may be the case even if no skin was excised at the time of breast-conserving surgery. Despite being an "apparent" skin deficit as a result of scarring and radiotherapy rather than a real deficit, it will need correction to optimise the result.

When the tumour is excised immediately before volume replacement, the breast skin is mobilised in the oncoplastic plane, over and around the tumour. The breast is then mobilised off pectoralis major muscle. The tumour is excised with generous margins and in continuity with lateral tissue to form the access tunnel as required. Bed biopsies are performed and the material removed is sent for frozen section, and a full cavity re-excision is undertaken to maximise the chance of clear margins (Fig. 17.1) [24]. Alternatively, a "delayed-immediate" reconstruction can be undertaken 1 week after tumour excision and when final histopathology results are available [29]. This is a particularly useful option after neoadjuvant chemotherapy when frozen-section analysis is more likely to be falsely negative.

An immediate LD miniflap is best performed via a cosmetically discreet "lazy S" incision in the anterior axillary line, providing access to the breast for tumour excision and the back for raising the LD flap [30]. The LD flap is raised in the plane just beneath the fascia, sparing the subcutaneous fat but taking a layer of fat over the muscle, which contributes to the flap volume (Fig. 17.2). Division of the entire fascial attachment of the LD muscle to teres major muscle, all serratus anterior muscle branches and the tendon of the LD muscle allows full transposition of the flap into the resection defect (Fig. 17.3). This is particularly important when reconstructing more remote defects in the medial or lower pole of the breast. Finally, the tendon needs to be secured to pectoralis major muscle to prevent unintentional tension on the pedicle, before the flap is modelled and sutured into the resection defect (Fig. 17.4). When harvesting the flap it is best to overestimate the volume required to allow for muscle atrophy over time. As a result, the volume of the reconstructed breast should be larger than that of the opposite breast at the end of the procedure, and a good cosmetic result can be anticipated if these key steps are observed (Fig. 17.5).

Perforator flap incisions are planned to incorporate the best perforators, and with a view to minimising the cosmetic defect. This is usually an ellipse in the bra line, sited with the anterior tip at the lateral border of the inframammary fold. Alternatively it may be oriented vertically, sparing the medial back, if the patient wishes. TDAP flaps are raised in a plane above or just below the deep fascia and the perforator is identified and dissected through the muscle and up to the thoracodorsal artery itself until the required pedicle length has been achieved (for details see Hamdi et al. [23]). Perforators from the descending branch of the thoracodorsal artery are preferred over perforators from the transverse branch but the inconsistent perforator size, quality, quantity and location means dissection must be painstaking, and is often reported as tedious [23, 28, 31]. If the perforator is less than 0.5 mm in diameter, the flap is at risk of failure, so conversion to a muscle-sparing LD flap is advised. The flap is brought through the muscle and placed in the defect, such that the anterior border lies medially or is rotated to lie inferiorly.

LICAP flaps are based on the perforators arising from the costal segment of the intercostal artery. In a cadaveric dissection study, Hamdi et al. [19] showed a variable number of intercostal perforators and a dominant perforator in 92 % of cases: these lay, on average 3.5 cm from the anterior border of the LD muscle. If the pedicle is long enough, the flap can be rotated through 180° [19, 21]. If the perforator is eccentric within the area of the flap, this rotation may allow significantly greater reach.

All flaps are partially or totally de-epithelialised, depending on whether skin is required to replace a deficit. If the flap is totally subcutaneous, Doppler monitoring cannot be undertaken.

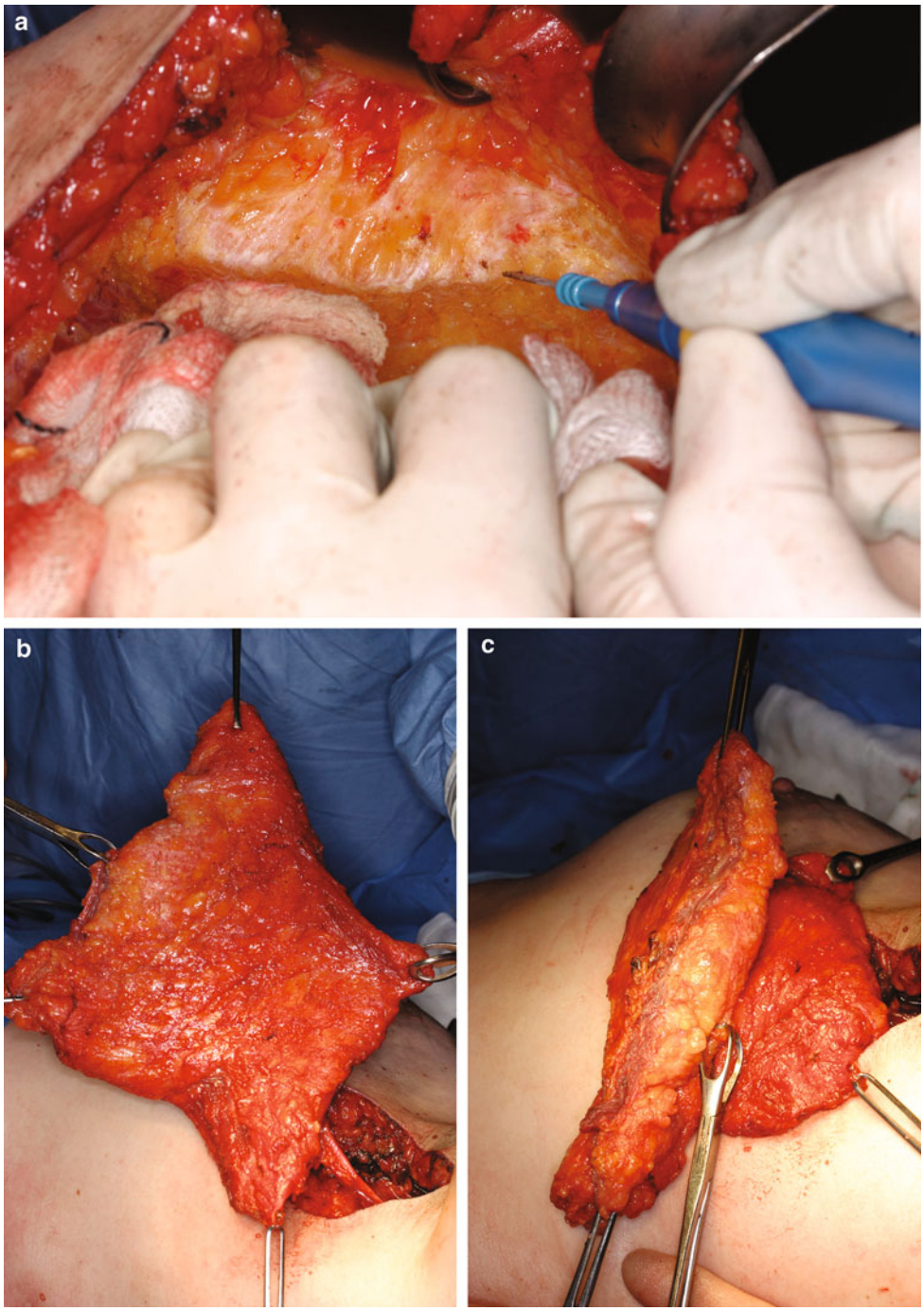

Fig. 17.2 Harvesting the latissimus dorsi (LD) miniflap. **a** Dissection of the superficial surface of the flap in a plane immediately under Scarpa's fascia (the deep fascia). **b** The layer of fat on the superficial surface of the flap harvested as a result of dissecting in this plane. **c** View of the divided distal end of the flap, showing the layer of superficial fat, which is thicker than the muscle itself at this level

17.4 Outcome

The literature on volume replacement comprises mainly single-institution series, i.e. level 3 evidence. There is a lack of objective outcome reporting, very few comparative studies and it is likely that publication bias exists. It is not clear whether volume replacement techniques are being widely used by surgeons other than the recognised experts such as Hamdi, Rainsbury and Munhoz. Those achieving less successful outcomes are less likely to report their results.

17.4.1 Oncological Outcomes

Although the literature on "oncoplastic surgery" as a whole is expanding rapidly, it remains very heterogeneous in the indications for surgery, the techniques used and the duration

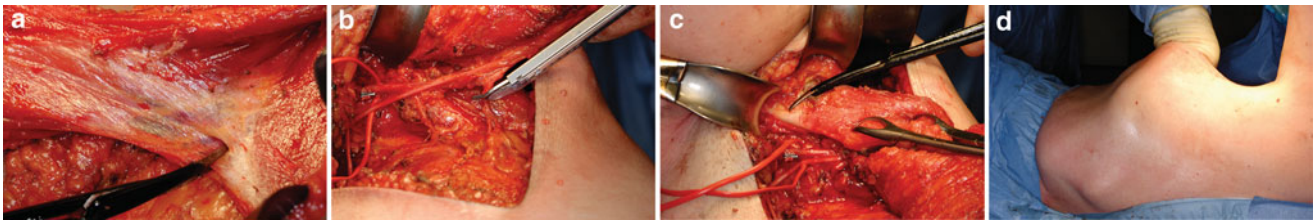

Fig. 17.3 Division of all LD miniflap attachments and the resulting donor defect. **a** Division of the well-developed fascia between LD muscle (*top left*) and teres major muscle (*bottom right*), dissecting in a cranial direction. The thoracodorsal vessels lie immediately deep to this unnamed fascial layer. **b** Clip ligation of a serratus anterior muscle branch in preparation for division of the vessels. **c** Protecting the subscapular vessels with a sling during division of the LD tendon. **d** The assistant's hand outlines the extent of the LD donor defect following flap harvest

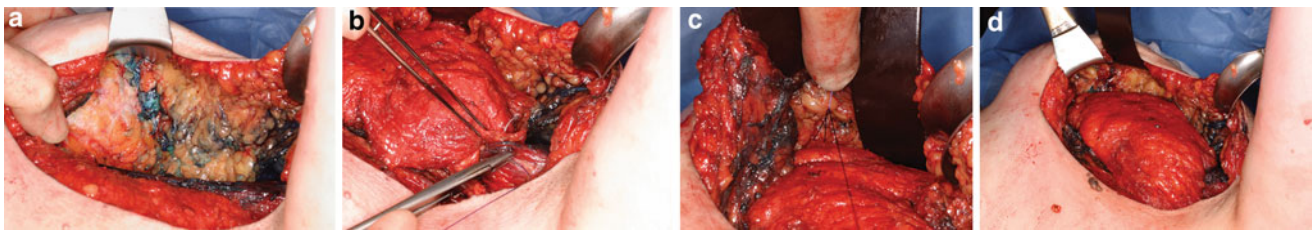

Fig. 17.4 Reconstruction of the resection defect. **a** Lateral view of the walls of the resection defect. **b** Suturing the tendon of the LD miniflap to the lateral border of pectoralis major muscle. **c** Suturing folded distal edge of the flap onto the medial cavity wall. **d** Appearance of the flap at end of the procedure after it has been sutured into the resection defect

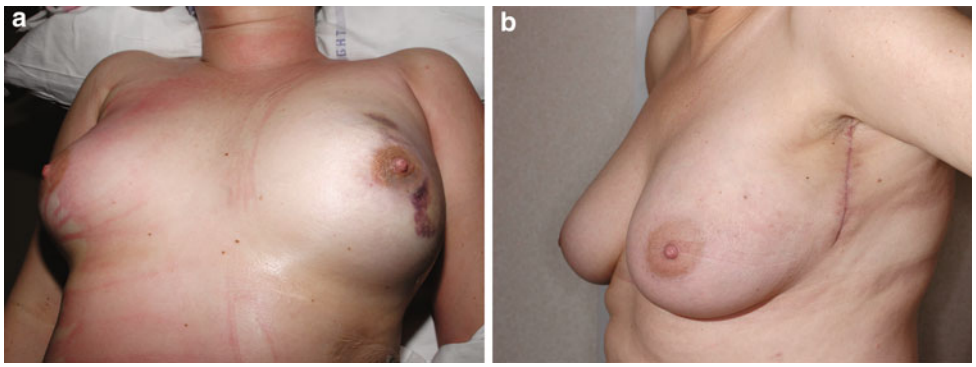

Fig. 17.5 Postoperative appearance**. a** Appearance before extubation, showing over-replacement of the resected volume to allow for subsequent volume loss**. b** Appearance at 6 weeks, showing short 'lazy-S' lateral scar and natural breast shape

of follow-up. Overall, oncoplastic breast-conserving surgery has a local recurrence rate approximately equivalent to that of standard breast surgery, which may be because of the balance between allowing wider excision for some tumours while being used in patients with more extensive disease [32–35].

Tables 17.1 and 17.2 summarise the limited literature on local recurrence after volume replacement with distant flaps. For LD miniflap series, the local recurrence rates range from 0 to 5 % with a stated follow up of 24–54 months. It is striking that most reports on perforator flap surgery focus on the techniques of surgical reconstruction This may reflect the interests of the population of surgeons undertaking the different forms of reconstruction, with more breast/general surgeons doing LD miniflaps and plastic surgeons doing perforator flaps. Alternatively, it may simply be because perforator flaps have been used in fewer patients and more recently so that follow-up data are only now becoming mature enough for scrutiny [21]. Finally, it is reasonable to assume that the oncological decision-making with regard to tumour excision is dissociated from the method used to fill the defect, so the local recurrence rate should not differ according to reconstructive technique used. However, Rietjens et al. [35] report that LD volume replacement was used for cases with a large defect and that larger tumours had a higher recurrence rate, so it is possible that over time a trend will emerge.

Table 17.1 Case series of latissimus dorsi miniflap (LDMF) volume replacement

Authors	Flap	Number	Tumour size	WLE weight/ volume	LR and follow-up	Cosmesis	Complications
Noguchi et al. [14]	LDMF	5				4/5 good cosmesis by moire topography	
Raja et al. [30]	LDMF	20	25 mm	57 % > 150 g		Cosmetic failure uncommon (10 % vs. WLE 34 %)	
Kat et al. [36]	LDMF	30					Two minor wound infection, six seromas
Dixon et al. [29]	LDMF	25		Median 94 g		Similar to WLE	21 seromas, no other major morbidity
Gendy et al. [22]	LDMF	49	22 mm		2 LR at 53 months but had not had RT	Significantly better than for SSM	6 % required further surgery. One brachial plexopathy
Losken et al. [37]	LDMF	39			5 % at 44 months		
Nano et al. [38]	LDMF	18	Median 33 mm	130 g	0 at 24 months	17/18 satisfied (1 required mastectomy)	14 seromas, no major complications
Munhoz et al. [39]	LDMF	48	44 % > 2 cm				Flap complications in 7, donor site in 12
Naguib [40]	LDMF	29	Median 5.2 cm	219 cm^3		69 % cosmetically satisfactory	Persistent seroma 52 %. No sepsis or flap viability problems
Navin et al. [41]	LDMF	51	20 mm	217 g	None at mean of 33 months	86 % of respondents satisfied	One flap necrosis
Rusby et al. [24]	LDMF	110	34 mm	207 g	1 at median of 41.4 months		Three infection/wound problems
Hernanz et al. [42]	LDMF	41	22 mm	Median 167 cm^3	1/41 (2.4 %) at 54 months	65 % satisfactory	

LR local recurrence, *WLE* wide local excision, *RT* radiotherapy, *SSM* skin-sparing mastectomy

17.4.2 Cosmetic and Other Outcomes

Assessment of cosmetic outcome ranges from superficial to detailed. Again, the lack of data on cosmetic outcome after perforator flap surgery may simply reflect the proof-of-principle nature of many of the reports to date. For example, Hamdi et al. [23] gave extensive detail on the surgical technique but did not comment on the aesthetic outcome. Munhoz et al. [21] reported a series of 13 patients who underwent LICAP, all with "satisfactory results", but the assessment method was not described.

Not surprisingly, when quadrantectomy was compared with quadrantectomy plus immediate volume replacement , the symmetry (as assessed by moire topography) was satisfactory after volume replacement but there was a severe deformity after lateral quadrantectomy and no reconstruction [14]. Hernanz et al. used panel assessment of cosmetic outcome after LD volume replacement in 2007 [46] and in 2010 followed up an overlapping cohort including 19 of the same patients [42] using the BCCT.core software program [47]. This standardised, objective assessment may in the future make possible interseries comparisons and comparisons over time, although since different methods were used in the two studies of Hernanz et al., interpretation is difficult. They commented that four patients (21 %) had deteriorated from good to fair.

Although comparative studies are always difficult in surgical research because "clinical judgement" often results in a patient being advised to follow one course of action or another, in order to assess the results of volume replacement surgery after breast-conserving surgery, one would need to make a comparison with the alternative, i.e. a skin-sparing mastectomy and immediate breast reconstruction. Three

Table 17.2 Case series of other pedicled flaps in reconstruction after breast-conserving surgery

Authors	Flap	Number	Tumour size	WLE weight/ volume	LR and follow-up	Cosmesis	Complications
Hamdi et al. [18]	TDAP ICAP	18 3					Two partial flap necrosis
Hamdi et al. [23]	TDAP to various sites 73 immediate partial reconstruction, 5 delayed	99 73 5					90 perforator, 10 MS flap One major flap necrosis, partial in three
Zaha et al. [12]	Omental flap	24	32 mm	180 cm^3	None, duration of follow-up not stated	Excellent or good in 93 %	
Munhoz et al. [21]	LICAP AICAP	11 2	9 < 2 cm	Median 165 g	None at mean of 32 months	92 % satisfied or very satisfied	Two wound dehiscence, one fat necrosis

Several other oncoplastic series were excluded, e.g. [20, 35, 43–45], because it is not possible to separate data for volume replacement after breast-conserving surgery from that for other cohorts

TDAP thoracodorsal artery perforator, *ICAP* intercostal artery perforator, *LICAP* lateral intercostal artery perforator, *AICAP* anterior intercostal artery perforator, *MS* muscle-sparing

studies describe this comparison. Gendy et al. [22] reported postoperative complications, further surgical interventions, nipple sensory loss, restricted activities and cosmetic outcome by panel assessment. These were all better in the LD miniflap group than in the group of patients undergoing mastectomy and immediate breast reconstruction. Anxiety about residual cancer and ease of breast self-examination were similar in both groups. Similarly, Dixon et al. [29] compared women undergoing miniflap reconstruction with those having standard breast-conserving surgery or mastectomy and immediate whole breast reconstruction. Patients with miniflaps reported better shape, symmetry and less self-consciousness. Bassiouny et al. [43] compared patients undergoing quadrantectomy and immediate volume replacement with those undergoing nipple-sparing mastectomy and immediate reconstruction with an LD flap by means of a patient self-evaluation questionnaire and two independent observers of photographs using the Harris criteria. They found similar rates of complications and no significant difference in aesthetic results in the two groups.

17.5 Complications

Many complications are common to all volume replacement flaps. Oncologically, these include the possibility of positive margins, which may only be known some days after the procedure. Oncoplastic techniques allow larger volume excisions, so the incidence of positive margins is lower than that in a population undergoing standard breast-conserving surgery; however, there is still a quoted rate of 3–16 % [30, 33, 48]. This poses problems when volume replacement is done as an immediate procedure. Strategies to prevent this include assessing bed biopsy material by frozen section at the time of surgery and performing full cavity re-excision until the new margins are confirmed as clear [24]. Others advocate a delayed approach, waiting for the final pathology results before the patient is returned to the operating theatre 1 week after ablative surgery for the reconstruction [29]. Clearly the downside of this is a second operation, and in most cases margins are clear.

There have been concerns about mammographic follow-up after volume replacement surgery. The flap may undergo focal necrosis resulting in oil cysts or other mammographic changes. However, several reports state that distinguishing benign postsurgical changes from local recurrence is possible radiologically in most cases [2, 49].

Shoulder girdle dysfunction has been closely studied in patients undergoing full breast reconstruction using the LD muscle with or without an implant. Button et al. [50] used the DASH score (disabilities of the arm, shoulder and hand) to document changes from preoperative function up to 3 years after surgery and identified a functionally insignificant increase in the score in patients undergoing whole breast reconstruction using autologous LD muscle. Gendy et al. [22] investigated physical disability after LD miniflap and whole breast reconstruction with LD muscle and an implant and found equivalent degrees of shoulder disability, affecting work in 25 % of both groups. Hamdi et al. [51] reported on a series of 22 patients who had undergone TDAP flap volume replacement and participated in a functional study of shoulder function. When comparing the strength of the LD muscle on the side that had been operated on with that on the side that had not been operated on, they found that the strength seemed to be maintained. Shoulder mobility was similar, but active and possible forward elevation and passive abduction were significantly reduced.

Seroma formation is widely reported after LD reconstruction. Strategies to reduce this include use of drains, quilting, tissue adhesives and steroid injections [52–55]. Interestingly, Hamdi et al. [23] reported no seroma formation after TDAP flap volume replacement.

Another symptom unique to LD miniflap reconstructions is that of muscle movement and twitching. The surgeon must decide whether the thoracodorsal nerve should be preserved at the time of primary surgery. This may reduce the volume loss associated with muscle atrophy, but does leave the muscle innervated and therefore liable to contract when the patient forcefully adducts the upper arm. Rarely, muscle twitching is spontaneous, repetitive, forceful, visible and distressing for the patient, requiring secondary division of the nerve.

Flap loss rates are hard to gauge as many studies report the use of TDAP and ICAP flaps for a variety of indications and include both free and pedicled flaps [23, 56]. The flap loss rate in descriptions of the TDAP and LICAP flaps for partial breast reconstruction was partial flap loss in two of 31 patients in one series [18] and zero in another [21].

LD miniflap reconstruction of partial mastectomy defects is often criticised as "burning bridges" because if a patient develops in-breast recurrence, the LD muscle is no longer available for a salvage reconstruction after mastectomy. However, recurrence in this context is a relatively uncommon event [24] and if it does occur, free flap reconstruction could be considered after mastectomy and the peri-and post-cancer-treatment weight gain (on average 1–5 kg [57]) may contribute to the availability of alternative autologous tissue for reconstruction at a later date in the event of recurrence.

17.6 The Future of Volume Replacement

As more surgeons are trained in oncoplastic thinking, the need for secondary correction of partial mastectomy deformity should diminish. Alternative methods of filling defects, such as lipomodelling, are already being used (see Sect. 17.3). However, there will always be a group of women who do not wish to have multiple stages to their revisional surgery, have a large defect or who do not have sufficient donor fat, making a flap-based reconstruction more suitable.

The LD miniflap is a useful option for partial breast reconstruction and can be performed by all surgeons who routinely do LD whole breast reconstruction. Several units have published reasonable-sized series suggesting that this is a reliable technique. The popularity of deep inferior epigastric artery and other perforator flaps for whole breast reconstruction has led to wider availability and reliability of perforator flaps in general. ICAP and TDAP flaps are used in a manner similar to the LD miniflap, and have the advantage of preserving the function of the muscle. However, they require specific expertise and it is not clear whether the use of these flaps is confined to a few very specialist centres (e.g. Hamdi et al. [18, 20] and Munhoz et al. [21]). Even in these centres the numbers are relatively small, so it may be that few patients are suitable for these flaps. Possible reasons include the fact that the volume available is limited to the volume of skin and subcutaneous fat, excluding muscle, and the scar required for such flaps is cosmetically unappealing compared with either an axillary vertical incision or a short horizontal ellipse on the back through which an LD miniflap can be raised. Only time will tell whether perforator flaps will become more widespread as a means of partial breast volume replacement.

References

1. Bulstrode NW, Shrotria S (2001) Prediction of cosmetic outcome following conservative breast surgery using breast volume measurements. Breast 10(2):124–126
2. Monticciolo DL et al (1996) Autologous breast reconstruction with endoscopic latissimus dorsi musculosubcutaneous flaps in patients choosing breast-conserving therapy: mammographic appearance. AJR Am J Roentgenol 167(2):385–389
3. Cochrane RA et al (2003) Cosmesis and satisfaction after breast-conserving surgery correlates with the percentage of breast volume excised. Br J Surg 90(12):1505–1509
4. The Second All Breast Cancer Report (2011) UK National Cancer Intelligence Network
5. Breast cancer—UK incidence statistics—trends over time (2012). http://info.cancerresearchuk.org/cancerstats/types/breast/incidence/#geog. Accessed 1 April 2012
6. Thomas PR, Ford HT, Gazet JC (1993) Use of silicone implants after wide local excision of the breast. Br J Surg 80(7):868–870
7. Ogawa T et al (2007) Usefulness of breast-volume replacement using an inframammary adipofascial flap after breast-conservation therapy. Am J Surg 193(4):514–518
8. Kijima Y et al (2011) Immediate reconstruction using a modified thoracodorsal adipofascial cutaneous flap after partial mastectomy. Breast 20(5):464–467
9. Takeda M et al (2005) Breast conserving surgery with primary volume replacement using a lateral tissue flap. Breast Cancer 12(1):16–20
10. McCulley SJ, Macmillan RD, Rasheed T (2011) Transverse upper gracilis (TUG) flap for volume replacement in breast conserving surgery for medial breast tumours in small to medium sized breasts. J Plast Reconstr Aesthet Surg 64(8):1056–1060
11. Zaha H et al (2012) Free omental flap for partial breast reconstruction after breast-conserving surgery. Plast Reconstr Surg 129(3):583–587
12. Zaha H et al (2010) Partial breast reconstruction for an inferomedial breast carcinoma using an omental flap. World J Surg 34(8):1782–1787
13. Hamdi M et al (2009) Clinical applications of the superior epigastric artery perforator (SEAP) flap: anatomical studies and preoperative perforator mapping with multidetector CT. J Plast Reconstr Aesthet Surg 62(9):1127–1134
14. Noguchi MTT, Miyasaki I, Saito Y (1990) Immediate transposition of a latissumus dorsi muscle for correcting a postquadrantectomy breast deformity in Japanese patients. Int Surg 75:166–170
15. Rainsbury RM (2002) Breast-sparing reconstruction with latissimus dorsi miniflaps. Eur J Surg Oncol 28(8):891–895

16. Rainsbury RM (2007) Surgery insight: oncoplastic breast-conserving reconstruction–indications, benefits, choices and outcomes. Nat Clin Pract Oncol 4(11):657–664
17. Angrigiani C, Grilli D, Siebert J (1995) Latissimus dorsi musculocutaneous flap without muscle. Plast Reconstr Surg 96(7):1608–1614
18. Hamdi M et al (2004) Pedicled perforator flaps in breast reconstruction: a new concept. Br J Plast Surg 57(6):531–539
19. Hamdi M et al (2008) The lateral intercostal artery perforators: anatomical study and clinical application in breast surgery. Plast Reconstr Surg 121(2):389–396
20. Hamdi M et al (2006) The versatility of the inter-costal artery perforator (ICAP) flaps. J Plast Reconstr Aesthet Surg 59(6):644–652
21. Munhoz AM et al (2011) Immediate conservative breast surgery reconstruction with perforator flaps: new challenges in the era of partial mastectomy reconstruction? Breast 20(3):233–240
22. Gendy RK, Able JA, Rainsbury RM (2003) Impact of skin-sparing mastectomy with immediate reconstruction and breast-sparing reconstruction with miniflaps on the outcomes of oncoplastic breast surgery. Br J Surg 90(4):433–439
23. Hamdi M et al (2008) Surgical technique in pedicled thoracodorsal artery perforator flaps: a clinical experience with 99 patients. Plast Reconstr Surg 121(5):1632–1641
24. Rusby JE et al (2008) Immediate latissimus dorsi miniflap volume replacement for partial mastectomy: use of intra-operative frozen sections to confirm negative margins. Am J Surg 196(4):512–518
25. van Geel AN et al (2011) Partial mastectomy and m. latissimus dorsi reconstruction for radiation-induced fibrosis after breast-conserving cancer therapy. World J Surg 35(3):568–572
26. Hamdi M et al (2007) Advances in autogenous breast reconstruction: the role of preoperative perforator mapping. Ann Plast Surg 58(1):18–26
27. Masia J et al (2006) Multidetector-row computed tomography in the planning of abdominal perforator flaps. J Plast Reconstr Aesthet Surg 59(6):594–599
28. Lin CT et al (2006) Reliability of anatomical landmarks for skin perforators of the thoracodorsal artery perforator flap. Plast Reconstr Surg 118(6):1376–1386; discussion 1387
29. Dixon JM, Venizelos B, Chan P (2002) Latissimus dorsi mini-flap: a technique for extending breast conservation. Breast 11(1):58–65
30. Raja MA, Straker VF, Rainsbury RM (1997) Extending the role of breast-conserving surgery by immediate volume replacement. Br J Surg 84(1):101–105
31. Schwabegger AH et al (2002) Thoracodorsal artery perforator (TAP) flap: report of our experience and review of the literature. Br J Plast Surg 55(5):390–395
32. Asgeirsson KS et al (2005) Oncological and cosmetic outcomes of oncoplastic breast conserving surgery. Eur J Surg Oncol 31(8):817–823
33. Chakravorty A, Shrestha AK, Sanmugalingam N, Rapisarda F, Roche N, Querci Della Rovere G, Macneill FA (2012) How safe is oncoplastic breast conservation? Comparative analysis with standard breast conserving surgery. Eur J Surg Oncol 38(5):395–398
34. Clough KB et al (2003) Oncoplastic techniques allow extensive resections for breast-conserving therapy of breast carcinomas. Ann Surg 237(1):26–34
35. Rietjens M et al (2007) Long-term oncological results of breast conservative treatment with oncoplastic surgery. Breast 16(4):387–395
36. Kat CC et al (1999) The use of the latissimus dorsi musculocutaneous flap for immediate correction of the deformity resulting from breast conservation surgery. Br J Plast Surg 52(2):99–103
37. Losken A et al (2004) Immediate endoscopic latissimus dorsi flap: risk or benefit in reconstructing partial mastectomy defects. Ann Plast Surg 53(1):1–5
38. Nano MT et al (2004) Breast volume replacement using the latissimus dorsi miniflap. ANZ J Surg 74(3):98–104
39. Munhoz AM et al (2005) Outcome analysis of breast-conservation surgery and immediate latissimus dorsi flap reconstruction in patients with T1 to T2 breast cancer. Plast Reconstr Surg 116(3):741–752
40. Naguib SF (2006) Expanding the role of breast conservation surgery by immediate volume replacement with the latissimus dorsi flap. J Egypt Natl Canc Inst 18(3):216–226
41. Navin C, Agrawal A, Kolar KM (2007) The use of latissimus dorsi miniflap for reconstruction following breast-conserving surgery: experience of a small breast unit in a district hospital. World J Surg 31(1):46–50
42. Hernanz F et al (2011) Long-term results of breast conservation and immediate volume replacement with myocutaneous latissimus dorsi flap. World J Surg Oncol 9:159
43. Bassiouny M et al (2005) Quadrantectomy and nipple saving mastectomy in treatment of early breast cancer: feasibility and aesthetic results of adjunctive latissmus dorsi breast reconstruction. J Egypt Natl Canc Inst 17(3):149–157
44. Papp C, Wechselberger G, Schoeller T (1998) Autologous breast reconstruction after breast-conserving cancer surgery. Plast Reconstr Surg 102(6):1932–1936; discussion 1937–1938
45. Petit JY et al (2002) One hundred and eleven cases of breast conservation treatment with simultaneous reconstruction at the European Institute of Oncology (Milan). Tumori 88(1):41–47
46. Hernanz F et al (2007) Oncoplastic breast-conserving surgery: analysis of quadrantectomy and immediate reconstruction with latissimus dorsi flap. World J Surg 31(10):1934–1940
47. Cardoso MJ et al (2007) Turning subjective into objective: the BCCT.core software for evaluation of cosmetic results in breast cancer conservative treatment. Breast 16(5):456–461
48. Kaur N et al (2005) Comparative study of surgical margins in oncoplastic surgery and quadrantectomy in breast cancer. Ann Surg Oncol 12(7):539–545
49. Laws SA, Cheetham J, Rainsbury RM (2001) Temporal changes in breast volume after surgery for breast cancer and the implications for volume replacement with the latissimus dorsi myosubcutaneous miniflap. Eur J Surg Oncol 27(11):790
50. Button J et al (2010) Shoulder function following autologous latissimus dorsi breast reconstruction. A prospective three year observational study comparing quilting and non-quilting donor site techniques. J Plast Reconstr Aesthet Surg 63(9):1505–1512
51. Hamdi M et al (2008) Shoulder function after harvesting a thoracodorsal artery perforator flap. Plast Reconstr Surg 122(4):1111–1117; discussion 1118–1119
52. Ali SN et al (2010) The combination of fibrin glue and quilting reduces drainage in the extended latissimus dorsi flap donor site. Plast Reconstr Surg 125(6):1615–1619
53. Carless PA, Henry DA (2006) Systematic review and meta-analysis of the use of fibrin sealant to prevent seroma formation after breast cancer surgery. Br J Surg 93(7):810–819
54. Daltrey I et al (2006) Randomized clinical trial of the effect of quilting latissimus dorsi flap donor site on seroma formation. Br J Surg 93(7):825–830
55. Taghizadeh R et al (2008) Triamcinolone reduces seroma re-accumulation in the extended latissimus dorsi donor site. J Plast Reconstr Aesthet Surg 61(6):636–642
56. Guerra AB et al (2004) The thoracodorsal artery perforator flap: clinical experience and anatomic study with emphasis on harvest techniques. Plast Reconstr Surg 114(1):32–41; discussion 42–43
57. Howard-Anderson J et al (2012) Quality of life, fertility concerns, and behavioral health outcomes in younger breast cancer survivors: a systematic review. J Natl Cancer Inst 104(5):386–405

Nonconventional Techniques in Oncoplastic Surgery

18

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18.1 Introduction

The concept of oncoplastic surgery is not so complicated. If the surgeon can manage three "basic" reduction mammaplasty techniques—techniques derived from the upper nipple and areola blood supply (superior pedicle) [1–3], techniques derived from the lower/posterior nipple and areola blood supply (inferior pedicle) [4–7], and techniques derived from the glandular nipple and areola blood supply (periareolar) [8, 9], is possible to solve around 90 % of cases. In this chapter, the goal is show possible solutions in special cases that seem initially much too complicated owing to anatomical variations, tumor locations, or patients' wishes.

18.2 Oncoplastic Surgery with Implants

The indication for use of prostheses is always problematic in cases of partial immediate reconstruction after quadrantectomies as it is difficult to predict the aesthetic results after external radiotherapy. There is a higher risk of periprosthetic capsule formation, which can lead to malpositioning of the prosthesis with unsatisfactory aesthetic results. Nowadays, with the development of the new techniques of external radiotherapy, with an optimal target dose calculation, the use of prostheses may be indicated in cases of small breasts with reduced thickness and with use of a wide base and low projection implant just to maintain the volume (Figs. 18.1 and 18.2).

18.3 Oncoplastic Surgery Plus Intraoperative Radiotherapy and Bilateral Breast Augmentation with Implants

This is a technique performed routinely in the European Institute of Oncology (IEO) for patients with small tumors and small breasts who wish for conservative surgery and also to increase the volume of the breast [10–12]. To avoid postoperative complications due to the traditional external radiotherapy, intraoperative radiotherapy can be done. All patients are treated with breast-conserving surgery (quadrantectomy). Electron beam intraoperative therapy is delivered by two mobile linear accelerators immediately after breast resection with a single dose of 21 Gy, which in radiobiology terms is similar to the 45-Gy of external radiotherapy. In young patients, only a boost in the tumor bed of 10 Gy is given and complementary external radiotherapy is provided after the surgery [13].

The quadrantectomy approach can be done through a periareolar incision. After tumor resection, the lateral glandular flaps are undermined to allow the insertion of two metallic disks (lead and aluminum) to protect the thoracic wall from diffusion of radiotherapy. Then, the mobile radiotherapy equipment is placed and the calculated dose is applied in the gland around the quadrantectomy. Then, the reconstructive step begins with insertion of the prosthesis below the pectoralis major muscle and with use of glandular flaps to cover the defect from quadrantectomy. The same implant is also used in the contralateral breast augmentation (Figs. 18.3, 18.4, 18.5 and 18.6).

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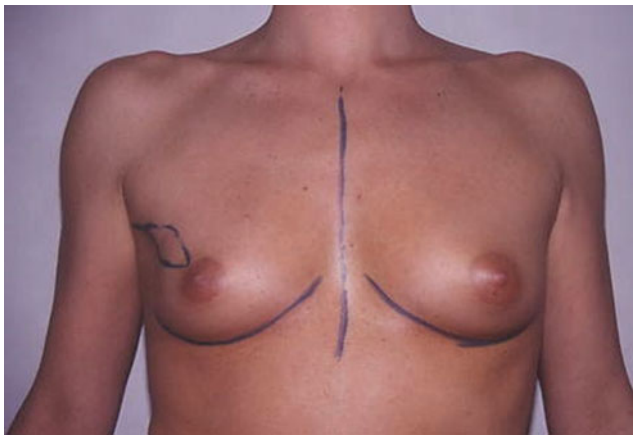

Fig. 18.1 Preoperative image: upper outer quadrantectomy of the *right* breast

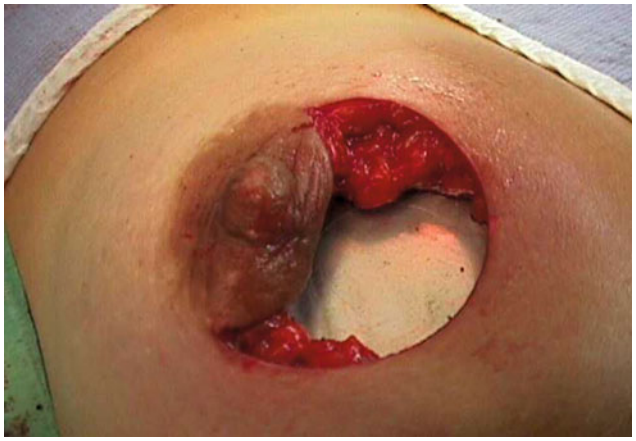

Fig. 18.4 After excision of the tumor, the metallic disks (aluminum and lead) are placed to protect the thoracic wall before starting the electron beam intraoperative therapy

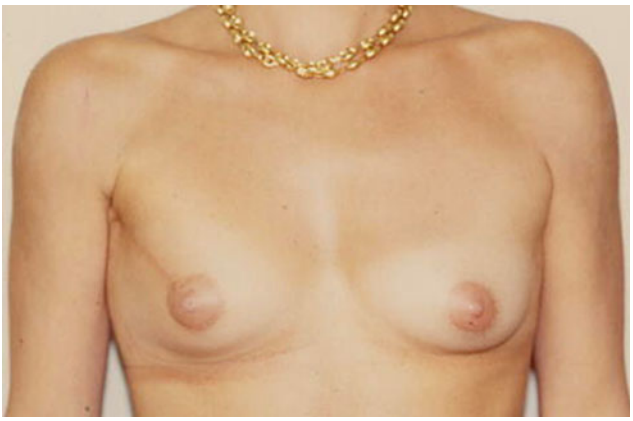

Fig. 18.2 Postoperative results 6 months after subpectoral 90-cm^3 implant insertion and external radiotherapy

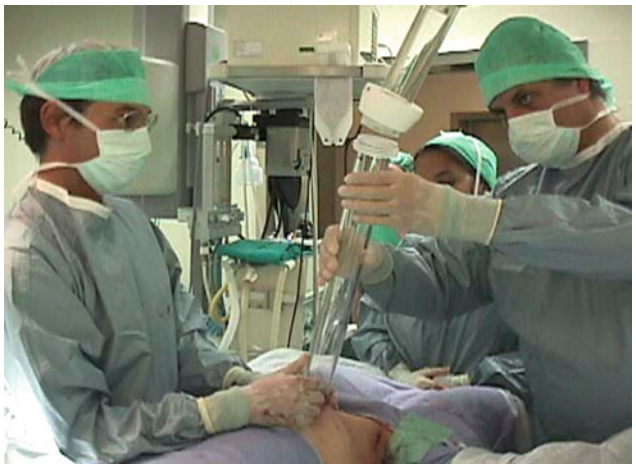

Fig. 18.5 Intraoperative image: sterile collimator adjustment to deliver the intraoperative radiotherapy

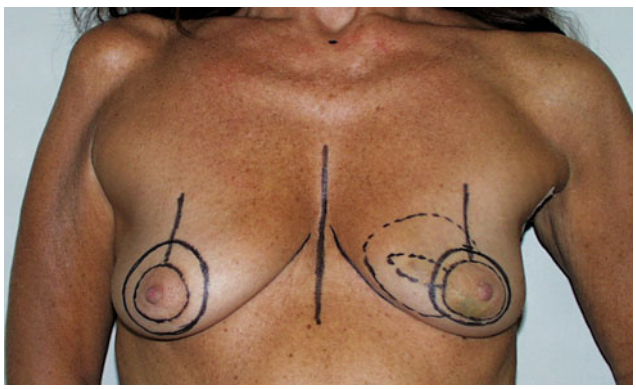

Fig. 18.3 Preoperative drawings: T1 tumor located between the internal quadrants of the *left* breast

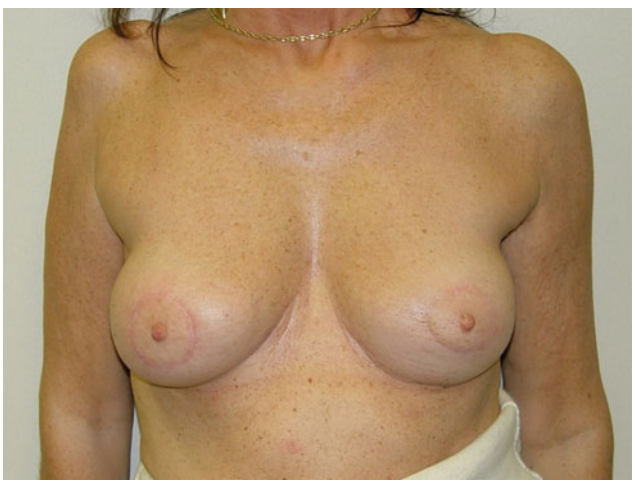

Fig. 18.6 Postoperative image at 6 months: good cosmetic results without capsula contracture or radiodystrophy

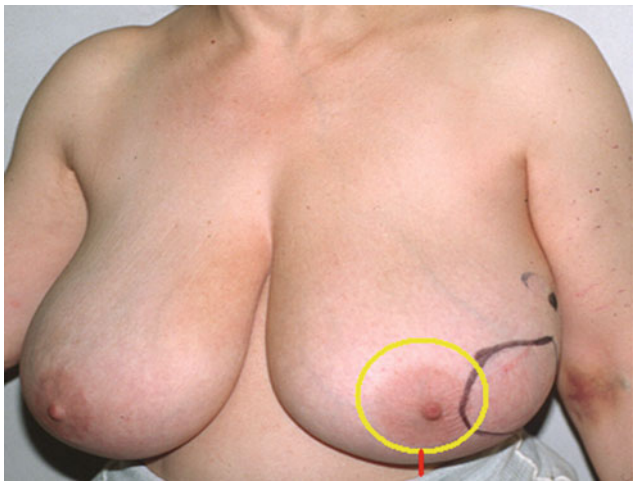

Fig. 18.7 Preoperative image: the *black line* is the tumor circumference

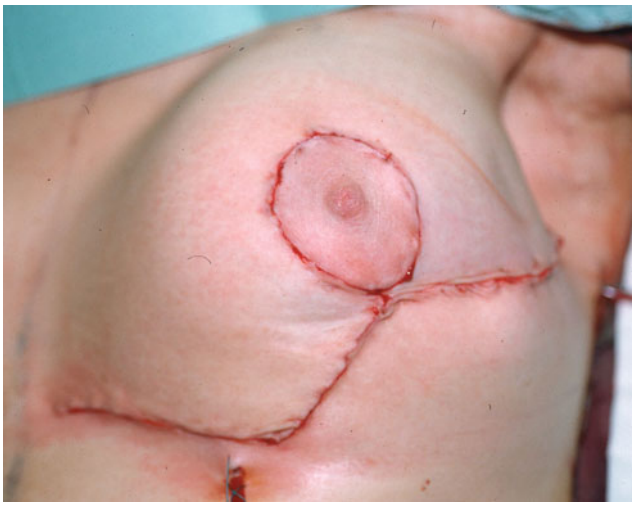

Fig. 18.9 On-table view

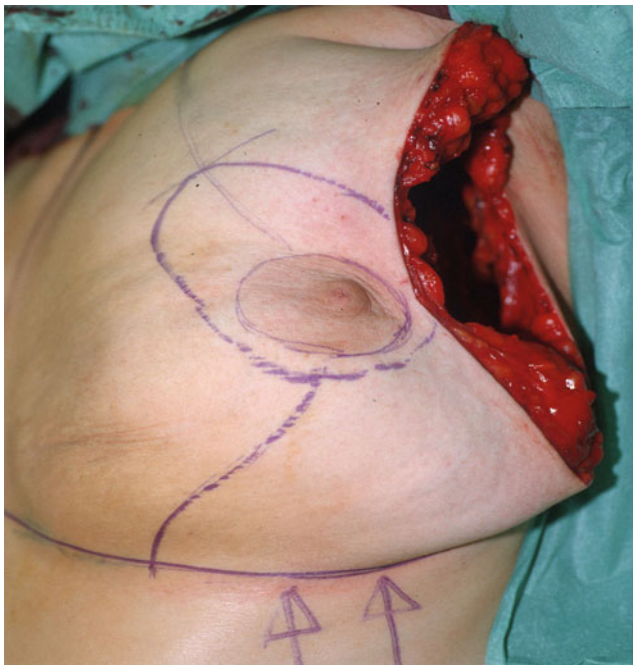

Fig. 18.8 Intraoperative image after the quadrantectomy (weight 420 g) and the drawing for Skoog and lower outer pedicle technique

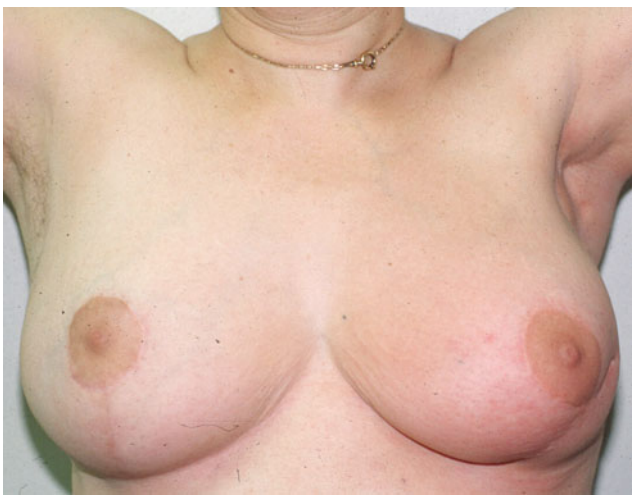

Fig. 18.10 Cosmetic results 3 months after radiotherapy

18.4 Combined Mammaplasty Techniques

The oncoplastic surgeon with good experience with the main mammaplasty techniques can in special indications, such as breast size and tumor localization, combine two or more techniques to achieve a good cosmetic result. The basic requirement is good knowledge of breast blood supply in order to avoid skin and/or glandular necrosis.

A useful technique in cases of large tumors in the upper outer quadrant and huge and ptotic breasts is the double pedicle technique. One pedicle is similar to that in Skoog technique, in order to pull up the nipple and areola complex with good blood supply [14, 15]. A second pedicle is a skin glandular pedicle, based on the vascular pedicles from the lateral border of the pectoralis major muscle and will be used to cover the glandular defect in the upper outer quadrant. This is a good solution in this situation with tumors that are very superficial and it where it is oncologically necessary to remove the skin over the lump, the only disadvantage being the large scars (Figs. 18.7, 18.8, 18.9, and 18.10).

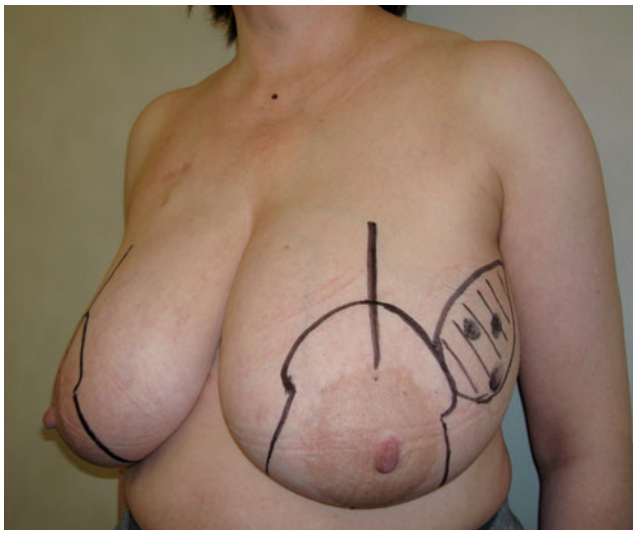

Fig. 18.11 Preoperative image: trifocal tumor in the upper outer quadrant. The drawing pattern is similar to that for the Lejour technique

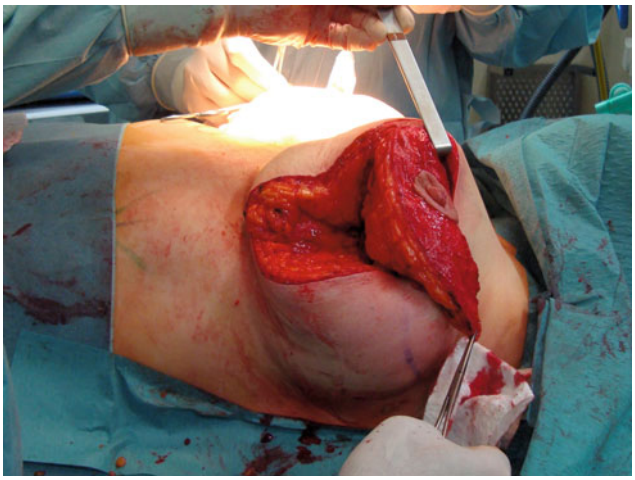

Fig. 18.13 Intraoperative image: the inferior triangle of glandular tissue normally removed with this technique will be rotated to cover the upper outer defect

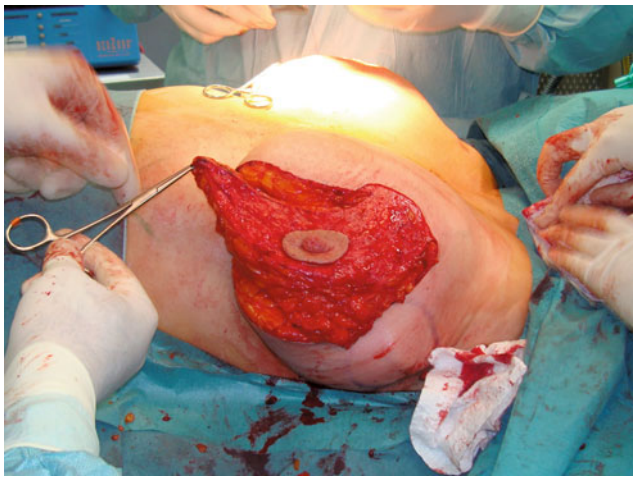

Fig. 18.12 Intraoperative image: after the quadrantectomy, a glandular flap is prepared on the basis of the upper inner quadrant

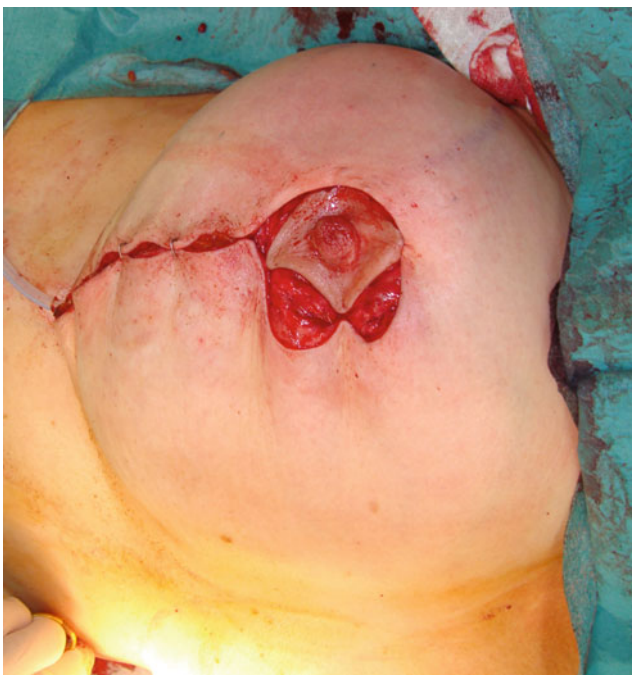

Fig. 18.14 Intraoperative image showing the final reshaping with only periareolar and vertical scars

Another option for tumors located in the upper outer quadrant is a technique similar to Lejour's technique, but using the inferior triangle of glandular tissue rotated to cover the quadrantectomy defect (Figs. 18.11, 18.12, 18.13, 18.14, and 18.15). This technique can be used in large breasts with a medium degree of ptosis, the advantage being the shortness of the scars.

18.5 Fasciocutaneous Abdominal Flaps

It is always a challenge to achieve good cosmetic results with conservative surgery for small tumors in small breasts. In the case of thin patients with a small breast without ptosis and small tumors located in the inferior quadrant, a fasciocutaneous flap harvest just above the inframammary fold and rotation to cover the defect can be indicated [16, 17]. The flap should be taken just above the inframammary fold and the pedicle oriented in the medial portion to preserve the perforator vessels coming through the upper part of the rectus abdominis muscle. The flap orientations follow the inframammary fold in order to maintain the scar exactly at

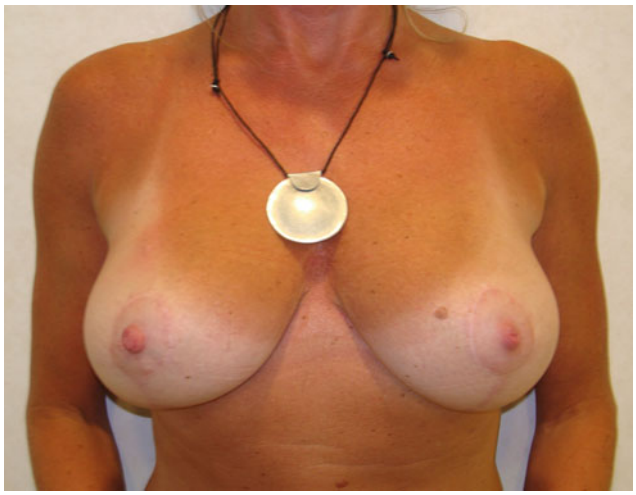

Fig. 18.15 Postoperative image after 6 months

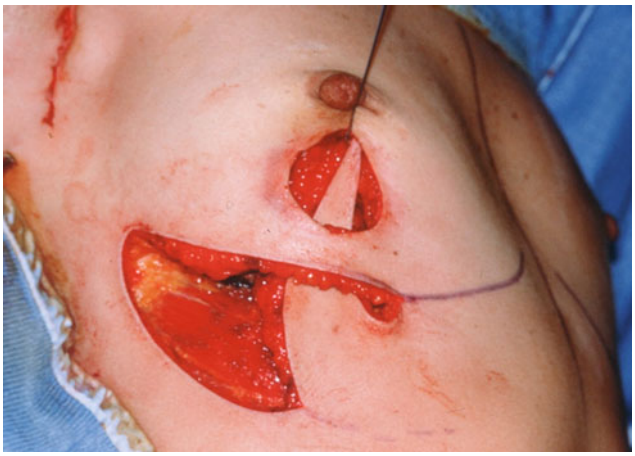

Fig. 18.17 Intraoperative image: flap rotation and the abdominal skin flap should be undermined to fix the final scar at the level of the inframammary fold

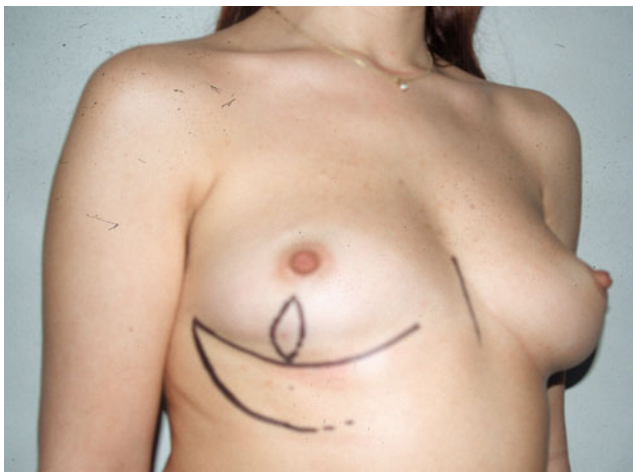

Fig. 18.16 Preoperative drawings: skin excision for lower tumor resection and flap drawing in order to put the final scar in the inframammary fold

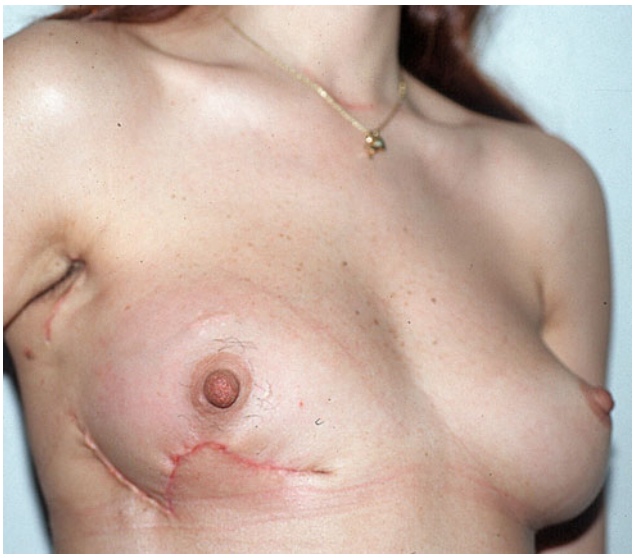

Fig. 18.18 Postoperative image after 1 month

this level so it is less visible (Figs. 18.16, 18.17, and 18.18) [18].

Others solutions can be used depending on the defect localization and the excess of skin in the inferior portion, lateral portion, or axillary portion (Figs. 18.19, 18.20, and 18.21).

18.6 Reshaping with Nipple and Areola Grafting

Some "special indications" of large conservative surgery can be taken into consideration following the patient's request. In the case of large tumors or multifocal tumors in the superior quadrants, a large quadrantectomy with skin excision can be indicated. In this case, a complete transposition of the lower pole of the breast in order to have a good breast shape is possible, but the nipple and areola complex should be transposed as a skin graft (Figs. 18.22, 18.23, 18.24, and 18.25) [19].

18.7 Musculocutaneous Flaps

An immediate reconstruction with musculocutaneous flaps may cause some difficulties, mainly due to the need for postoperative radiotherapy. Either a moderate or a major radiodystrophy could negatively affect the final aesthetic result.

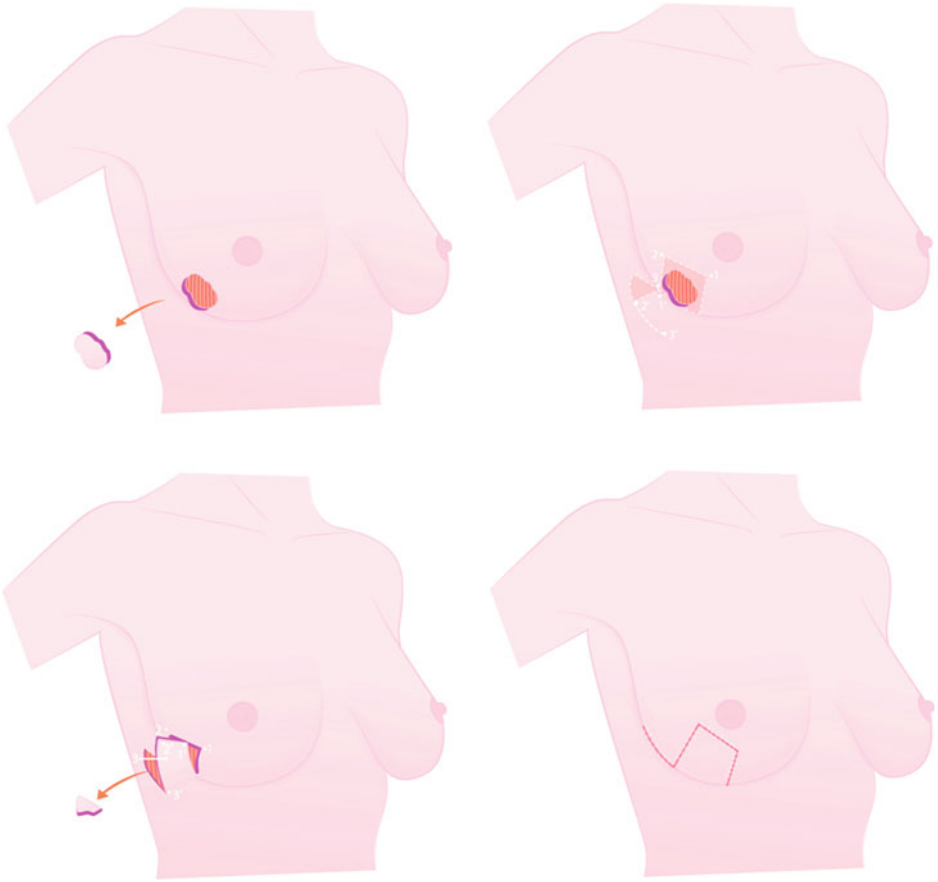

Fig. 18.19 Other options for lateral rotation skin flaps

Fig. 18.20 Options for axillary skin rotation flaps

Fig. 18.21 Options for inferolateral fasciocutaneous flaps

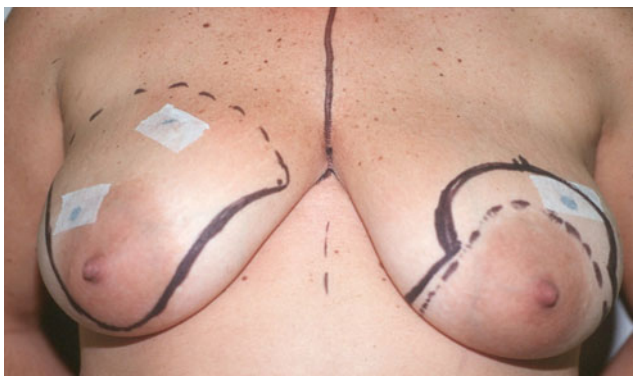

Fig. 18.22 Preoperative planning: bifocal tumor in the upper pole of the breast very close to the skin

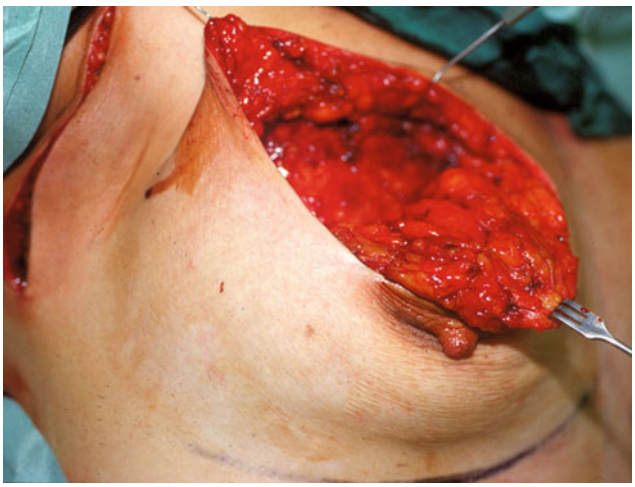

Fig. 18.23 Intraoperative view after the large skin and glandular resection

18.7.1 Latissimus Dorsi Flap

18.7.1.1 Indications

The latissimus dorsi flap technique was first proposed by Olivari [20] for breast reconstruction, and today it is possible to use it in selected cases for immediate partial reconstruction after quadrantectomy. The best indication for this technique is reconstruction of external quadrants or even repair of the central quadrant [21–23].

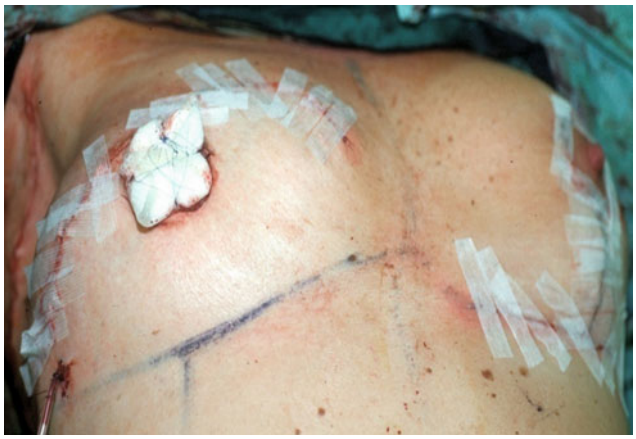

Fig. 18.24 Intraoperative view after glandular reshaping and nipple and areola transposition as a skin graft

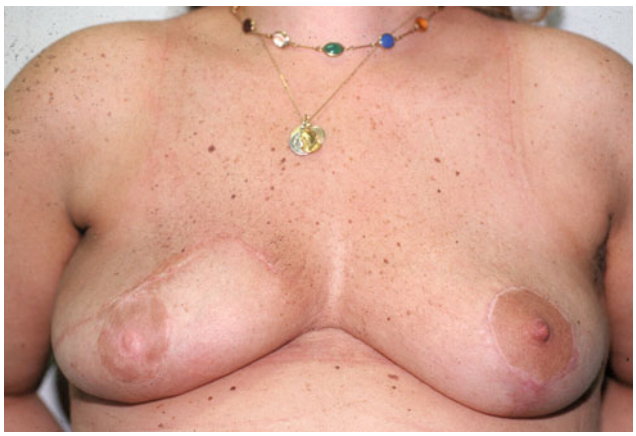

Fig. 18.25 Final results after 6 months

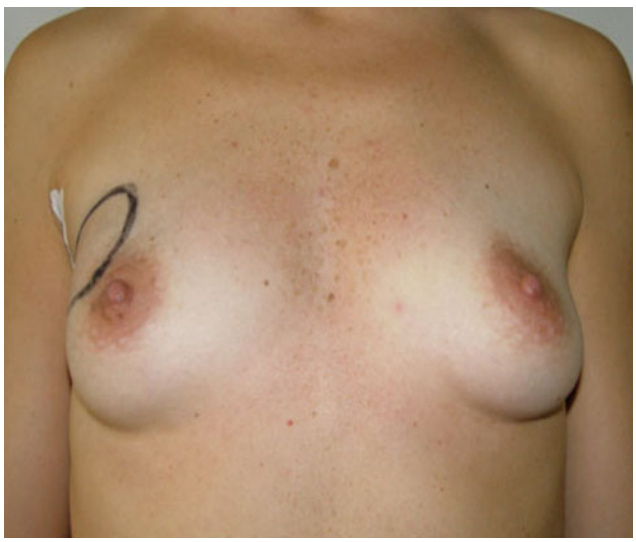

Fig. 18.26 Preoperative image: tumor located in the upper outer quadrant. Patient with small breast and who refused mastectomy

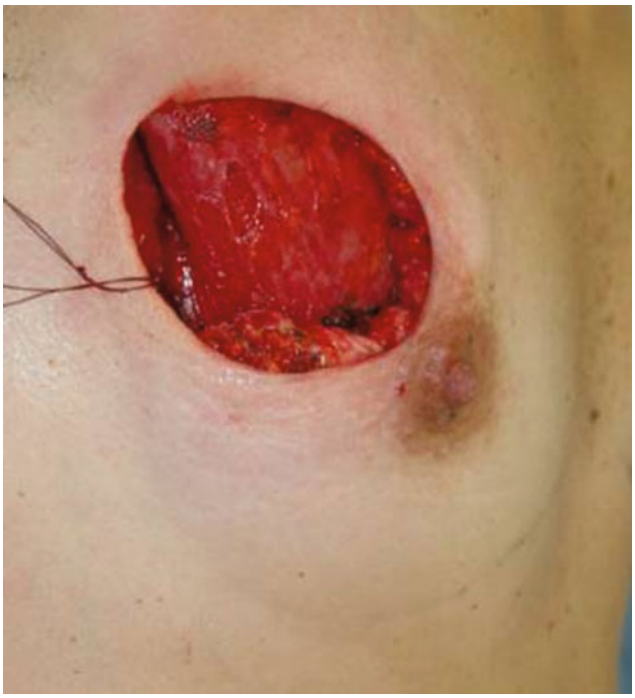

Fig. 18.27 Intraoperative image after the quadrantectomy and axillary dissection

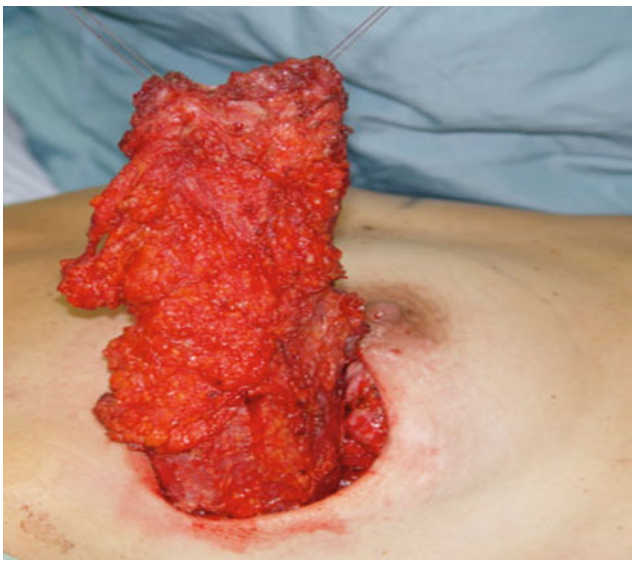

Fig. 18.28 Rotation of the latissimus dorsi musculoadipose flap

18.7.1.2 Technique

The traditional technique is described in more detail in the specific chapter about it. In this chapter we will focus on the musculoadipose flap of the latissimus dorsi muscle (with no dorsal scar) for immediate breast repair after

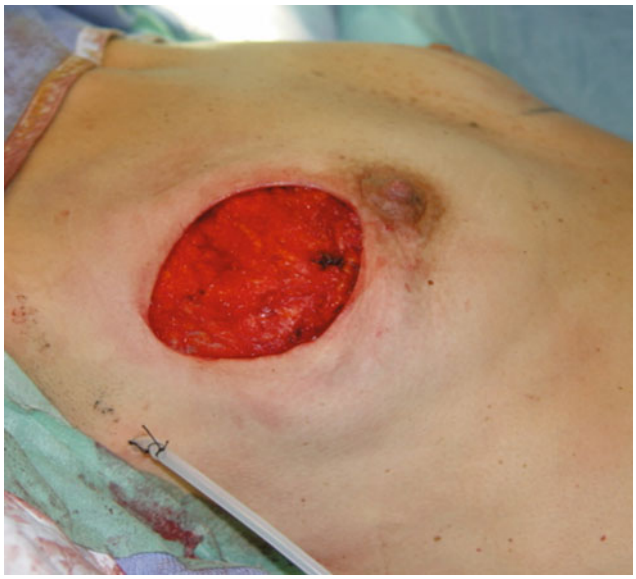

Fig. 18.29 The flap is used to cover the quadrantectomy defect

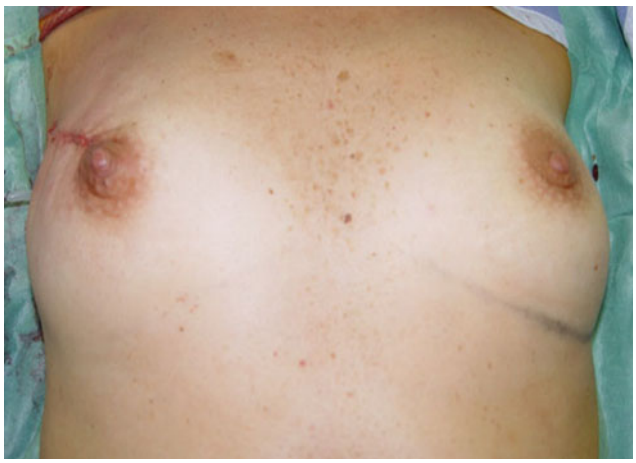

Fig. 18.30 The final results on the table

quadrantectomy. This technique can be used in cases of superoexternal quadrantectomy, with no skin removal, and in small breasts without ptosis.

After quadrantectomy and biopsy of the sentinel lymph node (or axillary lymphadenectomy), it is possible to prepare a musculoadipose flap of latissimus dorsi muscle through the same incision. This flap is placed in the anterior thoracic region to repair the defect from quadrantectomy (Figs. 18.26, 18.27, 18.28, 18.29, and 18.30).

18.7.2 Rectus Abdominis Flap

From our experience, we do not indicate immediate partial reconstruction after quadrantectomy with a musculocutaneous flap from the rectus abdominis muscle. This is a major surgical procedure for a partial repair and yet there is the risk of an incorrect aesthetic result after radiotherapy applied to the flap. There is a report of partial breast reconstruction with mini superficial inferior epigastric artery and mini deep inferior epigastric perforator flaps with satisfactory results [24].

18.8 Other Flaps

Several other methods related to oncoplasty have been reported for partial breast reconstruction, for example, transverse gracilis flap [25], omental flap [26, 27], and a combination of flaps [28]. However, they are rarely performed and are presently less popular.

18.9 Conclusion

In general, oncoplastic surgery can be performed by mammaplasty techniques. Knowledge and understanding of vascular supply of breast parenchyma and the nipple–areola complex is a very important key to success. When a simple mammaplasty technique cannot be used, there are other options that surgeons and patients can discuss. Prosthesis reconstruction can be performed with a low capsular contraction rate when the proper intraoperative radiotherapy protocol is used. Other fasciocutaneous and myocutaneous flaps can be done with promising results, and surgeon should keep in mind the oncoplastic principle to achieve the best oncologic and aesthetic benefit.

References

1. Lejour M (1993) Vertical mammaplasty. Plast Reconstr Surg 92:985–986
2. Lejour M (1999) Vertical mammaplasty: update and appraisal of late results. Plast Reconstr Surg 104:771–781; discussion 782–774
3. Pitanguy I (1967) Surgical treatment of breast hypertrophy. Br J Plast Surg 20:78–85
4. Ribeiro L, Accorsi A Jr, Buss A, Marcal-Pessoa M (2002) Creation and evolution of 30 years of the inferior pedicle in reduction mammaplasties. Plast Reconstr Surg 110:960–970
5. Ribeiro L (1975) A new technique for reduction mammaplasty. Plast Reconstr Surg 55:330–334
6. Robbins TH (1984) Inferior pedicle breast reduction technique. Plast Reconstr Surg 73:325
7. Robbins TH (1977) A reduction mammaplasty with the areola-nipple based on an inferior dermal pedicle. Plast Reconstr Surg 59:64–67
8. Benelli L (1990) A new periareolar mammaplasty: the "round block" technique. Aesthet Plast Surg 14:93–100
9. Goes JC (1996) Periareolar mammaplasty: double skin technique with application of polyglactine or mixed mesh. Plast Reconstr Surg 97:959–968

10. Rietjens M, De Lorenzi F, Veronesi P et al (2006) Breast conservative treatment in association with implant augmentation and intraoperative radiotherapy. J Plast Reconstr Aesthet Surg 59:532–535
11. Orecchia R, Ciocca M, Lazzari R et al (2003) Intraoperative radiation therapy with electrons (ELIOT) in early-stage breast cancer. Breast 12:483–490
12. Veronesi U, Orecchia R, Luini A et al (2010) Intraoperative radiotherapy during breast conserving surgery: a study on 1,822 cases treated with electrons. Breast Cancer Res Treat 124:141–151
13. Aristei C, Amichetti M, Ciocca M et al (2008) Radiotherapy in Italy after conservative treatment of early breast cancer. A survey by the Italian Society of Radiation Oncology (AIRO). Tumori 94:333–341
14. Botta SA, Rifai R (1991) Personal refinements in the single pedicle Skoog technique for reduction mammaplasty. Aesthetic Plast Surg 15:257–264
15. Skoog T (1963) A technique of breast reduction; transposition of the nipple on a cutaneous vascular pedicle. Acta Chir Scand 126:453–465
16. Holmstrom H (1979) The free abdominoplasty flap and its use in breast reconstruction. An experimental study and clinical case report. Scand J Plast Reconstr Surg 13:423–427
17. Holmstrom H, Lossing C (1986) The lateral thoracodorsal flap in breast reconstruction. Plast Reconstr Surg 77:933–943
18. Bohmert H (1980) Experience in breast reconstruction with thoraco-epigastric and advancement flaps. Acta Chir Belg 79:105–110
19. Spear SL, Hoffman S (1998) Relocation of the displaced nipple-areola by reciprocal skin grafts. Plast Reconstr Surg 101:1355–1358
20. Olivari N (1979) Use of thirty latissimus dorsi flaps. Plast Reconstr Surg 64:654–661
21. De Lorenzi F, Rietjens M, Soresina M et al (2010) Immediate breast reconstruction in the elderly: can it be considered an integral step of breast cancer treatment? The experience of the European Institute of Oncology, Milan. J Plast Reconstr Aesthet Surg 63:511–515
22. Munhoz AM, Montag E, Fels KW et al (2005) Outcome analysis of breast-conservation surgery and immediate latissimus dorsi flap reconstruction in patients with T1 to T2 breast cancer. Plast Reconstr Surg 116:741–752
23. Bobin JY, Delay E, Rivoire M (1994) Reconstruction of severe breast deformities following conservative cancer surgery and radiation therapy with a latissimus dorsi myocutaneous flap. Surg Technol Int 3:523–528
24. Spiegel AJ, Eldor L (2010) Partial breast reconstruction with mini superficial inferior epigastric artery and mini deep inferior epigastric perforator flaps. Ann Plast Surg 65:147–154
25. Schoeller T, Huemer GM, Wechselberger G (2008) The transverse musculocutaneous gracilis flap for breast reconstruction: guidelines for flap and patient selection. Plast Reconstr Surg 122:29–38
26. Zaha H, Sunagawa H, Kawakami K et al (2010) Partial breast reconstruction for an inferomedial breast carcinoma using an omental flap. World J Surg 34:1782–1787
27. Cothier-Savey I, Tamtawi B, Dohnt F et al (2001) Immediate breast reconstruction using a laparoscopically harvested omental flap. Plast Reconstr Surg 107:1156–1163; discussion 1164–1155
28. Lee J, Bae Y, Audretsch W (2012) Combination of two local flaps for large defects after breast conserving surgery. Breast 21(2) :194–198

Delayed Reconstruction After Breast-Conserving Surgery

19

Eduardo G. González

19.1 Introduction

In recent years, much been written about the term "oncoplastic surgery of the breast," probably without taking into account its original definition. According to Werner Audretsch [1], who described it for the first time in 1994, "oncoplastic surgery of the breast" originally included all the surgical approaches of plastic and reconstructive surgery that intended to achieve an oncological resection with satisfactory margins, in the context of a conservative treatment, trying to minimize potential deformities and obtaining better cosmetic results.

Later, after going through different definitions related to the surgical technique, such as "cosmetic quadrantectomy" [2], "lower pole tumor reduction mammaplasty" [3], and "central tumor reduction" [4], the concept was extended to the term "tumor-specific immediate reconstruction" [5] proposed by John Bostwick in 1996. This plastic surgeon from the USA not only included techniques for preventing the sequelae of the conservative treatment, but also all the spectrum of techniques employed for immediate reconstruction after a partial or complete mastectomy (immediate breast reconstruction) and to correct the sequelae of these (deferred breast reconstruction), as well as the techniques employed for the immediate repair in the surgical treatment of locally advanced and recurrent tumors of the thoracic wall.

Presently, after all these terminological discrepancies, it is usual in the medical community to relate the term "oncoplastic surgery of the breast" to Bostwick's classification.

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Conservative treatment of breast cancer (breast conservative treatment) has proved to be an oncologically safe procedure for disease control compared with mastectomy in tumors up to 5 cm according to several publications [6, 7]. This treatment includes a complete tumor resection with an oncological safety margin, the exploration of the axilla (sentinel lymph node biopsy or axillary lymphadenectomy), and breast volume radiotherapy with or without a boost on the tumor bed following the treatment protocols.

By definition, breast conservation not only implies locoregional oncological control of the disease but it is also essential to preserve the breast with a good aesthetic result.

So, what must the surgeon do to accomplish this premise?

- Know the different approaches and aesthetic incisions required to reduce sequelae (Fig. 19.1). The incisions should be made around the areola in upper-quadrant tumors, periareolar in lesions that are next to the nipple–areola complex, and radiated or through the submammary fold in tumors of the lower quadrants. In tumors of the upper and medial quadrant, the periareolar approach may avoid unsightly scars in that region.
- Know the techniques of gland shaping to avoid defects secondary to the loss of part of the gland after resection.
- Know the fundamentals and effects of radiotherapy in conservative treatment: several publications have analyzed the changes in the irradiated mammary gland according to its volume and the homogeneity of the dose delivered. In a prospective and randomized trial, Moody et al. [8] compared the adverse effects of radiotherapy in small, medium-sized, and large mammary glands, and found moderate and severe negative aesthetic results in only 6 % of small breasts and in up to 39 % of large ones. Gray et al. [9] evaluated 267 irradiated patients after conservative surgery. They observed a significant reduction in aesthetic results in patients with macromastia and inadequate treatment, with areas of overirradiation or underirradiation, about 10–15 % as a consequence of the lack of homogeneity of the dose owing to the size of the

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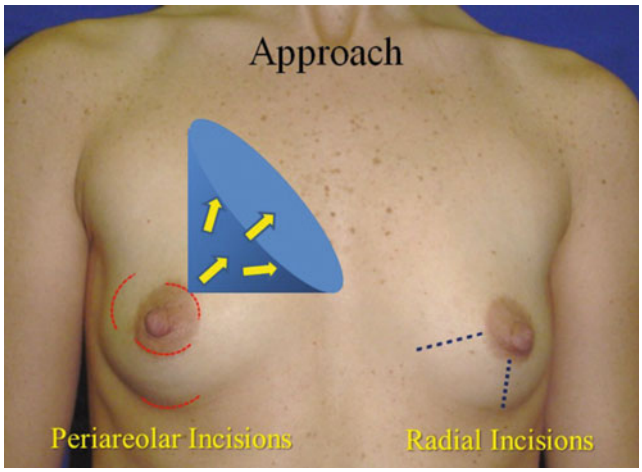


Fig. 19.1 Approaches and aesthetic incisions in conservative surgery. The incisions are indicated according to the place of resection and the Langer lines of the breast. It is interesting to point out the approach of the *upper* and medial quadrant through the periareolar region to avoid the scars in the region described by Grisotti as "no man's land" (in *blue*)

breast. Following these parameters, we can obtain approximately 70 % good results, leaving 30 % of patients with remaining deformities that would require a secondary surgical correction [10]. Oncoplastic surgery of the breast had its origin in the intent to prevent these unsatisfactory results of breast conservation observed in these 30 % of patients.

The crucial factor to develop and implement these techniques and the sequence related to other treatments (chemotherapy, radiotherapy) motivated further interdisciplinary analysis to evaluate its safety and results. It is in the limitations of conservative surgery related to the breast and tumor volume or to the site of the lesion (e.g., central tumors), which are classic relative contraindications for conservative treatment, where oncoplastic surgery of the breast achieves breast conservation and immediate reconstruction with oncological safety in adverse anatomical conditions.

On the other hand, oncoplastic surgery of the breast is also indicated in the following cases: superficial tumors that need a skin resection, secondary resections in breasts with multiple scars, widening of resection because of positive margins, and in patients with previous breast augmentation surgery and breast cancer who need oncologically safe margins and breast conservation.

In summary, and to respond to the difficult question of how do we decide who needs immediate reconstruction with breast conservative treatment, we can list three basic situations in which the oncoplastic surgery finds can apply it:

1. Problems related to the site of the tumor (central, in the midline, upper medial quadrants, etc.) or to tumor volume/breast volume relation [4].
2. In the treatment of locally advanced cancer treated with induction chemotherapy and salvage surgery, preserving the breast with wide resection margins and good local control.
3. Special situations such as skin resections in superficial tumors, patients with multiple previous scars, resections with wide margins in patients with ductal carcinoma in situ or secondary to tumorectomy with positive margins, or breast cancer in patients with previous breast augmentation surgery.

Following the previous exposition, we recommend that when the patient has risk factors that increase the possibility of sequelae after breast-conserving surgery, immediate breast reconstruction with oncoplastic techniques is preferable.

19.2 Etiology and Classification of the Sequelae

There are many factors that can be determinant in producing a deformity in the breast tat has been operated on. The most important is probably the gland resection itself that produces a reduction in the breast volume. In a planned resection, it is important to calculate the approximate tumor volume and the healthy tissue margin around it, for example: if we resect a tumor of 2-cm diameter with a margin of 1 cm, this is equivalent to 30 g of gland volume, but if we enlarge the margin to 2 cm, the defect enhances up to more than 100 g with a different impact on the final result. The tumor site is the second determinant factor: there are sites of the breast where the defect can be repaired favorably, such as the upper and lateral quadrants, and others such as the medial region or lower quadrants where the structural alteration is maximal and its correction difficult. The size of the breast is also important: many results are conditioned by this factor, the damage being less when the relationship between the breast and the tumor volume is larger. A body mass index greater than 30 is also related to a higher number of sequelae [11].

Breast retraction and fibrosis are the usual changes after radiotherapy, but there are some factors that can increase the sequelae secondary to this treatment. A total dose of 66 versus 50 Gy worsens the cosmetic results [12] and, as mentioned before, the gland and fat tissue volume also have a negative influence on this last issue [8, 9]. Chemotherapy can worsen the results, administered either simultaneously or sequentially with radiotherapy [13].

When patients seek consultations because of sequelae of a conservative treatment, there are some parameters related to the patient's anatomy that have to be evaluated, as well as the characteristics of the breast tat has been operated on and the symmetry of both breasts and the nipple–areola

Table 19.1 Cosmetic sequelae after conservative treatment of breast cancer: classification

	Berrino [17]	Clough et al. [18]	Fitoussi et al. [19]
Type I	Malposition and distortion of the NAC mainly due to postoperative fibrosis and scar contracture	Asymmetrical breasts with no deformity of the treated breast	Low ipsilateral deformity does not affect the shape or volume of the breast
Type II	IIa: localized tissue insufficiency is observed, which may be due to skin deficiency IIb: subcutaneous tissue deficiency IIab: both	Deformity of the treated breast, compatible with partial reconstruction and breast conservation	Good shape and sufficient volume, but with obvious asymmetry in relation to the contralateral healthy breast
Type III	Deformity is characterized by breast retraction and shrinkage and is mainly due to the effects of radiotherapy on residual breast parenchyma	Major deformity of the breast, requires mastectomy	Asymmetry does not maintain the shape and volume, frequent dislocation of the NAC
Type IV	Severe radiation-induced damage to the skin, NAC, and subcutaneous and glandular tissues is present	–	Greater deformity, lack of native tissue, scarring and radiation effects
Type V	–	–	Severe deformity from both surgery and prior radiotherapy, where the breast is too small and/or completely sclerosed

NAC nipple–areola complex

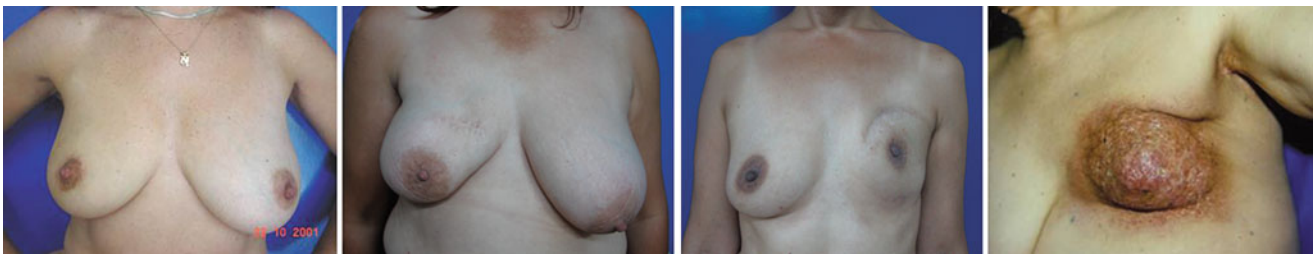


Fig. 19.2 Cosmetic sequelae after conservative treatment for breast cancer: classification. *Left* asymmetry without deformity (Clough et al. type I, Fitoussi et al. types I and II). *Left-Center* asymmetry with moderate deformity and mild dislocation of the nipple–areola complex (Berrino types I and II, Clough et al. type II, Fitoussi et al. type III). *Right-Center* breast deformity and asymmetry as well as of the nipple–areola complex (Berrino type III, Fitoussi et al. type IV). *Right* fibrosis and severe actinic sclerosis with severe disappearance of the nipple–areola complex (Berrino type IV, Clough et al. type III, Fitoussi et al. type V)

complex. Deferred breast reconstruction of these deformities is limited by five determinant factors: the lack of skin or gland tissue, scar retraction, radiodermatitis, and fibrosis.

Evaluation of sequelae is highly subjective, and the concordance between surgeons and patients or between different surgeon is generally low [14]. In recent years some informatic models have been designed (3dMD, BAT Software) to systemize this evaluation and improve the planning of reconstruction [15, 16]. A number of classifications have been proposed with the intention to evaluate the defects and plan corrections as shown in Table 19.1. In all of them there is generally coincidence in the evaluation of minor sequelae (type I or II), involving only asymmetries without or with minimal changes in the shape of the treated breast, except for Berrino's classification [17], which added the displacement of the nipple–areola complex (Fig. 19.2). Most of the "problematic" patients present with major sequelae that range from moderate deformities to severe sequelae with sclerosis of the whole breast that even sometimes needs mastectomy. For these sequelae the classifications are confusing and the indications for corrections range between simple treatments such as lipofilling and mastectomies with immediate reconstruction with microsurgical or pedicled flaps associated or not associated with prosthetic material [17–19].

19.3 Timing of Reconstruction of the Partial Mastectomy Defect: Our Experience

In our institutional experience after using the classifications mentioned in the previous for some years, we tried to simplify the evaluation of the sequelae and systemize the reconstruction techniques by employing a more functional concept related to each particular patient.

We analyzed the following parameters: age, biotype, time between the first medical consultation and the surgery and primary radiotherapy, grade of complexity of the sequelae, previous reconstruction intents, and presence of a prosthesis in the previously irradiated breast. Generally, in relation to all

these parameters, we waited for a least 1 year after radiotherapy had finished before recommending reconstruction, with the condition that the breast was stable and did not show signs of edema or radiodermatitis, and that physical examination and imaging (mammography, ultrasonography, MRI) confirmed the absence of local recurrences.

We divided the patients in two large groups based on the type of sequelae and also the complexity of the reconstruction technique needed for each particular patient: group A had minor defects and group B had major defects.

In group A we included the sequelae that did not compromise or only produced a mild change in the shape of the breast, with or without asymmetry of the nipple–areola complex or the breast. We divided this group into three subgroups:

1. Breast asymmetry without alteration of the shape of the breast that had been operated on.
2. Minor sequelae in the breast that had been operated on without asymmetry of the nipple–areola complex, with or without associated breast asymmetry.
3. Minor sequelae in the breast that had been operated on with asymmetry of the nipple–areola complex, associated or not associated with breast asymmetry.

In group B we included the sequelae that compromised moderately or severely the breast's shape with asymmetry of the nipple–areola complex. In this group we also added the damage produced by severe actinic sclerosis and fibrosis, and a special subgroup that corresponds to patients with prior reconstruction attempts with unsatisfactory results, who generally have implants and ask for a second procedure. We can divide this group into three subgroups:

1. Moderate or severe sequelae in the shape and volume of the treated breast without or with moderate actinic damage.
2. Moderate or severe sequelae in the shape and volume of the breast that has been operated on without or with moderate actinic damage and a previous reconstruction attempt with or without implants.
3. Severe actinic damage with loss of the shape and alteration of the volume of the treated breast. Marked sclerosis and fibrosis.

It is important to explain that in both groups the cause of breast asymmetry can be due to several factors related not only to the primary treatment but also to the biotype of the patient, changes in body weight, adjuvant oncological treatments, age, etc. (see Table 19.2).

Analyzing the patients according to this classification, we used a treatment algorithm to choose the most suitable surgical technique (see Figs. 19.3 and 19.4).

The indication for the surgical technique depends not only on the algorithm, but is also influenced by the surgeon's experience and the opinion of the patient if there is more than one possibility, always preferring the least aggressive one and evaluating quality of life [20].

Another interesting point is how this algorithm has changed in recent years according to the publication and application of new surgical techniques. Below, when we describe the different procedures we used, we will see for example, the influence of lipofilling in minimizing the procedure's aggressiveness, optimizing results, and diminishing the rate of complications.

19.4 Reconstruction Techniques for the Partial Mastectomy Defect

Breast reconstruction has evolved in some aspects in recent years, and the description of new techniques with the optimization of results was accompanied by the priority given to diminish morbidity and to offer procedures that not only have good result but also have fewer sequelae and allow patients to return early to normal activity.

Following the proposed algorithm and highlighting this evolution, we have an interesting number of techniques to use depending on the complexity of the patient's defects, background, and wishes, previous morbidity, potential of the reconstructive procedure, and implications for the quality of life.

Numerous publications [1, 3, 4] described local, myocutaneous or microsurgical flaps, prosthesis implantation, etc., to correct these defects, and established guidelines that were applicable for years, but they always emphasized the complexity, unpredictable results, and higher complication rate of these procedures compared with immediate reconstruction after conservative treatment.

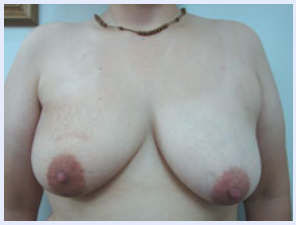
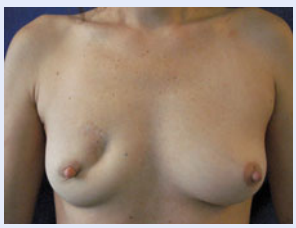
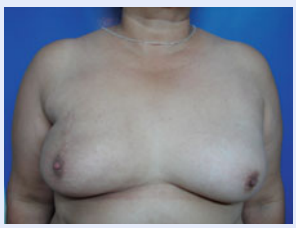
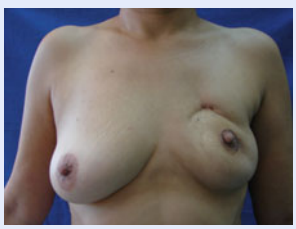
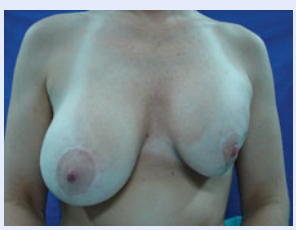
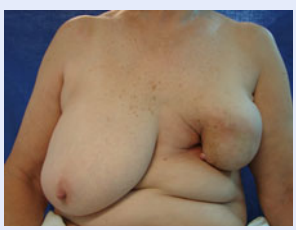
In our experience we went through different phases, and it is our intention to describe subsequently the techniques we can use presently, in which cases to apply them according to the algorithm we employed, the results, and to mention complications and how they changed in relation to the different indications.

19.5 Mastopexy or Reduction Mastoplasty with Repositioning of the Nipple–Areola Complex

We use reduction or pexia techniques in cases of breast asymmetry in ptotic or hypertrophic breasts without shape alterations in the breast operated on or with minimal alterations with or without asymmetry in the nipple–areola complex (IAR (Instituto Angel Roffo) functional classification, IARfc, a-I–II–III).

This technique should be avoided in patients with moderate or severe radiodystrophy, or when the scar from the previous surgery can change the design, diminishing the safety of the vitality of the pexia or reduction flaps. Previous radiotherapy produces capillary fragility and fibrosis in

Table 19.2 Cosmetic sequelae after conservative treatment for breast cancer: IAR functional classification

	Minor defects	Major defects	Examples
a-I	Breast asymmetry without altering the shape of the breast operated on	–	
a-II	Mild sequelae in the shape of the breast operated on without asymmetry of the NAC. They can be associated or not associated with breast asymmetry	–	
a-III	Mild sequelae in the shape of the breast operated on without asymmetry of the NAC, They can be associated or not associated with breast asymmetry	–	
b-I	–	Moderate or severe sequelae in the shape and volume of the treated breast without or with moderate actinic sequelae	
b-II	–	Moderate or severe sequelae in the shape and volume of the treated breast without or with moderate actinic damage with a previous attempt at reconstruction with or without implant insertion	
b-III	–	Severe actinic sequelae with loss of the shape and marked alteration in the volume of the treated breast. Marked sclerosis and fibrosis	

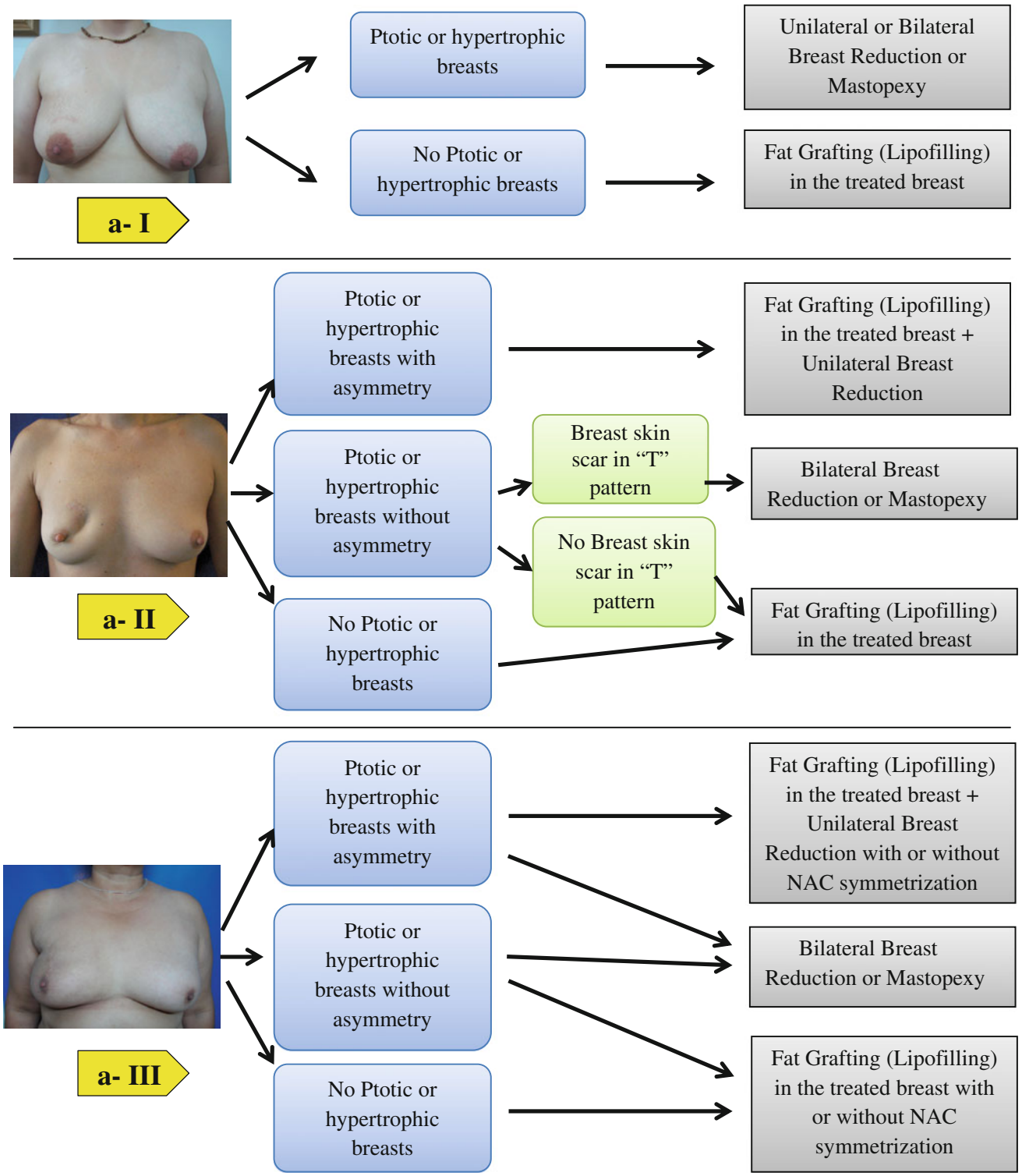
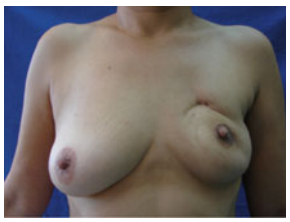


Fig. 19.3 Cosmetic sequelae after conservative treatment for breast cancer. Management algorithm for repair of partial mastectomy defects. Minor defects. *NAC* nipple–areola complex

the tissues, increasing complication rates, interfering with wound healing, and worsening the final aesthetic result. In cases of moderate or severe actinic damage, we can use lipofilling and omit reduction.

The technique chosen depends on the breast volume and shape, and previous scars. The site of the incisions is chosen not only taking into account the cosmetic result but also in the attempt to reduce further complications. They can be



b- I

Ptotic or hypertrophic breasts

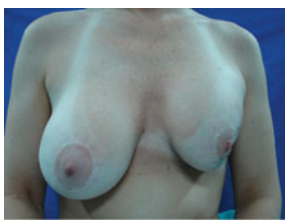
No Ptotic or hypertrophic breasts

Fat Grafting (Lipofilling) with or without external expansion (Brava System) + Breast reduction in the opposite breast

Latissimus Dorsi Flap or Local flaps + Breast reduction in the opposite breast

Latissimus Dorsi Flap or Local flaps

Fat Grafting (Lipofilling) in the treated breast with or without external expansion (Brava System)



b- II

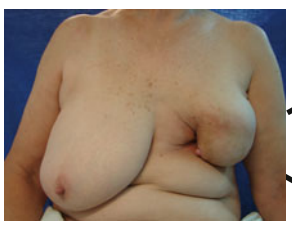
Primary BR with implants

Primary BR without implants

Latissimus Dorsi Flap + Expander or prosthesis + Breast reduction or pexia in the opposite breast

Tram/DIEP/Extended Latissimus Dorsi Flap +/- Breast reduction or pexia in the opposite breast

See b- I



b- III

Ptotic or hypertrophic breasts with asymmetry

No Ptotic or hypertrophic breasts

Mastectomy + Tram/DIEP/Extended Latissimus Dorsi Flap +/- Breast reduction in the opposite breast

Fig. 19.4 Cosmetic sequelae after conservative treatment for breast cancer. Management algorithm for repair of partial mastectomy defects. Major defects. *BR* breast reconstruction, *DIEP* deep inferior epigastric perforator, *Tram* transverse rectus abdominis myocutaneous

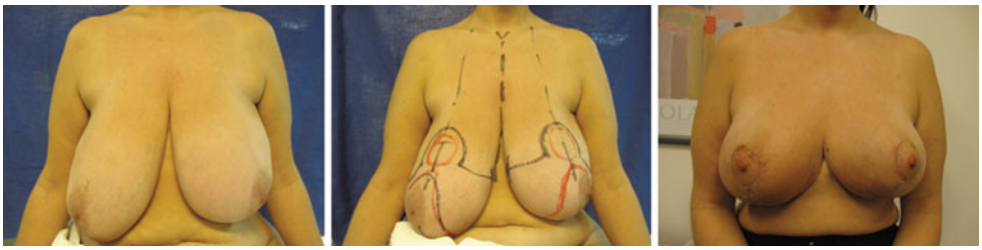


Fig. 19.5 Cosmetic sequelae after breast conservative treatment (BCT) in a patient with a tumor in the lower lateral quadrant of the left breast. Mild radiodermatitis without clinical manifestation. Breast hypertrophy and asymmetry and mild asymmetry of the nipple–areola complex (IAR functional classification, IARfc, a-III). Breast reduction with an inverted "T" nurtured by an inferior pedicle

designed in a "T" pattern, vertically or periareolar, always taking care of the vascularization of the skin and subcutaneous tissue flaps. We generally manage the gland pedicles that irrigate the nipple–areola complex according to the concept of "zone designations" proposed by Kronowitz et al. [21] (see Fig. 19.5).

19.6 Fat Grafting (Lipofilling)

Lipofilling is a centennial practice indicated for defect correction. Certain qualities of the fat, such as its easy acquisition, constant availability, and interminability, made its use very important in plastic and reconstructive surgery as a primary procedure or in combination with other methods.

After lipofilling was banned in 1987 by the American Society of Plastic and Reconstructive Surgery (ASPS), due to the radiological consequences and the possibility to interfere with mammographic diagnosis of breast cancer [22], in 2007 Rigotti et. al [23] takes this technique again and published their experience and described "the regenerative power of adipose derived stem cells" in rebuilding the damage from conservative treatment and breast irradiation because of its ability "proangiogenic in a territory with a chronic ischemic" secondary to radiotherapy.

Owing to the lack of publications and because the procedure was not standardized after the new publications, the ASPS created a work group in 2007 (ASPS Fat Graft Task Force) [24] to evaluate the safety and efficacy of autologous fat grafts in the breast, and to establish recommendations for future investigations. In relation to conservative treatment and follow-up, they stated that there would not be any difficulty because the microcalcifications that are seen afterward are generally of benign character in 5 % of cases. On the basis of a limited number of studies with a small number of patients, there seemed to be no interference in breast cancer detection. The oncological safety was also evaluated by the ASPS Fat Graft Task Force and 2009 it concluded that until that time there had been no reports indicating an increase in the risk of disease recurrence associated with autotransplantation of fat tissue. Nevertheless, it concluded that more studies are necessary to confirm these preliminary considerations [24].

To repair severe damage from conservative treatment, in some situations we have to provoke an external stretching and the expansion of the skin producing in this way a neovascularization and favoring fat injection, maintaining its vitality and allowing its regeneration. This is achieved by means of an external tissue expander (Brava system) described by Khouri [25], which is placed for approximately 10 h a day for long periods of time between lipofilling sessions.

Lipofilling is indicated nowadays for most of the minor sequelae of conservative treatment (IARfc a-I–II–III) and in most of the cases probably should be the first option, especially in patients with small or medium-sized breasts without or with little ptosis. This indication is because it is an outpatient treatment, minimally invasive, easy to perform, and has good results and a low rate of complications. In cases of major damage, its indication is limited to some cases of IARfc b-I group patients with a small breast volume or patients who accept various procedures including the use of the Brava system to avoid reconstruction with myocutaneous flaps (Latissimus Dorsi Myocutaneous Flap, transverse rectus abdominis myocutaneous flap , etc.). Lipofilling has no local contraindications and only has the disadvantage that more than one procedure might be necessary to achieve in some situations an optimal result, with intervals of approximately 3 months between each fat application. It is not recommended to indicate lipofilling when there is high risk of thromboembolism (contraindication of liposuction) or loss of fat tissue at the donor sites.

It is clear that is important to choose the right areas to obtain the fat, with an adequate amount of fat tissue according to the preference of the surgeon and the patient. The commonest sites are the abdomen, flanks, and hips. The liposuction, after injection of Klein's solution, is performed with 2–4-mm cannulas to allow a major recollection of adipocytes without damaging neurovascular structures. There must be delicate manipulation to avoid negative pressure and minimal exposure to air. The ideal processing of the fat is the one that can separate the blood cells, the infiltrated fluids, the oil, and the adipocytes with the least trauma possible. The major

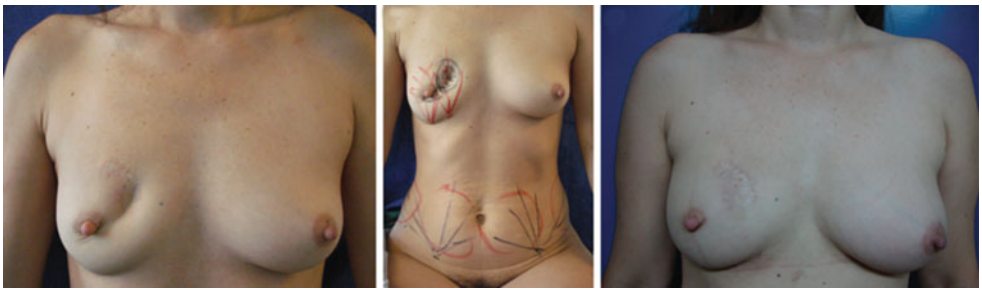


Fig. 19.6 Cosmetic sequelae after BCT in a patient with a tumor in the *upper* and medial quadrant of the *right* breast. Loss of volume with skin retraction and marked asymmetry (IARfc a-II). Results after two lipofilling procedures with correction of the defect and additional breast augmentation (60 and 120 g)

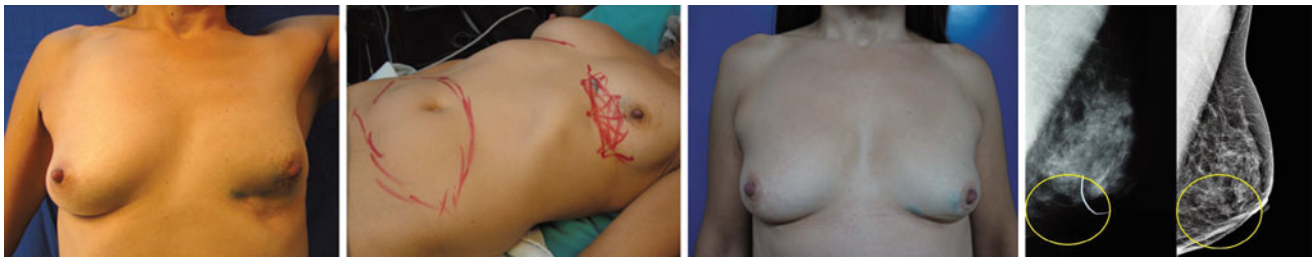


Fig. 19.7 Cosmetic sequelae after BCT in a patient with a tumor in the inferior quadrants of the left breast. Marked loss of volume with skin retraction and without asymmetry (IARfc b-I). Abdominal donor site. Results 2 years after one lipofilling procedure with correction of the defect (110 g). Preoperative and postoperative mammography, showing the breast volume augmentation without radiological consequences 2 years after the procedure

consensus is to centrifuge the sample at 3,000 rpm for 1–3 min [23] or manual centrifugation with a low number of revolutions per minute [25]. It is essential to optimize the results and avoid oil cysts, and to prepare the graft receptor site with transcutaneous punctures made with 14G needles (rigottomies) leaving the surgical bed like a honeycomb [23]. The injection of fat tissue is probably the most critical point to obtain good and enduring results with this technique, without increasing the rates of fat necrosis and complications. The fat grafts are nurtured by plasmatic soaking up to 1.5 mm from the edge of the graft. We use a curved duck-billed cannula with only one anterior opening (Khouri) and syringes of 5 and 10 ml, according to the defect we are going to correct, and we make a retrograde infiltration in various lineal directions without leaving empty cavities. It is important not to overcorrect defects and not forget that the best results are obtained with more than one procedure [23]. Some cases of breast reconstruction with lipofilling are shown in Figs. 19.6, 19.7, 19.8, 19.9 and 19.10.

19.7 Fasciocutaneous Flaps

These are skin–fat flaps that vascularize through a superficial pedicle (regional perforating vessels). They only have limited indications. Presently the most used fasciocutaneous flaps are the thoracoepigastric and thoracodorsal flaps. We use them in particular situations when there is no possibility to use other techniques in the lower and lateral quadrants (Fig. 19.11).

19.8 Latissimus Dorsi Myocutaneous Flap

The latissimus dorsi myocutaneous flap is a safe, and easy-to-harvest flap which allows, in general, repair of defects in the thoracic wall and breast. It consists of the transposition of the whole or part of the latissimus dorsi muscle to the anterior thoracic wall, with a skin and subcutaneous tissue paddle of adequate dimensions to repair the defect. It has some disadvantages: it does not generally give sufficient volume to the reconstructed breast in cases of total breast reconstruction or in cases of huge defects requiring in some cases the association with a prosthesis or expanders; it leaves a scar in the back; and it generally needs intraoperative exploration to ensure the integrity of the thoracodorsal pedicle.

This flap is useful to correct the damage produced by breast conservative treatment in any part of the breast. Presently, we use it only in patients with severe damage or when this damage cannot be repaired with minor procedures (lipofilling) (IARfc b-I–II–III). It can be associated with expanders or prosthesis if the flap alone is not sufficient to repair the volume of the defect. Its indication in

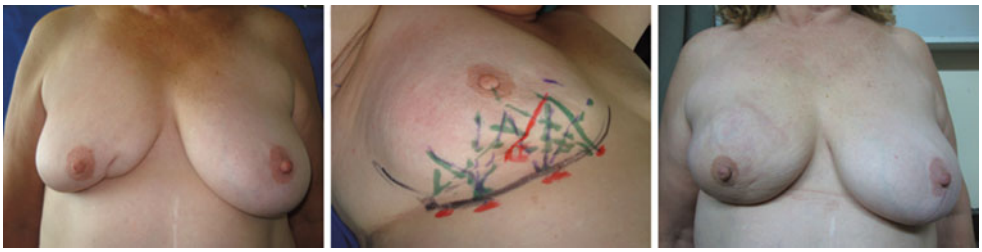


Fig. 19.8 Cosmetic sequelae after BCT in a patient with a tumor in the lower and medial quadrant of the right breast. Marked loss of volume with severe skin retraction and asymmetry (IARfc b-I). Donor site in the flanks. Design of the entry sites and directions of the fat injection. Result after two lipofilling procedures with correction of the defect (120 and 140 g, respectively) and good cosmetic result previous to the correction of symmetry

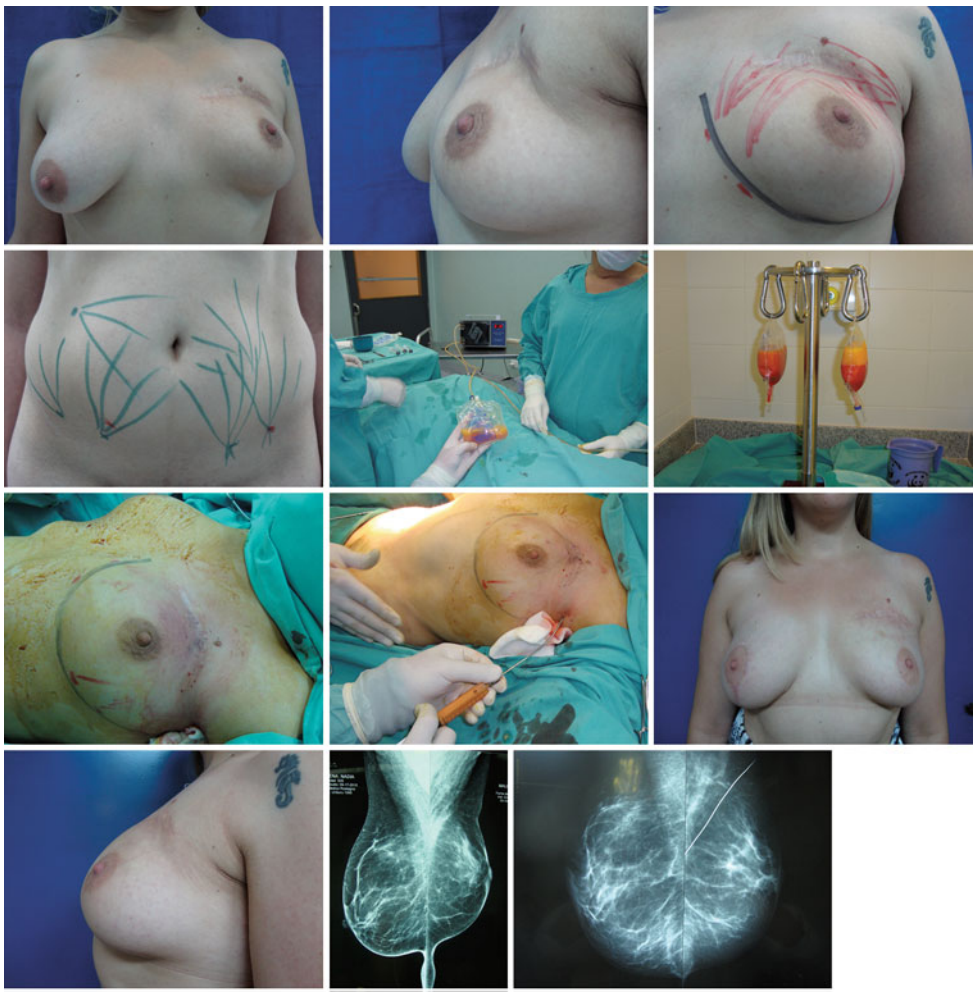


Fig. 19.9 Lipofilling surgical technique. Cosmetic sequelae after BCT in a patient who presented with a tumor in h12 of the *left* breast. Marked loss of volume with severe skin retraction and asymmetry, an old indication for a latissimus dorsi flap (IARfc b-I). Design of the entry sites and directions of fat injection. Abdominal donor site. Lipofilling surgical technique. Obtaining the fat with liposuction with a low-pressure pump. Manual centrifugation showing the aspirated liquid, fat, and oil. "Rigottomies." Retrograde fat injection with a curved Khouri needle. Lipofilling surgical technique. Final result after two procedures (130 and 150 g, respectively) and reduction of the other breast. Preoperative and postoperative mammography showing the volume augmentation without radiological consequences

minor sequelae is actually being revised since the implementation of lipofilling techniques. See Figs. 19.12, 19.13 and 19.14.

The surgical technique for this flap is well known, and in this chapter we will only detail some important steps for the correction of partial defects. We can synthesize them into:

- Detailed design of the paddle in the back to cover the defect, analyzing if the flap is going to be enough (skin, fat tissue, and muscle) [26] or if a prosthesis or an expander is necessary. In some particular situations it is only necessary to harvest a muscular flap to repair volume defects without need for a skin paddle (miniflap).
- Evaluation of the integrity of the thoracodorsal pedicle before harvesting the flap to avoid complications secondary to damage to it caused by primary surgery or actinic sclerosis.
- Careful modeling of the paddle to optimize the final result.

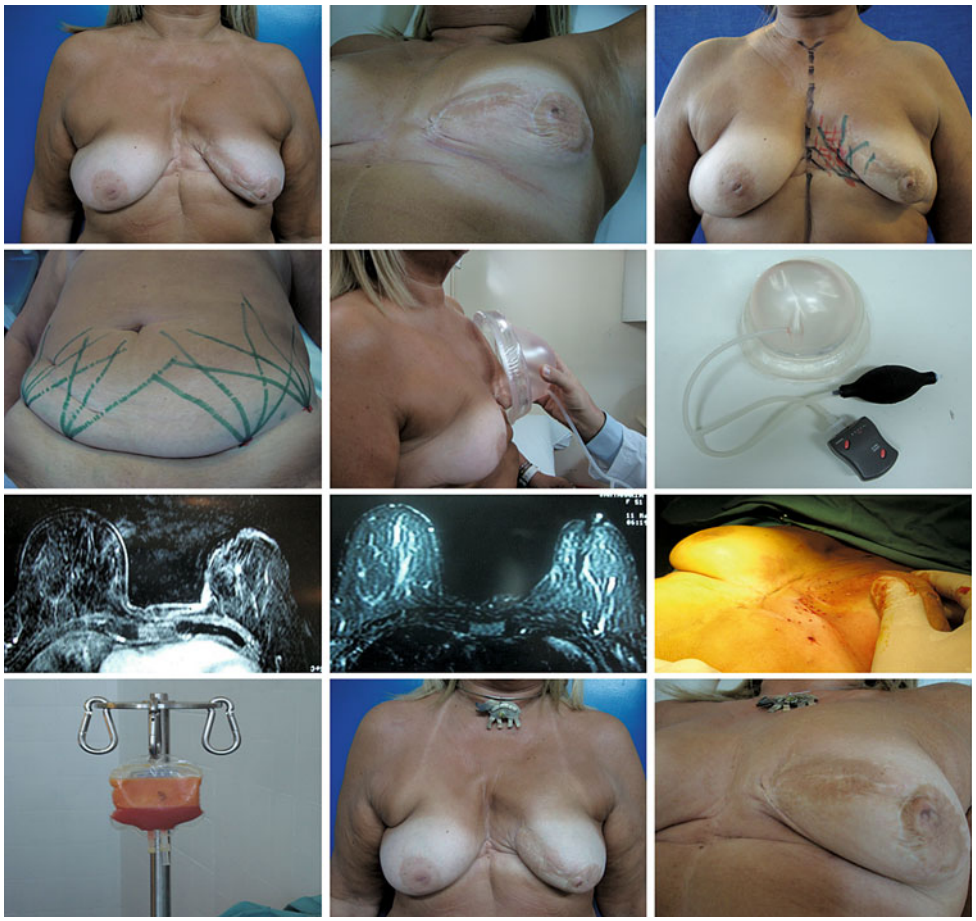


Fig. 19.10 Lipofilling surgical technique plus the Brava system. Severe cosmetic sequelae after BCT in a patient who presented with a tumor in the lower and medial quadrant of the left breast and had had various attempts at reconstruction without a prosthesis. Marked volume loss with severe skin retraction and moderate asymmetry, an old indication for a latissimus dorsi flap (IARfc b-II). Design of the entry spots and direction for fat injection. Abdominal donor site. Lipofilling surgical technique plus the Brava system. External expander and its placement, producing a vacuum and expansion. Control with MRI previously and after expansion evaluating the increase in volume and breast vascularization. Lipofilling surgical technique plus the Brava system. Rigottomies preparing the surgical bed for the fat graft. Fat centrifugation. Final result after three procedures (130, 120, and 110 g, respectively) with good shape and symmetry

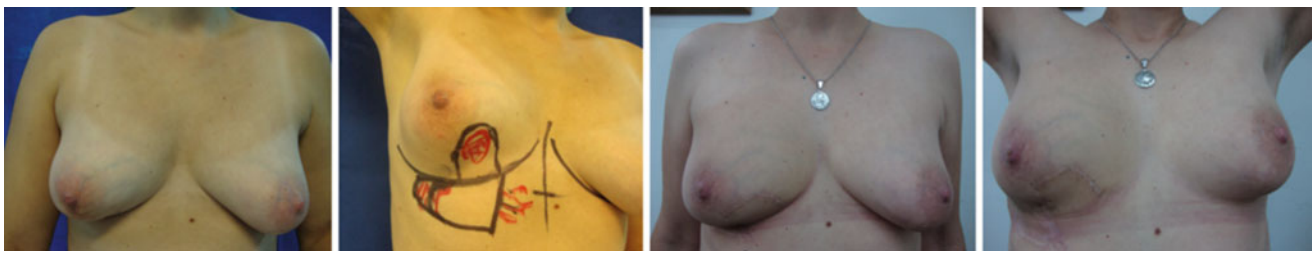


Fig. 19.11 Thoracoepigastric flap. Cosmetic sequelae after BCT in a patient who presented with a tumor in the *lower* and *medial quadrant* of the *right* breast. Loss of volume, skin retraction, and moderate asymmetry (IARfc a-II) Final result some time after radiotherapy, secondary to local recurrence

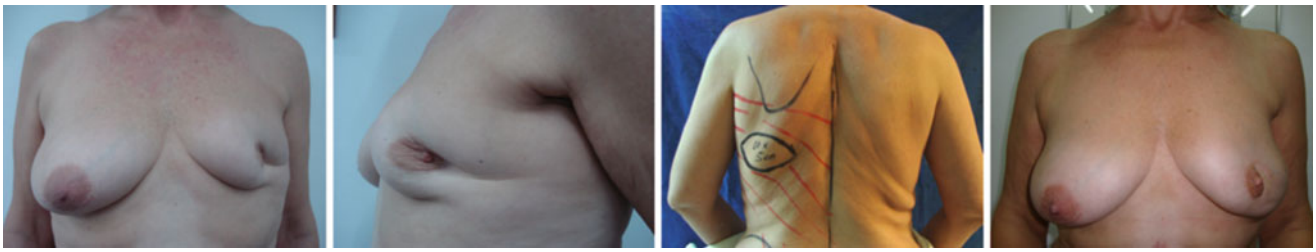


Fig. 19.12 Latissimus dorsi extended flap (fat tissue and muscle). Cosmetic sequelae after BCT in a patient who presented with a tumor in the lateral quadrants of the *left* breast. Marked loss of volume with severe skin retraction and asymmetry of the breast and nipple–areola complex (IARfc b-I). Design of the paddle that was deepithelized conserving only a small periareolar skin paddle to monitor the vitality of the flap. Final result

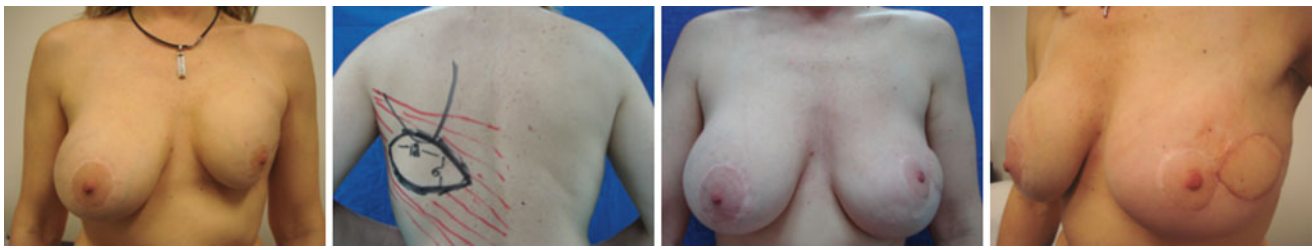


Fig. 19.13 Latissimus dorsi flap plus definitive expander. Cosmetic sequelae after BCT in a patient who presented with a tumor in the lateral quadrants of the *left* breast and had had four attempts at reconstruction with a prosthesis and pexia plus augmentation of the other breast. Marked loss of volume with severe skin retraction and asymmetry of the breast and nipple–areola complex (IARfc b-II). Design of the paddle that is going to replace the skin defect and addition of a definitive expander to gain volume and give shape to the breast. Final result

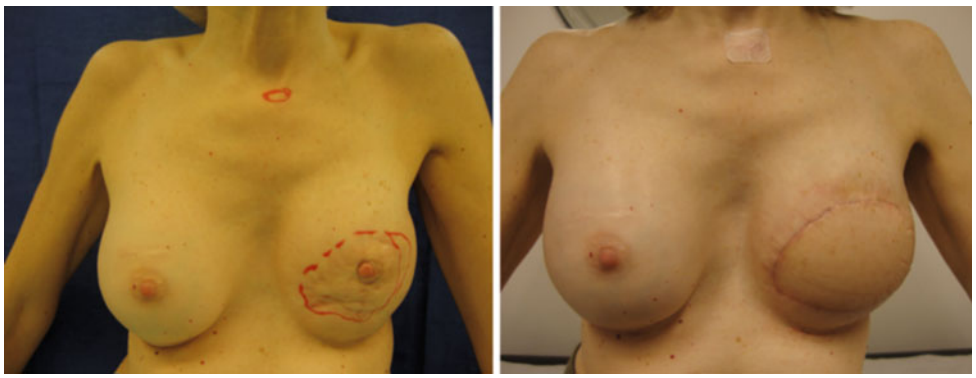


Fig. 19.14 Latissimus dorsi flap plus prosthesis. Cosmetic sequelae after BCT in a patient who presented with a tumor in the central region of the *left* breast and underwent an attempt at reconstruction with a prosthesis and augmentation of the other breast. Loss of volume with severe actinic sclerosis, skin retraction, and asymmetry of the breast and nipple–areola complex (IARfc b-II). Resection of the patch of surgical and actinic sequelae and replacement with a latissimus dorsi flap and definitive prosthesis. Final result

19.9 Transverse Rectus Abdominis Myocutaneous Flap and its Variants

Exceptionally, the transverse rectus abdominis myocutaneous flap and its variants are indicated to repair partial defects. In particular situations, in patients with severe defects with actinic sclerosis with or without suspicion of local recurrence and indication of mastectomy, this technique is indicated because of its advantage of giving a good shape and volume to the reconstructed breast and a better chance of symmetry [27]. See Fig. 19.15.

19.10 Prosthesis

When we try to repair with a silicone prosthesis, in addition to the damage produced by conservative treatment, the high rate of severe capsule contractures and other complications

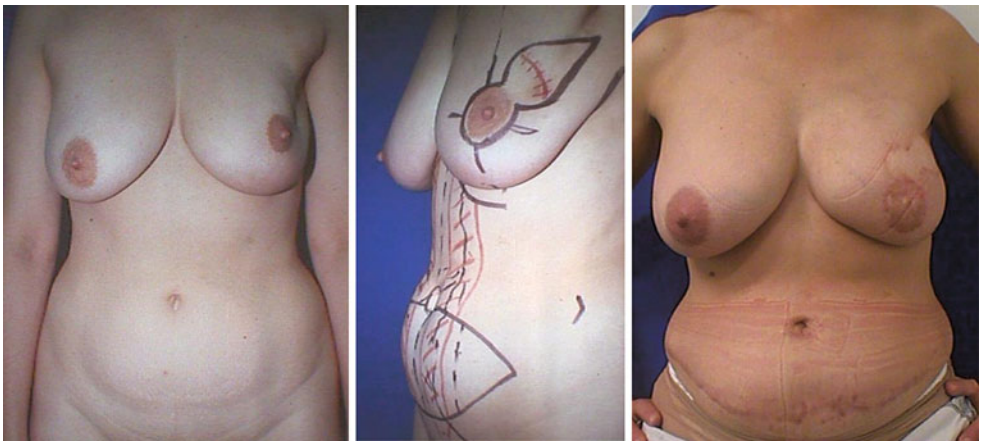


Fig. 19.15 Pedicled transverse rectus abdominis myocutaneous (TRAM) flap. Cosmetic sequelae after BCT in a patient who had a tumor in the *upper* and *lateral quadrant* of the *left* breast. Loss of volume with moderate actinic sclerosis, skin retraction, and asymmetry of the breast and nipple–areola complex (IARfc b-I). Resection of the area with sclerosis and fibrosis and the nipple–areola complex, and replacement with a TRAM flap. Final result after reconstruction of the nipple–areola complex

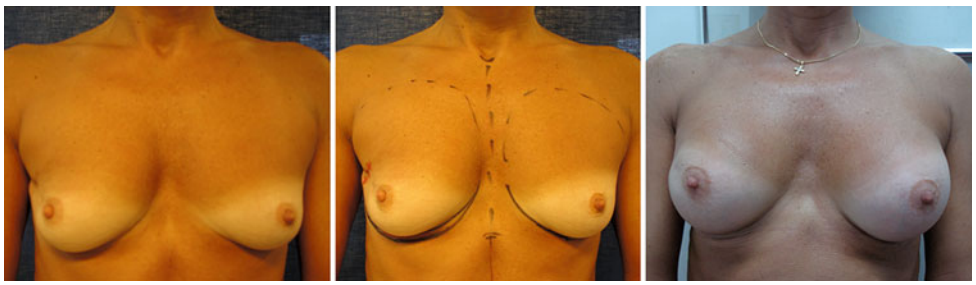


Fig. 19.16 Breast reconstruction with a prosthesis. Cosmetic sequelae after BCT in a patient who presented with a tumor in the *upper* and *lateral quadrant* of the *right* breast. Small loss of volume with mild actinic sclerosis (IARfc a-II). Bilateral augmentation mastoplasty with a prosthesis. Final result with good correction of the defect in terms of shape and mild residual asymmetry

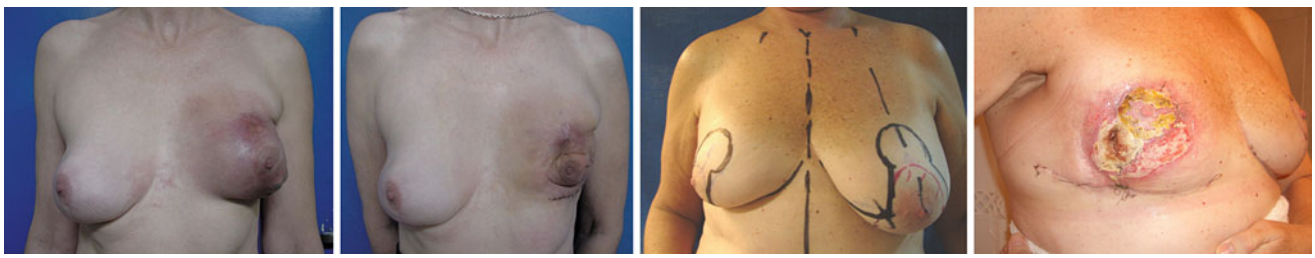


Fig. 19.17 Complications. *Left*Cosmetic sequelae after BCT in the *left* breast, reconstructed with augmentation mastoplasty. Spontaneous and late prosthesis extrusion. *Right* cosmetic sequelae after BCT in the *right* breast, reconstructed with reduction mastoplasty. Infection and skin necrosis

produced is well known. Despite recent advances in radiotherapy with new techniques and equipment to improve the homogeneity of the dose and reduce the sequelae in the gland and skin, there is still a question in the indication of this procedure to correct these sequelae. Probably, in individual cases with good skin quality and minor sequelae without asymmetries, its use could be indicated exceptionally. See Fig. 19.16.

19.11 Complications

The complications are coincident with the description in numerous publications that report a higher complication rate in deferred breast reconstruction compared with immediate procedures after conservative treatment. These

high complication rates (between 40 and 60 %) are probably a consequence of the secondary changes produced by radiotherapy (scar retraction, radiodermatitis, and fibrosis), which make the procedures difficult and interfere with the cosmetic results [21–29] (see Fig. 19.17). In our experience [29], we observed coincidently a high complication rate, around 60 %. This rate represents a significant reduction in the last 5 years as a consequence of a change in the surgical technique chosen, with an increased number of patient's reconstructed with lipofilling, a procedure that has lower morbidity than the conventional techniques [30].

19.12 Conclusions

Oncoplastic surgery was incorporated into primary treatment of breast cancer to prevent the damaging consequences of this treatment, and produced important aesthetic and psychological benefits without altering oncological safety. In conservative treatment, despite there existing multiple reconstructive techniques to prevent sequelae, there are still a number of patients who for different reasons have unsatisfactory results magnified by the effects of radiotherapy. Traditionally, aggressive techniques with high complication rates (autologous tissue, prosthesis) and unstable results were employed for the reconstruction of these defects. However, recent years the introduction of lipofilling has opened up a new and promising stage, achieving in many cases highly satisfactory and stable results, with lower morbidity.

References

1. Audretsch W et al (1994) Oncoplastic surgery: "target" volume reduction, (BCT mastopexy) lumpectomy reconstruction (BCT reconstruction) and flap supported operability in breast cancer. In: Proceedings of the second European congress on senology, Vienna, Austria. Monduzzi, Bologna, pp 139–157
2. Silverstein M (1993) Cosmetic quadrantectomy. Paper presented at the annual Miami breast cancer conference, Miami
3. Clough K et al (1995) Conservative treatment of the breast cancer by mammaplasty and irradiation: a new approach to lower quadrant tumors. Plast Reconstr Surg 96:363–370
4. Grisotti A (1994) Immediate reconstruction after partial mastectomy. Oper Tech Plast Reconstr Surg 1:1–12
5. Audretsch W et al (1998) Tumor-specific immediate reconstruction (TSIR) in breast cancer patients. Perspect Plast Surg 11:71–106
6. Veronessi U et al (1995) Breast conservation is a safe method in patients with small cancer of the breast. Long term results of three randomized trials on 1973 patients. Eur J Cancer 31A(10):1574–1579
7. Fisher B et al (1995) Reanalysis and results after 12 years of follow-up in a randomized clinical trial comparing total mastectomy with lumpectomy with or without irradiation in the treatment of breast cancer. N Engl J Med 333:1456–1461
8. Moody A et al (1994) The influence of breast size on late radiation effects and association with radiotherapy dose inhomogeneity. Radiother Oncol 33:106–112
9. Gray J et al (1991) Primary breast irradiation in large breasted or heavy women: analysis of cosmetics outcome. Int J Radiat Oncology Biol Phys 21:347–354
10. Clough K et al (1998) Cosmetic sequelae after conservative treatment for breast cancer: classification and results of surgical correction. Ann Plast Surg 41:471–481
11. Cardoso M et al (2007) Factors determining esthetic outcome after breast cancer conservative treatment. Breast J 13(2):140–146
12. Bartelink H et al (2001) Recurrence rates after treatment of breast cancer with standard radiotherapy with or without additional radiation. N Engl J Med 345(19):1378–1387
13. Markiewicz D et al (1996) The effects of sequence and type of chemotherapy and radiation therapy on cosmesis and complications after breast conservation therapy. Int J Radiat Oncol Biol Phys 35(4):661–668
14. Hoeller U (2003) Cosmesis from the patient's and the doctor's view. Int J Radiat Oncol Biol Phys 57(2):345–354
15. Moyer HR et al (2008) Three-dimensional digital evaluation of breast symmetry after breast conservation therapy. J Am Coll Surg 207(2):227–232
16. Fitzal F et al (2007) The use of a breast symmetry index for objective evaluation of breast cosmesis. Breast 16(4):429–435
17. Berrino P (1987) Postquadrantectomy breast deformities: classification and techniques of surgical correction. Plast Reconstr Surg 79(4):567–572
18. Clough K et al (1998) Cosmetic sequelae after conservative treatment for breast cancer: classification and results of surgical correction. Ann Plast Surg 41(5):471–481
19. Fitoussi A et al (2010) Management of the post-breast-conserving therapy defect: extended follow-up and reclassification. Plast Reconstr Sur 125(3):783–791
20. Winters Z et al (2010) A systematic review of the clinical evidence to guide treatment recommendations in breast reconstruction based on patient-reported outcome measures and health-related quality of life. Ann Surg 252:929–942
21. Kronowitz S et al (2008) A management algorithm and practical oncoplastic surgical techniques for repairing partial mastectomy defects. Plast Reconstr Surg 122:1631
22. ASPRS Ad-Hoc Committee on New Procedures. Report on autologous fat transplantation. Plast Surg Nurs 7:140
23. Rigotti G et al (2007) Clinical treatment of radiotherapy tissue damage by lipoaspirate transplant: a healing process mediated by adipose-derived adult stem cells. Plast Reconstr Surg 119(5): 1409–1422; discussion 1423–1424
24. Gutowski K et al (2009) Current applications and safety of autologous fat grafts: a report of the ASPS Fat Graft Task Force. Plast Reconstr Surg 124:272
25. Khouri R (2000) Nonsurgical breast enlargement using an external soft-tissue expansion system. Plast Reconstr Surg 105: 2500–2512
26. Delay E (1998) Autologous latissimus breast reconstruction: a 3-year clinical experience with 100 patients. Plast Reconstr Surg 102:1461–1478
27. Moran S et al (2000) Immediate free TRAM reconstruction in lumpectomy and radiation failure patients. Plast Reconstr Surg 106(7):1527–1531
28. González E et al (2006) Utilidad y sistematización de las técnicas de cirugía oncoplástica en la prevención y corrección de las secuelas del tratamiento conservador. Consideraciones oncológicas y cosméticas. Rev Arg Mastol 25(86):49–69

29. Clough K et al (2003) Oncoplastic techniques allow extensive resections for breast-conserving therapy of breast carcinomas. Ann Surg 237(1):26–34
30. González E et al (2010) Evaluación clínica de la corrección de los defectos post tratamiento conservador y mastectomía con radioterapia con o sin reconstrucción mamaria con auto-transferencia de tejido adiposo sin manipulación de stem cells. Revista XXVI Jornadas Nacionales de Oncología del Instituto "Ángel H. Roffo", 31 de agosto al 3 de septiembre de 2010

Part III

Breast Reconstruction After Mastectomy

History and Development of Breast Implants

20

Mario Rietjens, Marco Aurélio da Costa Vieira, Cícero Urban, and Visnu Lohsiriwat

20.1 Introduction

The first breast implants were created by Cronin [1] in 1962, and then there were big developments. The initial concern was to find a biocompatible material: properly tolerated by the body and also inert. In 1958, Scales [2] proposed a review of the criteria needed for implants considering their biocompatibilities:

- No chemical activity
- No physical transformations when in contact with the body
- No stimulus to inflammatory reactions or foreign material
- No carcinogenic effect
- Able to tolerate the mechanical force
- Easy to produce at very low cost
- Able to be sterilized.

Initially, liquid silicone showed these characteristics and it was used for aesthetic purposes through cutaneous injections. Such practice was subsequently abandoned when it was verified that liquid silicone particles can migrate to regional lymph nodes and then to other organs, such as the lungs and the liver [3, 4].

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The first concern of silicone manufacturers was to make an implant with an envelope that could prevent the migration of silicone particles. Moreover, this envelope should not be excessively thick in order to maintain a more natural consistency of the reconstructed breast. The problem found with this first generation of implants was the durability of the envelope as there was a gradual degradation of the envelope and this resulted in rupture and spreading of the silicone gel. This event contributed to a decision by the Food and Drug Administration (FDA) to prohibit the use of silicone gel breast implants in 1992 [5]. In the USA and also all over the world there was a huge increase in the use of implants with silicone gel, and patients did not have proper control of the integrity of the implant. Furthermore, they were not informed that the implant needed to be replaced because it might rupture. Since then, there has been a new evolution in materials, with the reintroduction of implants containing a physiological solution, eliminating the use of silicone gel. The main problem of such implants with saline content is the rate of deflation, due to technical problems inherent to the valve; some studies showed a 5 % deflation rate after 5 years of implantation [6].

The next challenge was to deal with the problem related to the periprosthetic capsule, which was one of the most frequent complications of breast implants. Changing the position of the implants from the subglandular plane to the retropectoral plane decreased periprosthetic capsule formation. The introduction of implants covered with a coat of polyurethane contributed to the reduction of the capsular contracture [7], but the use of these implants was prohibited by the FDA, as it was proved in an experimental study that the degradation of polyurethane produced a substance that is potentially carcinogenic and could cause bladder tumors [8]. However, this initiated the development of implants with an external texture which could have the same effect as polyurethane in order to reduce periprosthetic capsular contracture. Nevertheless, some randomized studies compared implants with a smooth textured envelope, and did not find a significant reduction in the level of capsular

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Table 20.1 Evolution of breast implants

Years	Development
1962	Implants in Sialastic® silicone gel—first generation
1965	Implants in Simaplast saline solution
1975	Implants in "low-bleed" silicone gel—second generation
1976	Implants with a double chamber
1976	Anatomic implants
1986	Implants coated in polyurethane
1988	Implants with a textured surface
1990	Implants with hydrogel
1992	Prohibition by the FDA of the use of silicone gel implants
1993	Implants with Trilucent lipid
1995	Anatomic implants in cohesive silicone gel—third generation
2002	Anatomic implants in silicone gel with differentiated shapes for the right and left breast (PIP implants)
2003	Implants coated in a titanium microstructure
2011	PIP and Rofill implant crises

PIP Poly Implant Prosthèse

contracture [9]. A new generation of cohesive silicone gel allowed the production of form-stable implants with anatomic shapes, thereby improving the aesthetic results of breast cancer reconstruction (Table 20.1).

20.2 Types of Implants

There are various types of breast implants and they can be categorized according to the characteristics of the material or the indications

- Smooth, textured, polyurethane, and microtextured in titanium envelopes
- Saline-filled, regular, or cohesive silicone gel, mixed gel and other nonhomologous substances (soybean oil, peanut oil, hydrogel, etc.)
- Round and anatomic shapes or other shapes
- Fixed or variable volume.

20.2.1 Saline Implants

These implants are made with a silicone envelope and a valve that allows inflation by means of a physiological solution during the surgical procedure. The envelope may be either smooth or textured. The envelope has good elasticity, and allows variation of the inflation from the saline solution in order to obtain better symmetry with the contralateral breast. Overinflation of 10–20 % more than the volume recommended by the implant manufacturer is suitable as it causes better distension of the envelope and prevents the implant folding. These folds could subsequently cause rupture of or extrusion of material from the prosthesis, especially in the case of thin and irradiated tissue coverage. The shape might be round or anatomic, but it is more difficult to maintain an anatomic shape when saline solution is used as the implant does not have the same consistency as cohesive gel. The valve may be anterior or posterior according to the technique. Small incisions can be adequate for insertion of the implant, and it can then be inflated with the physiological solution.

Practically, it would be simpler to use implants with anterior valves or periareolar and posterior valves for axillary incision cases. The valve is one of the critical points of saline implants, as a rare production defect may cause partial or total leakage of the physiological solution. Usually, this leakage does not produce any pathological damage to the patient, as it is a physiological solution and can be reabsorbed. The main problem is a good aesthetic result; the deflation can lead to the necessity for a revision or substitution procedure (Fig. 20.1). Some studies reported different levels of leakage or disruption of saline implants. A French group has demonstrated leakage level of 15 % in 650 patients with an average follow-up of 5 years [10].

20.2.2 Silicone Gel Implants

These implants have a fixed volume. They are made of an envelope of silicone gel. Currently, the thickness of the envelope is carefully considered. It can be more resistant and avoid the "perspiration" of silicone gel particles. Silicone gel is elastomeric and its viscosity depends on the molecular mass, so now it is possible to manufacture a more cohesive gel. This kind of gel is used in the manufacture of anatomic implants, which need to be slightly more rigid in

Fig. 20.1 Round prostheses: physiological solution (with a valve for filling) and prosthesis in silicone gel

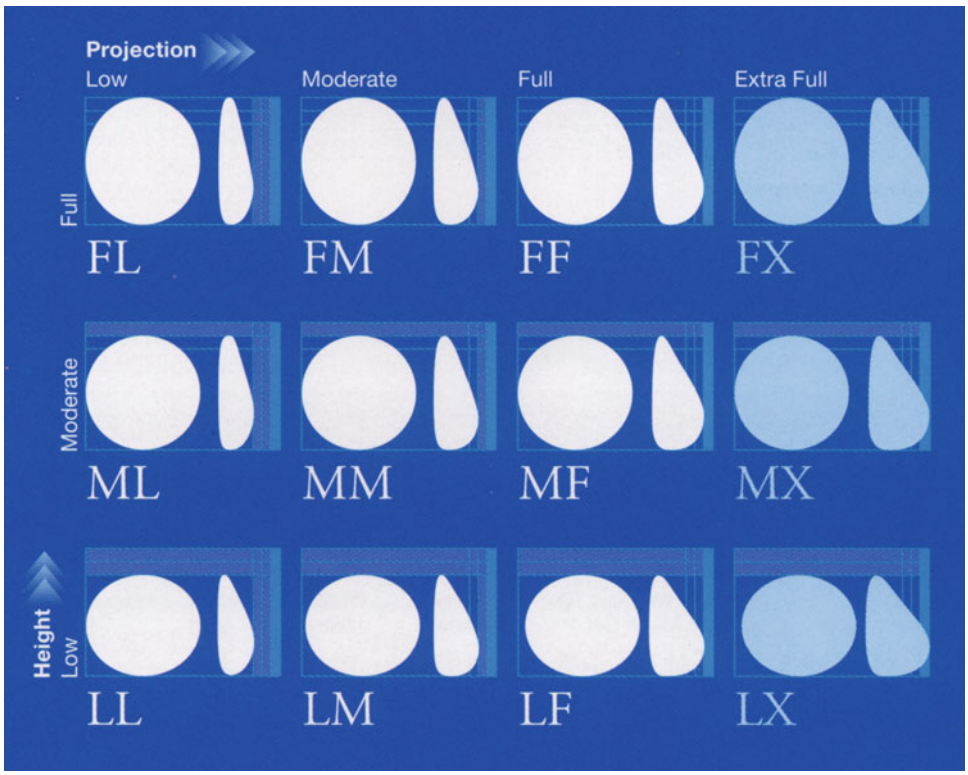

Fig. 20.2 Different models of anatomic prostheses following the parameters of base width, height, and projection

order to maintain the anatomic shape. Anatomic implants with cohesive gel were a great advance in terms of improving the aesthetic results in breast reconstruction. It is possible to achieve a better shape with less projection of the upper pole of the breast. Implant manufactures are now using three types of cohesive gel: low, medium and high cohesive gel for both anatomic and round implants. For this reason, plastic surgeons have a very large choice depending on the shape and consistency of the breast.

A technical refinement is necessary when using this implant for breast reconstruction. When the mastectomy flaps are thick and well vascularized, it is possible to make a partial cover of the implant with only the pectoralis major muscle. This technical element contributes to a better aesthetic result, with more projection of the lower pole of the breast. Using a round prosthesis with complete coverage of the pectoralis major muscle and the serratus anterior muscle may create a round and less natural shape [11]. Another advantage of cohesive gel is increasing patient safety by reducing the phenomenon of perspiration of the particles. As it is more cohesive, this gel probably reduces migration to the lymph nodes even in cases of disruption of implants. The main advantage of anatomic implants is the possibility to choose different shapes and volumes, as some manufacturers supply different models of implants that differ according to three parameters: height, width, and anterior projection. It is easier to select the ideal implant according to the different morphological characteristics of the patient (Fig. 20.2).

Other manufacturers provide innovative features such as prostheses for the right or the left breast and with a concave posterior wall for thoracic wall convexity (Poly Implant Prosthèse, PIP, implant). Although this was an interesting idea, this manufacturer suffered a crisis in 2010 owing to suspicion of the use of industrial (nonmedical and nonapproved use in humans) silicone in their implants [12].

The disadvantages of anatomic implants with cohesive gel are:

- Harder consistency of the reconstructed breast, which may create a periprosthetic capsular contracture.
- Wider skin incision. In cosmetic augmentation mammaplasty, round implants can be inserted even through a small periareolar incision. In contrast, anatomic implants need bigger incisions, preferably in the inframammary fold, to allow compression-free insertion, as even a slight compression could deform them.
- Increased risk of implant rotation. This is more frequent when there is a postoperative seroma or absence of periprosthetic capsular formation. Sometimes is possible to rerotate the implant into the correct position with a "manual massage"; if this is not possible, then a surgical revision is needed [13].

20.2.3 Double-Chamber Implants

These implants are made with an internal coat of silicone gel and an external chamber that can be filled with20–50 ml of physiological solution. The initial purpose was to create a more fragile external chamber that will degrade 3 or 4 months after implantation, therefore reducing the implant volume by 20–50 cm^3 when the periprosthetic capsule stabilizes. There was no clear advantage of reducing periprosthetic capsular contracture when compared with single-chamber implants, so the use of double-chamber prostheses was discontinued.

20.2.4 Polyurethane-Coated Implants

These implants are made with an external coat of polyurethane, and they are more efficient in preventing capsular contracture than those with a smooth envelope. The physical characteristic of the polyurethane-coated implant causes disorientation of the direction of collagen fibers, which does not occur in smooth-envelope implants [14]. Some publications have demonstrated that the metabolism of polyurethane produced 2,4-toluenediamine and 2,6-toluenediamine, which could be carcinogenic [7, 15]. The incidence of periprosthetic contracture and other complications was reported to be less than 1 % [16]. In the case of infection with a polyurethane prosthesis, removal of the prosthesis with all polyurethane residues is mandatory to avoid cutaneous fistula.

20.2.5 Titanium Microstructure Implants

These are relatively new implants, launched on the market in 2003, and they have the following characteristics: the internal part is silicone gel and the external envelope is silicone with a titanium microstructure. The aim is to reduce reactions to foreign bodies and consequently to decrease the incidence of periprosthetic capsules. An in vivo animal study show titanium-coated silicone grafts were not effective in protecting against infection; however, they might reduce the rate of capsular contracture [17].

20.2.6 Definitive Expanders

These implants have an adjustable volume. The external chamber is filled with silicone gel and an internal chamber can be filled with physiological solution; therefore, it is easier to match the volume symmetry of the opposite breast. The internal chamber lies at the lower portion of the implant; therefore it creates the anatomic-shape-like prosthesis. An external valve connects with the internal chamber through a 2-mm silicone tube; this device can be removed (Becker's prosthesis) or fixed to the prosthesis (Allergan style 150). The valve can be easily placed in the axillary region or other superficial locations. A parasternal placement may cause discomfort to the patient and should be avoided [18]. This type of implant is also useful for an immediate breast reconstruction with a fragile skin flap and high risk of necrosis if high tension is found. In such cases, the implant can be inserted without filling the internal chamber, and inflation can be done after 3 or 4 weeks when a viable skin flap is approved. There is also the possibility to correct the volume when the body weight changes in the postoperative period owing to chemotherapy or hormone therapy (Figs. 20.3, 20.4).

Two disadvantages in the use of implants of this type are

1. Patients experience some discomfort from an axillary valve. If the implant has a removable valve, it can be removed simultaneously with the nipple and areola complex reconstruction procedure. If the valve cannot be removed and the final volume is obtained, then it is possible to place the valve behind the implant when the subsequent surgical procedure is required.
2. The point of connection of the tube on the implant surface is rather vulnerable. There is a risk of physiological solution leaking through the protection valve in a tube-removed implant. On other hand, there is a major mechanical traction force that may result in disruption of the implant if the tube is not removed.

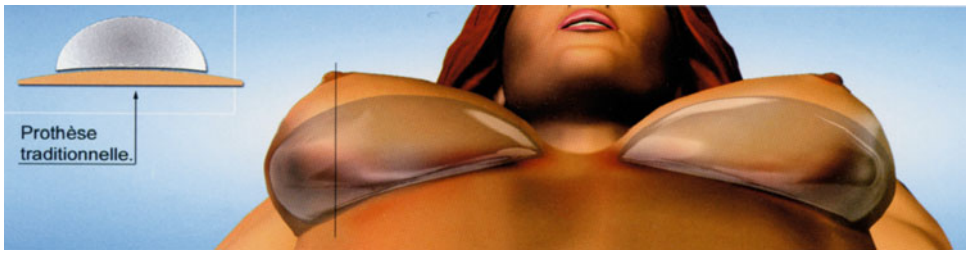

Fig. 20.3 Anatomically differentiated prostheses, one shape for the *right* side and another shape for the *left* side

Fig. 20.4 Definitive expanders. These are prostheses with a silicone gel chamber and a second chamber with physiological solution, where the volume can be adjusted through a small subcutaneous valve. Prosthesis filled to the maximum level (*left*) and prosthesis without physiological solution filling (*right*)

20.2.7 Temporary Expanders

These are implants with an elastic silicone envelope and a filling valve that allows inflation by means of physiological solution. The postoperative skin can be expanded to match the volume symmetry of the contralateral skin. However, a second surgical procedure is needed to replace the expander with the definitive implant. There are different models and shapes of expanders: round or anatomic, with integrated valves or with separated valves. The older models are round and have separated valves which are connected with the device through a 2-mm-diameter silicone tube. The disadvantage of these models is that they not only produce distension of the lower pole but they also cause distension of the upper pole and the pectoralis major muscle. Such distension causes pain and discomfort when patients move their upper limbs; distension of the upper pole is more likely than distension of the lower pole (Fig. 20.5). Another disadvantage is the positioning of the valve, that is usually placed in the axillary region. It may cause pain or discomfort if it is too big, or it may even make inflation difficult if it is rather small or the patient is obese. Currently, the most frequently used models are those with various heights, an external textured envelope, and incorporated

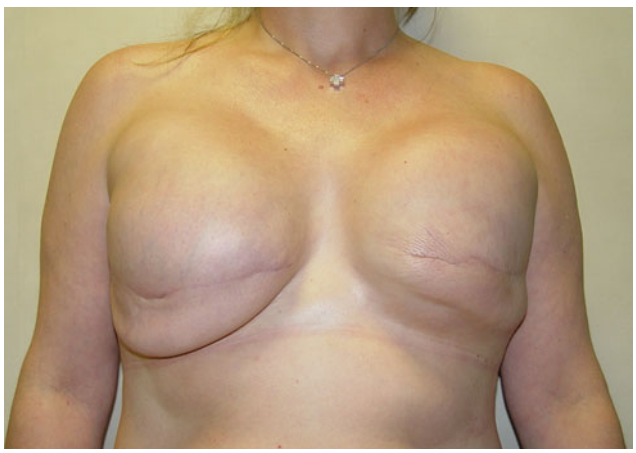

Fig. 20.5 Round expanders (not anatomic) produce a distension of the *upper part* of the breast with pain and an unacceptable aesthetic result

valves. The anatomic shape is appropriate for a significant distension of the lower pole, producing skin distension with symmetry to the opposite breast. It does not cause discomfort from the stretching of the pectoralis major muscle (Fig. 20.6). The various heights of prostheses may help to determine the expansion of the lower pole. The textured

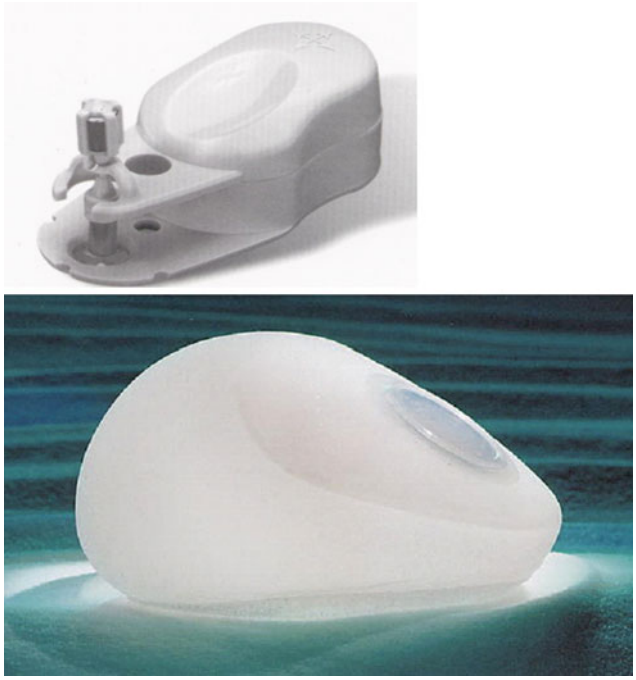

Fig. 20.6 Temporary expander with incorporated valve; the magnet for external use specifies the exact point for placing the needle in order to fill the prosthesis with the physiological solution

envelope may prevent the malpositioning of the prosthesis. Moreover, it may reduce the incidence of periprosthetic capsule formation. The hypothesis is that the textured envelopes produce a heterogeneous disposition of the fibroblasts, which reduces the tension of the periprosthetic capsule. The incorporated valve makes the patient feels more comfortable and also avoids the problems of valve placement in the axilla.

Special attention must be given to positioning of the anatomic textured expander with an incorporated valve:

- Make sure that the expander is placed with the valve on the anterior wall of the prosthesis.
- Make sure that the lower base is placed exactly at the inframammary fold, as the exact position of the implant helps to create the proper position of the reconstructed inframammary fold without the need for capsulotomy or fixation.
- Make sure that there is no folding in the lower portion of the expander over the region of the valve, as there is the risk of perforation if the needle is inserted through the skin and folding envelope.
- Try to place the expander horizontally in the thoracic region, in order to avoid inappropriate medial or lateral distension.

The time and frequency of inflation depend on the skin flap and the elasticity of tissues. A more appropriate rapid distension is more efficient and less uncomfortable for patients. The expander must be filled intraoperatively without tension of the mastectomy skin flap and suture line. During the operation, methylene blue dye can be added to the physiological solution in order to make the postoperative needle placement easier. If the mastectomy flap is viable, one can fill the expander with 60 ml physiological solution weekly until the target volume is achieved.

20.3 Controversy About Silicone

Millions of women have had silicone gel implants in the USA over the past decades. Controversy about silicone began with the suspicion of a relation between silicone and autoimmune diseases (rheumatoid arthritis, scleroderma, lupus erythematosus, etc.), neurological diseases [19], or a carcinogenic effect. As a result, the FDA (prohibited the use of silicone gel implants [5], except for cases of mammary reconstruction or aesthetic mammaplasty for breast augmentation as part of clinical studies.

A review of the literature proposed by the American Academy of Neurology [20] excludes the correlation risk of silicone breast implants and neurological disorders. Other major epidemiological studies [21–26] concluded that there is no connection between silicone gel and autoimmune diseases. Also other clinical [27, 28] and epidemiological [29–31] studies demonstrated a relation between breast implants and incidences of breast cancer.

Currently, the problem that concerns the FDA is the diagnosis of subclinical rupture of the prosthesis. The extremely thin external envelope may allow silicone perspiration and also subclinical envelope disruption. A meta-analysis of more than 10,000 prostheses by Marotta et al. [32]. showed an increasing rate of rupture with time The rupture rates were 26 % at 3.9 years, 47 % at 10.3 years, and 69 % at 17.8 years ($p < 0.001$). Mammography, ultrasonography and magnetic resonance imaging (MRI) have some limitations for the diagnosis of rupture. Mammography can basically diagnose a late rupture, when the periprosthetic capsule is calcified. Ultrasonography has a sensitivity of 47–74 % and specificity of 55–96 %. Ultrasonography is an operator-dependent examination and needs learning experience. MRI would be the best type of test to diagnose rupture [33], as it has a sensitivity of 46–100 % and specificity of 92–100 %. However, its cost is high and it cannot be performed in obese patients, patients with claustrophobia, and patients with an artificial pacemaker. MRI hepatic spectroscopy can diagnose the migration of silicone particles to the liver in cases of rupture of the silicone breast implant [34, 35]. In 2006, the FDA recommended implant manufacturers conduct postmarketing studies. Thousands of women enrolled in the Mentor and Allergan studies to evaluate complications but 79 % of patients in the Mentor study and nearly 40 % of patients in the Allergan study were lost to follow-up.

The PIP crisis in 2011 showed the inadequacy of current data on the safety of breast implants and the need for reliable independent postmarketing surveillance studies [12].

20.4 European Institute of Oncology Biomechanical Study

Because of the concern of subclinical rupture of silicone gel prostheses, we proposed a diagnostic–clinical–biomechanical study of prostheses in patients who undergo a prosthesis substitution for different reasons; for example, suspected rupture, asymmetry, periprosthetic capsular contracture, and increase in weight:

Diagnostic stage: All patients should undergo preoperative MRI to set the level of sensitivity and specificity for subclinical rupture through a blind experiment.

Clinical stage: A preoperative evaluation of the periprosthetic capsule according to Baker's classification [36] and clinical signs of rupture (inflammation of the site or deformity of the prosthesis) must be performed. Intraoperative evaluation with a bacteriological test of the periprosthetic liquid and histological examination of the periprosthetic capsule and the pectoralis muscle are performed. The histological examination aims to find the diffusion of silicone gel particles in adjacent tissues according to the time of implantation and the condition of the prosthesis.

Biomechanical stage: Once the prosthesis has been removed, it will be subjected to mechanical analyses, both static-dynamic (integrity of the envelope, resistance to pressure, elasticity, etc.) and chemical (viscosity, molecular weight, spectroscopy, etc.) analyses. The results are compared with the initial characteristics of each prosthesis. Moreover, to obtain commercial authorization, these prostheses must have been subjected to all the initial tests. This stage will evaluate the biomaterial degradation according to the implantation timing of each type of prosthesis and the different manufacturers.

The initial results found that MRI is a good method to evaluate the implant conditions. The sensitivity and specificity of the method were 97 and 98 %, respectively. The inhomogeneous silicone signal or water drop sign inside the silicone gel can be a diagnostic sign for a prerupture phase. For the biomechanical evaluation, it was demonstrated that a round implant with noncohesive gel had a high incidence of rupture, with less time from implantation than anatomic implants with cohesive gel. A possible explanation is the molecular weight of silicone in cohesive gel is greater than that in noncohesive gel. This produces less envelope swelling and the envelope maintains good resistance for a long time after implantation. Definitive results will be published soon.

20.5 PIP Implants

The anatomic PIP implant was used at the European Institute of Oncology from 2003 to 2006. A total of 680 implants were used in 639 patients. The technical choice was due to the innovative concept of implant: an anatomic implant with different characteristics for the right and left breast and with a concave posterior wall to adapt better to the thoracic wall.

In March 2010, the Agence Française de Sécurité Sanitaire des Produits de Santé (AFSSAPS; French bureau for control of drugs) forbade the sale of PIP implants because there was a higher incidence of implant rupture compared with other implants. It also required recall for all concerned patients according to the findings of the clinical examination and the radiological examination and the desire of the patient for possible removal [37].

In January 2011, the European Institute of Oncology risk management unit started a recall campaign for all patients with a PIP implant without a recent medical and radiological examination. In this first recall population, around 280 patients had breast ultrasonography and clinical examination, and it was found that 6 % of them had implant rupture (unpublished data). In the AFSSAPS publications, the incidence of implant rupture was around 11 %.

In December 2011, there was a global panic regarding PIP implants owing to the information that the silicone used in PIP implants was not of medical grade and was suspected of being carcinogenic. This suspicion has not been confirmed by rigid scientific data. Almost all patients around the world with a PIP implant wish for it to be replaced or for a check up. At the European Institute of Oncology, we are following the policies of the Italian government:

- Complete checking of all patients who have PIP implants
- Recall all patients without an examination in the last 6 months to offer breast ultrasonography to evaluate the integrity of the implant and consultation with a plastic surgeon
- Offer patients the possibility of the implant being changed.

This polemic problem generated a big problem around the world, not only a psychological problem but also an economic problem. More rigid controls for all implant manufacturers may be necessary to avoid the same problem occurring again.

20.6 Protocol for Follow-up of Patients with Mammary Prostheses in the European Institute of Oncology

All patients who will undergo a mammary reconstruction with a prosthesis or an augmentation mammaplasty must be informed that silicone gel prostheses will be used. These

prostheses undergo a process of degradation of the external cover and therefore need to be replaced 10–20 years after implantation. Patients need to have an annual clinical and ultrasonographic examination as well as MRI after 10–15 years. In the case of suspected implant rupture, the prostheses must be replaced. In the case of a small amount of diffusion of the silicone to axillary lymph nodes, our protocol is not to remove the inflammatory nodes, because we observed that these nodes became normal few months after implant removal. The lymph nodes are removed only if carcinoma metastasis is suspected or if they are large and painful ones.

References

1. Cronin TD, Gerow FJ (1963) Augmentation mammaplasty: a new "natural feel" prosthesis. Excerpta medica foundation, Amsterdam, p 41
2. Scales JT (2004) Biological and mechanical factors in prosthetic surgery. In: Gilles L (ed) Modern trends in surgical material. Butterworth, London
3. Barnard JJ, Todd EL, Wilson WG, Mielcarek R, Rohrich RJ (1997) Distribution of organosilicon polymers in augmentation mammaplasties at autopsy. Plast Reconstr Surg 100:197–203
4. Gaubitz M, Jackisch C, Domschke W, Heindel W, Pfleiderer B (2002) Silicone breast implants: correlation between implants ruptures, magnetic resonance spectroscopically estimated silicone presence in the liver, antibody status and clinical symptoms. Rheumatology (Oxford) 41:129–135
5. Kessler DA (1992) The basis of FDA's decision on breast implants. N Engl J Med 326:1713–1715
6. Stevens WG, Hirsch EM, Stoker DA, Cohen R (2006) A comparison of 500 prefilled textured saline breast implants versus 500 standard textured saline breast implants: is there a difference in deflation rates? Plast Reconstr Surg 117:2175–2178; discussion 9–81
7. Handel N, Silverstein MJ, Jensen JA, Collins A, Zierk K (1991) Comparative experience with smooth and polyurethane breast implants using the Kaplan-Meier method of survival analysis. Plast Reconstr Surg 88:475–481
8. Chan SC, Birdsell DC, Gradeen CY (1991) Urinary excretion of free toluenediamines in a patient with polyurethane-covered breast implants. Clin Chem 37:2143–2145
9. Fagrell D, Berggren A, Tarpila E (2001) Capsular contracture around saline-filled fine textured and smooth mammary implants: a prospective 7.5-year follow-up. Plast Reconstr Surg 108:2108–2112
10. Soubirac L, Jougla E, Hezard L, Grolleu JL, Chavoin JP (2002) Deflation of breast implants, pre-filled with saline or hydrogel. Results an analysis of 650 treated patients. Ann Chir Plast Esthet 47:273–279
11. Little JW, Golembe EV, Fisher JB (1981) The "living bra" in immediate and delayed reconstruction of the breast following mastectomy for malignant and nonmalignant disease. Plast Reconstr Surg 68:392
12. Heneghan C (2012) The saga of poly implant prosthese breast implants. BMJ 344:e306
13. Panettiere P, Marchetti L, Accorsi D (2004) Rotation of anatomic prostheses: a possible cause of breast deformity. Aesthetic Plast Surg 28:348–353
14. Smahel J (1978) Tissue reactions to breast implant coated with polyurethane. Plast Reconstr Surg 61:80–85
15. Benoit FM (1993) Degradrations of polyurethane foams used in Meme breast implants. J Biomed Mater Res 27:1341
16. Vazquez G, Pellon A (2007) Polyurethane-coated silicone gel breast implants used for 18 years. Aesthet Plast Surg 31:330–336
17. Hernandez-Richter T, Wittmann B, Wittmann F, Loehe F, Rentsch M, Mayr S et al (2007) Titanium-coated silicone is not effective for preventing graft infection. Zentralbl Chir 132:32–37
18. Cordeiro PG, Pusic AL, Disa JJ, McCormick B, VanZee K (2004) Which is the best position for the remote injection dome using the adjustable expander/prosthesis in breast reconstruction. Plast Reconstr Surg 113:877–881
19. Sergotti TJ, Limoli JP, Baldwin CM Jr, Laub DR (1986) Human adjuvant disease, possible autoimmune disease after silicone implantation: a review of the literature, case studies and speculation for the future. Plast Reconstr Surg 78:104–114
20. Ferguson JH (1997) Silicone breast implants and neurologic disorders. Neurology 48:1504–1507
21. Hochberg MC (1996) Lack of association between augmentation mammaplasty and systemic sclerosis (scleroderma). Arthritis Rheum 39:1125–1131
22. Friis S, Mellemkjaer L, McLaughlin JK et al (1997) Connective tissue disease and other rheumatic conditions following breast implants in Denmark. Ann Plast Surg 39:1–8
23. Sanchez-Guerrero J (1995) Silicone breast implants and the risk of connective tissue disease and symptoms. N Engl J Med 332: 1667–1670
24. Sherine G, O'Fallon WM, Kurland LT et al (1994) Risk of connective tissue diseases and other disorders after breast implantation. N Engl J Med 330:1697–1702
25. Miller AS, Willard V, Kline K et al (1998) Absence of longitudinal changes in rheumatological parameters after silicone breast implantation: a prospective 13 year study. Plast Reconstr Surg 102:2299–2303
26. Nyren O, Yin L, Josefsson S et al (1998) Risk of connective tissue disease and related disorders among women with breast implants: a nation-wide retrospective cohort study in Sweden. Br Med J 316:417–422
27. Petit JY, Le MG, Mouriesse H, Rietjens M, Gill P, Contesso G, Lehmann A (1994) Can breast reconstruction with gel-filled silicone implants increase the risk of death and second primary cancer in patients treated by mastectomy for breast cancer? Plast Reconstr Surg 94:115–119
28. Petit JY, Le MG, Rietjens M, Contesso G, Lehmann A, Mouriesse H (1998) Does long-term exposure to gel-filled silicone implants increase the risk of relapse after breast cancer? Tumori 84:525–528
29. Berkel H, Birdsell DC, Jenkins H (1992) Breast augmentation: a risk factor for breast cancer? N Engl J Med 326:1649
30. Deapen DM, Pike MC, Casagrande JT et al (1986) The relationship between breast cancer and augmentation mammaplasty: an epidemiologic study. Plast Reconstr Surg 77:548
31. Deapen DM, Brody GS (1992) Augmentation mammaplasty and breast cancer: a 5-years update of the Los Angeles Study. Plast Reconstr Surg 89:660
32. Marotta JS, Goldberg EP, Habal MB, Amery DP, Martin PJ, Urbaniak DJ, Widenhouse CW (2002) Silicone gel breast implant failure: evaluation of properties of shells and gels for explanted prostheses and meta-analysis of literature rupture data. Ann Plast Surg 49:227–247
33. Ikeda DM, Borofsky HB, Herfkens RJ, Sawyer-glover AM, Birdwell RL, Glover GH (1999) Silicone breast implant rupture: pitfalls of magnetic resonance imaging and relative efficacies of

magnetic resonance, mammography and ultrasounds. Plast Reconstr Surg 104:2054
34. Pfleiderer B, Campbell T, Hulka CA et al (1996) Silicone Gel-filled breast implants in women: findings at H-1 MR spectroscopy. Radiology 201:777–783
35. Gaubitz M, Jackisch C, Domschke W, Heindel W, Pfleiderer B (2002) Silicone breast implants: correlation between implant ruptures, magnetic resonance spectroscopically estimated silicone presence in the liver, antibody status and clinical symptoms. Rheumatology 41:129–135
36. Spear SL, Baker JL Jr (1995) Classification of capsular contracture after prosthetic breast reconstruction. Plast Reconstr Surg 96:1119–1123
37. Carillon MA, Giard S, Emmanuelli V, Houpeau JL, Ceugnart L, Chauvet MP (2012) Breast implants and health alert PIP: experience of the regional cancer center of Lille. Bull Cancer 99:147–153

Staged Implant-Based Breast Reconstruction 21

Deirdre M. Jones and Peter G. Cordeiro

21.1 Introduction

Implant-based breast reconstruction is the most widely used form of breast reconstruction today. It comprises a straightforward set of procedures that can be relied on to provide a satisfactory result in most cases. It is often the optimal choice for most women wishing to undergo post-mastectomy reconstruction, and approximately 75 % of breast reconstructions that are performed in the USA are implant-based [1]. This chapter describes the development of implant-based reconstruction over time, the products that are available, and the refined techniques routinely employed to achieve consistently good outcomes.

Implants for breast reconstruction were first introduced in the 1960s. Initially, these were made of rubber sponge and Dacron or silastic silicone rubber, and over the decades evolved to saline-filled and then silicone gel implants. Implants evolved as a reconstructive response to the emergence of skin-sparing mastectomy. They were placed subcutaneously through a variety of inframammary, lateral radial, lateral, or inferolateral arc incisions.

Today, there is a wide range of expanders and implants to choose from, although the overwhelming majority in routine use are silicone-based. Composition, shape, surface, and size are the primary differentiating characteristics. Depending on the circumstances, we use silicone or saline fill, round or anatomical shape, smooth or textured surface, and a full range of dimensions according to the volume, width, height and projection required. It is important to rationalize the range of devices used in order to improve efficiency and to develop the necessary expertise.

When implant-based breast reconstruction was initiated in the 1970s, breast surgeons were still routinely excising gland and skin en bloc. The commonest option for implant reconstruction was one-stage reconstruction and was delayed for 6 months or more after mastectomy. Tissue expansion was not an option at that time. With the acceptance of skin-sparing mastectomy and the development of tissue expansion, it became feasible to perform immediate reconstruction in either one or two stages. The option of immediate reconstruction over delayed reconstruction reduces the overall anesthetic time and the number of operations needed. It can provide a better aesthetic outcome by optimizing the use of the native breast skin. It is also psychologically beneficial for some women.

The comparative benefit of a one-stage or two-stage approach is a constantly evolving debate among reconstructive surgeons, and new advances in implant technology and dermal substitutes and patient demands drive this process. Nonetheless, it can be said that single-stage implant reconstruction with or without symmetrization is most suitable for the small, nonptotic breast, and that two-stage reconstruction allows the surgeon to optimally set the final breast pocket exactly where it needs to be, accurately reproducing the inframammary fold and maximizing medial breast fullness, skin envelope distribution, scar appearance, and overall breast position. Two-stage implant reconstruction allows a more predictable outcome in the hands of most surgeons.

It is widely believed that patients benefit from having their oncological resection performed by a dedicated breast oncologist, and the reconstruction performed by a reconstructive plastic surgeon, so that the oncological imperatives are not compromised and the patient receives an optimal aesthetic result on the first attempt in most cases. In practice, this principle works very well. Our ideal algorithm for two-stage implant-based breast reconstruction is as follows:

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1. Skin-sparing mastectomy with or without nipple-sparing mastectomy and insertion of subpectoral/subserratus tissue expanders.
2. Expansion on a weekly basis over 5–6 weeks with completion of chemotherapy if indicated during this period.
3. When fully expanded, and at least 4 weeks after completion of chemotherapy, exchange of tissue expanders for permanent implants. If indicated, radiotherapy commences 4 weeks after exchange to allow robust wound healing.

21.2 Choice of Patient

Each reconstructive surgeon has his or her own ideas and preferences in relation to which reconstructive approach best suits the needs of any given patient. This personal algorithm may be based on a combination of multiple patient factors, as well as the surgeon's training and expertise, time efficiency, and cost/benefit considerations. The patient best suited to implant-based breast reconstruction is often a small-breasted or medium-breasted, slender woman with a well-defined body shape and minimal breast ptosis. Implants are less well suited to women with very large breasts, or women who are overweight, because even the biggest implant might not give sufficient definition to the breast in the context of the whole body. In cases like this, when a woman is sufficiently fit, she is often a suitable candidate for autologous breast reconstruction. Nonetheless, it is certainly possible for women with an elevated BMI to achieve excellent aesthetic results with implants. Patients choose implant reconstruction because they want a shorter, simpler combination of procedures, and/or because they do not wish to sacrifice muscles or other body tissues in order to achieve a satisfactory breast shape. Furthermore, these patients are comfortable with the concept of having a silicone medical device implanted. Women who are unsuited to autologous reconstruction because of comorbid conditions or because they have insufficient donor tissue often do best with implant-based reconstruction.

21.3 Choice of Implant

This is a decision made jointly between the surgeon and the patient. In practice, the basic choices that need to be made are:

1. Saline or silicone fill
2. Round or anatomical shape
3. Smooth or textured surface
4. Size.

A recent multicenter cross-sectional study utilizing Breast-Q, the validated outcomes measurement tool in breast surgery, revealed that patients who received silicone implants reported a higher overall satisfaction rating with their breast reconstruction than patients who received saline implants [2]. In choosing the approximate size of the reconstructed breast, the surgeon must be guided by the patient's preferences while also being constrained by the patient's frame, and the quality of her skin and soft tissues. For the patient who prioritizes shape and definition over softness and mobility, the textured anatomical silicone implant is best. For the patient who focuses on softness and movement, the soft, round silicone implant is a good choice. There is a putative advantage to the smooth implant in terms of mobility on the chest. Although the textured implant has been associated with less movement on the chest wall, it tends to hold its shape and position better over time, and is associated with a lower rate of capsular contracture. Again, reconstructive surgeons have their own preferred shapes and surfaces, but it is vital to attempt to identify and consider preoperatively the preferences of patients in order to give them breasts with which they will be satisfied. The implant type can usually be chosen preoperatively in most cases, and should be detailed in the patient's informed consent.

21.4 Surgical Steps in Two-Stage Implant-Based Breast Reconstruction

Following mastectomy, the mastectomy skin flaps are inspected, trimmed as necessary, and tissue expanders are placed in a submusculofascial pocket and filled to 10–50 % of total volume as tolerated. Expansion commences on days 10–14 postoperatively, and at each visit 60–120 ml of fluid is added. Generally five or six visits to the clinic achieve a volume that is 10–20 % larger than the contralateral breast size or the projected final breast size to allow for the formation of a well-defined inframammary fold and adequate ptosis. Chemotherapy, if indicated, is administered during this expansion period. Once expansion is completed, final exchange can take place. As a minimum, a 4-week recovery period should be allowed after completion of chemotherapy and final implant exchange [3].

21.5 Advantages of Accelerated Expansion

By maximizing expansion volumes and minimizing the number of expansions, one can shorten the total expansion period and reduce overall patient morbidity. Placing as much fluid as possible in the expander intraoperatively is also strategically beneficial. Equally, this accelerated approach has not resulted in a higher rate of expander

extrusion [3]. Contraindications to accelerated expansions are previous radiotherapy, poor-quality skin flaps, and an excessively tight skin envelope. The clinical judgment that comes with experience is invaluable in this decision-making process.

21.6 Technical Refinements

Most implant-based breast reconstructions are performed as immediate procedures following skin-sparing and possibly nipple-sparing mastectomies. The first part of the procedure involves the formation of a subpectoral, subserratus, subrectus musculofascial pocket in which to place the silicone expander prosthesis.

The patient is supine, with her arms brought to the sides or tucked. The quality of the skin flaps formed by the breast surgeon should be assessed and any bleeding stopped. A subpectoral pocket is first dissected with the use of a lighted retractor and monopolar diathermy. The pectoralis minor muscle is not disturbed. The subpectoral planes are avascular and easily dissected. The thoracoacromial pedicle and internal mammary perforators should be preserved if possible, and carefully cauterized if not. The ideal pocket extends to a gentle subclavicular curve superiorly, to 1–2 cm from the midline medially, to 1–2 cm below the inframammary fold inferiorly, and to the anterior axillary line laterally. To achieve sufficient expansion potential inferomedially, it is often necessary to release the inferomedial fibers of the pectoralis major origin. Similarly, to achieve sufficient expansion for ptosis, the submuscular dissection should extend for 1–2 cm in the plane beneath the rectus abdominis fascia, and should extend laterally in that plane to the anterior axillary line. At that level the rectus fascia medially and the superficial chest wall fascia are also released to allow good expansion. Laterally, it is necessary to raise a serratus anterior flap, comprising just sufficient muscle to complete a robust submuscular pocket.

The width of the breast pocket is then measured in centimeters, and the choice of tissue expander is based primarily on that value. In most mastectomy defects, the primary skin deficit is in the vertical axis, and so maximal expansion should also be in this axis. For this reason the senior author generally uses full-height expanders in order to maximize vertical expansion for a given volume. While the expander is being prepared (with fresh gloves, the air is removed, and 60 ml of normal saline is introduced), meticulous hemostasis and bacitracin irrigation of the submuscular pocket should be performed to minimize the risk of hematoma formation. The skin is prepared with povidone-iodine and the area is redraped. The skin flaps are retracted as the surgeon places the expander without touching the skin (Fig. 21.1a). The muscle pocket is closed with a 2/0 Vicryl continuous suture taking care not to puncture the expander (Fig. 21.1b). The implant port is carefully located using a magnet and as much saline as is tolerated by both the muscle flaps and skin flaps is added (Fig. 21.1c). The total fluid placed is recorded. The mastectomy pocket is again carefully examined for bleeding and irrigated. Two suction drains are placed, one superiorly and one inferiorly, exiting the skin at the level of the mid breast and as far laterally as is practical. The skin is trimmed as appropriate and approximated with 3/0 Vicryl intradermal sutures in a very secure deep closure, and a 4/0 Monocryl subcuticular suture is run over the top. Dry gauze dressings and a custom-designed surgical bra complete the procedure. Patients routinely spend one night in hospital for a unilateral mastectomy and tissue expander insertion, and two nights for a bilateral mastectomy. Delayed tissue expander insertion is generally a day-surgery procedure.

The patient is educated prior to discharge about drain stripping and emptying, and is followed up in the clinic in less than 1 week. Expansion usually begins 2 weeks postoperatively and 60–100 ml is placed on each visit until the goal volume is reached. If indicated, patients often have chemotherapy during this period. Total expansion to a volume of about 10–20 % over the required final implant volume generally requires five or six visits to the clinic. The expansion is allowed to consolidate for 2 weeks, and implant exchange may take place any time after that. Radiotherapy can be safely initiated 4 weeks after implant exchange.

When the patient returns for implant exchange, it is performed as an outpatient procedure. Implant sizers are selected preoperatively on the basis of the shape and dimensions of the tissue expander that was used, and the projected volume of the reconstructed breast. It is worthwhile stocking the correct sizers so that the surgeon has an accurate idea of how any given implant will look. It saves time, and avoids wastage of expensive implants. The operating room setup is critical to a satisfactory aesthetic outcome. The patient is positioned supine on the operating table so that she can be safely placed in a sitting position several times during the procedure. This is achieved by placing the arms and hands comfortably across the lower abdomen and padding and taping them securely. The head is placed in an elevated foam mold and is again taped to the operating table using a soft foam tape over a surgical pad. The skin of the forehead must be taped in order to prevent the head from slipping forward when the patient is placed in a sitting position intraoperatively. It is wise to check that the setup is secure before the patient is draped and inaccessible (Fig. 21.2).

After the patient has been draped, the old mastectomy scars are excised down to muscle and sent for pathological examination. The skin flaps overlying the muscle are

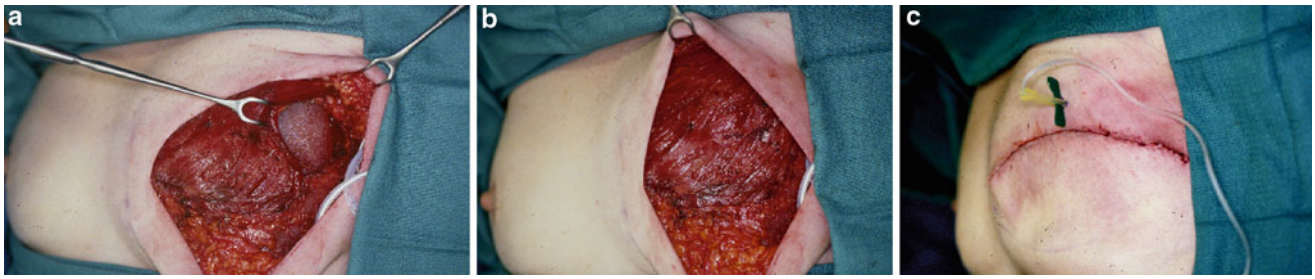

Fig. 21.1 **a** The expander prosthesis is placed in a submusculofascial pocket. **b** The musculofascial pocket is closed with a 2/0 Vicryl continuous suture, and two drains are placed in the subcutaneous space. **c** The skin is closed neatly with 4/0 Monocryl and the port is located using a magnet. It is possible to place up to half of the expander volume at this point, depending on the pocket size and the vascularity of the skin flaps

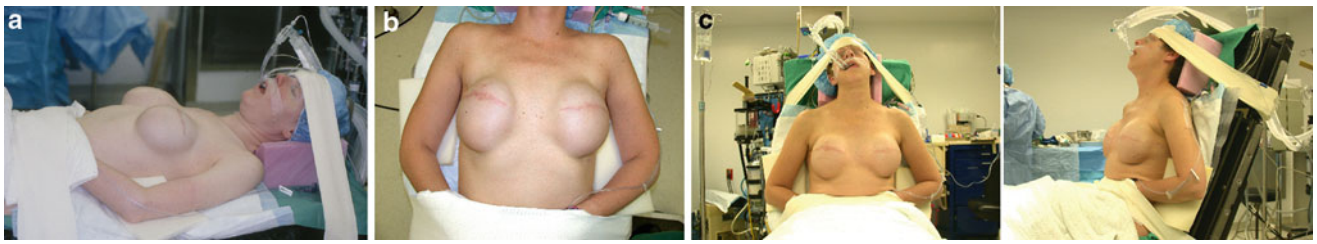

Fig. 21.2 **a** For implant exchange the patient is carefully positioned with hands secured, padded, and taped across lower abdomen and with the head resting on an elevated foam mold with the forehead securely taped to the bed. **b** The pectoralis major muscle tends to force the expanders in an inferolateral direction, which must be addressed at the time of exchange to achieve medial fullness. **c** It is always wise to check that the patient is correctly positioned, and the table is functioning properly prior to preparing and draping the patient

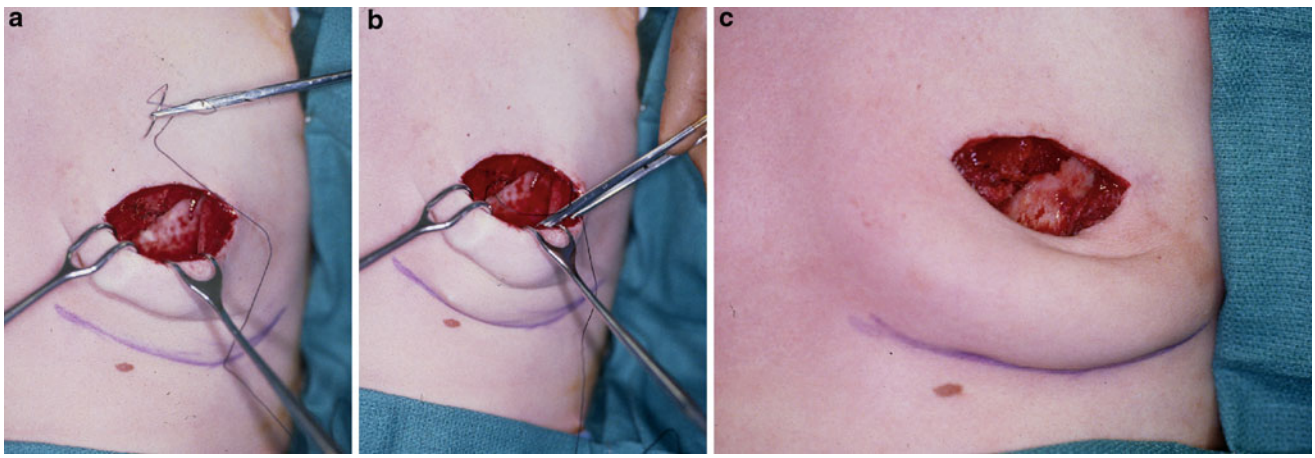

Fig. 21.3 **a** After removal of the expander, the inframammary fold is created with four to six 2/0 silk sutures firmly approximating the dermis of the skin flap to the capsule and periosteal tissue of the anterior abdominal wall to create a well-defined crease. **b** This technique requires careful inspection with the patient sitting up in order to achieve symmetry and a gentle, natural-looking crease. It is often necessary, even in experienced hands, to revise these sutures intraoperatively. **c** The objective is to achieve a gently curving inframammary crease

carefully undermined and elevated to expose sufficient pectoralis major muscle to incise and remove the expander. The pectoralis major muscle should be incised in the line of the muscle fibers, at an angle sufficiently oblique to ensure that the muscle closure does not directly underlie the skin closure but rather bisects it. The expander is carefully removed, the capsule examined, and the patient is placed in a full sitting position. At this point, the height of the inframammary fold is set. The desired inframammary fold position is marked with ink on the skin, and a 2/0 silk suture is passed parallel to the desired fold position, approximating the dermis to the capsule and chest wall at the desired height. Four to six of these sutures are placed. The capsule anterior to this suture line is then incised to create ptosis in the

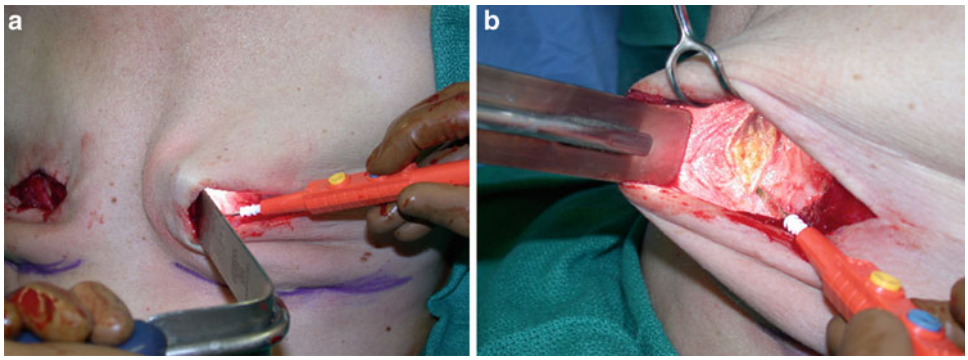

Fig. 21.4 **a** A circumferential capsulotomy is performed. **b** It is often necessary to dissect the pectoralis major origin inferomedially in order to medialize the final implant for optimal fullness

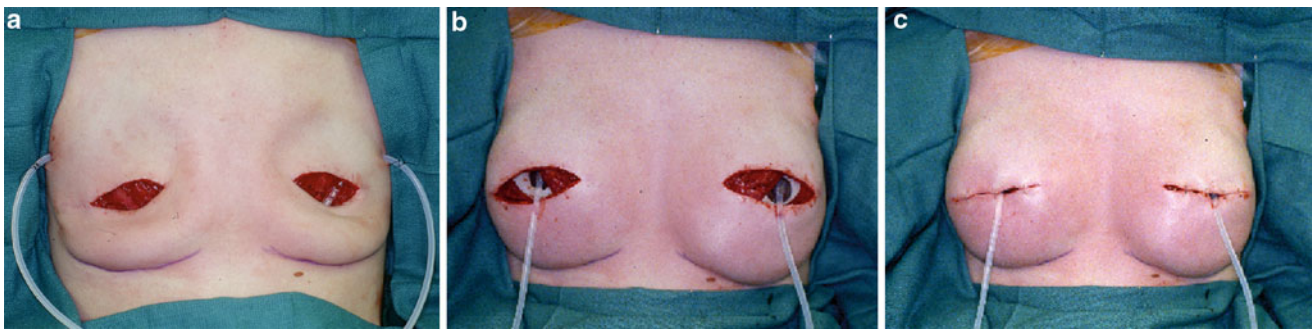

Fig. 21.5 **a** A single submuscular drain is placed at mid-breast level, ideally through one of the old drain scars. **b** Implant sizers are placed bilaterally and filled to the desired volume. **c** The muscle and skin are closed with skin staples, the patient is placed in a sitting position, and the breast pocket, inframammary crease, volume, and symmetry are carefully assessed. When the surgeon is satisfied, the sizers are removed and replaced with the corresponding final implant

inferior pole (Fig. 21.3). The remaining capsule is incised circumferentially using monopolar diathermy and a lighted retractor, and meticulous hemostasis is performed (Fig. 21.4a). It is often necessary to dissect the inferomedial pocket in order to medialize the final implant (Fig. 21.4b). A single submuscular drain is sited at mid-breast level, using the previous drain scars (Fig. 21.5a). Implant sizers are filled to their index volume and placed in the breast pockets (Fig. 21.5b). The skin is stapled closed and the patient is once again placed in a sitting position (Fig. 21.5c).

Symmetry of the breasts is assessed by comparing inframammary fold position, medial, lateral and superior breast contours, and the degree of breast ptosis. There is a learning curve involved, and occasionally many modifications to inframammary fold position, sizer volume, and the implant pocket must be made in order to achieve a satisfactory result. This is a painstaking process, and it cannot be achieved without positioning the patient in a sitting position intraoperatively.

Once the surgeon is satisfied that optimal aesthetics have been achieved, the sizers are removed and after hemostasis and placement of a single drain the most closely corresponding permanent implant is placed, and the muscle and skin are closed and dressed in the usual way. The nipple–areola complex is reconstructed using a modified skate flap and full-thickness graft 3–6 months later. The second stage of the reconstruction is then complete (Fig. 21.6). If necessary, the nipple–areola complex can be tattooed when fully healed (Fig. 21.7).

21.7 Complications and their Causes

Staged implant-based breast reconstruction is subject to a well-described set of complications. These have variously been underreported and overreported in the literature. However, reliable data are available to demonstrate that complications in staged implant-based reconstruction are predictable and in most cases treatable. Complications can be divided into those which occur less than 12 months postoperatively (early) and those which occur late. In a risk-profiling study of complication rates, smoking status, obesity, hypertension, and age greater than 65 years were noted to be independent risk factors [5].

21.8 Early Complications

In a series of over 1,500 implant-based reconstructions, the overall incidence of early complications was 5.8 % [4, 5]. The rate of complications at the stage of tissue expander

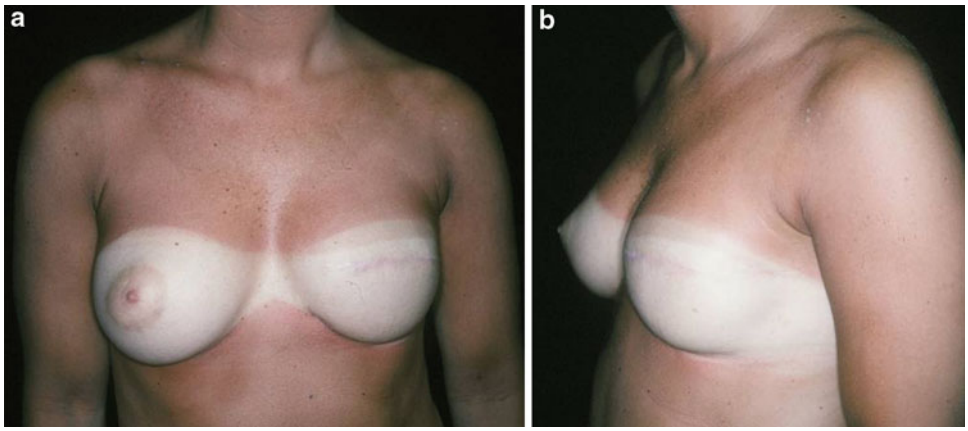

Fig. 21.6 **a** The muscle and skin are closed and allowed to heal. **b** After 3–6 months the patient is ready for nipple–areola complex reconstruction

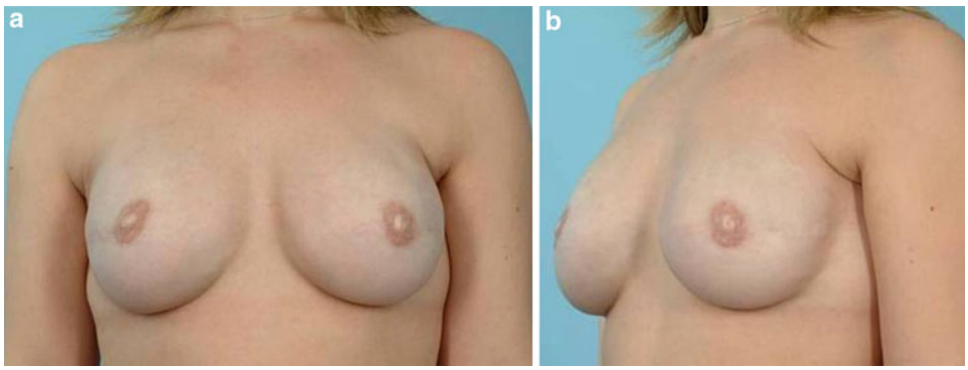

Fig. 21.7 **a** The senior author uses a modified skate flap will a full-thickness skin graft for nipple–areola complex reconstruction. **b** When it has fully healed, the complex is tattooed if indicated

insertion was 8.5 %, which was far higher than the rate with implant exchange (2.7 %). The commonest early complication was hematoma (4 %), followed by infection (2.5 %) and mastectomy skin flap necrosis (2 %), displacement, delayed healing, seroma, failed expansion, and expander deflation. However, in relation to early complications, Cordeiro [5] concluded the following:

1. They are commoner after the expander insertion than after the exchange procedure, but tend to be minor and surmountable.
2. Chemotherapy administered during the expansion phase does not increase the incidence of complications.
3. The rate of early complications in previously irradiated patients is low.

In a study of 770 consecutive patients, the main reasons for the premature removal of tissue expanders in 1.8 % of patients were infection, expander exposure, skin necrosis, patient dissatisfaction, and disease progression [6].

21.9 Late Complications

In the same series [4, 5], the rate of complications occurring after 1 year was 7.3 % overall. These complications usually involved the final implant reconstruction, the commonest being capsular contracture grade III/IV in nonirradiated breasts (10 %), in previously irradiated breasts (20 %), and in breasts irradiated following reconstruction (50 %). The rate of moderate to severe rippling in anatomical cohesive gel implants was 6.6 %. There was no significant difference between the incidence of rippling in saline and silicone, although patients with BMI > 30 tended to have less obvious rippling. Implants were lost because of leak, rupture, deflation, volume discrepancies, and capsular contracture. Approximately 4 % of implants required exchange.

Often these complications can be attributed to changes in the soft tissues following radiotherapy (capsular contracture, implant exposure and extrusion, and recurrent infection). However, infections can develop many years after reconstruction for no obvious reason. Visible skin rippling is an unavoidable risk of implant use, and patients should be aware from the beginning that this risk exists.

21.10 Controversies

Implant-based breast reconstruction has always been and continues to be a controversial area within reconstructive surgery. This may be explained in part by the popularity of silicone in both the cosmetic field and the reconstructive field and the very large numbers of women worldwide who now have silicone breast implants. The old concerns

regarding the safety of silicone and its potential to precipitate autoimmune disease have finally been allayed, only to have been supplanted by the as yet undetermined risk of the very rare anaplastic large cell lymphoma.

21.11 Bilateral and Prophylactic Mastectomies

More women presenting with extensive ductal or lobular breast carcinomas, those with a recognized genetic predisposition and those with bilateral disease, undergo bilateral mastectomies, and it is recognized that reconstruction and the achievement of symmetry and a good aesthetic outcome is more straightforward in these patients. However, oncological considerations and patient peace of mind should always be prioritized over cosmesis.

21.12 Acellular Human Dermis

The use of acellular human dermis (AHD) in implant-based breast reconstruction is a recent development. Its proposed advantages include a reduction in the extent of submuscular dissection through augmentation of the soft tissues, a reduction in postoperative pain, improved cosmesis, reduced rates of capsular contracture, and increased control over the positioning of the inframammary fold. It may also permit higher intraoperative fill volumes, maximum skin preservation, and it may reduce the incidence of capsular contracture. It has been associated with increased rates of infection and seroma formation, and with increasing the rate of expander removal in the context of skin flap necrosis. In a study of 153 patients undergoing breast reconstruction with AHD, it was found that increased BMI, axillary lymph node dissection, and age greater than 65 years were associated with an increased complication rate [7]. Radiotherapy was not found to be an independent risk factor. Although there was a significantly higher rate of seroma formation with AHD, it was not sufficient to impede the progress of the reconstruction.

The AHD is sutured to the inframammary fold inferolaterally and to the inferior borders of the pectoralis muscle, removing the need to raise serratus anterior flaps to complete the submusculofascial pocket. It serves to provide lower pole support for the tissue expander and later for the implant. It also allows the surgeon to preserve or set the inframammary fold in a fixed position, which may be helpful in single-stage breast reconstructions. It may shorten the second stage of the procedure and assist in achieving symmetry in unilateral reconstructions. It also helps to achieve better symmetry in nipple-sparing mastectomies, where the inframammary fold can be set at the time of initial expander insertion. It is a useful adjunct where the tissues are deficient, as in the case of previously augmented breasts. It is contraindicated in previously irradiated tissues. Its greatest benefit is allowing a one-stage reconstruction, and in allowing more fluid to be placed initially, shortening the expansion period.

AHD is very expensive and currently costs more than the breast implants themselves. Some surgeons use it routinely, others when it is specifically indicated, and others, such as the senior author, avoid its use completely. Some patients are uncomfortable with the concept of using cadaveric dermis, and informed consent for its use should be sought. Also, in the setting of mastectomy skin flap necrosis, AHD underlying the necrotic skin may increase the likelihood of expander loss through communication and infection. However, in the right candidate, with well-vascularized skin flaps, there is a potential role for AHD in breast reconstruction. Further multicenter trials are needed to establish its true risk and utility profile.

21.13 Nipple-Sparing Mastectomy

Nipple-sparing mastectomy is another area of controversy, with breast surgeons disagreeing on the oncological safety of preserving the nipple and areola in certain cases. It is thought to minimally increase the risk of tumor recurrence, and because it is difficult to reconstruct this complex anatomical feature well, it is tempting to keep it when possible. It certainly contributes to the overall aesthetic of the reconstructed breast. Nipple-sparing surgery complicates both the oncological surgery and the reconstructive surgery, reducing the surgical exposure, and obliging the reconstructive surgeon to achieve excellent nipple symmetry.

Because of the intact skin envelope, tissue expansion of 50–80 % of expander volume can occur intraoperatively. Placement of the mastectomy incision is also key to an excellent aesthetic result, and there is considerable flexibility in placing it, depending on breast size, ptosis, previous scars, etc. In our series of 115 nipple-sparing mastectomies, 5.2 % of mastectomy specimens, corresponding to 9.1 % of patients, had occult disease. In the same series, partial nipple loss (22 %) and full nipple loss (13 %) were troublesome features of the procedure [8]. The reported annual risk of local recurrence in nipple-sparing mastectomy differs widely in the literature, but is thought to be in the region of 0.8 % with intraoperative radiotherapy [9]. It may be an acceptable technique for prophylactic risk-reducing mastectomy, or for women with small, peripherally located tumors, but there are still no long-term data to validate its oncological safety in patients with invasive and in situ disease.

21.14 Long-Term Patient Satisfaction

In our series of over 1,500 implant-based breast reconstructions, 95 % of patients expressed satisfaction with the appearance of their breasts and 90 % stated that they would choose implants or no reconstruction at all over autogenous reconstructions if they had to make the choice again. Breast-Q is a validated patient survey tool that seeks to establish the levels of long-term patient satisfaction with the various options that are available for breast reconstruction through detailed questionnaires. It provides large amounts of useful data that will influence the evolution of breast reconstruction over time. Current evidence seems to suggest that women's satisfaction with autologous reconstruction is stable, or increases over time, whereas their satisfaction with implant-based reconstruction seems to decrease [10]. There are many possible reasons for these trends, but it does suggest that the perfect breast implant has yet to be developed.

In a recent multicenter cross-sectional study by McCarthy et al. [2] using the Breast-Q model, patients reported higher satisfaction with silicone implants than with saline implants. Postreconstruction radiotherapy was felt to have had a significant negative impact on satisfaction with both silicone implants and saline implants, and most interestingly, overall satisfaction with implant-based reconstruction was noted to decrease over time. It is not certain why satisfaction decreases over time, but it may have to do with capsular contracture formation. It was also noted that patients reported higher satisfaction in the setting of bilateral reconstructions, most likely because better symmetry can be achieved.

21.15 Conclusions

The process of staged implant-based breast reconstruction should be driven by the prioritization of oncological safety and ultimate patient satisfaction and peace of mind. Patient education and choice in the process is fundamental, and the full range of reconstructive options should ideally be available to the patient, and their relative pros and cons should be discussed in detail. Finally, the reconstructive surgeon should have training in the appropriate techniques, and should have a comprehensive evidence and employ an experience-based approach to candidate selection, and to the treatment of complications, particularly those relating to radiotherapy.

References

1. Spear SL, Meshabi AN (2007) Implant-based reconstruction. Clin Plast Surg 34(1):63–73
2. McCarthy CM et al (2010) Patient satisfaction with post-mastectomy breast reconstruction: a comparison of saline and silicone implants. Cancer 116(24):5584–5591
3. Pusic AL, Cordeiro PG (2003) An accelerated approach to tissue expansion for breast reconstruction: experience with intraoperative and rapid postoperative expansion in 370 reconstructions. Plast Reconstr Surg 111(6):1871–1875
4. Cordeiro PG, McCarthy CM et al (2006) A single surgeon's 12-year experience with tissue expander/implant breast reconstruction—part II. Plast Reconstr Surg 118(4):832–839
5. Cordeiro PG, McCarthy CM et al (2006) A single surgeon's 12-year experience with tissue expander/implant breast reconstruction—part I. Plast Reconstr Surg 118:825–831
6. Disa JJ et al (1999) The premature removal of tissue expanders in breast reconstruction. Plast Reconstr Surg 104(6):1662–1665
7. Antony AK, Dias JJ et al (2010) Acellular human dermis implantation in 153 immediate two-stage tissue expander breast reconstruction: determining the incidence and specific predictors of complications. Plast Reconstr Surg 125(6):1606–1614
8. Chen CM, Cordeiro PG et al (2009) Nipple-sparing mastectomy and immediate tissue expander/implant breast reconstruction. Plast Reconstr Surg 124(6):1772–1782
9. Petit JY, Veronesi U et al (2011) Nipple sparing mastectomy—is it worth the risk? Nat Rev Clin Oncol 8(12):742–747
10. Hu ES, Alderman AK et al (2009) Patient-reported aesthetic satisfaction with breast reconstruction during the long-term survivorship period. Plast Reconstr Surg 124(1):1–8

One-Stage Breast Reconstruction with Definitive Form-Stable Implants

22

Mario Rietjens, Cicero Urban, Marilyn Sandford, and Flavia Kuroda

22.1 Introduction

The treatment of breast cancer at the beginning of the last century was frankly mutilating to patients. Standard surgery removed large amounts of skin and adjacent muscles. Aggressive external radiotherapy further degraded the tissues, with significant deleterious aesthetic, functional, and psychological sequelae. In that era, few options existed for breast reconstruction, and even fewer for a single-stage breast reconstruction using definitive implants. Our evolving understanding of the biological characteristics of breast tumors has allowed refinement of treatment, making treatment less mutilating. Concurrently, we are developing a greater appreciation for the psychological affects of treatment. Modern breast cancer treatments need to take into account and try to maintain the quality of life for the patient while providing excellent oncologic control. A single-stage breast reconstruction evolved with that goal in mind.

Immediate breast reconstruction with implants started in the 1980s. At that time, large clinical trials (Milan and NSABP) established the efficacy of less aggressive surgery for local control of the disease [1–3]. This technical evolution with breast-conserving surgery established the role of partial mastectomy. It also affected the future techniques used for mastectomy by demonstrating that much of the breast envelope, skin, pectoralis muscle, and inframammary fold could be preserved. These more refined and tissue-conserving mastectomies (skin-sparing and nipple-sparing mastectomies) made immediate breast reconstruction with implants a viable option. Definitive implant reconstruction reduced the number of additional surgical interventions and reduced the indications for more complex breast reconstruction techniques such as pedicle or free flaps. A single-stage procedure can have economic benefits both for the patient and for the medical system, avoiding the use of temporary expanders. Definitive implant reconstruction also improves a patient's quality of life, lowers the feeling of mutilation caused by the oncologic treatment, and encourages faster social reintegration [4, 5].

The aim of this chapter is to show how to select patients and the implants for the procedure. It reviews the evolution of the technique and examines the technical advantages, limits, and complications of immediate breast reconstruction as a single-step surgery with definitive form-stable implants and contralateral mammoplasty for symmetry.

22.2 Patient Selection

The best candidates for immediate breast reconstruction with implants are those in which the breast volume is small or of medium size, the planned mastectomy does not involve resection of large amounts of skin, and there is no evidence of tumor infiltration of the skin or chest wall musculature (Figs. 22.1 and 22.2). Larger-volume breasts or breasts with important mammary ptosis can be candidates for the procedure but in combination with either a reduction of the contralateral breast or a mastopexy for correction of mammary ptosis [5, 6]. Even in these cases it is possible to achieve some degree of ptosis (Fig. 22.3).

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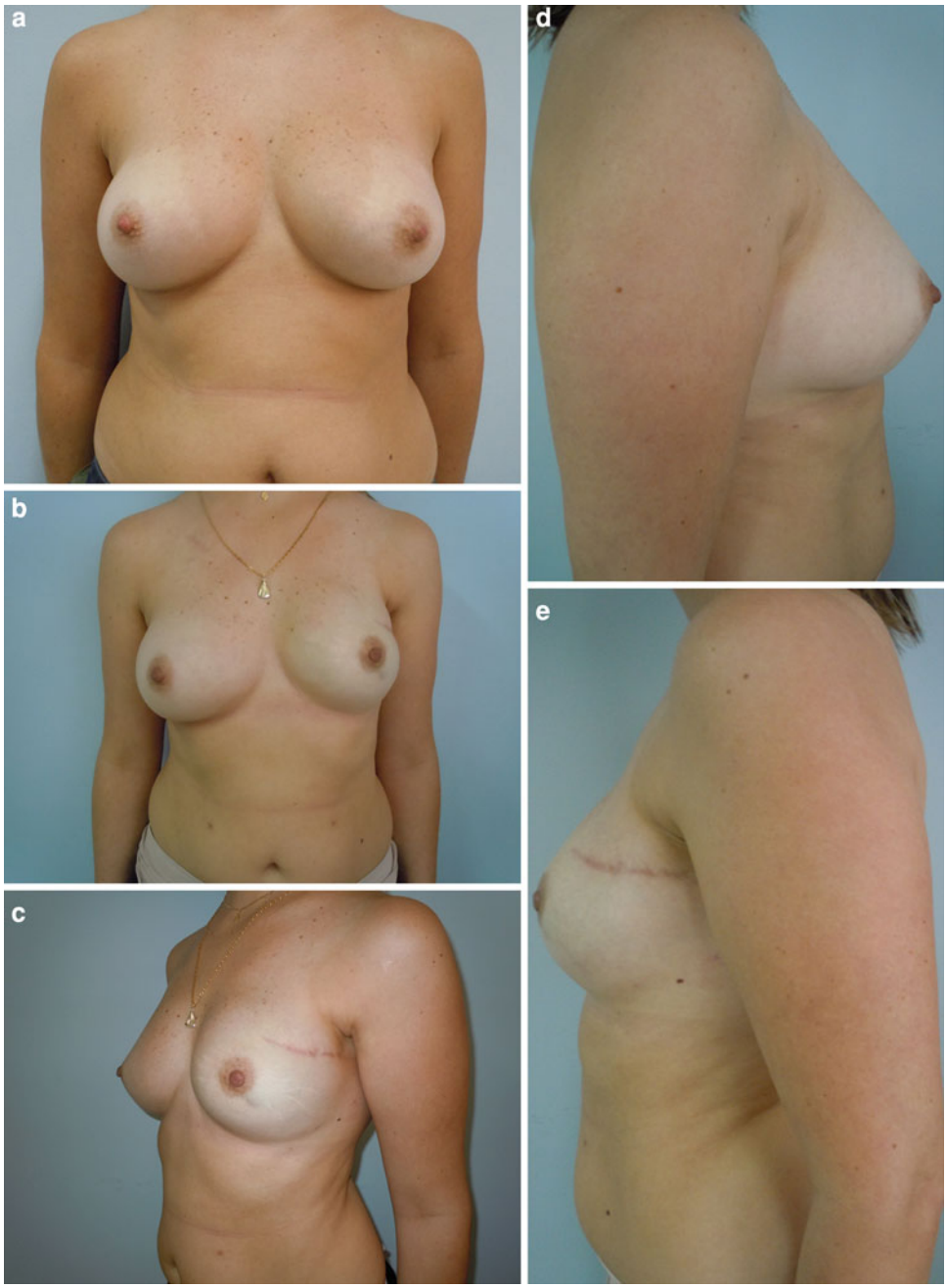

Fig. 22.1 **a** Preoperative view for a 38-year-old patient with invasive ductal carcinoma in the left breast (T2N0). **b–e** Postoperative images 1 year after a nipple-sparing mastectomy and immediate breast reconstruction with an anatomic form-stable implant

Multidisciplinary preoperative evaluation is necessary when deciding on the reconstructive technique and to assess the patient for possible oncologic contraindications to immediate breast reconstruction, including (Tables 22.1 and 22.2):

- Technical problems: tumor infiltration of skin or muscles, which complicates the technical performance of breast reconstruction with implants and is a formal indication for postoperative radiotherapy of the chest wall.
- Risk of delay in adjuvant treatments: Patients with aggressive tumors (e.g., young patients with clinical and histopathologic evidence of rapid growth, and significant involvement of axillary lymph nodes) need to start the chemotherapy shortly after surgery. However, if the same patients have minor wound complications such as a local infection after biopsy, then one needs to consider the possibility that a major surgery could result in bilateral breast infection, which could delay the beginning of the oncologic treatment.
- Psychological problems: It is appropriate to be observant of signs that suggest an underlying psychological issue that could impede the success of a reconstruction. Prior hospitalizations for psychiatric issues, inappropriate affect, and disorganized thought processes are just some

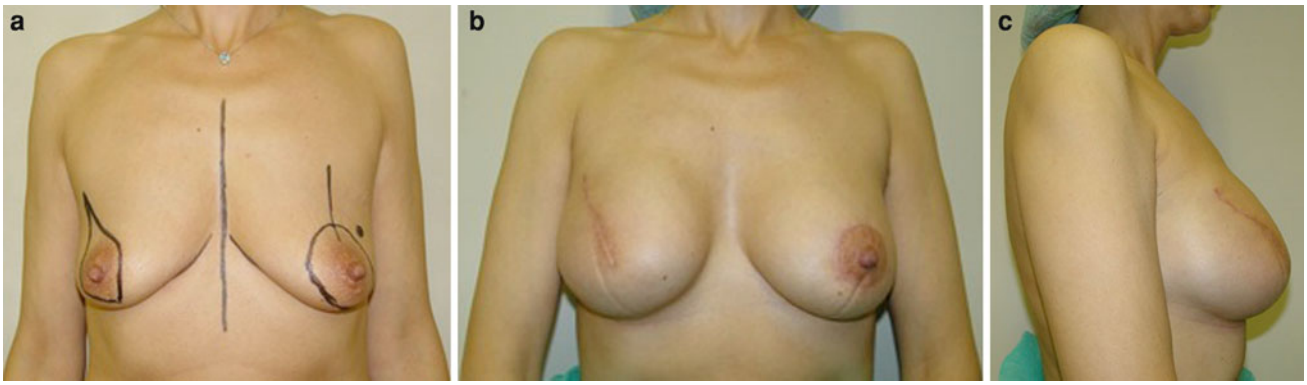

Fig. 22.2 **a** Preoperative example of right-sided skin sparing mastectomy with immediate breast reconstruction with a definitive anatomic prosthesis and a partial muscular pocket. A left-sided mastoplasty for augmentation and correction of ptosis was planned. **b**, **c** Frontal and lateral views 3 months later

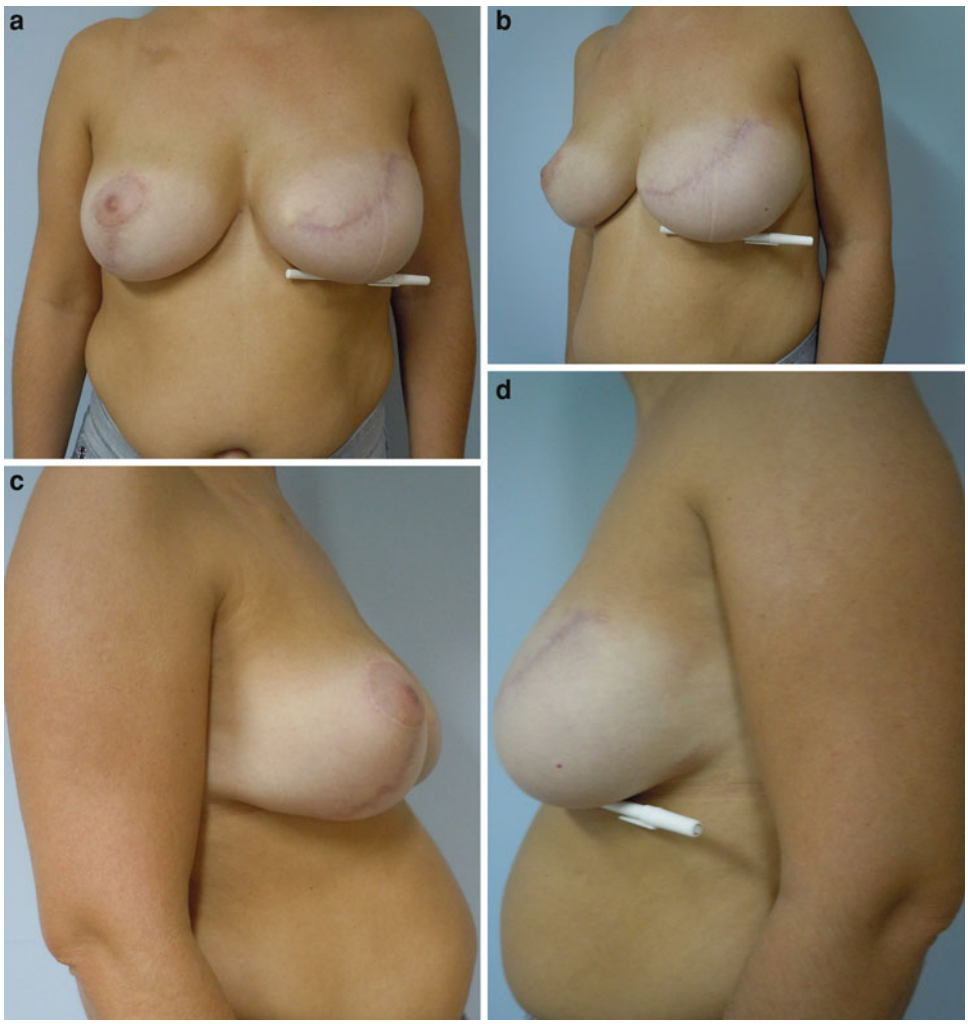

Fig. 22.3 Postoperative images 1 year after skin-sparing mastectomy and immediate breast reconstruction with an anatomic form-stable implant and contralateral breast reduction in a large breast preserving some degree of natural ptosis

of the red flags that could indicate a psychological disorder. Psychological assessment can be helpful to assist in appropriate patient selection and ensure that unresolved psychological issues do not derail the reconstruction, such as excessive expectations with breast reconstruction or difficulties to collaborate in the

Table 22.1 Potential advantages of one-stage immediate breast reconstruction with definitive form-stable implants

Advantages
A single procedure that can avoid a second surgery to change the temporary expander
No donor site morbidity
Short operative time and recovery
Skin with similar color, texture, and sensation

Table 22.2 Relative contraindications for one-stage immediate breast reconstruction with definitive form-stable implants

Characteristic	Difficulty
Chest wall or skin infiltration	Adjuvant radiotherapy
Aggressive tumors	Early start of chemotherapy and adjuvant radiotherapy
Psychological problems	Incapacity to understand the limits and potential complications
Several breast hypertrophy and morbid obesity	Increase in the levels of fibrinogen, prothrombin, and factors VII, VIII, IX, and X
Previous irradiation	Higher risks of infection, bad aesthetic outcome, and loss of implant
Tobacco	Higher risks of infection, wound healing problems and loss of implant
Failed previous reconstruction with implants	Retraction

postoperative period, or even to accept complications and limitations.

- Severe breast hypertrophy: This is as a relative contraindication because even with major reduction of mammary volume it can be very hard to obtain a satisfactory aesthetic result. Morbid obesity poses additional difficulties too.
- Previous breast irradiation: Mastectomy due to a recurrence after conservative surgery with adjuvant radiotherapy is a relative contraindication. In these cases, the best option is the use of a musculocutaneous flap. It is possible to attempt an immediate reconstruction when the breast is small or when there are minimal sequelae from the radiotherapy (i.e., the skin is soft and pliable). Caution is advised and any attempt must be exhaustively discussed with the patient, with a focus on the high level of complications (cutaneous necrosis, exposure or dislocation of the prosthesis, and periprosthetic capsular contraction). There is a specific Chap. 42 in this book on this topic.
- Smoking: A significant association between smoking status and postoperative complications exists. Overall complications, reconstructive failure, mastectomy flap necrosis, and infection are commoner in smokers than in nonsmokers. Smokers who undergo postmastectomy expander/implant reconstruction should be informed of the increased risk of surgical complications and should be counseled on smoking cessation [7].
- Failure of previous reconstruction with a temporary/definitive expander and/or implant: This can cause severe tissue retraction.

22.3 Preoperative Evaluation

A multidisciplinary team must evaluate patients who are candidates to undergo a breast reconstruction procedure before their being admitted to hospital. The preoperative evaluation considers reconstructive options and aims to choose the best technique for each situation. The patient is provided with detailed information on perioperative care and expectations. The assessment includes selecting the model, shape, and size of implants to be inserted. Our planning process includes photographs of the patient standing and preoperative drawings. Technical details such as the type of incision and oncologic details such as the need for any additional workup of the contralateral breast are determined at this time. Preoperative breast evaluation must include bilateral mammography and breast ultrasonography in combination with the physical examination to assess the extent of disease. We use breast MRI selectively (see the specific Chap. 3 on breast imaging). We routinely obtain a chest X-ray and abdominal and gynecological ultrasonography images. In select cases, we obtain images from staging studies such as a bone scan and a CT scan of the chest and abdomen. There are no specific therapies that need to be performed prior to the surgery. We use antibiotic prophylaxis, most commonly a cephalosporin, prior to skin incision. We re-dose the antibiotic intraoperatively in the limited number of procedures that last over 4 h [8].

22.4 Technique

The patient is placed on the operating table with both arms extended out on arm boards. This position allows two teams to work concomitantly whenever a contralateral procedure is planned, therefore reducing the surgical time. After completion of the oncology portion of the procedure, the site is cleaned with povidone–iodine or clorohexidine solution and the surgical instruments used in the oncology step are removed. An initial evaluation is made to check the integrity of the pectoralis major muscle, as well as the vascularization of the mastectomy skin flaps, and the inframammary fold. The degree of abduction of the arm is adjusted relative to the thorax to allow relaxation of the pectoralis major muscle.

The table is flexed at the waist so that the patient's thorax is raised 45°.

We have used three techniques for immediate breast reconstruction. The techniques have evolved in an effort to improve the cosmetic outcome:

1. *Immediate breast reconstruction with a complete muscular pocket* This original technique was described by Little et al. [9] with the name "muscular bra". The technique gave more protection to the implant in cases of limited skin necrosis and it allowed isolation of the axillary cavity and thus helps to limit migration of the implant toward the axilla. This was the only immediate reconstruction option available before the advent of form-stable implants. Prior to that, the only implants available where round, and that limited the options for improving aesthetic results. With anatomic form-stable implants, the technique for immediate reconstruction evolved because it is possible to achieve a better shape to the reconstructed breast if it is not laterally recovered by the serratus muscle as this allows better inferior and anterior projection. This creates a more natural shape to the reconstructed breast. However, there were two significant problems associated with eliminating the serratus portion of the muscular pocket. First, some mastectomy incisions, especially those that remove that nipple–areola complex as a horizontal ellipse, end up with the lateral part of the sutured incision directly on the implant with no intervening tissue. There is no protection of the implant in cases of skin necrosis and/or dehiscence of the scar. If this complication occurs, there is an increase in the risk of exposure of the implant, leading to removal. A second problem occurs with thin flaps with a fragile vasculature. In these cases, the complete muscular pocket places well vascularized muscle directly underneath the entire skin flap. This underlying muscle may help maintain the viability of the compromised skin flap. The layer of muscle may also reduce the tactile effect of "feeling" the implant, which is very frequent when the lateral skin flap is rather thin.
2. *Immediate breast reconstruction with a partial muscular pocket* This technique started to be developed in the Plastic Surgery Department of the European Institute of Oncology in 2003, and at the Curitiba Breast Unit in 2004. It came about with the introduction of new anatomic form-stable implants and with the acceptance of a refinement of the mastectomy technique, which allowed preservation of nearly all the breast skin. The technical aim was to improve the cosmetic outcome of the implant reconstruction by eliminating the serratus portion of the muscular pocket but also to avoid placing the sutured incision directly over the implants. Incision placement is critical; as one wants to be sure that the final scar from the mastectomy can be placed completely on the pectoralis major muscle. One also wants to select patients where the final skin flaps will not be very thin and at risk of necrosis. With this technique it is possible to achieve a much more natural lateral contour of the breast (Fig. 22.4). The biggest drawback is the tactile feeling that patients have when they touch the inferolateral region of their breasts, as they can feel the underlying implant. With this technique, the lower and medial detachment of the pectoralis major muscle is performed as in the traditional technique (Fig. 22.5). After the definitive implants have been inserted, the lateral border of the implant pocket is formed by suturing the skin flap down to the musculature of the chest wall with an absorbable suture. It is critical to prevent both the lateral and the axillary migration of the implant. Lateral muscular cutaneous fixation is also needed in cases in which the breast base is too wide and when we have to insert an implant with a smaller base. This fixation also helps to avoid the lateral movement of the breast implant. In this case, suction drains to drain the whole cavity should be considered. When axillary dissection is performed, the risk of losing the implant is about three times higher than when only sentinel node biopsy is performed (unpublished data from the Curitiba Breast Cancer Unit). This could be related to surgical time, drains, and the alteration in postoperative lymphatic drainage. In these cases, a pectoralis minor flap can be useful to cover the lateral part of the implant and prevent implant malposition from dislocation to the axilla (Fig. 22.6).
3. *Immediate breast reconstruction with the cutaneous suspension technique* This technique was described and developed by Rietjens et al. [10]. It uses a complete muscular pocket to allow implant coverage, but it also uses an abdominal advancement cutaneous flap with Mersilene mesh fixation to create a more natural inframammary fold with better inferior and external projection. The best candidate for this technique is a small-breasted woman with limited ptosis who does not need to have the contralateral breast corrected. The preoperative marking includes an assessment of the elasticity and mobility of the cutaneous tissues of the upper abdomen while the patient is standing. This assessment allows the surgeon to calculate the size of the cutaneous flap to be used. Afterward, both the current and the future inframammary fold are marked; the latter is marked between 4 and 6 cm below the current inframammary fold. After the mastectomy is completed, the reconstruction is started with the preparation of the complete muscular pocket: medial undermining of the pectoralis major muscle and lateral undermining of the serratus muscle. An extensive subcutaneous undermining is performed below the current inframammary fold extending down

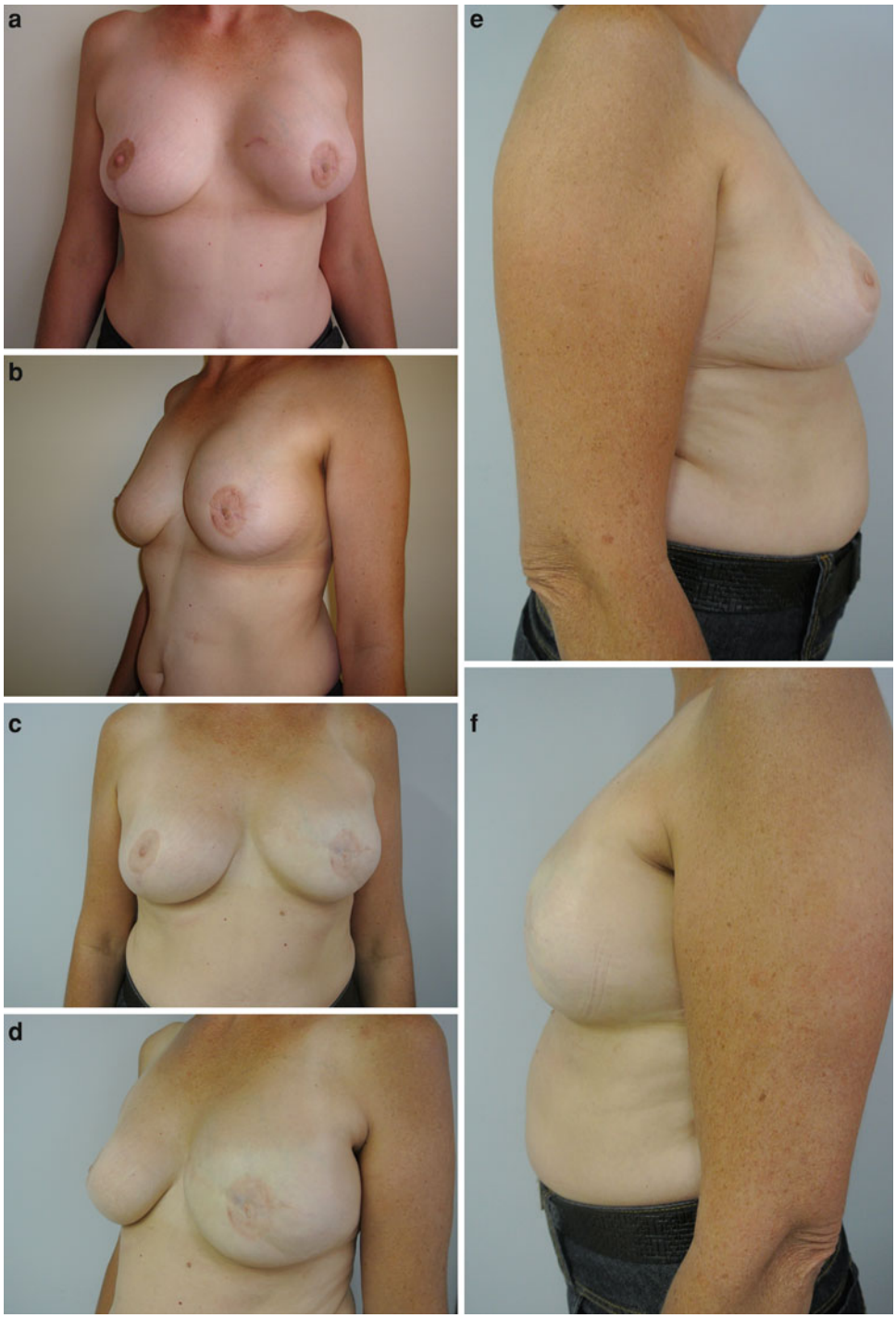

Fig. 22.4 **a**, **b** Postoperative images 2 years after skin-sparing mastectomy and immediate breast reconstruction with an anatomic form-stable implant and contralateral breast reduction with a partial muscular pocket. **c–f** Postoperative images 8 years later, demonstrating stability of the aesthetic outcomes

past the line demarcating the future inframammary fold. This dissection allows there to be adequate mobility of the cutaneous flap. Then, a mesh of nonabsorbable material (usually Mersilene, as it is durable and malleable) is used to fix the flap in place. The mesh is cut so that one of the edges is rounded off to a curve that will match the newly planned inframammary fold. This edge is sutured to the dermis and superficial fascia at the premarked new inframammary fold level with nonabsorbable stitches. They need to be well anchored to resist inferior traction. Taking these "healthy" bites can cause small skin retractions where the sutures are placed. In our experience, these retractions soften with time, and they eventually disappear as the skin heals and the periprosthetic capsule is formed. Once the mesh is fixed to the future inframammary fold, the mesh is pulled superiorly until the created fold comes to the same level as the contralateral side. The free edge of the mesh is

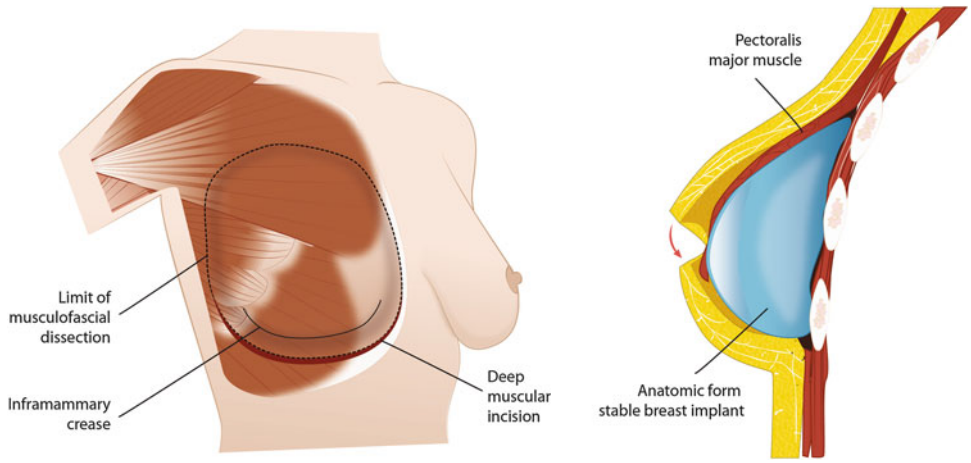

Fig. 22.5 Limits and localization of the implant in a partial muscular pocket

then fixed with one or two nonabsorbable stitches on the fifth or sixth coastal cartilage, and the surplus of skin is removed. The implant is placed between the mesh and the pectoralis major muscle, and then the muscular pocket is completely closed with a suture between the lateral edge of the pectoralis major muscle and the anterior edge of the serratus muscle. Two drains are placed: one touching the implant, inside the muscular pocket, and the other draining the subcutaneous space and the axilla. It is advisable to keep the patient in a semisitting position (at 45°) as this lessens the traction on the sutures anchoring the advancement flap and thus lessens less postoperative pain. This technique can be applied to avoid the use of expanders when there is no need to remove large amounts of skin [11]. It avoids a second surgical step with general anesthesia. This technique has been used in 67 cases of immediate breast reconstruction and in six cases of delayed reconstruction. In 14 cases (19.2 %) it was necessary to perform a second surgery with general anesthesia for capsulotomy, replacement of the implant, and reconstruction of the nipple–areola complex. In three cases (4.1 %), the implant was removed because of exposure or infection. In 33 cases, only local anesthesia was needed for reconstruction of the nipple–areola complex, and for finishing the reconstructive phase. In this series, the capsular contracture was evaluated as Baker I in 24 cases, Baker II in 16 cases, Baker III in nine cases, and Baker IV in one case. The breast symmetry, the patient's satisfaction, and the surgeon's aesthetic evaluation were graded 7.56, 7.75, and 7.60 (with 1 representing extremely poor and 10 representing excellent) (Figs. 22.7, 22.8, 22.9, 22.10, 22.11).

An additional option for immediate, single-stage breast-implant reconstruction is the use of allogeneic tissue (AlloDerm, LifeCell, Woodlands, TX, USA). This is an immunologically inert acellular dermal matrix which is used to reduce the risk of rejection or implant extrusion. Allogenic dermal grafting provides an additional layer of tissue between the skin and the implant with minimal complications, eliminates the need for tissue expansion/implant reconstructive process, prevents implant migration, and improves cosmetic outcomes. Its aim is to create a pectoralis–AlloDerm pocket to cover and position the implant. An inferolateral AlloDerm hammock has been used as an inferior extension of the pectoralis major muscle to provide a mechanical barrier between the implant and skin and to control the position of the implant [12–14]. It has not approved been yet for use in the European Union and Brazil. There is a specific Chap. 23 in this book about this.

22.5 Contralateral Mammaplasty

Correction of the opposite breast is often necessary in order to obtain the best symmetry in breast reconstruction. Contralateral surgery is performed in more than 80 % of cases and it is generally proposed as part of the first reconstructive surgery with the aim of avoiding a second operation with general anesthesia, reducing the admission time in hospital, and consequently reducing the cost of the reconstructive breast procedure. Some surgeons tend to perform contralateral symmetry mammoplasty most of the time in reconstruction with implants when compared with reconstruction with musculocutaneous flaps [15].

The techniques proposed are applied according to the patient's desires and the possibilities to obtain better symmetry of the reconstructed breast. It is important to bear in mind that each technique has its limitations. For example, the surgeon must be able to anticipate the amount of ptosis that can be created in the reconstructed breast. In some situations, it is difficult, if not impossible, to create a breast with ptosis when using implants. But for well-selected cases, where the amount of skin is important, it is possible to achieve a natural ptosis (Fig. 22.2). Reconstructions with

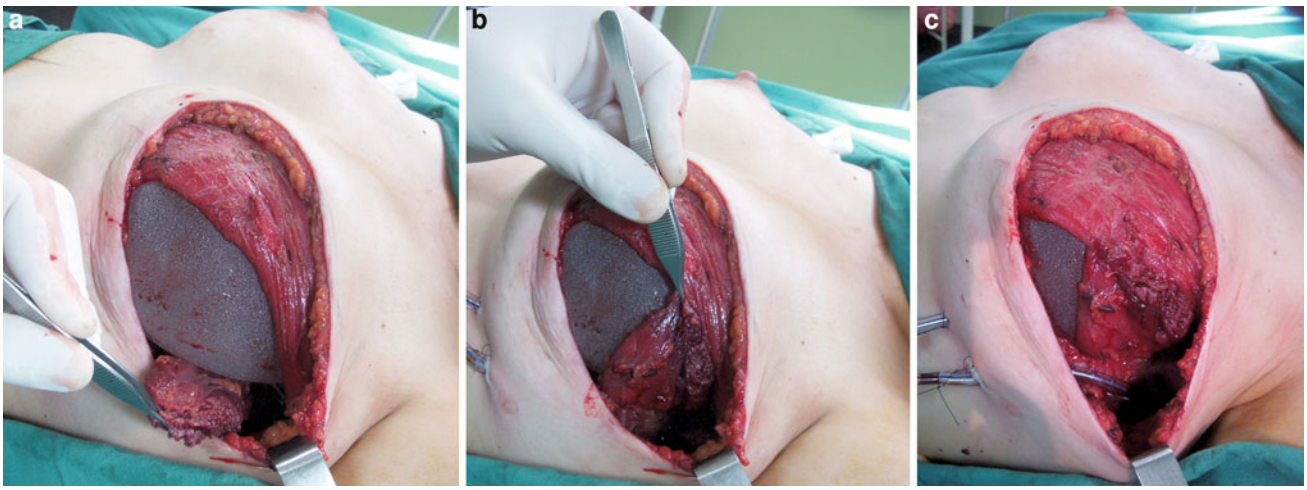

Fig. 22.6 Pectoralis minor flap technique to cover the lateral part of the implant and prevent implant malposition from dislocation to the axilla

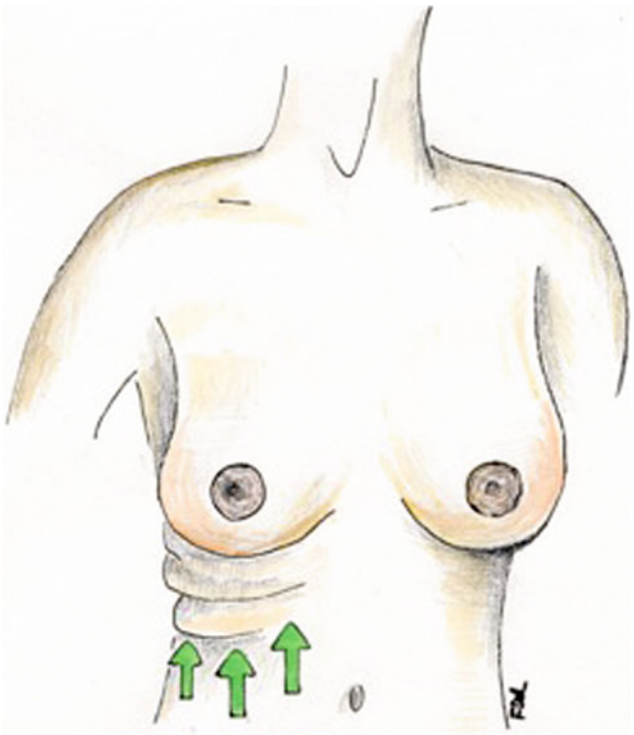

Fig. 22.7 Evaluation of the amount of skin that can be used in the upper abdominal cutaneous flap

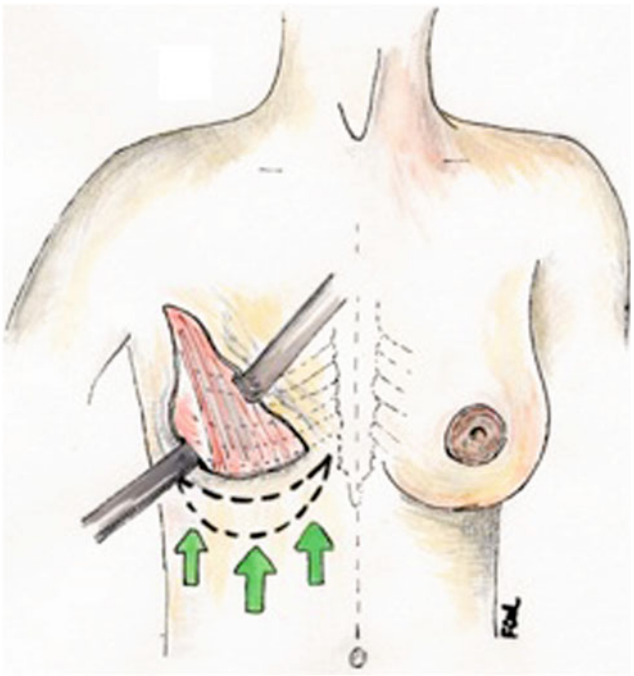

Fig. 22.8 Preparing the complete muscular pocket: pectoralis major muscle and serratus muscle

musculocutaneous flaps from the rectus abdominis muscle, on the other hand, can often have a natural-appearing amount of ptosis. In the right circumstances with some breasts and appropriate skin-sparing mastectomies, it is possible to achieve some degree of ptosis in immediate breast reconstruction with implants. These details must be considered when we plan the final result of a symmetry mammaplasty.

The techniques most frequently applied are:

- Reductive mammaplasty with a medial–lateral posterior pedicle, initially based on traditional periareolar techniques [16, 17]: This is usually applied to cases of reduction up to 200 g, with low level of ptosis, and for young patients with elastic skin.
- Reductive mammaplasty based on a superior pedicle as described by Lejour [18] or Pitanguy [19]: This technique is usually applied to reduction procedures between 200 and 700 g, without associated major initial ptosis.
- Reductive mammaplasty with an inferoposterior pedicle as described by Ribeiro [20] or Robbins [21]: This

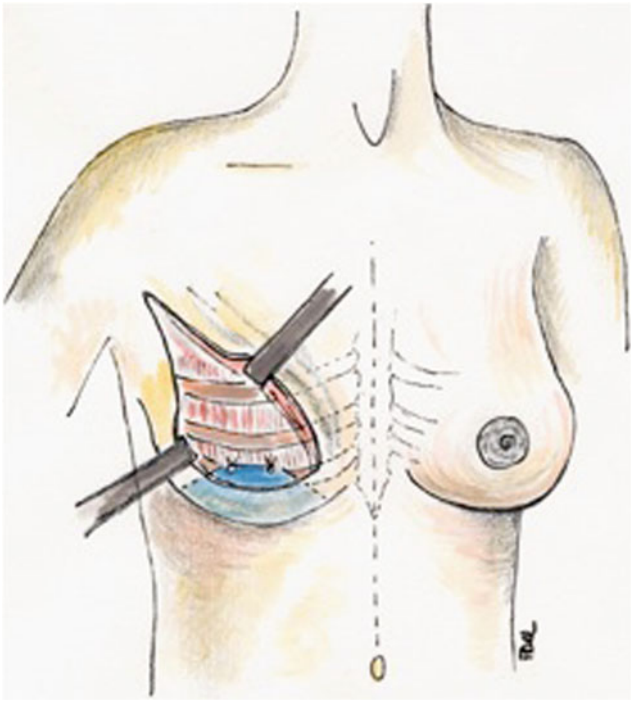

Fig. 22.9 The mesh of nonabsorbable material is fixed in the future sulcus, pulled superiorly, and fixed on the fifth or sixth coastal cartilage

technique is generally used for reductions above 700 g, with a moderate degree of initial ptosis.

- Reductive mammaplasty with graft of the areola and nipple as described by Thorek [22]: We apply this technique to gigantomasties combined with a major initial ptosis.
- Mastopexy: We generally use a periareolar technique when there is a small ptosis, and the Lejour technique for those cases with a higher degree of ptosis in which a great amount of skin has to be removed.
- Augmentation mammaplasties: We typically use round implants with a wider base and smaller projection to obtain a better symmetry of the reconstructed breast. The position can be subglandular if the breast is more than 1 cm thick in the upper quadrants. For small breasts and those less than 1 cm thick in the upper quadrants, we place the implant in the subpectoral position and leave the implant subglandular once it is outside the borders of the pectoralis muscle. In some cases, the patient needs both volume augmentation and a mastopexy. In this situation, we use the *dual plane* technique, which involves inferior detachment of the pectoralis major muscle and correction of the glandular ptosis with the crossing of flaps. The incision can be inferior periareolar, complete periareolar, or vertical periareolar (Lejour type). The choice of incision depends on the degree of ptosis to be corrected and the amount of skin to be removed [23, 24].

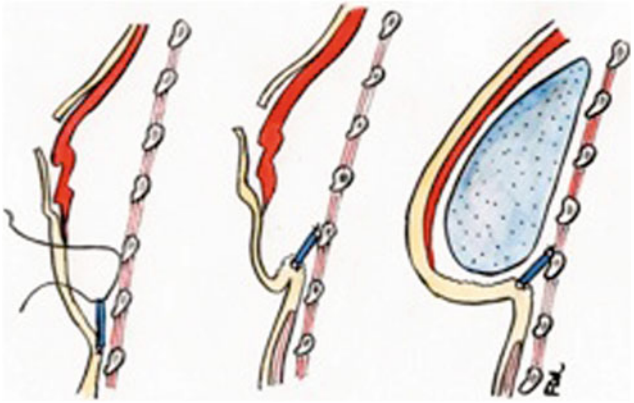

Fig. 22.10 Lateral view of the mesh position. The prosthesis is placed anteriorly

It is important to bear in mind that both clinical and radiological evaluation of the contralateral breast must be performed prior to a mammaplasty. A palpable nodule, skin retraction, pathologic nipple discharge, or an abnormality on imaging needs appropriate evaluation. Your center standards can guide the workup, but strong consideration should be given to preoperative core biopsy of all abnormalities. Breast MRI may also be appropriate. In centers where preoperative core biopsy is not available, it is recommended that one performs a careful intraoperative bimanual palpation of the gland and biopsies any suspicious areas. Additionally, imaged localized biopsies such as wire localization or a radioguided occult lesion localization procedure can be done if stereotactic core biopsy or mammotomy are not available. All tissue removed during the reduction mammaplasty should be submitted for histological examination. The orientation of the specimen should b provided to the pathologist so that appropriate margin evaluation can be done if an unsuspected malignancy is found. The literature shows that the average incidence of a contralateral lesion is about 5 % [25–27].

22.6 Secondary Revisions

Secondary revisions are frequent in cases of breast reconstruction with implants to improve symmetry and aesthetic results. The most frequent indications are:

- Formation of periprosthetic capsule, Baker grade III or IV.
- Malposition of the implant after healing.
- Asymmetry: This may be due to changes in body weight (either intentional or as a result of chemotherapy) or a suboptimal choice in the volume and/or shape of implant during the first surgical step.
- Rotation of an anatomic implant.

Revision techniques that can be used are:

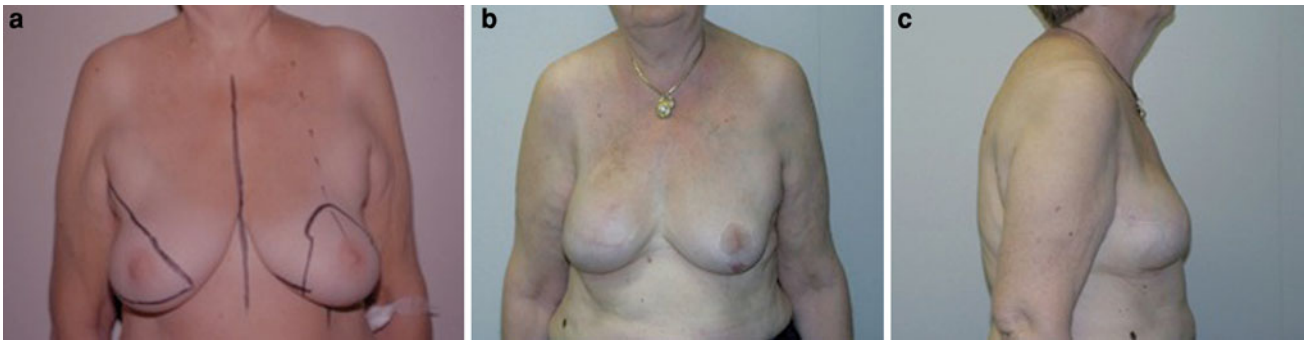

Fig. 22.11 **a** Preoperative drawings planning a right-sided mastectomy with broad removal of skin, immediate breast reconstruction with the mesh and with a definitive prosthesis, and a left-side mastopexy to be performed in the same surgery. **b**, **c** Postoperative frontal and lateral views after 6 months

- *Capsulectomies* These are indicated when there is a rather thick periprosthetic capsule, causing pain and an unsatisfactory aesthetic result. In rare cases, the patient may actually have a reaction to the prosthetic material. Chest wall radiotherapy greatly increases the risk of capsular contraction. At the Plastic Surgery Department in the European Institute of Oncology, issues of radiotherapy complicating an implant reconstruction are rare for two reasons. First, our radiation oncologists only prescribe chest wall radiotherapy after mastectomy in situations of extensive axillary lymph node involvement (over seven involved nodes) and in cases of locally advanced tumors. However, chest wall radiotherapy is recommended more frequently in other countries. In the USA, it is considered the standard for four or more positive nodes and the option is discussed with patients for one to three positive nodes. Second, we do not recommend immediate implant reconstructions for patients who have clear indications for chest wall radiotherapy. Our standard is to perform a mastectomy followed by radiotherapy. Reconstruction options are assessed after the completion of the radiotherapy. We do our capsulectomies, if possible, through the existing scar. Ideally, the incision is located over the pectoralis major muscle as this provides a protective layer between the implant and the suture line. After the skin incision has been made, we dissect in the subcutaneous space over to the lateral edge of the pectoralis major muscle. In cases where the edge of the pectoralis major muscle is too far away to be reasonably reached from this approach, we split the pectoralis major muscle in the same direction of the fibers. When the inferolateral cutaneous flap is thick, we recommend excision of the entire periprosthetic capsule. However, when this cutaneous flap is fragile and thin, or if it has been subjected to postoperative radiotherapy, a partial excision of the capsule is performed. The portion of capsule associated with the inferoexternal flap is left intact to avoid damaging the flap. Removal of the posterior capsule is also avoided to minimize the risk of hematoma and seroma in the postoperative period. We always do our capsulectomies with the patient under general anesthesia and we always place a drain.
- *Capsulotomies* These are indicated in cases of adherence or retraction of the periprosthetic capsule, leading to malpositioning of the implant or an unacceptable aesthetic result. As noted above, we try to place the incision within the previous scar if possible. We find the capsule either by dissecting through the subcutaneous tissues over to the edge of the pectoralis muscle or by splitting the fibers of the pectoralis muscle to get down to the capsule. The capsule is entered and the implant is explanted. The location and type of capsulotomy to be performed is determined preoperatively with the patient standing up. Our commonest approach is to make a circular incision in the base of the capsule. Then, radical incisions are added to allow better distension of the reconstructed breast and consequently a better shape after the implant is reinserted. We commonly use general anesthesia for these cases but in less complex cases, local anesthesia with sedation is enough.
- *Repositioning of the inframammary fold* The inframammary fold is an important landmark that needs to be properly positioned to achieve good symmetry in breast reconstruction. Malpositioning of it may occur after the first surgery as a result of the formation of the periprosthetic capsule. When the inframammary fold ends up too high, corrective surgery is easier. An inferior capsulotomy should allow one to place it in the correct position. When it is placed below the ideal position, correction becomes technically more difficult (Fig. 22.12). The drawing to determine the repositioning of the inframammary fold must be made before the surgery with the patient standing up. We do the operation with the patient at 90°, if possible. An inferior circular capsulotomy is made and the implant is removed. A new sulcus is created by suturing the anterior wall of the capsule to the inferior

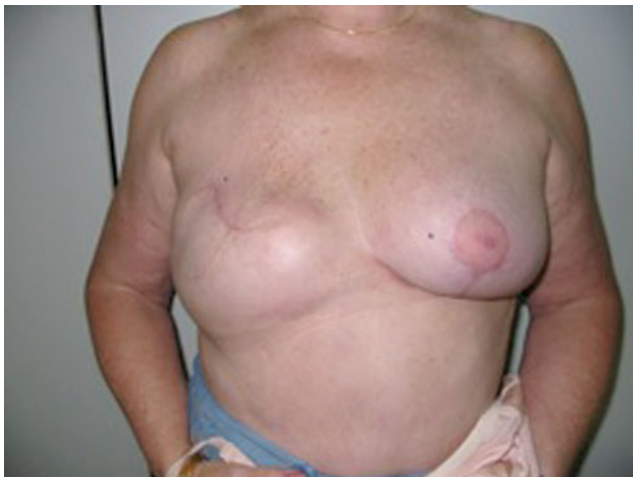

Fig. 22.12 Malpositioning of the sulcus 3 months after immediate reconstruction with an anatomic form-stable implant

superficial aponeurosis (superficial fascia of the underlying chest wall musculature) in the posterior capsule at the level of the new inframammary fold. Capsule wall to capsule wall fixation allows the portion of the capsule that was inferior to the desired inframammary fold to be excluded. In some cases, the repair will not be durable and the inframammary fold will again drop down. This is due to excessive tension in the stitches or fragility of the capsule. In such cases, correction using Mersilene mesh (nonabsorbable) could be an option, as described in the previous section. A drain is used and the patient is kept in a semisitting position for 48 h. For this surgery, the patient undergoes general anesthesia.

- *Implant replacement* This is indicated when there is asymmetry of shape or volume, or in the case of a possible rupture of the implant. The technique used will depend on the surgical plan. When the implant volume needs to be increased, it is usually necessary to perform a capsulotomy to increase the volume capacity of the pocket. Capsulotomy is generally not required in cases that involve implant replacement of lower volume. Special attention must be given to replacing a round implant with a smaller anatomic one because if the pocket is too large, the anatomic implant may rotate, with subsequent deformation of the reconstruction. Usually, this type of surgery can be performed with local anesthesia and sedation.

22.7 Complications

Complications related to breast reconstruction with implants can be classified as immediate (during the first 2 months after the surgery) or secondary (after this period). The most frequent complications include:

1. *Hematomas* The expected incidence of hematoma after breast reconstruction procedures is 1–2 %. The risk of hematomas is inversely proportional to the length of the skin incision. With the current trend of using some aesthetic incisions, it is harder to achieve excellent hemostasis. Other factors that may contribute to hematoma formation are the frequent use of prophylactic antithrombotic therapy, general anesthesia, and the sitting position of the patient during the surgical procedure. The latter two contribute by keeping a relative hypotension intraoperatively, which can cause bleeding in the postoperative period when the arterial blood pressure returns to normal. When large hematomas occur, surgical exploration and evacuation is appropriate for two reasons. First, it allows the source of the bleeding to be controlled. Second, a significant postoperative hematoma, with a prolonged reabsorption, is a risk factor for a periprosthetic capsule that is Baker level III or IV.
2. *Seromas* The physiopathologic changes associated with seromas are linked with liberating inflammatory mediators from traumatized tissues and to an interruption of blood and lymphatic flow. Even though the use of suction drains is routine for the prevention of seromas, seromas frequently occur. Axillary lymphadenectomy significantly increases the risk of a postoperative seroma. Suction drains are used routinely in almost all breast prosthesis surgeries, except for small capsulotomies and/or prosthetic replacements performed with local anesthesia. We remove the drains when the output is serous and the volume was below 70 ml in the past 24 h. In the case of abundant drainage, the patient is discharged to home with the drain in place and will return to the clinic for removal of the drain. When seromas occur after the drains have been removed, we assess the volume of the seroma and monitor the situation. The evaluation can be done clinically by an experienced surgeon or, in the case of doubt, ultrasonography can clarify the situation. In the case of a small seroma around the implant, we reassess the patient after 4–7 days in order to check if there has been increase or decrease of the seroma. If the seroma is in the axilla, the implant is not at risk of damage from the needle and aspiration can be used more liberally. Care must be exercised with large seromas around the implant. We aspirate these under ultrasound guidance or we may be able to displace the implant from the point of puncture, in which case the aspiration can be done without ultrasound guidance. We do not send serous fluid for Gram stain and cultures. However, purulent fluid must be sent for Gram stain, cultures, and antibiotic sensitivity studies. Empiric antibiotic therapy may be started prior to definitive cultures. Patients with large seromas can frequently experience fever peaks at 37.5 or 38 °C, although no infection is found.

3. *Infection and dehiscence of scar* These two topics may be dealt with as a set because they frequently occur together. Review of the literature shows an incidence of infection after breast reconstruction with expanders or definitive prosthesis that may range from 1 to 24 % [28]. This same study analyzed the possible factors that could influence the incidence of infection and it was clear that axillary lymphadenectomy and radiotherapy are statistically significant risk factors for an increased risk of infection [28–30]. One must consider how to mange this set of complications. A very interesting study grouped patients according to the clinical factors quality of cutaneous cover, dehiscence of scar, and infection level (absent, average, or severe), and according to the group to which the patient belonged, a therapeutic approach was proposed [31]. From our experience, this classification into clinical groups can be done but we use a simpler classification. The simplification is based on a study that showed that previous radiotherapy does not affect the success of the treatment for infection or cutaneous dehiscence [32]. The groups and strategies could be classified as:
   - *Dehiscence of scar without infection* For recent dehiscence (less than 48 h) with good skin cover, a conservative approach can be proposed, which includes culturing of the prosthesis capsule, thorough washing out of the wound with saline plus a disinfectant, placement of a suction drain, reinsertion of the same implant, resuture of the dehiscence, and empiric oral antibiotic therapy (until culture and sensitivity is known) with appropriate adjustment of antibiotic therapy once the specific organism has been identified. For dehiscence over 48 h and/or poor quality of the skin cover, the procedure is the same, but it is advisable to replace the implant because of contamination or even to substitute it with a lower-volume implant or exchange it for an expander.
   - *Dehiscence of scar with evident infection* For cases of light infection with good skin cover it is possible to try a conservative approach. The patient must be informed about the risk of failure. For severely infected patients or when the conservative approach has failed, it is necessary to remove the implant altogether, thoroughly rinse out the prosthetic capsule, place drains, and place the patient on antibiotics until the infectious process has resolved. The patient is reevaluated in 6 months and at that time a plan for the new reconstructive technique is made, Occasionally, a musculocutaneous flap must be used.
   - *Infection of the prosthetic capsule without dehiscence of scar* A study performed in our department at the European Institute of Oncology [30] has shown an increase in the risk of delayed infection of the prosthetic capsule in cases involving postoperative chemotherapy (mainly in cases of high-dose chemotherapy), and strangely the bacteriological test of removed purulent secretion is negative. The initial approach is aspiration of the fluid found in the periprosthetic capsule, bacteriological test (Gram stain, culture and sensitivity), and oral or intravenous antibiotic therapy, according to the intensity of infection and the patient's general condition. In the case of failure of the conservative approach or spontaneous drainage from the capsule of pus, the following will be necessary: removal of the prosthesis, thorough rinsing of the cavity, draining of the periprosthetic capsule, and antibiotic therapy until there is resolution of the infectious process.
4. *Periprosthetic capsular contraction and rupture of implant* Baker type III and type IV capsular contraction is a complication that has a rather variable incidence in the literature. The most recent generation of anatomic textured prostheses are expected to reduce the incidence of capsules that need surgical correction through capsulotomy and capsulectomy as previously described. The factors that result in the formation of an excessive capsule are not yet completely known. Subclinical infection and intraoperative contamination are two possible causes that have been studied so far. The mechanism of implant rupture is related to the natural degradation of the implant envelope and to the quality of the periprosthetic capsule. Implants with cohesive gel tend to remain in place, with no extravasation of silicone into the neighboring tissues. The extravasated silicone does not cause collagen vascular or neurological diseases, and does not have oncogenic potential or teratogenicity. The lifespan of these latest-generation implants is not yet completely known. Prophylactic exchange of these implants is not necessary (see the Chap. 33 about the history of breast implants).
5. *Rotation of implants* This is a new complication that appeared with the use of anatomic implants. It is not frequent, and it is probably related to pockets with excessive volume and/or insufficient capsule formation to keep the implants in their correct orientation.
6. *Rippling* The real incidence and causes of this aesthetic long-term complication are not well known, and this complication can nowadays can be corrected by the use of lipofilling (Fig. 22.13).
7. *Local recurrences* These are not exactly a complication of the reconstruction. They are more related to margin status, age of the patient, treatment protocols, and tumor biology rather than the surgery itself. Local recurrences in skin-sparing mastectomies are statistically similar to those of the traditional modified radical mastectomies. Preserving the inframammary fold and uninvolved skin does not bring about major oncologic risks or affect

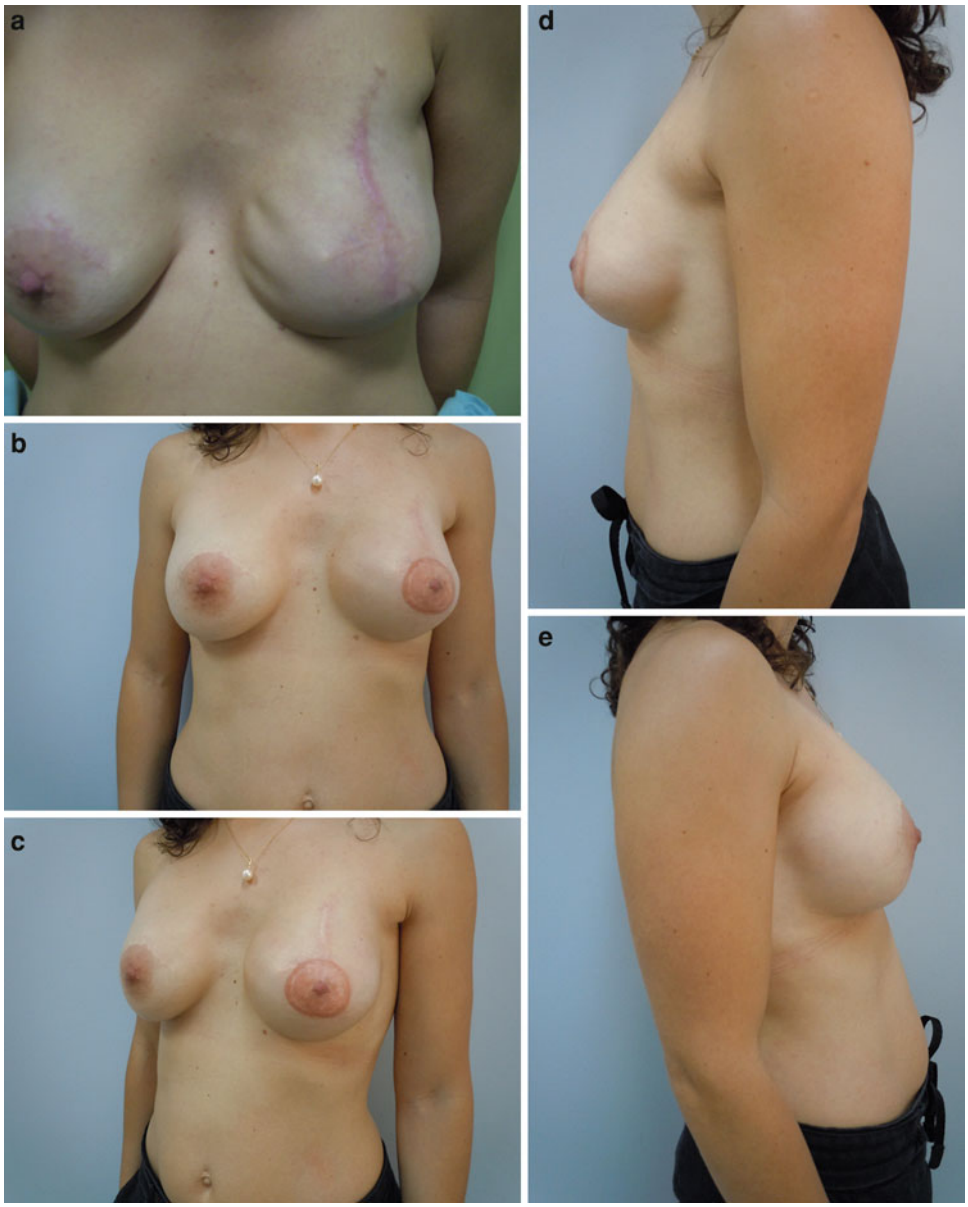

Fig. 22.13 **a** Rippling after breast reconstruction with an anatomic form-stable implant. **b–e** Postoperative images 4 months after correction of the rippling with lipofilling

patient survival. Local recurrences after mastectomies must be considered as systemic until staging studies show otherwise.

22.8 Conclusions

Immediate breast reconstruction with anatomic implants associated with skin-sparing and nipple-paring mastectomies has been one of the greatest advances in reconstructive breast cancer surgery in the past few years. It has a low level of complications. It decreases both the time spent in reconstructive surgical procedures and the number of surgical procedures for most patients. Surgical revisions of the reconstruction are still needed in some cases and are one of the greatest limitations. However, these are surgical procedures that have minor risks, and many of the procedures can be performed with the patient under local anesthesia. Currently, this is our most commonly used technique owing to its practicality, lack of long-term complications as we see with the musculocutaneous flap, and satisfactory aesthetic results with the various anatomic implants available on the market.

References

1. Veronesi U, Saccozzi R, Del Vecchio M, Banfi A, Clemente C, De Lena M et al (1981) Comparing radical mastectomy with quadrantectomy, axillary dissection and radiotherapy in patients with small cancers of the breast. N Engl J Med 305(1):6–11

2. Sarrazin D, Le M, Rouëssé J, Contesso G, Petit JY, Lacour J et al (1984) Conservative treatment versus mastectomy in breast cancer tumors with microscopic diameter of 20 mm or less the experience of the Institut Gustave-Roussy. Cancer 53(5):1209–1213
3. Lacour J, Le M, Caceres E, Koszarowski T, Veronesi U, Hill C (1983) Radical mastectomy versus radical mastectomy plus internal mammary dissection. Ten-year results of an international cooperative trial in breast cancer. Cancer 51(10):1941–1943
4. Warren AG, Morris DJ, Houlihan MJ, Slavin SA (2008) Breast reconstruction in a changing breast cancer treatment paradigm. Plast Reconstr Surg 121(4):1116–1126
5. Roostaeian J, Pavone L, Da Lio A, Lipa J, Festekjian J, Crisera C (2011) Immediate placement of implants in breast reconstruction: patient selection and outcomes. Plast Reconstr Surg 127(4):1407–1416
6. Goodwin SJ, McCarthy CM, Pusic AL, Bui D, Howard M, Disa JJ et al (2005) Complications in smokers after postmastectomy tissue expander/implant breast reconstruction. Ann Plast Surg 55(1):16–20
7. Disa JJ, McCarthy CM, Mehrara BJ, Pusic AL, Hu QY, Cordeiro PG (2009) Postmastectomy reconstruction: an approach to patient selection. Plast Reconstr Surg 124(1):43–52
8. Lee BT, Duggan MM, Keenan MT et al (2011) Commonwealth of Massachusetts Board of Registration in Medicine Expert Panel on immediate implant-based breast reconstruction following mastectomy for cancer: executive summary, June 2011. J Am Coll Surg 213(6):800–805
9. Little JW, Golembe EV, Fisher JB (1981) The "living bra" in immediate and delayed reconstruction of the breast following mastectomy for malignant and nonmalignant disease. Plast Reconstr Surg 68(3):392–403
10. Rietjens M, Garusi C, Lanfrey E, Petit JY (1997) Cutaneous suspension: immediate breast reconstruction with abdominal cutaneous advancement using a non-resorptive mesh. Preliminary results and report of 28 cases. Ann Chir Plast Esthet 42(2):177–182
11. Rietjens M, De Lorenzi F, Venturino M, Petit JY (2005) The suspension technique to avoid the use of tissue expanders in breast reconstruction. Ann Plast Surg 54(5):467–470
12. Gamboa-Bobadilla GM (2006) Implant breast reconstruction using acellular dermal matrix. Ann Plast Surg 56(1):22–25
13. Breuing KH, Colwell AS (2007) Inferolateral AlloDerm hammock for implant coverage in breast reconstruction. Ann Plast Surg 59(3):250–255
14. Breuing KH, Warren SM (2005) Immediate bilateral breast reconstruction with implants and inferolateral alloderm slings. Ann Plast Surg 55(3):232–239
15. Losken A, Carlson GW, Bostwick J 3rd, Jones GR, Culbertson JH, Schoemann M (2002) Trends in unilateral breast reconstruction and management of the contralateral breast: the Emory experience. Plast Reconstr Surg 110(1):89–97
16. Benelli L (1990) A new periareolar mammoplasty: the "round block" technique. Aesthetic Plastic Surg 14(2):93–100
17. Sampaio Goes JC (1991) Periareolar mammoplasty. Double skin technique. Breast Dis 4:111–127
18. Lejour M (1994) Vertical mammaplasty and liposuction. Quality Medical Publishing, St. Louis
19. Pitanguy I (1967) Surgical treatment of breast hypertrophy. Br J Plast Surg 20:78
20. Ribeiro L (1975) A new technique for reduction mammoplasty. Plast Reconstr Surg 12:110
21. Robbins TH (1977) A reduction mammaplasty with the areola-nipple based on an inferior dermal pedicle. Plast Reconstr Surg 59:64–67
22. Thorek M (1931) Histological verification of efficacy of free transplantation of the nipple. Med J Rec 134:474
23. Tebbetts JB (2001) Dual plane breast augmentation: optimizing implant-soft-tissue relationships in a wide range of breast types. Plast Reconstr Surg 107:1255–1272
24. Tebbetts JB (2002) A system for breast implant selection based on patient tissue characteristics and implant-soft tissue dynamics. Plast Reconstr Surg 109:1396–1409
25. Petit JY, Rietjens M (1991) Deformities following tumorectomy and partial mastectomy. In: Noone B (ed) Plastic and reconstructive surgery of the breast. Decker, Philadelphia
26. Petit JY, Rietjens M, Contesso G, Bertin F, Gilles R (1997) Contralateral mastoplasty for breast reconstruction: a good opportunity for glandular exploration and occult carcinoma diagnosis. Ann Surg Oncol 4(6):511–515
27. Rietjens M, Petit JY, Contesso G, Bertin F, Gilles R (1997) The role of reduction mammaplasty in oncology. Eur J Plast Surg 20:246–250
28. Nahabedian MY, Tsangaris T, Momen B, Manson PN (2003) Infectious complications following breast reconstruction with expanders and implants. Plast Reconstr Surg 112(2):467–476
29. Pittet B, Montandon D, Pittet D (2005) Infection in breast implants. Lancet Infect Dis 5(2):94–106
30. Rey P, Martinelli G, Petit JY, Youssef O, De Lorenzi F, Rietjens M et al (2005) Immediate breast reconstruction and high-dose chemotherapy. Ann Plast Surg 55(3):250–254
31. Spear SL, Howard MA, Boehmler JH, Ducic I, Low M, Abbruzzesse MR (2004) The infected or exposed breast implant: management and treatment strategies. Plast Reconstr Surg 113(6):1634–1644
32. Yii NW, Khoo CT (2003) Salvage of infected expander prostheses in breast reconstruction. Plast Reconstr Surg 111(3):1087–1092

The Use of Acellular Dermal Matrices in Implant-Based Breast Reconstruction

23

Glyn Jones

23.1 Introduction

Expander/implant reconstruction is one of the most widely used forms of breast reconstruction. Despite its popularity, it is fraught with the problems of capsular contracture, rippling of implants beneath the overlying thin skin envelope, and pseudoptosis of the device as the lower pole skin attenuates with time. Numerous solutions to these issues have been tried, often with little success. During the past 8 years, acellular dermal matrices have been increasingly incorporated into implant-based reconstructions and appear to offer a degree of resolution to many of these troublesome issues.

Although autologous techniques remain the gold standard of breast reconstruction for many surgeons, time constraints, resource allocation, availability of operating time, and decreasing reimbursement have all contributed to the ongoing popularity of prosthetic-device-based techniques despite their problems. Many patients are also concerned about the magnitude of some of the autologous approaches, including free tissue transfer, and see implant reconstruction as a quick and relatively easy answer to their reconstructive needs.

Surgeons familiar with all of these approaches are only too painfully aware of some of the major negatives associated with implant reconstructions. These include:

- Window shading of the pectoralis major muscle release
- Lack of control of the expander or implant pocket size and location
- Visible implant ripples
- Post-operative infection
- Problems achieving adequate lower pole expansion
- Significant capsular contracture rates in the long term
- The negative impact of radiation on implant-based reconstruction.

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At the time of surgery, coverage of the device with pectoralis major muscle provides upper pole cover, which can reduce long-term visible rippling of an underlying implant. Unfortunately inferomedial pectoralis major muscle release is complicated by window shade retraction of the muscle in a cephalad direction. Traditionally this has been countered by placing percutaneous sutures to anchor the muscle to the mastectomy skin envelope, an approach complicated by necrosis of marginally vascularized skin. The technique only provides cover to the upper pole, leaving the lower pole devoid of anything but thin skin coverage. Attempts at raising rectus muscle or fascia and the serratus fascia laterally can aid in resolving this dilemma but come at the expense of creating tight banding across the bottom of the reconstruction right where fullness and suppleness are most necessary. Having a biologic material to bridge the gap between the caudal edge of the pectoralis major muscle and the inframammary crease provides reliable, supple cover which can stretch with time or expansion.

In addition to the dilemma of providing cover, surgeons are faced intraoperatively with the difficulty of maintaining an expander or implant in its exact location within a larger mastectomy pocket than the device requires. Without the ability to control pocket size, particularly laterally, a device can shift or even rotate, creating major problems later. Having a biologic mesh to help shape and control pocket size is a desirable advantage in achieving excellent outcomes, particularly when one-stage direct-to-implant reconstructions are attempted.

With the acute intraoperative issues dealt with, we face the task of achieving successful expansion with subsequent expander/implant exchange. Isolating a prosthetic device from the mastectomy space could potentially reduce infection and device loss.

Once the implant has been exchanged for a permanent implant, we face the problem of visible rippling and wrinkling of the implant beneath the skin. Although cohesive gel implants have reduced this issue substantially, it remains a

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Table 23.1 Biologic materials available for breast reconstruction

Name	Company	Source tissue	Alpha-gal removed
DermaMatrix	MTF (Synthes)	Human dermis	NA
Flex HD	MTF (Ethicon)	Human dermis	NA
Neoform/AlloMax	Tutogen (Mentor)	Human dermis	NA
AlloDerm	LifeCell	Human dermis	NA
Strattice	LifeCell	Porcine dermis	Yes
SurgiMend	TEI Biosciences	Fetal bovine dermis	No
Veritas	Synovis	Bovine pericardium	No

cause for concern. Any biologic material that places more thickness between the skin and the implant can only serve to improve this troublesome problem and enhance esthetic outcomes.

Probably the most troubling complication of all remains that of capsular contracture.

With all of these complications in mind, acellular dermal matrices have become a useful and simple adjunct to our surgical armamentarium, providing significant improvement in clinical outcomes. The last 15 years has seen a dramatic increase in the number of patients receiving postoperative radiation therapy as the criteria for radiation therapy have expanded to include earlier forms of breast cancer. Radiation exerts a negative influence on implant reconstruction by tightening the overlying skin envelope and increasing the incidence of capsular contracture, resulting in deteriorating symmetry and increasing deformity with time. Acellular dermal matrices appear to be a valuable adjunct to improving the outcomes of implant-based reconstruction in the face of evolving data suggesting a reduction in significant capsular contracture following radiation of implant reconstructions.

In the past 15 years, numerous biologic materials have been introduced for use in reconstructive surgical procedures. Theoretically, biologically derived materials should allow a surgeon to achieve a better, more natural clinical outcome than by using synthetic materials. However, along with the many choices of biologic materials available to plastic surgeons, there are very few published data on most of these materials and considerable confusion as to the differences between them. Surgeons must be equipped with a fundamental understanding of these materials and how they work so they can make educated choices when developing a reconstructive strategy.

23.2 Currently Available Biologic Materials

Numerous allogeneic and xenogeneic tissue scaffolds have been introduced commercially. The nature and source of some of the most widely marketed materials are shown in Table 23.1.

The goal of using regenerative tissue matrices in reconstructive surgery is to establish an environment that enables the patient to "regenerate" tissue other than scar or foreign body capsule that mimics the autologous tissue and allows the surgeon to achieve an excellent outcome with durable esthetics and function.

23.3 Biologic Matrix Applications in Breast Reconstruction

Reconstructive options for using biologic matrices in breast reconstruction include the following:

- Implant reconstruction
- Expander reconstruction
- Augmentation of the reconstructed nipple
- Abdominal wall reinforcement
- Reducing capsular contracture after radiation therapy.

The aim of this chapter is to discuss the use of acellular dermal matrices in implant and expander reconstruction.

23.3.1 Implant Reconstruction

Patients undergoing skin-sparing mastectomy for breast cancer may be candidates for either immediate implant or expander insertion. Direct-to-implant insertion is becoming an increasingly attractive proposition as methods to assess skin viability become more available. Prerequisites for successful direct-to-implant insertion include a well-vascularized skin envelope and adequate skin surface area. The use of indocyanine green based fluorescence imaging has revolutionized our ability to assess skin vascularity at the time of mastectomy. If the skin envelope is viable, an implant of size similar to that of the original breast volume may be inserted without fear of postoperative necrosis. Unfortunately, such implant placement requires accuracy of implant positioning and maintenance of that position if the esthetic outcome is to be acceptable to both the patient and the surgeon. The mastectomy pocket is, by definition, larger than the space occupied by the implant. There is a tendency for the implant to fall laterally and inferiorly as well as to

slide out from beneath the pectoralis major muscle into a subcutaneous plane. To correct both of these issues, a sheet of acellular dermal matrix can be used to reduce both pectoralis major muscle window shading and control the implant pocket dimensions and location. The larger the implant and the greater the degree of ptosis required, the larger this sheet of matrix should be. My personal preference is for a sheet of 8 × 16 cm for most expander reconstructions, and an additional 6 × 16 cm sheet may be necessary for large (700–800 cm^3) implant reconstructions. In addition, the surgeon can use AlloDerm as a lower pole reinforcement to reduce both lower pole implant rippling and long-term capsular contracture.

23.3.1.1 Operative Technique

The perfusion and viability of the mastectomy skin envelope should be carefully assessed prior to committing to a direct-to-implant approach. It is the author's preference to use indocyanine green laser fluorescence for this assessment as it is quick, easy, and exceptionally accurate. The inferolateral border of pectoralis major muscle is grasped with an Alice tissue forceps (Fig. 23.1) and the subpectoral plane is entered (Fig. 23.2). Pectoralis major muscle is released from the 6 o'clock to 3 o'clock position on the right and from the 6 to 9 o'clock position on the left (Fig. 23.2a), producing a release that gives rise to the window shade effect of the muscle. A sheet of AlloDerm or Strattice (LifeCell, Branchburg, NJ, USA) is washed in saline for 2 min to rinse off preservatives (Fig. 23.3). The superomedial corner of the matrix is sutured to the inferomedial cut edge of the pectoralis major muscle with running 2-0 polydioxanone suture (Fig. 23.4). The suture is run along the medial breast border (Fig. 23.5), then across the curve of the inframammary crease and can be sutured to a raised

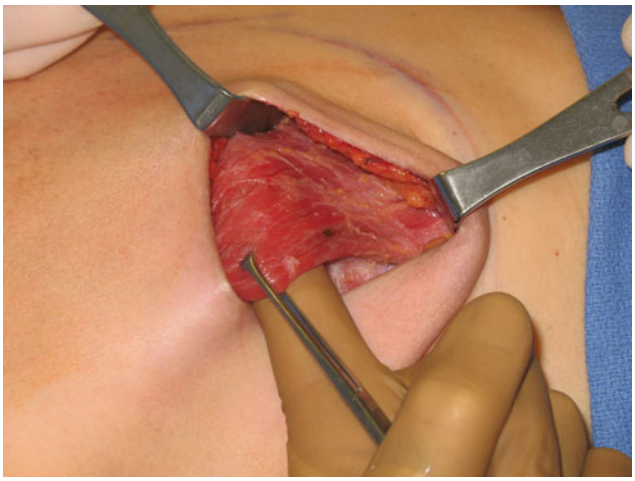

Fig. 23.2 The subpectoral plane is elevated

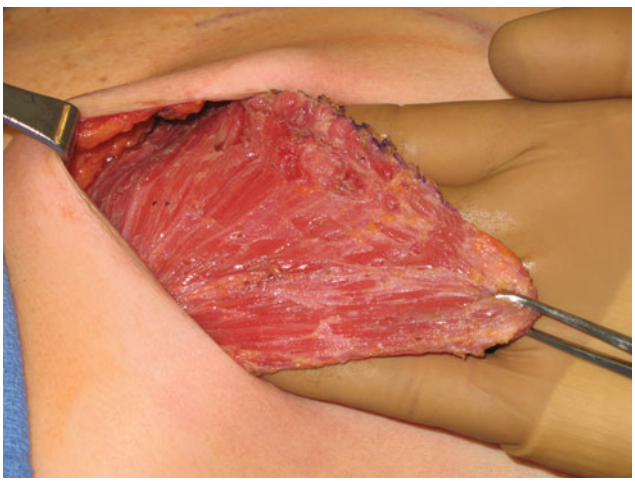

Fig. 23.3 The pectoralis major muscle is elevated after incising the origin inferomedially

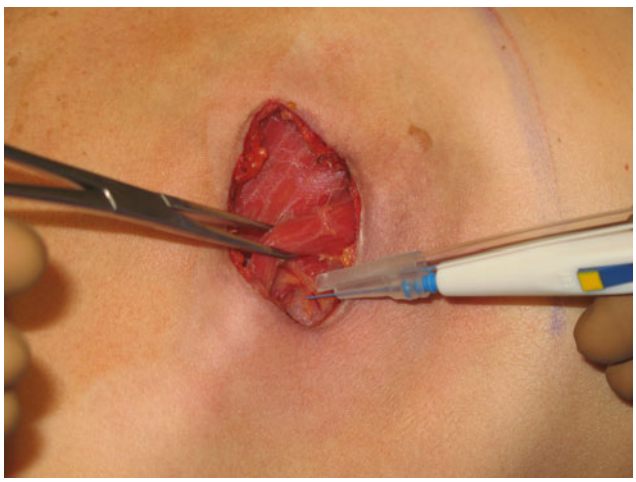

Fig. 23.1 The inferolateral border of pectoralis major is elevated with cautery

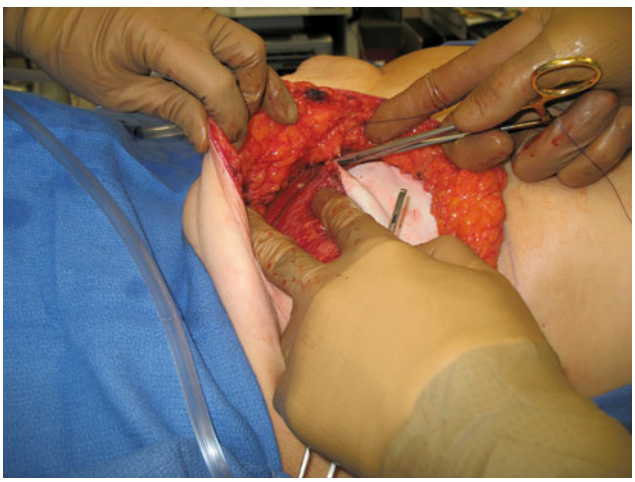

Fig. 23.4 The sheet of acellular dermal matrix is sutured t the cut origin of pectoralis major medially

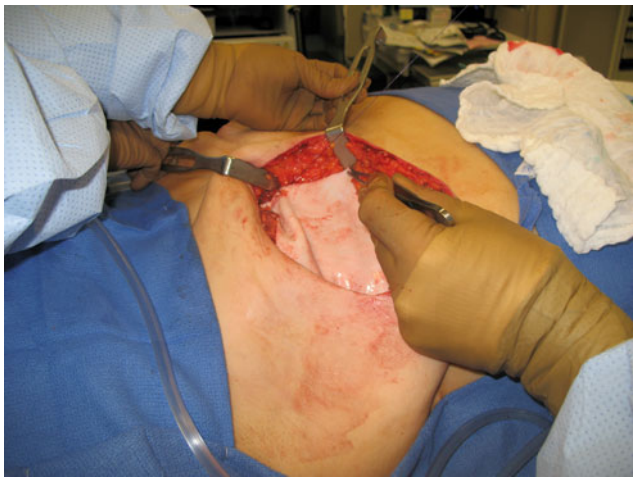

Fig. 23.5 Suturing is continued inferiorly along the inframammary crease and laterally to serratus anterior fascia to complete the creation of an inferior sling of acellular dermal matrix

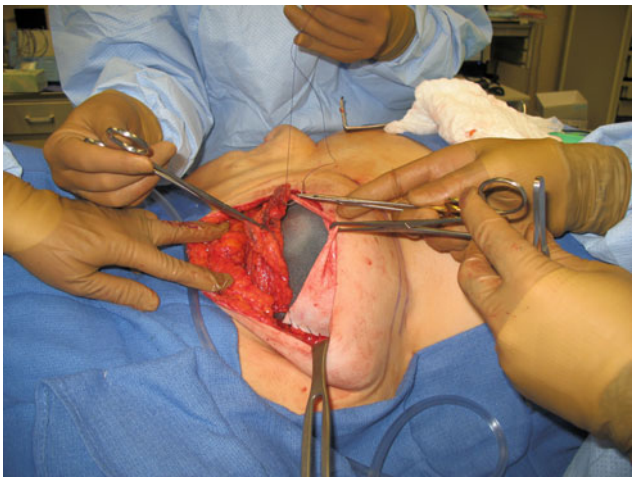

Fig. 23.7 The prosthetic device (expander or implant) is placed beneath the acellular dermal matrix inferiorly and the matrix is sutured to the caudal border of pectoralis major muscle superiorly

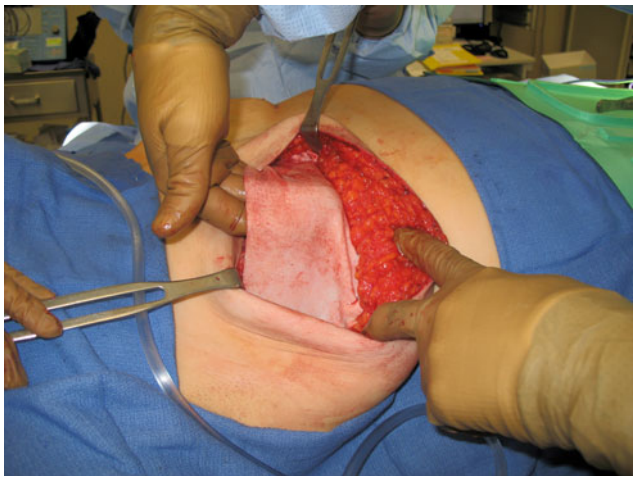

Fig. 23.6 The completed sling is shown

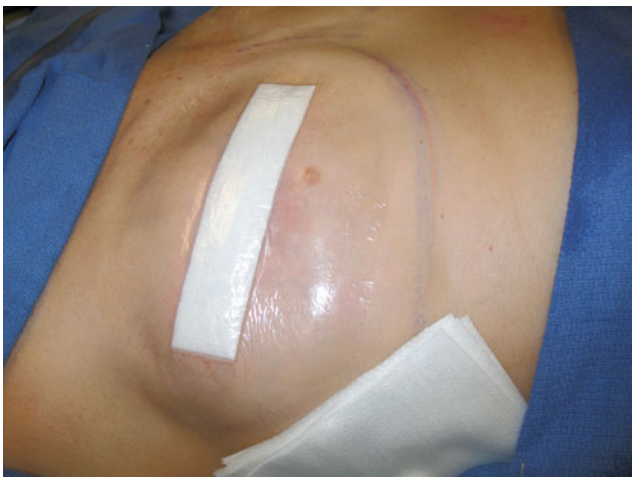

Fig. 23.8 The completed closure with dressings applied

cuff of serratus anterior fascia laterally which provides an additional domain for an implant if required. This creates an inferior sling of AlloDerm into which an implant or expander can be placed (Fig. 23.6). The device is placed beneath the AlloDerm inferiorly and the Strattice superiorly, following which the caudal edge of the pectoralis major muscle is sewn to the cephalad edge of the AlloDerm with running 2-0 polydioxanone suture (Fig. 23.7). This creates complete coverage of the implant with the mesh. It is essential that a drain be placed between the AlloDerm and the overlying skin in order to minimize seroma formation, which could inhibit contact between the mesh and the skin, thereby reducing vascular ingrowth and incorporation. The skin is then closed with absorbable subcutaneous and subcuticular sutures in a two-layer closure sealed with cyanoacrylate cement, SteriStrips, and an occlusive water-proof dressing such as Tegaderm (Fig. 23.8).

Direct-to-Implant Reconstruction

A 55-year-old woman (Fig. 23.9a) with cancer of the left breast and cancer phobia requested bilateral mastectomy with immediate implant reconstruction. She was a nonsmoker and had well-perfused skin flaps. AlloDerm was placed in the lower poles of both breasts, and high-profile 650-cm^3 gel implants were placed subpectorally. In Fig. 23.9b, she is shown 9 months after nipple reconstruction; the result is soft and stable, with good symmetry.

23.3.2 Expander Reconstruction

Tissue expander insertion after mastectomy (Fig. 23.10) is subject to the potential problems of poor lower pole coverage, expander migration, and capsular contracture. The use of acellular dermal matrix provides thicker lower pole

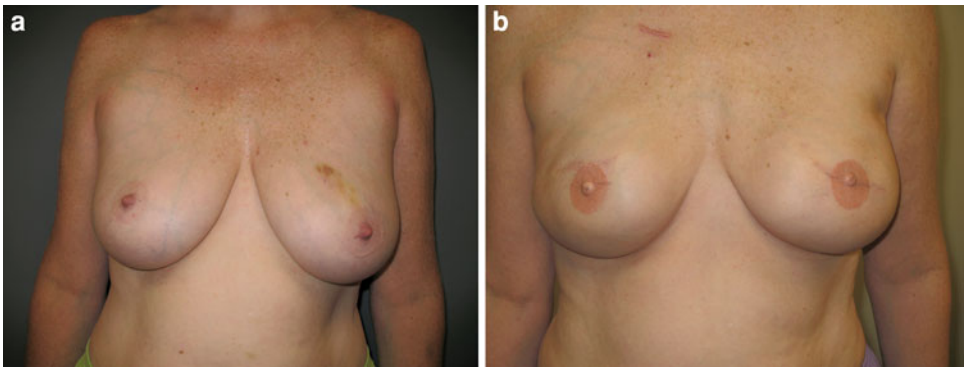

Fig. 23.9

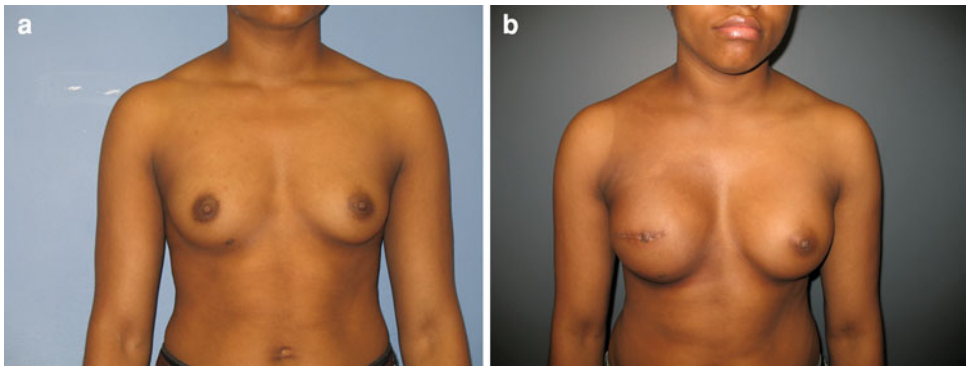

Fig. 23.10 This patient underwent expander insertion after right mastectomy for breast cancer. She had an implant exchange followed by radiation therapy and nipple reconstruction. No tattoo was performed. She is shown 1 year after treatment (**b**), with excellent shape and maintenance of symmetry despite radiation therapy. Her breast remains soft and supple

coverage and support and may reduce capsular contracture. In addition, the complete coverage of an expander by muscle and acellular dermal matrix compartmentalizes the device from a potentially more contaminated mastectomy pocket. This may reduce acute infection rates associated with expanders and could increase expander salvage in the presence of cellulitis of the mastectomy skin postoperatively. The technique of insertion is identical to that used with implant insertion. The expander should be inflated to the maximum intraoperative volume permissible that would allow adequate skin perfusion as it is preferable to have the matrix compressed up against the overlying mastectomy skin to encourage vascular ingrowth into the matrix as rapidly as possible. Drain insertion is mandatory to prevent seroma formation between the matrix and the skin.

23.3.3 Augmentation of the Reconstructed Nipple

Nipple reconstructions undergo a degree of atrophy over time. Nipples reconstructed from expanded mastectomy skin are most prone to this phenomenon because of the thin dermis present in breast skin and the lack of subcutaneous tissue following skin-sparing mastectomy. Several techniques have been used as possible solutions to this problem. These include staged autologous fat injection before elevation of the nipple-skin flaps, implantation of additional autologous dermal grafts, and the use of commercially available acellular dermal matrices. The latter technique obviates the need for a donor site.

Nahabedian and others have described the use of AlloDerm in secondary nipple reconstruction using C–V flaps, with satisfactory maintenance of projection over time. Although histologic evaluation of mature AlloDerm in the nipple has not been reported, Silverman conducted an animal study analyzing the cell repopulation and vascularization of AlloDerm sutured into a roll and implanted within a subcutaneous flap in rabbits. The results demonstrated revascularization of all layers of the matrix, with maintenance of projection.

23.3.3.1 Data Regarding Capsular Contracture in Nonirradiated Patients

Although numerous acellular dermal matrices exist on the market today, many of them are products formerly used

with differing degrees of success or failure in the hernia market and few have undergone rigorous premarket testing and clinical trials in breast surgery. Currently, the most widely tested and used products are AlloDerm and Strattice, both developed and marketed by LifeCell. This chapter is not intended to be an endorsement of any product or company but reflects the author's experience with this particular product series as well as the fact that the literature is replete with hundreds of articles on the successful use of AlloDerm and Strattice in breast reconstruction, whereas there are few if any articles attesting to the long-term success of most of the other products. These data may, however, be forthcoming in the future and comparisons will be interesting.

Experience with AlloDerm in breast reconstruction goes back approximately 8–10 years. Capsular contracture data are steadily emerging and more and more articles are attesting to the fact that AlloDerm incorporation in immediate or delayed breast reconstruction appears to be associated with significant decreases in capsular contracture. Breuing reported a zero contracture rate at 3 years in nonirradiated breast in a series of 97 immediate and four delayed reconstructions with either implants or expanders.

Although data to support this contention are still emerging, we are beginning to see an encouraging trend in this direction. Research in my own patient population has demonstrated capsular contracture occurring in 22 of 79 breasts treated without acellular dermal matrix, but in only 14 of 109 patients treated with acellular dermal matrix. Although these figures barely attain statistical significance, greater study numbers will probably indicate a significant difference in the long term. Infection rates between the two groups were similar, but expander salvage was significantly higher in the patients treated with acellular dermal matrix than in those without insertion of acellular dermal matrix. Jansen reviewed the recent literature and found a spread of capsular contracture rates of 0–8 % with AlloDerm use, all of which were well below reported averages for non-AlloDerm-based capsular contracture rates historically. Basu et al. demonstrated a highly statistically significant difference in capsular structure histologically between conventional fibrous capsules and the more elastic AlloDerm-based capsules seen with use of acellular dermal matrix resulting in suppler, soft clinical outcomes. In our own experience, we have seen a reduction in capsular contracture based on AlloDerm use when compared with our historical controls of non-AlloDerm patients (Table 23.2).

Table 23.2 Rates of capsular contracture

Capsular contracture grade	No AlloDerm used (%)	AlloDerm used (%)
I	72	87.1
II	21.5	1.6
III	6.3	0
IV	0	0

23.3.3.2 Data Regarding Reduction of Capsular Contracture After Radiation Therapy

Expander/implant reconstruction in the face of prior or subsequent radiation therapy has been associated with worse clinical outcomes than in the nonirradiated patient population. Spear et al. demonstrated dramatically increased complication rates, including capsular contracture, distortion, increased infection rates, and loss of the reconstruction. They reported an 84 % complication rate, with 39 % of patients requiring conversion to an autologous technique. The incorporation of acellular dermal matrices into expander/implant reconstruction appears to be helpful in reducing these complications according to 5-year observations in our practice.

The stimulus for their use was triggered by some of the earlier animal studies suggesting that subcutaneous AlloDerm insertion followed by radiation therapy did not appear to adversely affect vascularization, cell density, or graft thickness. In our own early data on patients undergoing adjuvant radiation therapy, only two of eight breasts (25 %) treated with acellular dermal matrices developed grade II capsular contracture, whereas six of seven breasts (85 %) without acellular dermal matrices developed grade II to III capsular contracture ($p < 0.05$). Of these non-AlloDerm irradiated patients, 14 % had grade II capsules and 71 % had grade III capsules, a highly significant difference between the two groups. This trend has been borne out over a 5-year period. We have been so impressed by these sustained outcomes that conversion to autologous reconstruction after irradiated implant reconstruction is now a relative rarity in our practice. Furthermore, the patients who have maintained an implant-based reconstruction in the face of radiation therapy have maintained at most a grade II capsule without progression to grade III or grade IV capsules as was so common in the past. The trend has reduced both patient morbidity and health care costs in this important patient subset.

23.3.3.3 Data on Cost Analysis

An additional cause of concern about the use of acellular dermal matrices in breast reconstruction has been the issue of cost. Jansen et al. reviewed cost outcome analyses of AlloDerm use based on the Canadian health care system and found that AlloDerm use reduced operative times and postoperative complications, resulting in fewer take backs, greater use of direct-to-implant reconstruction, and fewer reoperative events for capsular contracture. On the basis of

their estimates, direct-to-implant reconstruction with AlloDerm was particularly cost-effective.

23.3.3.4 Data on Infection Rates

Infection following expander and implant reconstruction is a major cause of postoperative morbidity. This is exacerbated by radiation therapy as evidenced by the data of Spear et al. Although user experience and familiarity with the product may affect infection rates, the use of acellular dermal matrices certainly does not seem to increase infection rates and may even decrease them owing to separation of the mastectomy pocket from the implant pocket by both the pectoralis major muscle and the acellular dermal matrix. Nahabedian found that in their series, the use of acellular dermal matrix neither increased nor decreased infection rates in expander/implant reconstruction, a conclusion which is similar to our own experience.

23.4 Conclusion

Acellular dermal matrices have assumed a pivotal role in the prevention of complications in implant-based and expander-based breast reconstruction. An increasing body of data from multiple centers confirms this trend. Although the materials are costly at the outset, the short-, medium-, and long-term benefits far outweigh the negatives associated with their use and it is likely that they will become a standard of care in the management of expander-based and implant-based breast reconstruction in the future.

References

1. Ashikari RH, Ashikari AY, Kelemen PR et al (2008) Subcutaneous mastectomy and immediate reconstruction for prevention of breast cancer for high-risk patients. Breast Cancer 15:185
2. Basu CB, Leong M (2010) Hicks MJ Acellular cadaveric dermis decreases the inflammatory response in capsule formation in reconstructive breast surgery. Plast Reconstr Surg 126(6):1842–1847
3. Baxter RA (2003) Intracapsular allogenic dermal grafts for breast implant-related problems. Plast Reconstr Surg 112:1692; discussion 1697
4. Becker S, Saint-Cyr M, Wong C et al (2009) AlloDerm versus DermaMatrix in immediate expander-based breast reconstruction: a preliminary comparison of complication profiles and material compliance. Plast Reconstr Surg 123:1; discussion 107
5. Bindingnavele V, Gaon M, Ota KS et al (2007) Use of acellular cadaveric dermis and tissue expansion in postmastectomy breast reconstruction. J Plast Reconstr Aesthet Surg 60:1214
6. Boehmler JH IV, Butler CE, Ensor J et al (2009) Outcomes of various techniques of abdominal fascia closure after TRAM flap breast reconstruction. Plast Reconstr Surg 123:773
7. Bökel C, Brown NH (2002) Integrins in development: moving on, responding to, and sticking to the extracellular matrix. Dev Cell 3:311
8. Breuing KH, Colwell AS (2007) Inferolateral AlloDerm hammock for implant coverage in breast reconstruction. Ann Plast Surg 59:250
9. Breuing KH, Warren SM (2005) Immediate bilateral breast reconstruction with implants and inferolateral AlloDerm slings. Ann Plast Surg 55:232
10. Brigido SA (2006) The use of an acellular dermal regenerative tissue matrix in the treatment of lower extremity wounds: a prospective 16-week pilot study. Int Wound J 3:181
11. Caplan AI (1991) Mesenchymal stem cells. J Orthop Res 9:641
12. Colwell AS, Breuing KH (2008) Improving shape and symmetry in mastopexy with autologous or cadaveric dermal slings. Ann Plast Surg 61:138
13. Costantino PD, Govindaraj S, Hiltzik DH et al (2001) Acellular dermis for facial soft tissue augmentation: preliminary report. Arch Facial Plast Surg 3:38
14. Cothren CC, Gallego K, Anderson ED et al (2004) Chest wall reconstruction with acellular dermal matrix (AlloDerm) and a latissimus muscle flap. Plast Reconstr Surg 114:1015
15. Disa JJ, Chiaramonte MF, Girotto JA et al (2001) Advantages of autologous fascia versus synthetic patch abdominal reconstruction in experimental animal defects. Plast Reconstr Surg 108:2086
16. Disa JJ, McCarthy CM, Mehrara BJ et al (2008) Histologic analysis of angiogenesis and lymphangiogenesis in acellular human dermis. Plast Reconstr Surg 121:159e
17. Dubin MG, Feldman M, Ibrahim HZ et al (2000) Allograft dermal implant (AlloDerm) in a previously irradiated field. Laryngoscope 110:934
18. Eppley BL (2001) Experimental assessment of the revascularization of acellular human dermis for soft-tissue augmentation. Plast Reconstr Surg 107:1
19. Gamboa-Bobadilla GM (2006) Implant breast reconstruction using acellular dermal matrix. Ann Plast Surg 56:22
20. Garramone CE, Lam B (2007) Use of AlloDerm in primary nipple reconstruction to improve long-term nipple projection. Plast Reconstr Surg 119:1663
21. Garramone CE, Lam B (2007) Use of AlloDerm in primary nipple reconstruction to improve long-term nipple projection. Plast Reconstr Surg 119:1663
22. Glasberg SB, D'Amico RA (2006) Use of regenerative human acellular tissue (AlloDerm) to reconstruct the abdominal wall following pedicle TRAM flap breast reconstruction surgery. Plast Reconstr Surg 118:8
23. Harper JR, McQuillan DJ (2007) A novel regenerative tissue matrix (RTM) technology for connective tissue reconstruction. Wounds 19:163
24. Holton LH, Haerian H, Silverman RP et al (2005) Improving long-term projection in nipple reconstruction using human acellular dermal matrix: an animal model. Ann Plast Surg 55:304–309
25. Holton LH III, Chung T, Silverman RP et al (2007) Comparison of acellular dermal matrix and synthetic mesh for lateral chest wall reconstruction in a rabbit model. Plast Reconstr Surg 119:1238
26. Ibrahim HZ, Kwiatkowski TJ, Montone KT et al (2000) Effects of external beam radiation on the allograft dermal implant. Otolaryngol Head Neck Surg 122:189
27. Jansen LA, Macadam SA (2011) The use of AlloDerm in postmastectomy alloplastic breast reconstruction: part I: a systematic review. Plast Reconstr Surg 127(6):2232–2244
28. Jansen LA, Macadam SA (2011) The use of AlloDerm in postmastectomy alloplastic breast reconstruction: part Il: a cost analysis. Plast Reconstr Surg 127(6):2245–2254
29. Jin J, Rosen MJ, Blatnik J et al (2007) Use of acellular dermal matrix for complicated ventral hernia repair: does technique affect outcomes? J Am Coll Surg 205:654

30. Jones GE, Harper A (2009) Technical advances in breast reconstruction. In: Jones G (ed) Bostwick's plastic and reconstructive breast surgery, 3rd edn. Quality Medical Publishing, St. Louis
31. Liao EC, Breuing KH (2007) Breast mound salvage using vacuum-assisted closure device as bridge to reconstruction with inferolateral AlloDerm hammock. Ann Plast Surg 59:218
32. Livesey S, Herndon D, Hollyoak M et al (1995) Transplanted acellular allograft dermal matrix. Transplantation 60:1
33. Margulies AG, Hochberg J, Kepple J et al (2005) Total skin-sparing mastectomy without preservation of the nipple-areola complex. Am J Surg 190:907
34. Mofid MM, Singh NK (2009) Pocket conversion made easy: a simple technique using AlloDerm to convert subglandular breast implants to the dual-plane position. Aesthet Surg J 29:12
35. Nahabedian MY (2007) Does AlloDerm stretch? Plast Reconstr Surg 120:1276
36. Nahabedian MY (2005) Secondary nipple reconstruction using local flaps and AlloDerm. Plast Reconstr Surg 115:2056
37. Nahabedian MY (2009) AlloDerm performance in the setting of prosthetic breast surgery, infection and irradiation. Plast Reconstr Surg 124(6):1743–1753
38. Otterburn D, Losken A (2009) The use of porcine acellular dermal material for TRAM flap donor-site closure. Plast Reconstr Surg 123:74e
39. Prantl L, Schreml S, Fichtner-Feigl S et al (2007) Clinical and morphological conditions in capsular contracture formed around silicone breast implants. Plast Reconstr Surg 120:275
40. Preminger BA, McCarthy CM, Hu QY, Mehrara BJ, Disa JJ (2008) The influence of AlloDerm on expander dynamics and complications in the setting of immediate tissue expander/implant reconstruction: a matched-cohort study. Ann Plast Surg 60:510
41. Preminger BA, McCarthy CM, Hu QY, Mehrara BJ, Disa JJ (2008) The influence of AlloDerm on expander dynamics and complications in the setting of immediate tissue expander/implant reconstruction: a matched-cohort study. Ann Plast Surg 60:510
42. Salzberg CA (2006) Nonexpansive immediate breast reconstruction using human acellular tissue matrix graft (AlloDerm). Ann Plast Surg 57:1
43. Silverman RP, Singh NK, Li EN et al (2004) Restoring abdominal wall integrity in contaminated tissue-deficient wounds using autologous fascia grafts. Plast Reconstr Surg 113:673
44. Spear SL, Bedford SM (2007) Discussion of Saulis AS, Mustoe TA, Fine NA. A retrospective analysis of patient satisfaction with immediate postmastectomy breast reconstruction: comparison of three common procedures. Plast Reconstr Surg 119:1677
45. Spear SL, Parikh PM, Reisin E et al (2008) Acellular dermis-assisted breast reconstruction. Aesthetic Plast Surg 32:418
46. Topol BM, Dalton EF, Ponn T et al (2008) Immediate single-stage breast reconstruction using implants and human acellular dermal tissue matrix with adjustment of the lower pole of the breast to reduce unwanted lift. Ann Plast Surg 61:494
47. Zienowicz RJ, Karacaoglu E (2007) Implant-based breast reconstruction with allograft. Plast Reconstr Surg 120:373

Immediate Implant-Based Breast Reconstruction Using Variable Lower Pole Support

24

Michael Sheflan and Iain Brown

24.1 Introduction

Implant-based breast reconstruction continues to be the mainstay of the reconstructive repertoire and yet remains the greatest of all the reconstructive challenges. Although the use of an implant may appear to be the simplest and most straightforward option, this apparent simplicity belies subtle complexity, which must be overcome if a predictable, natural and reliable reconstruction is to be created.

Successful outcomes require:

24.1.1 Individualized Analysis, Planning and Selection

As with any other technique, implant-based breast reconstruction requires the careful analysis of the patient's specific tissue characteristics, biodimensional measurements and careful consideration of individual desires and expectations. In particular, the surgeon must

- Have an understanding and appreciation of the individual aesthetic components that contribute to the 'natural' breast form: a gradual upper pole, proportionate lower pole curvature, medial-to-lateral take-off and defined inframammary fold (IMF) and lateral mammary fold (LMF)
- Be able to select the correct implant to recreate the natural breast form.

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24.1.2 Creation of a Perfect Skin Envelope

The perfect reconstruction begins with the perfect mastectomy; an oncologically sound dissection does not need to compromise the viability or pattern of the resultant skin envelope. With careful planning and technical excellence, it is possible to preserve the optimal amount of healthy, well-perfused skin to drape the internal domain and produce a natural and predictable outcome.

24.1.3 Creation of a Stable Internal Domain

The standard complete submuscular pocket has several recognized limitations; most importantly it is difficult to produce natural ptosis or create a well-defined IMF. Even if an acceptable shape and volume can be achieved, the reconstruction is unlikely to age naturally. Deterioration of shape and increasing asymmetry are common and a result of instability between the pocket and the implant. Hence, there is often the need for the additional or maintenance procedure may be either to the reconstruction, the contralateral breast or both. Further surgical procedures may be avoided if a natural ptosis is achieved with the primary reconstruction.

The use of enhanced lower pole support to the upper subpectoral pocket with an acellular dermal matrix (ADM) or a deepithelialized lower pole (dermal) sling (LPS) can overcome many of these challenges. The creation of a precise, stable internal domain improves the likelihood of a lasting harmony between tissues and the implant; and hence a more reliable and predictable long-term outcome.

24.2 The Case for Lower Pole Support

24.2.1 Better Support of the Prosthesis

By creating a subpectoral pocket with an LPS or an ADM, one can position the implant device in such a way as to

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off-load pressure on the overlying soft tissues. Pectoral contraction is less likely to displace the implant superiorly, which could degrade the upper pole appearance. It is also less likely to allow lateral implant drift and a stepped cleavage when the patient lies supine.

24.2.2 Better Defined and Anchored Inframammary Fold

Whether the inframammary fold (IMF) is sutured, as with use of an ADM, or reinforced, when an LPS is used, the device is cradled above and anterior to the fixed IMF. This produces a more natural ptosis with the IMF hidden behind the lower breast curvature. As the tissues of pocket and skin envelope relax over time, a fixed IMF allows a natural increase in ptosis.

24.2.3 Better Defined and Anchored LMF

The lateral contour and overall breast shape is further defined by a smooth but nevertheless fixed LMF. Whether the LMF is created with accurate lateral suturing of the ADM, or precise sub-serratus anterior lateral pocket dissection (in the LPS technique), a smooth, natural and more predictable lateral curvature can be achieved.

24.2.4 More natural Medial-to-Lateral 'Take-Off'

For optimal cleavage and gradual medial 'take off', the implant must rest as low and medial as possible in the pocket created. Careful fixation of the ADM or LPS to the most medially divided fibres of the pectoral muscle allows the surgeon to control this unpredictable area of the pocket. It is also essential to have a device with the correct width and adequate lateral control to optimize the implant's medial position.

24.2.5 More possibility of Using a Fixed-Volume Versus Variable-Volume Anatomical Device

Even with an adequate, tension-free, healthy skin envelope, a traditional complete subpectoral pocket rarely allows implantation of the final desired volume in the first setting. In recent years, permanent shaped-adjustable (combined expander/implant) devices have improved outcomes [1–3]. However with the use of an ADM or LPS, it is usually possible to obtain a one-stage reconstruction with a definitive fixed-volume implant. If volume is not adequate, or there are concerns about skin envelope viability, then use of the LPS or ADM technique with a variable-volume implant (either as a one-stage expander/implant or as two-stage expander then implant) will produce a more natural breast than expansion of a standard complete submuscular pocket. Gradual expansion is done after an initial healing and relaxation phase to allow a more predictable descent to the final desired ptotic outcome.

24.2.6 Reduced Need for Contralateral Surgery

The use of an LPS or ADM creates a more natural final breast aesthetic than a traditional complete submuscular reconstruction. There is therefore a greater likelihood of achieving an initial match with the contralateral breast. Producing a stable long-term outcome will also improve the chances of maintaining symmetry, thus reducing the need for contralateral surgery later [4].

With lower pole support techniques it becomes possible to offer an implant-based reconstruction to women who, in the past, may have declined such a reconstruction because they were reluctant to have surgery to their contralateral (healthy) breast.

These techniques may also improve the options in hospitals or insurance-led healthcare systems where there are logistical or financial constraints on offering multiple, staged surgeries.

24.2.7 Better Harmony of Tissues and Device

In the author's experience, the use of an ADM or LPS creates a better harmony between the device and a patient's tissues, thus creating a stable internal domain; like a 'hand in a glove'. The ADM and LPS both cover about two-thirds of the implant, resulting in decreased compression of the soft tissues (pectoralis major and lower pole skin envelope). A stabler environment is therefore created, with a better distribution of pressure on, and exerted by, the implant. Using enhanced lower pole support has led to an observed reduction in our capsular contracture rates and reoperation rates.

A stabler internal domain allows better perfusion of all soft tissues (skin, muscle, capsule, LPS, ADM). It seems plausible, although as yet unproven, that optimized perfusion of soft tissue microcirculation may help to minimize acute radiotherapy-induced vasculitis (and fibrosis) and hence offer some protection against radiotherapy-induced complications.

24.3 The LPS or ACD?

24.3.1 Selection of the LPS Technique

The LPS technique is well suited to patients with large, ptotic breasts who desire a smaller volume and a more uplifted final breast. The technique involves a skin-reducing mastectomy using a Wise pattern, resulting in a section of excess lower pole skin which, once deepithelialized, provides autologous lower pole dermal support [5, 6].

A resultant safe and well-perfused skin envelope after mastectomy is essential for a good outcome in immediate reconstruction [7–9], but this is never better demonstrated than when using the LPS technique. Problems with skin envelope perfusion, ischaemia and necrosis with risk of infection and implant threat have discouraged some surgeons, mostly early in their learning curves, from perfecting the technique. However, with careful planning, precision technique and delicate tissue handling, it is possible to minimize these complications to acceptably low levels (see Sect. 1.7.1).

The likelihood of envelope necrosis or wound-healing complications is increased in certain scenarios. Patients with a history of obesity, smoking, diabetes, previous radiotherapy, and small vessel disease should be counselled on an increased risk of immediate postoperative complications or even reconstructive failure.

24.3.2 Selection of the ADM Technique

Patients with smaller, less ptotic breasts are unlikely to have sufficient surplus lower pole skin to create an adequate dermal sling and therefore require an ADM to provide lower pole dermal support.

There are several different types of ADM currently available and other innovative materials are already in the advanced stages of product development (Tables 24.1 and 24.2). The choice of ADM must take into account several factors:

- Immune reactivity, i.e. host adoption without inflammation
- Handling qualities
- Structural support ability
- Collagen matrix properties (no chemical cross-linking)
- Tissue incorporation and integration ability
- Tissue regeneration ability
- Cell revascularization ability.

ADMs are sourced from allogenic human cadaveric/bariatric dermis or from xenogenic tissues (porcine or bovine; dermis, pericardium, intestinal submucosa). They differ in thickness from less than 1 mm to over 4 mm, with the latter

Table 24.1 Comparison and summary of allograft acellular dermal matrices (ADM)

ADM	Year introduced	Supplier	Location	Material	Cross-linked	Sterilized (method)	Lyophilized	Hydration/ soak time	Refrigeration required	Shelf life (years)
AlloDerm	1994[a]	LifeCell	Branchburg, NJ, SA	Human dermis	No	No (aseptically processed)	Yes	10–40 min (2 steps)	Yes	2[a]
AlloMax		Davol (CR Bard) (processed by RTI Biologics)	Warwick, RI,USA	Human dermis	No	Yes (gamma irradiation)	No (supplied dehydrated)[2]	'Rapidly'	No	5
DermaMatrix	2005[a]	Synthes CMF (processed by MTF)	West Chester, PA, USA	Human dermis	No	No (aseptically processed)	Yes	3 min	No	3
DermaSpan	2011[b]	Biomet	Warsaw, IN, USA	Human dermis	No[b]	Yes (gamma irradiation)	Yes	15–45 min	No	2
FlexHD	2007[a]	Ethicon (J&J) (processed by MTF)		Human dermis	No[b]	No (aseptically processed)[a]	No	None	No[a]	3
Repriza	2010[b]	Specialty Surgical Products	Victor, MT, USA	Human dermis	No	Yes (irradiation)	No	None	No	2

Information from product sheets except as noted
[a] From [43]
[b] From [44]

Table 24.2 Comparison and summary of xenograft ADM

ADM	Year introduced	Supplier	Location	Material	Cross-linked	Sterilized (method)	Lyophilized	Hydration/ soak time	Refrigeration required	Shelf life (years)
Permacol	2000[b]	Covidien	Norwalk, CT, USA	Porcine dermis	Yes (HMDI)	Yes (gamma irradiation)	No (supplied moist)	None	No	3
Strattice	2008[a]	Lifecell	Branchburg, NJ, USA	Porcine dermis	No	Yes	No (supplied moist)	≥2 min	No	2[a]
SurgiMend	2006	TEI Biosciences	Boston, MA, USA	Bovine dermis	No	Yes (ethylene oxide)	Yes	60 s	No	3
Veritas	2001	Synovis	St. Paul, MN, USA	Bovine pericardium	No, propylene oxide capped amine technology	Yes (irradiation)	No	None	No	2[a]
XenMatrix	2006	Davol (CR Bard)	Warwick, RI, USA	Porcine dermis	No	Yes	No	None	No	5

Information from product sheets except as noted
HMDI—Hexamethylene Di-Isocyanate
[a] From [43]
[b] From [44]

best suited for cosmetic purposes, where bulking is desired, or for large ventral abdominal hernias, where strength is desired.

Whereas human ADMs typically come in various rectangular sizes, some xenogenic ADMs are provided in shapes more suited to the subsequent three-dimensional conformation a flat sheet will take when placed over an implant. Such shaping, as well as premade fenestrations, helps the ADM to conform to the implant without pleating or wrinkling.

Human cadaveric ADMs typically maintain greater intraoerative and postoperative stretch than do xenogenic ADMs. Care and thought must be given in anticipating the potential for gradual 'window-shading' of the ADM higher on the upper pole of an expander during filling when a human ADM is employed. When using a less extensible xenogenic ADM, one must anticipate further travel of the inferior margin of the pectoralis major muscle towards the IMF during expansion.

24.4 Technique and Surgical Considerations

24.4.1 The Perfect Skin-Sparing Mastectomy

The perfect breast reconstruction depends upon the perfect mastectomy. Although the planning, decision-making and technical execution of the reconstructive component are important, many of the short-term and long-term complications from immediate reconstruction are mostly related to a suboptimal mastectomy.

24.4.1.1 Who Should Perform the Mastectomy?

It is not important whether a general or a plastic surgeon performs the mastectomy, provided the surgeon has the appropriate training and skills to be able to safely find and then stay within the mastectomy plane.

24.4.1.2 Where Is the Mastectomy Plane?

The mastectomy plane lies between the subcutaneous fat and the superficial fascia of the breast, crossed by the ligaments of Cooper that travel through the subcutaneous fat to anchor in the dermis (Fig. 24.1a). There is a conventional view that the superficial fascial plane is not reliably present and thus the plane may not always be identifiable. This appears to be based on an often-quoted small observational study [10] of breast-reduction specimens. There is, however, a compelling embryological explanation for the constant presence of this fascia, even if patient factors (extremes of BMI) or surgical factors (poor or closed techniques) mean that it is not always visualized. The

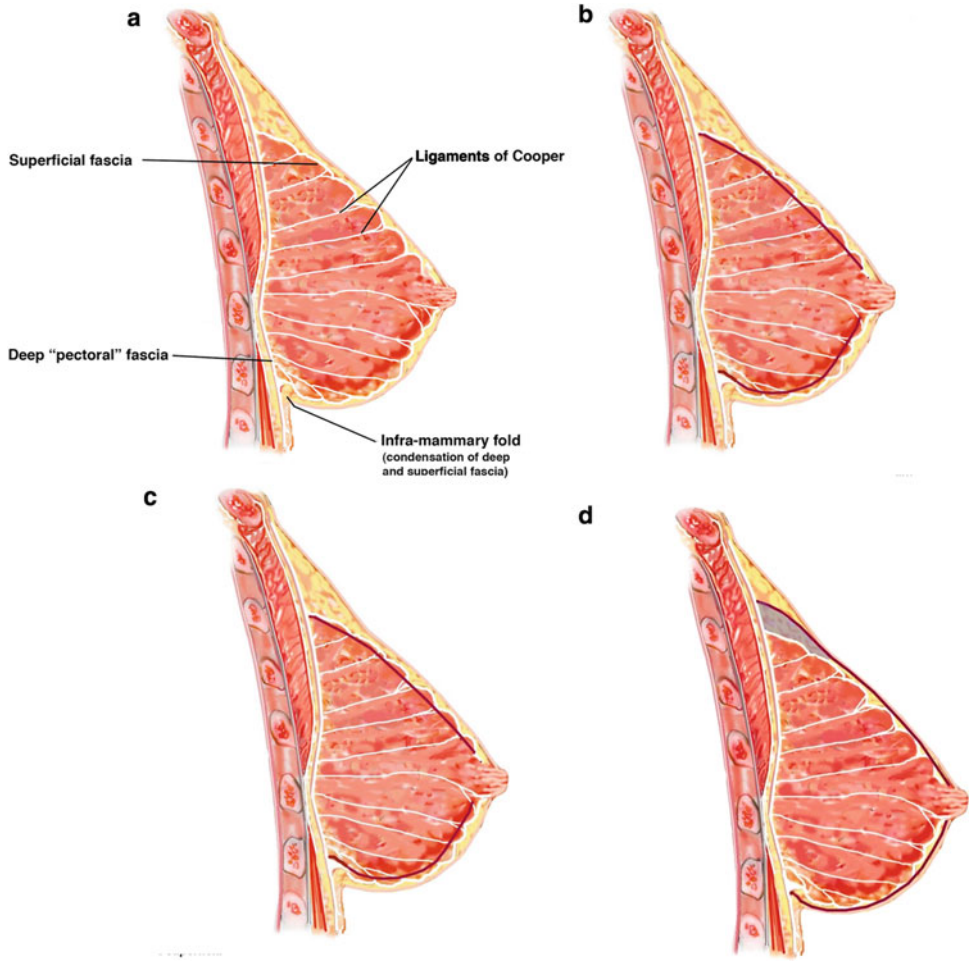

Fig. 24.1 Sagittal views of the breast demonstrating **a** fascial planes and ligamentous anatomy, **b** 'thin' skin flaps (increased risk of skin necrosis and unnecessary subcutaneous fat excision above the breast), **c** 'thick' skin flaps (increased risk of residual breast tissue and local recurrence) and **d** 'ideal' mastectomy plane over superficial fascia

superficial fascia is formed as a condensation from the sixth embryological week, when the primary ectodermal breast bud invaginates into the underlying mesenchyme [11].

Regardless of the technique and instruments used, achieving the correct dissection plane is essential for optimal oncological safety and viability of the skin envelope. A 'thin' or traumatized skin flap is more likely to have compromised perfusion. A 'thick' skin flap is more likely to carry residual breast tissue with an unnecessary increased risk of future disease or local recurrence (Fig. 24.1b, c). There are several well-designed studies that demonstrate residual breast tissue left on mastectomy skin flaps in up to 50 % of biopsies looked at [12–14]. Without evidence of intact superficial fascia on the mastectomy specimens removed, such studies should be interpreted with caution.

It should be remembered that the 'ideal' skin flap thickness is proportionate to a patients BMI and body habitus and is therefore 'patient-dependent' not 'surgeon-dependent'. It should be possible to aim for complete removal of the breast tissue, and breast surgeons should continue to strive for the cleanest possible dissection in the plane; i.e. over the fascia, with division of the ligaments of Cooper as close to dermal attachments as possible (Fig. 24.1d).

24.4.1.3 What Is the Best Technique for Performing Skin-Sparing Mastectomy?

Planning the mastectomy must take into account the three-dimensional shape of the envelope, the likely tension on the skin and the access that the incision will give, for both the least traumatic removal of the gland and the safest, most accurate insertion of the implant.

Once the optimal amount of skin (with or without nipple) for the best envelope and reconstruction has been decided upon, the joint surgical objectives are:

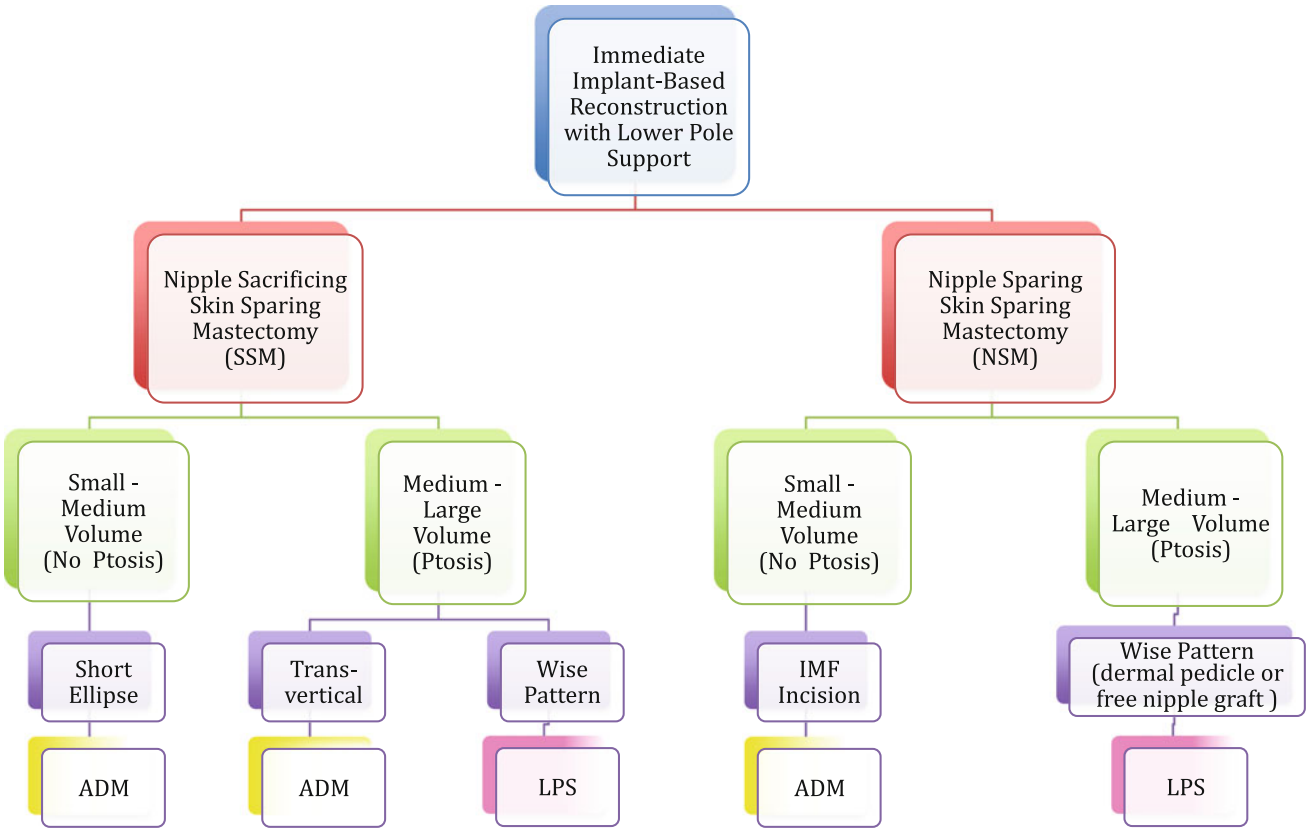

Fig. 24.2 Mastectomy and technique selection algorithm for implant-based reconstruction with lower pole support. *ADM* acellular dermal matrix, *IMF* inframammary fold, *LPS* lower pole derma sling

- To optimize oncological safety—removing all breast tissue whilst respecting the mastectomy plane and envelope landmarks
- To optimize envelope viability—not compromising the perfusion of the skin envelope.

There is no agreement, nor need there be, on the single best technique for performing skin sparing mastectomy. Some surgeons find infiltration helpful to develop the plane (with or without adrenaline). Alternatively a dry technique with direct visualization of the fascia and ligaments may be preferred. Scalpel, scissors, diathermy electrodissection, ultrasound, laser and argon all have their advocates. In selecting the technique for mastectomy, every surgeon must decide how best to reconcile the compromise among ease of dissection, speed, haemostasis and the development of complications such as seroma, haematoma and skin necrosis.

Finally, the appropriate selection of the technique and instruments to use for a specific mastectomy should be based not on a surgeon's routine preference, but after consideration of that patient's individual soft tissue characteristics and risk factors for skin necrosis (obesity, smoking status, etc.,).

24.4.2 Classification of Skin-Sparing Mastectomy with use of the ADM Technique

An algorithm for mastectomy and technique selection for implant-based reconstruction with lower pole support is show in Fig. 24.2.

24.4.2.1 Skin-Sparing Mastectomy in the Non-ptotic Breast: The Short Ellipse Incision

When the nipple is to be sacrificed, our preference is for a short ellipse including the nipple with an oblique orientation (Fig. 24.3a). The dimensions and exact orientation of the ellipse should take into account the desired final three-dimensional shape and volume of the breast. The incision may require a short 'lazy-S' lateral extension, so that it is large enough to allow safe access for mastectomy, accurate insetting of the ADM and access to the axilla if necessary. Excess skin should be excised with caution and after consideration of the characteristics of the skin envelope (elasticity, compliance, possible perfusion problems) as well as how to achieve a comfortable fit between the implant domain and the skin envelope. It is

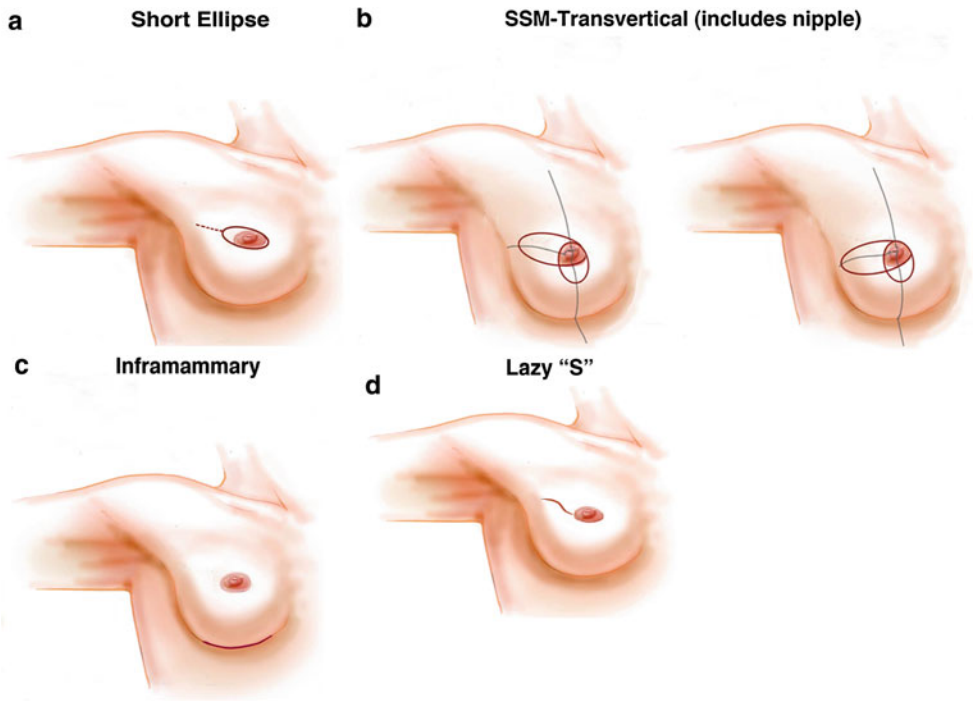

Fig. 24.3 Mastectomy incisions for use with the ADM technique: **a** short ellipse incision with or without 'lazy-S' lateral extension (skin sparing mastectomy); **b** transvertical incision (skin-reducing mastectomy); **c** inframammary incision (nipple-sparing mastectomy); **d** 'lazy-S' oblique lateral incision (nipple-sparing mastectomy)

always possible to modify and excise further if there is large skin excess when the envelope is redraped over the newly created mound. The oblique scar created is usually not conspicuous after nipple–areola reconstruction (Fig. 24.4).

24.4.2.2 Skin-Reducing Mastectomy in the Large or Ptotic Breast: The Transvertical Incision

If an ADM is to be used rather than an LPS, then our preference is for the transvertical approach (Fig. 24.3b), which combines two vectored skin excisions—the larger, horizontal one is placed lateral or oblique to the nipple–areola complex (NAC) and the shorter, vertical elliptical excision overlaps the former in the NAC area. The resultant skin envelope has a more pleasing final shape and a better positioned scar than if a longer, wider oblique or transverse ellipse is used. The transvertical approach avoids the potential ischaemia-related wound-healing problems encountered by some surgeons when using the Wise-pattern skin envelope (Figs. 24.5 and 24.6).

24.4.2.3 Nipple-Sparing Mastectomy in the Small to Moderate-Sized Breast: The Inframammary Incision

Traditional periareolar and circumareolar incisions have been shown in the best centres to have an increased risk of nipple–areola necrosis [15, 16]. Although it is possible to use an oblique orientated 'lazy-S' upper outer quadrant incision (Fig. 24.3d), our preference is for the use of an inframammary incision whenever possible (Fig. 24.3c). Although this is more technically challenging, there is less of a risk to nipple viability. The resultant access to the lower pole is ideal for the accurate insertion of the ADM and affords precise control and fixation of the IMF. It also produces a very favourable and 'hidden' scar (Figs. 24.7 and 24.8).

As mentioned earlier, the technique and instrumentation chosen for mastectomy through the IMF incision is less important than the surgeon's ability to produce a healthy, non-traumatized skin envelope and a well-perfused nipple. Where access is difficult, the use of a headlight and delicate use of retractors is essential. Great care must be taken by the surgeon and assistant to avoid mechanical crush of the lower pole skin. An endoscope may be useful in the large breast (video-assisted mastectomy) for direct visualization of the medial, superior and lateral extent of the envelope, thus minimizing retraction injury or damage to the important skin perforator vessels.

Although the risk of occult nipple involvement or future nipple disease is acceptably low, provided predictive criteria for further nipple disease are followed [17, 18], we still recommend a subareolar ductal biopsy in all cases of nipple preservation with intraoperative frozen section. This

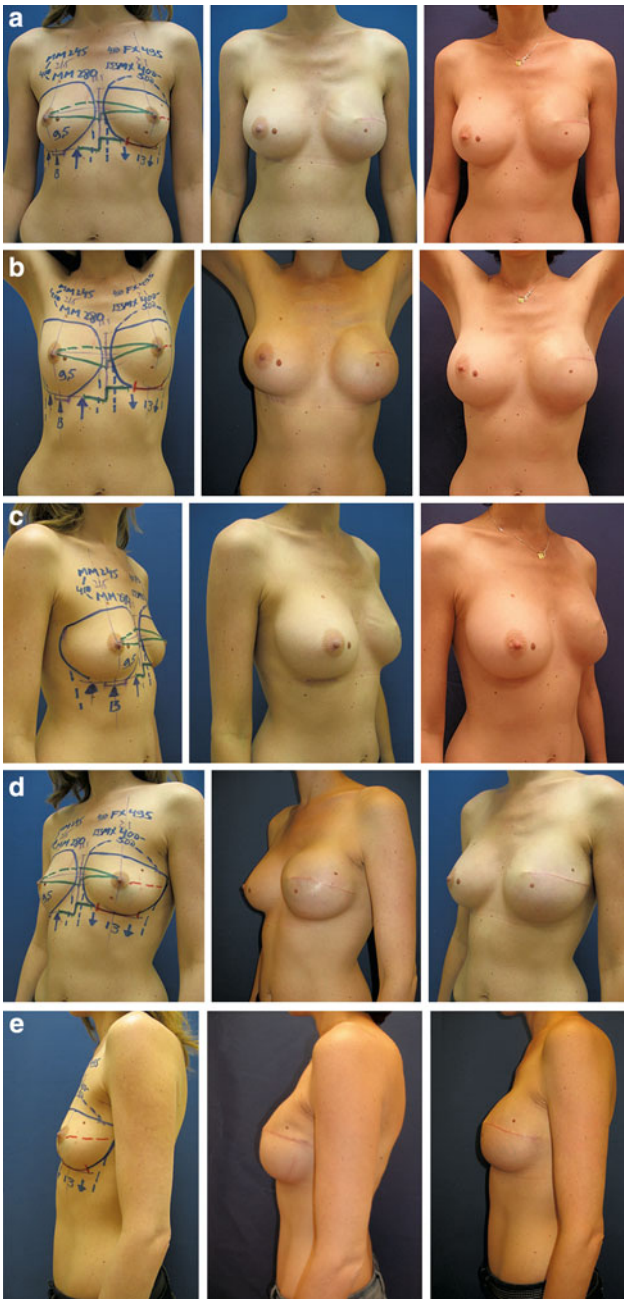

Fig. 24.4 Left skin-sparing mastectomy (270 g) with short elliptical oblique incision and two-stage reconstruction with an expander and ADM (Natrelle Style 133 MX500, Surgimend 10 cm × 15 cm) and then a definitive implant (Natrelle Style 410 MX550). Contralateral right dual-plane augmentation in the first stage (Natrelle Style 410 MM280). Preoperative and postoperative images demonstrating intermediate and final outcome following refinement with fat-grafting

requires close collaboration with an excellent histopathologist with a low false-negative rate for detecting occult disease on frozen section. Others may prefer to perform preoperative MRI, staged subareolar duct excision or subareolar vacuum-assisted biopsy prior to making a decision about the safety of nipple preservation. If the frozen section (or subsequent pathology report) demonstrates occult subareolar disease, then the nipple must be excised intraoperatively (or in a second procedure).

24.4.3 Classification of Skin-Reducing Mastectomy with the LPS Technique

An algorithm for mastectomy and technique selection for implant-based reconstruction with lower pole support is show in Fig. 24.2.

24.4.3.1 Skin-Reducing Mastectomy in the Large and Ptotic Breast: The Wise-Pattern Incision

A Wise pattern provides both excellent access for mastectomy and creates the surplus lower pole skin necessary to create the deepithelialized LPS and a natural ptosis (Fig. 24.9a). Great care must be taken to avoid tension on closure caused by excising the skin too widely, particularly at the T-junction. This can be prevented by intentionally leaving the vertical limbs 1–2 cm longer than for a standard Wise-pattern marking or wedging a skin dart into the T-junction. The vertical scar is subsequently concertinaed to below the height of the maximum projection of the breast mound (after the definitive implant volume is in place or the maximum temporary implant volume has been inserted into the expander).

The LPS is fixed internally to reinforce the IMF with interrupted absorbable sutures. This stops the IMF from drifting down under the weight of the implant; which then will rest in the dermal sling in front of the fixed IMF. A stable IMF facilitates an evolving but predictable natural ptosis (Figs. 24.10 and 24.11).

When the LPS is used, it should be remembered that unlike the relatively non-distensible ADM, the autologous LPS is stretchable. Even with a fixed IMF, one should avoid the use of excessively large implants, which may lead to 'overstretching' of the lower pole and a 'bottomed out' appearance over time.

24.4.3.2 Nipple-Sparing Mastectomy in the Ptotic Breast

A Wise-pattern skin reduction may be performed with preservation of the NAC on a superior or superior-medial dermal pedicle (Fig. 24.9b). The LPS may then be created and inset in the standard method. Nipple viability is increasingly at risk, the larger the skin envelope and the greater the elevation required to achieve its new position on the reconstructed breast mound. If more than 3–4 cm of elevation is required, and the patient wishes to keep her nipple, then a safer option is a free transplantation of the

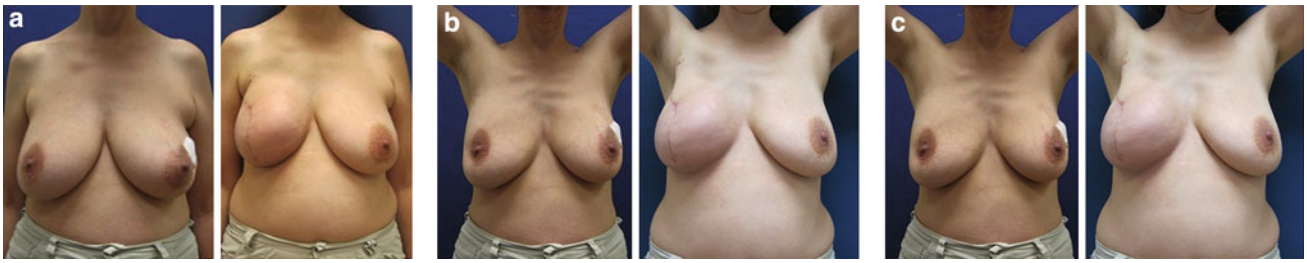

Fig. 24.5 Skin-reducing mastectomy with transvertical incision and immediate implant and ADM reconstruction (Natrelle Style 410 FX615, Surgimend 10 cm × 20 cm). Preoperative and postoperative images: a 42-year-old woman with multifocal carcinoma in the right breast (872 g)

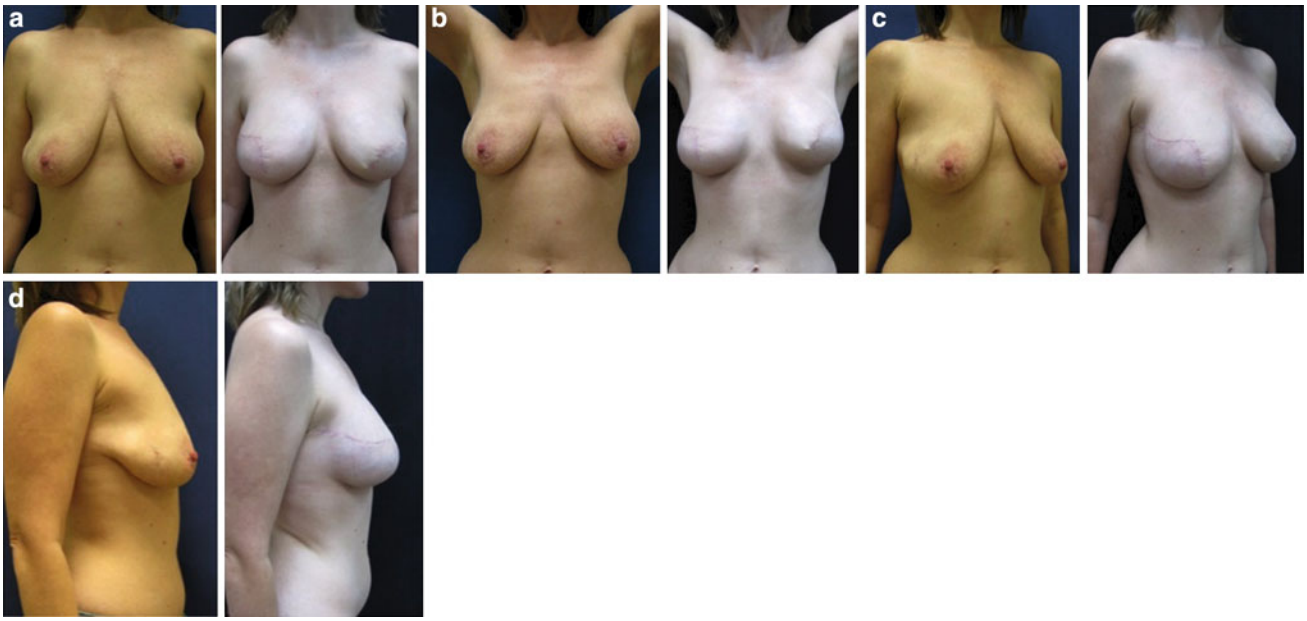

Fig. 24.6 Bilateral skin-reducing mastectomy with transvertical incisions and immediate implant and ADM reconstructions (Natrelle Style 410 FF335, Surgimend 10 cm × 15 cm). Preoperative and postoperative images: a 47-year-old, *BRCA1* gene carrier (right breast 295 g, left breast 315 g)

NAC as a full-thickness graft onto a deepithelialized recipient areolar bed. *This technique has been described for completeness of our algorithm, but should be approached with a degree of caution and should be performed only by surgeons familiar with skin-reducing mastectomy and acceptably low flap loss and other complication rates.*

24.5 Implant Selection

24.5.1 Fixed Volume Versus Variable Volume Versus Expander

In deciding whether to use a fixed-volume or a variable-volume adjustable implant, the surgeon must consider both the skin envelope and the pocket characteristics; either of these may conspire to restrict the initial volume of the device to be implanted.

24.5.1.1 Skin Envelope Tension/Viability Restricting Implant Volume

Skin envelope tension ought not to be a problem with careful preoperative planning and assessment of the tissue characteristics. However, there may be several reasons why the skin envelope may still prevent use of a definitive final fixed-volume implant:

- Previously irradiated skin (e.g. after local recurrence in the previously conserved but irradiated breast or after cancer with the need for risk-reducing mastectomy) may not initially accommodate the intended implant volume.
- If for oncological safety more skin needs to be excised at mastectomy than planned.
- The perfusion and hence viability of the skin envelope is uncertain after the mastectomy. This can be assessed more accurately using intraoperative full-field laser Doppler imaging technology (Sect. 1.7.1).

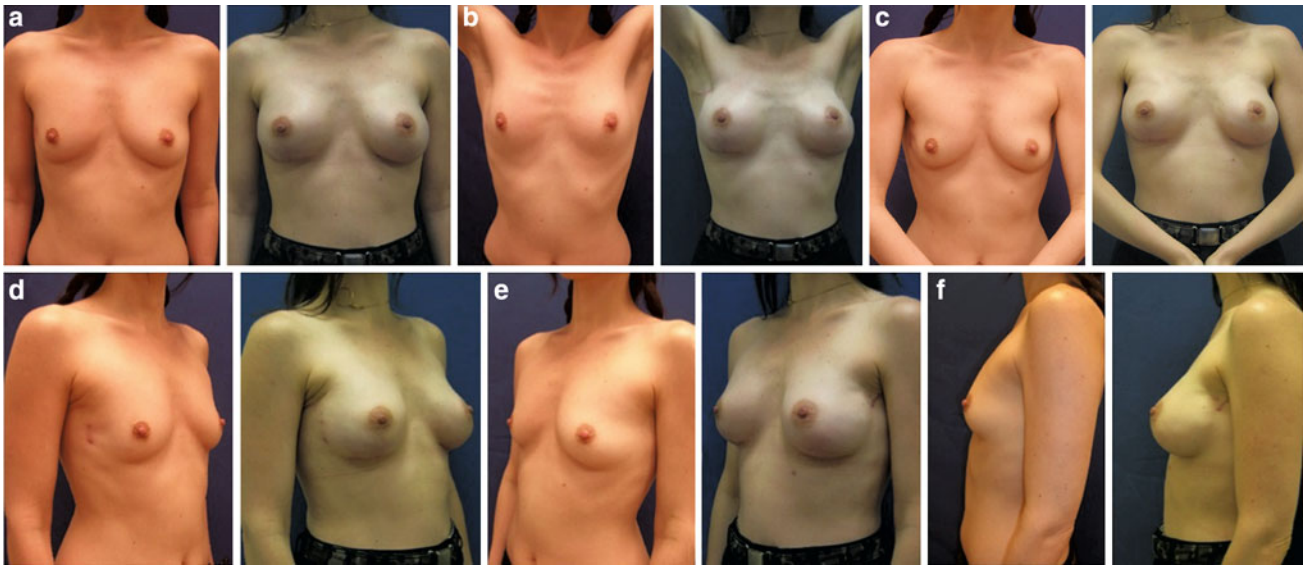

Fig. 24.7 Bilateral nipple-sparing mastectomy with inframammary incision and immediate implant and ADM reconstructions (Natrelle Style 410 MX325, Surgimend 10 cm × 15 cm). Preoperative and postoperative images: a 38-year-old, *BRCA1* gene carrier with carcinoma in the right breast (120 g) and risk-reducing mastectomy of the left breast (133 g)

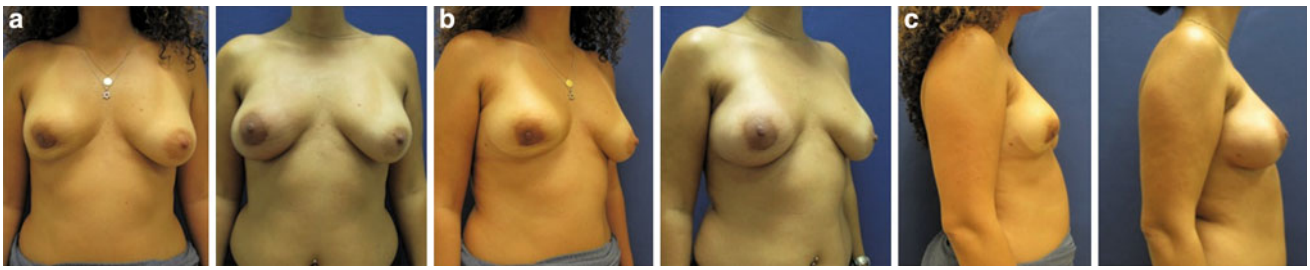

Fig. 24.8 Nipple-sparing mastectomy with inframammary incisions and immediate implant and ADM reconstructions (Natrelle Style 410 FX410, Surgimend 10 cm × 15 cm). Preoperative and postoperative images: a 35-year-old woman requiring complete right mastectomy (350 g) after incomplete excision of carcinoma (wide excision 75 g)

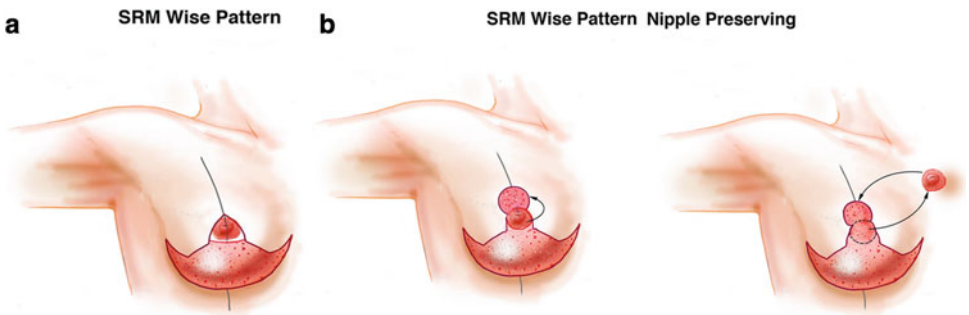

Fig. 24.9 Mastectomy incisions for use with the LPS technique: **a** Wise-pattern incision (skin-reducing mastectomy); **b** Wise-pattern incision, nipple-sparing on dermal pedicle or free graft (nipple-sparing mastectomy, skin-reducing mastectomy)

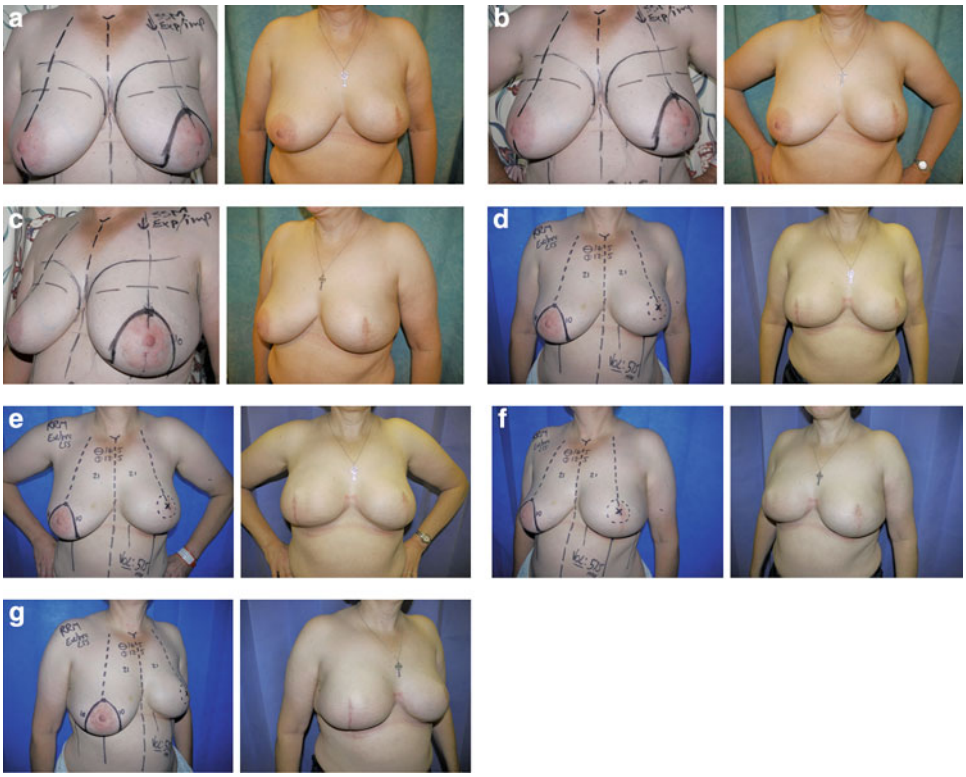

Fig. 24.10 Sequential bilateral skin-reducing mastectomy with a Wise-pattern incision and the LPS technique with adjustable-volume expander/implants (Natrelle Style 150 s—SH520). Preoperative and postoperative images: a 51-year-old woman after left mastectomy (630 g) for multifocal high-grade ductal carcinoma in situ followed by right mastectomy (675 g) for risk reduction 1 year later. Demonstration of reliability and reproducibility of outcomes

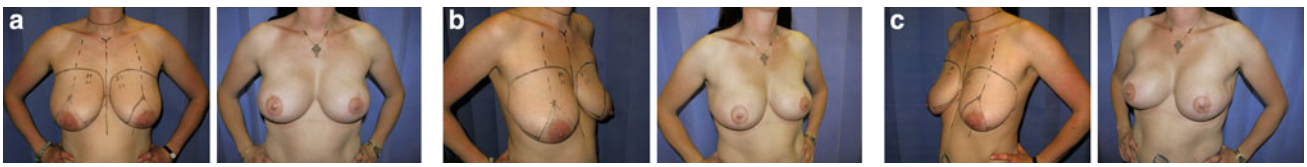

Fig. 24.11 Bilateral skin-reducing mastectomy with Wise pattern incisions and the LPS technique with adjustable-volume expander/implants (Natrelle Style 150 s—SH520). Preoperative and postoperative images: a 42-year-old *BRCA2* gene carrier undergoing bilateral risk-reducing mastectomy (right breast 610 g and left breast 595 g)

24.5.1.2 Pocket Characteristics Restricting Implant Volume

Intraoperatively, the composite pocket of the pectoralis major muscle and dermal support may also be found to prevent use of the final planned volume. Reasons for this may or may not be predictable preoperatively:

- Previously irradiated chest wall—progressive atrophic change and exaggerated fibrosis may lead to a reduced compliance of the pectoralis major muscle.
- Poor quality and adequacy of muscle.
- Traumatized or resected pectoralis major muscle following the skin-sparing mastectomy.

Use of a variable-volume device can partially overcome some of these problems. With the expander–implant devices currently available, e.g. Natrelle Style 150 (Allergan) or Becker 35 (Mentor), it may still be possible to offer a one-stage solution. Gradual expansion may then occur after the initial relaxation and healing phase as an outpatient procedure over the subsequent weeks.

In cases where it is deemed safer to have a minimal initial volume in the pocket (or to have the ability to completely remove any tension from the soft tissues if skin envelope viability is threatened), then a shaped tissue expander, such as the Natrelle Style 133 (Allergan), may be

used. Second-stage exchange to a permanent fixed-volume device would occur only once final expansion and the desired volume are settled upon.

24.5.2 Implant Selection/Dimension Assessment

24.5.2.1 Base Width

The defining dimension for a natural breast shape is the base width. The desired breast width may be assessed preoperatively in discussions with the patient and with demonstration of likely positions of cleavage medially and breast contour laterally. If allowance is made for overlying soft tissue, the estimated base width of the implantable device is approximately 1.0–1.5 cm (the average soft tissue pinch thickness) less than the desired breast width.

Intraoperatively, the final base width of the device can be measured more accurately by direct measurement of the pocket created. The author prefers to have a range of base widths available above and below the predicted preoperative implant width.

24.5.2.2 Implant Height

With the available matrices of shaped anatomical devices, there is a choice of available implant heights for any given base width. The implant height selected must take into account the preoperative biodimensional assessment of the patient's chest wall. An implant with greater height than the natural breast base height may prevent a 'step off' deformity in situations where excess chest wall subcutaneous tissue has been excised beyond the visible upper pole of the breast owing to an overenthusiastic mastectomy. The final height of the pocket can be rechecked intraoperatively before the final implant selection is made.

24.6 ADM-Based Lower Pole Support: Technical Points

24.6.1 ADM Insertion

After mastectomy, the pectoralis major muscle is divided from its origin inferiorly and medially (3 or 9 o'clock position, respectively). Posterolaterally, the pectoralis major muscle is freed from underlying pectoralis minor muscle (Fig. 24.12).

Depending on the choice of ADM, it may need to be cut to an appropriate curved shape. Our preference is for a semioval sheet of SurgiMend, a terminally sterilized bovine-derived ADM, which is fenestrated and measures 15 cm × 10 cm. It is large enough to provide lower pole support to most of the commonly used implant base widths. Additional sizes are available to accommodate patients as needed.

A common practice is hydration of ADMs in antibiotic cocktails as an added measure against microbial contaminants originating from the patient's skin or nipple. There are no studies to date evaluating whether this practice reduces complications. Immersion of ADMs in disinfecting agents (povidone-iodide, chlorhexidine, etc.) should be avoided as some such agents may concentrate in the ADMs and lead to chemical cytotoxicity. ADMs should be soaked in room-temperature fluids; hot saline from a warming oven can denature native dermal collagen and lead to a foreign body response and rejection. Many ADMs are supplied sterile, whereas some are aseptically processed and packaged with antibiotics that must be rinsed from the ADM by multiple saline soaks prior to use. This is to avoid the potential for 'red breast syndrome' or hypersensitivity reactions to antibiotics.

The superior edge of the ADM is sutured from medial to lateral, superiorly to the cut end of the muscle, using an absorbable, interrupted, and braided suture. Care should be taken to firmly anchor the material medially and to define the important medial IMF/cleavage area. The ADM must not be pulled too tight, but should be held gently to allow it to find its own tension-free position that best accommodates the lower ventral curvature of the implant. Once the ADM has been fixed medially, the use of an appropriate anatomical sizer in the developing pocket will allow more precise positioning and fixation of the ADM so it may fit 'like a hand in a glove' over the selected implant without wrinkling or pleating. Once the definitive sizer or implant is in position, the lateral most cut end of the pectoralis major muscle should be wedged downwards into a slit made in the ADM. This will put the muscle under moderate tension in a way that will prevent upwards 'window-shading' of the muscle.

24.6.2 LMF Definition

The ADM is then fixed laterally to the interface of the fascia over serratus anterior muscle. Even if the mastectomy has progressed beyond the intended LMF, the ADM should be fixed in a way that defines the lateral border of the intended internal domain and allows the lateral skin envelope to be draped comfortably over it. Lateral trimming of the ADM may be necessary if there is excess material. If the ADM is of insufficient width, then a composite ADM may be created with additional material as a full lateral patch. We have also had excellent uncomplicated results using separate strips of material to act as a lateral buttress.

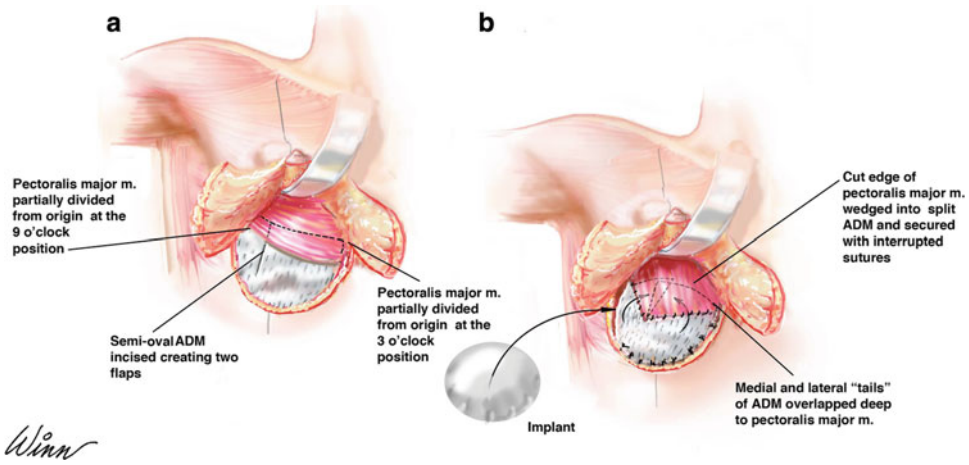

Fig. 24.12 ADM technique: technical points

24.6.3 IMF Definition

Lateral and medial fixation sutures are accurately inserted from the lower border of the ADM to the fascial condensation of the IMF. If the IMF has been breached or stretched during mastectomy, then the IMF can be reconstituted with these sutures.

24.6.4 Insertion of Definitive Implant Device

Depending on the mastectomy incision, the implant is inserted into the pocket via the most convenient route; either over the superior border of the ADM or under the inferior or lateral border. After removal of the sizer implant and insertion of drain(s), standard 'minimal handling' precautions are employed before the implant is inserted. Our preference is to insert the inferior (or superior) sutures accurately but without tying. Implant insertion under a curved retractor is then straightforward, and the final sutures may be tied with less risk of 'cutting out', which otherwise requires difficult, and potentially hazardous resuturing, in the presence of the implant.

24.7 Autologous LPS: Technical Points

24.7.1 Pocket Dissection

In contrast to the ADM technique, when using the autologous LPS, there is unlikely to be sufficient dermal material to support the implant laterally. For accurate lateral definition we use a sub-serratus anterior extension of the muscular pocket. The inferior division of the pectoralis origin is continued laterally in a horizontal line to the required pocket width through the fascia and costal digitations of the serratus anterior. The subserratus pocket is developed gradually upwards from the cut edge until the lateral pocket opens up to join the subpectoral dissection (Fig. 24.13).

Great care must be taken to elevate serratus digitations from the lateral ribs without breaching the intercostal musculature underneath or the often-flimsy serratus muscle at the lateral pectoral margin. If the serratus layer is attenuated, then a small lateral portion of adjacent pectoralis minor muscle maybe freed and transposed to reinforce the serratus layer ('lateral pectoral slide manoeuvre'). The reward for meticulous dissection laterally is a precise muscular pocket that will hold the entire upper portion of the implant and control the lateral border of the prosthesis without the need for lateral sutures. The lower cut border of the muscular pocket is then easily sutured to the dermal sling, with either a continuous suture or interrupted sutures, over the definitive implant or sizer.

24.7.2 The IMF

Even if the IMF is left intact after mastectomy, it is often stretched and somewhat displaced on the chest wall. It should be routinely reinforced at the desired position using interrupted absorbable sutures. This will prevent it from drifting inferiorly under the weight of the implant. When the implant is in position on the LPS, it is actually sitting in front of the newly fixed IMF. This facilitates an evolving natural ptosis on a stable IMF.

24.7.3 The 'Medial Corner'

When the LPS is used, there may be occasions when the dermal sling is deficient medially. The pectoralis major origin should still be divided in the same way as when using an ADM, but in this scenario it may not be possible to

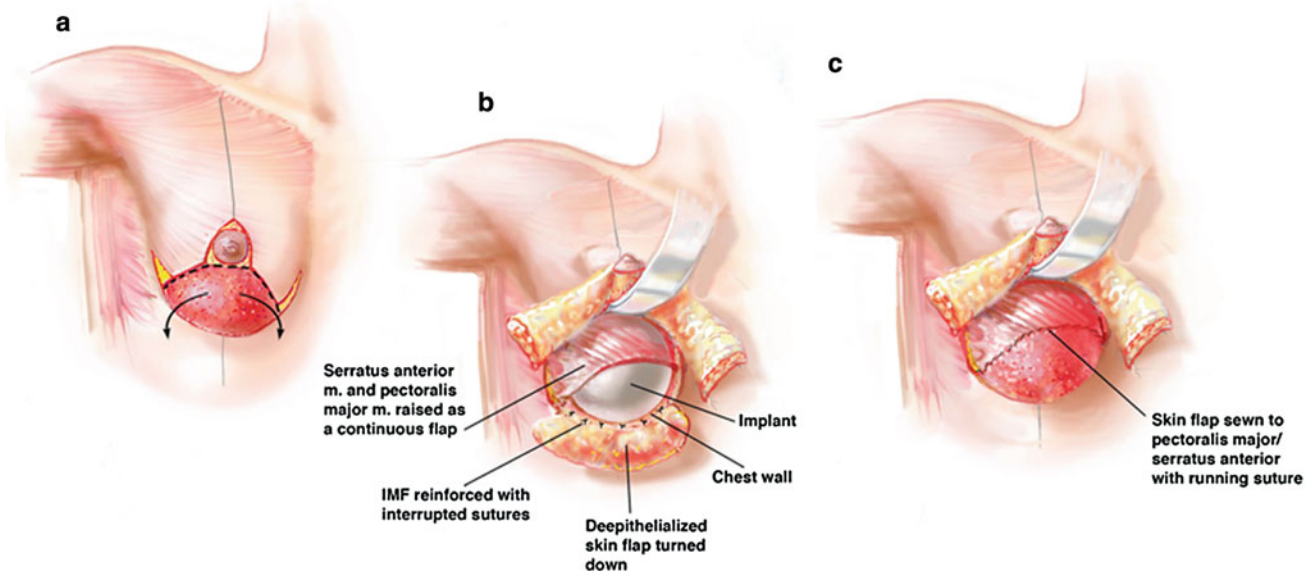

Fig. 24.13 LPS technique: technical points

oppose muscle to dermal sling over the implant in the medial corner of the pocket. In our experience, leaving the pocket open medially has not led to any complications, but our preference is still to use an ADM patch if there is any risk whatsoever of the implant lying immediately under the wound.

24.8 Minimizing Complications

As ADM use increases and newer materials become available, there is a growing body of literature to support safety and acceptable complication rates with the use of ADMs in implant reconstruction [19–25].

Some of the published meta-analyses however have shown increased rates of infection, seroma, haematoma and explantation compared with control subpectoral implant reconstructions [26, 27]. It is unsurprising that complications are commoner in patients who go on to have adjuvant chemotherapy and/or radiotherapy [28]. Other meta-analyses have not shown significant differences in complication rates compared with other methods of implant reconstruction and seem to concur with our assumption that this technique confers significant benefits in terms of cosmesis, reduced expander times, number of maintenance surgical procedures and a reduced overall time to completion of reconstruction [29, 30].

In our experience, although aesthetic results remain unquestionably better, complication rates when using lower pole support are comparable with standard subpectoral pocket based implant reconstructions for prolonged seroma, haematoma, implant infection, implant loss or device-related problems (rotation, rippling, edge palpability, port flipping or device failure). Our infective complications and implant loss occurred exclusively in the presence of seromas and skin necrosis or in a small proportion of those patients who had adjuvant chemotherapy, radiotherapy or both (Tables 24.3 and 24.4).

24.8.1 Skin Envelope Necrosis

To optimize perfusion and minimize the risk of skin envelope necrosis requires adherence to all of the technical points discussed so far. Excellent mastectomy technique requires careful patient assessment, accurate incision planning, meticulous tissue handling and tension-free draping and closure.

If the reconstructive team involves a general surgeon and a separate reconstructive surgeon, then close cooperation, joint planning and an agreed strategy are essential. Good communication with the anaesthetic team throughout the procedure is also important. To optimize skin perfusion, it is essential to ensure adequately monitored and stable haemodynamics as well as core temperature.

If, despite the best efforts, the skin envelope viability remains uncertain, then further intraoperative monitoring of skin perfusion can help inform decision-making regarding the need for further skin excision or whether to use a variable-volume device. Different strategies may be employed to assess skin envelope perfusion; intraoperative temperature or oximetry probes may not be reliable enough by the time an intraoperative decision has to be made and optical near-infrared spectroscopy, although a promising method for assessing global perfusion of skin flaps [31], is not yet

Table 24.3 Combined author's experience of implant breast reconstruction with lower pole support 2007–2011

	ADM experience (Surgimend), 341 immediate implant reconstructions, March 2001–July 2011 (Tel Aviv, Israel)	LPS experience, 102 immediate implant reconstructions, January 2007–January 2012 (Cornwall, UK)
Total skin-sparing mastectomy	341	102
Bilateral skin-sparing mastectomy	262 (131 patients)	50 (25 patients)
Unilateral skin-sparing mastectomy	79	52
Direct to implant (1-stage)	270	90
Tissue expander (2-stage)	71	12
Total radiotherapy	57	12
Preoperative radiotherapy	32 (9.4 %)	4 (3.9 %)
Postoperative radiotherapy	25 (7.3 %)	8 (7.8 %)
Total chemotherapy	62	10
Preoperative chemotherapy	43 (12.6 %)	0
Postoperative chemotherapy	19 (5.6 %)	10 (9.8 %)

LPS lower pole dermal sling

Table 24.4 Complications after implant-based reconstructions with lower pole support 2007–2011

	ADM experience (Surgimend), 341 immediate implant reconstructions, March 2001–July 2011 (Tel Aviv, Israel)	LPS experience, 102 immediate implant reconstructions, January 2007–January 2012 (Cornwall, UK)
Skin flap necrosis	18 (5.2 %)	10 (9.8 %)
Necrosis and infection	7 (2.0 %)	1 (1.0 %)
Infection (no necrosis)	1 (0.3 %)	4 (3.9 %) all after chemotherapy
Haematoma	7 (2.0 %)	5 (4.9 %)
Seroma	9 (2.6 %)	4 (3.9 %)
Failure (implant loss)	6 (1.75 %)	4 (3.9 %) all after chemotherapy
Capsule (grade 3–4)	7 (2.0 %) all after radiotherapy (7/57 = 12.3 % radiotherapy cases)	4 (3.9 %) all after radiotherapy (4/12 = 33.3 % radiotherapy cases)
Rotation	1 (0.3 %)	1 (1.0 %)

commercially available. Our preference is to use intraoperative full-field laser Doppler imaging technology to assess skin perfusion and viability. The laser signal illuminates an area of 7 cm × 7 cm of the skin envelope and is transmitted to a depth of up to 2 mm. The frequency shift caused by laser interaction with circulating red blood cells is used to calculate concentration, average speed and perfusion of the skin flaps, which is then displayed as a real-time perfusion colour map on the monitor. Poorly perfused skin should be excised.

If the planned closure with a fixed-volume prosthesis is no longer possible, or the tension is likely to be too great, then we recommend use of an adjustable-volume implant or expander.

24.8.2 Capsular Contracture

To some extent capsule formation is an inevitable consequence of implantation. Symptomatic and troublesome capsular contracture requiring intervention however can be minimized by adherence to recognized precautions—such as careful tissue handling and haemostasis, strict asepsis, the choice of ADM and the best-quality prosthesis.

Reducing capsular contracture risk still further demands the optimal balance and minimal tension between soft tissues, skin and the internal domain. The use of an ADM or LPS creates a less inflammatory, stabler internal domain, and in our experience this is an important reason why we continue to see evidence of reduced capsular contracture

rates with lower pole dermal support. Some of the recent meta-analyses and reviews of the early-published experience with ADMs appear to bear this out [32, 33].

24.8.3 Capsular Contracture Secondary to Radiotherapy

Whether radiotherapy is unexpectedly recommended after mastectomy and reconstruction (despite preoperative planning to the contrary) or a patient chooses to have an implant-based reconstruction with the knowledge that radiotherapy is to come, there is an inevitable increased risk of aesthetic compromise [34–36].

It is this that has led some to advocate avoidance of a definitive implant-based reconstruction in the face of radiotherapy, in favour of either delayed autologous reconstruction or a delayed–immediate reconstructive approach with temporary expanders during radiotherapy [37, 38]. Expansion during or after radiotherapy, even as part of a two-stage strategy, is not effective on its own to minimize radiation-induced aesthetic compromise [39].

Modern, individualized radiotherapy planning can go some way to ameliorating the unwanted effects of radiotherapy on the reconstructed breast; use of the three-dimensional treatment planning system for exact dose calculation, hyperfractionation of dose schedules and avoidance of specific skin boluses are all important advances in radiotherapy administration. A patient-specific approach to the intended treatment target, with particular attention to dose depth from the skin, assessment of surgical margins and a better understanding of tumour biology, has led to improvements in our implant-based reconstruction outcomes.

Use of lower dermal support seems to also improve outcomes in irradiated reconstructions. We believe this to be related, once again, to having established a better cushioning, padding, perfusion and harmony between soft tissues and a stable internal domain, as well as careful optimization of the health of the overlying skin envelope. Lower dermal support minimizes the tension within and exerted by the internal domain on the skin envelope. This ensures the best possible perfusion of skin and soft tissues in preparation for the radiotherapy. There is good evidence for enhanced fibroproliferation with radiotherapy in the presence of implants, and some important signalling pathways have been identified [40]. We hypothesize that in addition to this, collapsed small vessels (due to extra tension in skin, muscle and the developing capsule) may be more susceptible to radiotherapy-induced vasculitis, and hence subsequent fibrosis, than if the microcirculation is kept optimally perfused by minimizing tension within the soft tissues.

24.8.4 Acute and Chronic Pain

The reduced tension and stability of a subpectoral and ADM/LPS pocket, as compared with a full submuscular pocket, should lead to less immediate postoperative pain on early pectoral movement. There is the potential for increased discomfort from the subserratus lateral pocket dissection in the LPS technique and care must be taken not to traumatize underlying costal periosteum. The use of intercostal blocks and other regional local anaesthetic techniques can improve acute pain in the initial postoperative period.

As discussed earlier, the use of lower pole support techniques, specifically an ADM, seems to reduce the incidence of capsular contracture. We believe that this may then in turn lead to a reduction in development of chronic pain.

24.9 Refining Long-Term Results

Injection of autologous fat may be very effective as a secondary adjunct to improve outcomes in breast reconstruction generally [41] and in implant-based reconstructions specifically [42] by:

- Creating a more natural cleavage and upper pole take-off
- Smoothing out and filling uneven areas of the skin envelope where mastectomy flaps may have been taken too thin
- Improving contour/shape and transitional area irregularities
- Covering thin areas where there may be implant rippling or edge palpability
- Reducing radiotherapy-induced skin change and fibrous capsule formation.

The attendant risk to the underlying implant is small, but if soft tissues are thin and there is a significant risk of inadvertent intracapsular fat injection, simultaneous exchange for a new prosthesis may be appropriate.

Three-dimensional imaging (e.g. Vectra system) will demonstrate (and quantify) contour and volume discrepancies. Better objective and quantitative assessment can improve the quality of consultations and allow accurate planning for fat grafting refinement procedures.

References

1. Salgrello M, Seccia A, Eugenio F (2004) Immediate breast reconstruction with anatomical permanent expandable implants after skin-sparing mastectomy: aesthetic and technical refinements. Ann Plast Surg 52:358

2. Spear SL (1998) Editorial comment. Adjustable implant reconstruction. In: Spear SL (ed) Surgery of the breast: principles and art. Lippincott-Raven, Philadelphia, pp 373–374
3. Eskenazi LB (2007) New options for immediate reconstruction: achieving optimal results with adjustable implants in a single stage. Plast Reconstr Surg 119:28–37
4. Gui GP, Tan SM, Faliakou EC et al (2003) Immediate breast reconstruction using biodimensional anatomical permanent expander implants: a prospective analysis of outcome and patient satisfaction. Plast Reconstr Surg 111:125–138; discussion 139–140
5. Hudson DA, Skoll PJ (2002) Complete one-stage immediate breast reconstruction with prosthesis material in patients with large or ptotic breasts. Plast Reconstr Surg 110:487
6. Bayram Y, Kulachi Y, Igril C et al (2010) Skin-reducing subcutaneous mastectomy using a dermal barrier flap and immediate breast reconstruction with an implant: a new surgical design for reconstruction of early-stage breast cancer. Aesthetic Plast Surg 34:71–77
7. Scott HC, Sumer D (2003) Skin-sparing mastectomy flap complications after breast reconstruction: review of incidence, management and outcome. Ann Plast Surg 50:249–255; discussion 255
8. Carlson GW, Styblo TM, Lyles RH et al (2003) The use of skin-sparing mastectomy in the treatment of breast cancer: the Emory experience. Surg Oncol 12:265–269
9. Davies K, Allan L, Ross D et al (2010) Factors affecting post-operative complications following skin-sparing mastectomy with immediate breast reconstruction. Breast 20:21–25
10. Beer GM, Varga Z, Budi S et al (2002) Incidence of superficial fascia and its relevance in skin-sparing mastectomy. Cancer 94:1619–1625
11. Seltzer V (1994) The Breast: embryology, development and anatomy. Clin Obstet Gynecol 37:879–880
12. Ho CM, Mak CK, Lau Y et al (2003) Skin involvement in invasive breast carcinoma: safety of skin-sparing mastectomy. Ann Surg Oncol 10:102–107
13. Barton FE Jr, English JM, Kingsley WB et al (1991) Glandular excision in total glandular mastectomy and modified radical mastectomy: a comparison. Plast Reconstr Surg 88(3):389–392; discussion 393–394
14. Carlson GW, Grossl N, Leweis MM et al (1996) Preservation of the inframammary fold: what are we leaving behind? Plast Reconstr Surg 98:447–450
15. AlgaithyZK Petit JY, Lohsiriwat V et al (2012) Nipple sparing mastectomy: can we predict the factors predisposing to necrosis? EJSO 38:125–129
16. Garwood ER, Moore D, Ewing C et al (2009) Total skin-sparing mastectomy: complications and local recurrence rates in 2 cohorts of patients. Ann Surg 249:26–32
17. Garcia-Etienne CA, Cody HS III, Disa JJ et al (2009) Nipple-sparing mastectomy: initial experience at Memorial Sloan-Kettering Cancer Center and a comprehensive review of the literature. Breast J 15:440–449
18. Rusby JE, Smith BL, Gui GPH (2009) Nipple-sparing mastectomy. Br J Surg 97:305–316
19. Antony AK, McCarthy CM, Cordeiro PG et al (2010) Human dermis implantation in 153 immediate two-stage tissue expander breast reconstructions: determining the incidence and significant predictors of complications. Plast Reconstr Surg 125:1606–1614
20. Chun YS, Verma K, Rosen H et al (2010) Implant-based breast reconstruction using acellular dermal matrix and the risk of postoperative complications. Plast Reconstr Surg 125:429–436
21. Lanier ST, Wang ED, Chen JJ et al (2010) The effect of acellular dermal matrix use on complication rates in tissue expander/implant breast reconstruction. Ann Plast Surg 64:674–678
22. Liu AS, Kao H, Reish RG et al (2010) Post-operative complications in prosthesis-based breast reconstruction using acellular dermal matrix. Plast Surg Adv. doi:10.1097/PRS.0b013e31820cf233
23. Nahabedian MY (2009) AlloDerm performance in the setting of prosthetic breast surgery, infection, and irradiation. Plast Reconstr Surg 124:1743–1753
24. Rawlini V, Buck DW, Heyer K et al (2010) Tissue expander breast reconstruction using prehydrated human acellular dermis. Plast Reconstr Surg 125:1–10
25. Spear SL, Parikh PM, Reisin E et al (2008) Acellular dermis-assisted breast reconstruction. Aesthetic Plast Surg 32:418–425
26. Hoppe IC, Yueh JH, Wei CH et al (2011) Complications following expander/implant breast reconstruction utilizing acellular dermal matrix: a systematic review and meta-analysis. E-plasty.com 11:417–428
27. Newman MI, Swartz KA, Samson MC et al (2011) The true incidence of near-term postoperative complications in prosthetic breast reconstruction utilizing human acellular dermal matrices: a meta-analysis. Aesthetic Plast Surg 35:100–106
28. Adetayo OA, Salcedo SE, Bahjri K et al (2011) A meta-analysis of outcomes using acellular dermal matrix in breast and abdominal wall reconstructions: event rates and risk factors predictive of complications. Ann Plast Surg [E-pub ahead of print]
29. Sbitany H, Serletti JM (2011) Acellular dermis–assisted prosthetic breast reconstruction: a systematic and critical review of efficacy and associated morbidity. Plast Reconstr Surg 128:1162–1169
30. Sbitany H, Langstein HN (2011) Acellular dermal matrix in primary breast reconstruction. Aesthetic Surg J 31:30S–37S
31. Payette JR, Kohlenberg E, Leonardi L et al (2005) Assessment of skin flaps using optically based methods for measuring blood flow and oxygenation. Plast Reconstr Surg 115:539–546
32. Jansen LA, Macadam SA (2011) The use of Alloderm in postmastectomy alloplastic breast reconstruction: part I: a systematic review. Plast Reconstr Surg 127:2232–2244
33. Kim JYS, Davila AA, Persing S et al (2011) A meta-analysis of human acellular dermis and submuscular tissue expander breast reconstruction. Plast Reconstr Surg 129:28–41
34. Evans GR, Schusterman MA, Kroll SS et al (1995) Reconstruction and the radiated breast: is there a role for implants? Plast Reconstr Surg 96:1111–1115; discussion, 1116–1118
35. Behranwala KA, Dua RS, Ross GM et al (2006) The influence of radiotherapy on capsule formation and aesthetic outcome after immediate breast reconstruction using biodimensional anatomical expander implants. J Plast Reconstr Aesthetic Surg 59:1043–1051
36. Whitfield GA, Horan G, Irwin MS et al (2009) Incidence of severe capsular contracture following implant-based immediate breast reconstruction with or without postoperative chest wall radiotherapy using 40 Gray in 15 fractions. Radiother Oncol 90:141–147
37. Kronowitz SJ, Robb GL (2009).Radiation therapy and breast reconstruction: a critical review of the literature. Plast Reconstr Surg 124:395–408. Review
38. Kronowitz SJ (2010) Delayed-immediate breast reconstruction: technical and timing considerations. Plast Reconstr Surg 125:463–474
39. Nava MB, Pennati AE, Lozza L et al (2011) Outcome of different timings of radiotherapy in implant-based breast reconstructions. Plast Reconstr Surg 128:353–359
40. Lipa JE, Qiu W, Huang N et al (2010) Pathogenesis of radiation-induced capsular contracture in tissue expander and implant breast reconstruction. Plast Reconstr Surg 125:437–445

41. Losken A, Pinelli XA, Sikoro K et al (2011) Autologous fat grafting in secondary breast reconstruction. Ann Plast Surg 66: 518–522
42. Serra-Renom JM, Munoz-Olmo JL, Serra-Mestre JM (2010) Fat grafting in postmastectomy breast reconstruction with expanders and prostheses in patients who have received radiotherapy: formation of new subcutaneous tissue. Plast Reconstr Surg 125: 12–18
43. Maxwell GP, Gabriel A (2010) Bioprosthetic materials for plastic surgery of the breast. In: Spear SL et al (eds) Surgery of the breast: principles and art. Lippincott Williams & Wilkins, Philadelphia, pp 1488–1494
44. Moyer HR, Losken A (2009) The science behind tissue biologics. Plastic Surgery News 3(4)

Nipple-Sparing Mastectomy with Electron Intraoperative Radiotherapy

25

Jean Yves Petit, Stefano Martella, and Visnu Lohsiriwat

25.1 Introduction

Despite the proved efficacy and safety of breast conservative treatment [1, 2], mastectomy remains indicated in approximately 20–30 % of new primary breast cancer cases. In our institute, mastectomy rates increased from 23 to 28 % during the last 10 years. The increased use of magnetic resonance imaging (MRI) explains the increased rate of mastectomies when doubt about multicentric tumour exists on MRI. Nipple-sparing mastectomy (NSM) with immediate reconstruction can be proposed provided there is no clinical involvement of the nipple–areola complex (NAC) [3, 4]. Today, NSM has an important place in the treatment of breast cancer. The psychological benefits of breast reconstruction after mastectomy have been assessed for a long time by many authors [5–7]. Positive psychological results of NSM have been underlined [8–10]. There are ongoing discussions concerning the surgical technique, the indications for intraoperative radiotherapy on the NAC and the type of reconstruction. Complications of NSM are well studied and there is no conflicting debate. Skin necrosis occurs in 5–10 % of cases and depends more on the surgical glandular removal than on the additional electron intraoperative radiotherapy (ELIOT) [11]. Discussion of the technique is important to improve the glandular dissection and the quality of the tumour removal: the thinner the skin flaps, the more complete the glandular resection, the higher the risk of skin and NAC necrosis. The main concern with NSM indications is cancer safety and the risk of local recurrences.

Our inclusion criteria are the absence of nipple retraction or bloody discharge and the absence of retroareolar microcalcifications. Multifocality is not a reason for exclusion, provided that all tumour sites are distant from the areola. Invasive carcinomas and ductal carcinoma in situ are included.

We describe our technique and experience.

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25.2 Surgical Technique

25.2.1 Mastectomy Technique

The mastectomy skin incisions are designed according to the tumour location and, in prophylactic mastectomy, according to the preferences of the patient and the surgeon. We categorize our incision into four types: (1) superolateral radial incision (2) inferolateral radial incision (3) superior circumareolar incision and (4) periareolar incision (Fig. 25.1). The superolateral radial incision was the preferred choice for most tumours except for lower external quadrant tumours, where the inferolateral radial incision was chosen. The superior circumareolar incision is drawn in a curvilinear shape distant from the areola and usually lies over the tumour site. The periareolar incision lies exactly at the junction between the areola and the breast skin. It is not used when the NAC circumference is small to avoid devascularization of the NAC. In all mastectomies for cancer, a small patch of skin was removed with an incision. The total mammary gland removal is performed by sharp dissection using a surgical blade or a diathermy knife or combined methods [12]. (Fig. 25.2) The glandular tissue is dissected underneath the dermis, leaving a thin layer of 3–5 mm of fat tissue to preserve the subdermal vessels. The risk of skin necrosis, especially on the NAC, is related to the thickness of the dermal flaps and to the type of skin incision in the case of a large breast [12]. The retroareolar histological features are checked by frozen section, and when the specimen is free of tumour, the NAC can be preserved.

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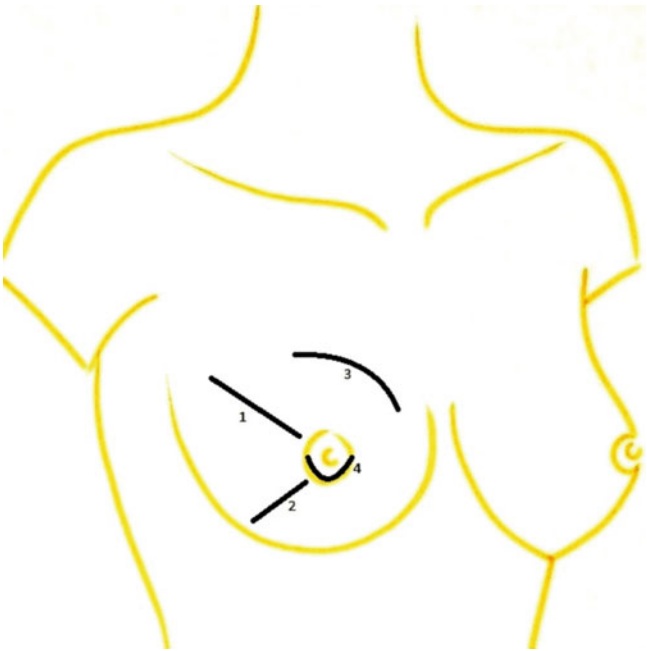

Fig. 25.1 Skin incision

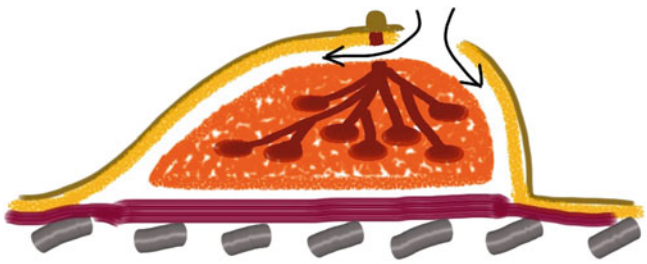

Fig. 25.2 Glandular dissection

Breast surgeons who are not trained in plastic surgery usually focus on removing radically the breast tissue more than on preserving the blood supply of the skin flaps. The limit between the breast tissue and the dermis is not well defined and the gland is closely connected by the "Duret creasts" to the dermis. Such anatomic connections make the dissection of the gland and the prevention of the blood supply of the cutaneous flaps difficult. The risk of flap necrosis is related to the preservation of the subdermal vessel network and the length of the flaps [13]. The gland is removed down to the pectoral fascia, which is preserved in around half of patients. The specimen is sent to the pathologist with stitches to mark the retroareolar area and on the axillary tail of the gland. A separate slice of glandular tissue taken from the retroareolar area is sent to the pathologist for frozen examination.

All patients with N0 cancer undergo sentinel lymph node biopsy, and if the findings are positive, axillary dissection is conducted. Node-positive patients undergo an axillary node dissection.

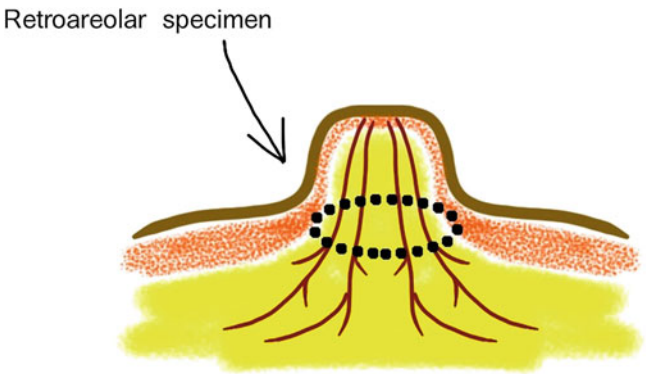

Fig. 25.3 Retroareolar specimen sampling

25.2.2 Pathological Intraoperative Examination

The retroareolar specimen is cored out from underneath the nipple (Fig. 25.3). The tumour site of the retroareolar specimen is inked and sent to the pathologist for frozen-section examination. The minimum of 5-mm thickness is required behind the areola to reduce the risk of NAC necrosis [12]. The confirmation of negative findings is required to complete preservation of the NAC and conduct the ELIOT procedure.

Artefacts caused by freezing may reduce the reliability of analysis of frozen sections of epithelial cells of the ducts. Invasive carcinoma or ductal carcinoma in situ and subtle cellular or architectural abnormalities might be more difficult to assess in frozen sections than in definitive sections. Lohsiriwat et al. [14] showed that the frozen section of subnipple tissue has specificity of 96.6, sensitivity of 88.2 and accuracy of 93.5 %, whereas Benediktsson and Perbeck [15] found specificity of 98.5 %. Some authors have proposed a histological retroareolar evaluation before the mastectomy by a surgical biopsy or by a mammotome in place of the traditional frozen section [16–18]. In our experience, we observed 8.2 % false-negative results [11].

25.2.3 ELIOT Technique

At the European Institute of Oncology, one electron beam shot is delivered by a linear accelerator in all patients in whom the NAC was preserved. Our protocol includes ELIOT on the NAC according to the linear-quadratic model (with an α/β ratio of 4 for breast cancer) equivalent to a fractionated dose ranging from 40 to 45 Gy. The clinical target volume, fully encompassed by the collimator, is the diameter of the areola plus a 1-cm margin around it. The entire target is included in the 90 % isodose [11, 19–21]. The lead disk and aluminium disk are positioned beneath the NAC and on the surface of the pectoralis major muscle to prevent muscular and chest wall

Fig. 25.4 Intraoperative radiotherapy setting

irradiation before delivering ELIOT. The radiologist and physical technician provide ELIOT in the operating theatre. However, irradiation of the NAC is postponed or cancelled if the blood supply after the subcutaneous mastectomy is critical (Fig. 25.4).

25.2.4 Reconstruction Technique

The plastic surgeon is called upon immediately to reconstruct the breast using one of the techniques adapted to the particular case: definitive implant, expander or musculocutaneous flaps. At the European Institute of Oncology, definitive one-step implant is the main procedure for total breast reconstruction if feasible and provides good results especially in the case of small or nonptotic breasts. (Figs. 25.5, 25.6) Surgeons aim for total submuscular coverage by creating a pocket under the pectoralis major muscle, pectoral fascia and serratus anterior muscle. To obtain a natural ptosis, the reconstruction can be performed with an autologous flap. (latissimus dorsi or transverse rectus abdominis myocutaneous flaps) The deepithelialized flap provides a live implant, avoiding the risk of contracture. The use of alloplastic material can also improve the natural shape and ptosis. The risk of reconstruction failure

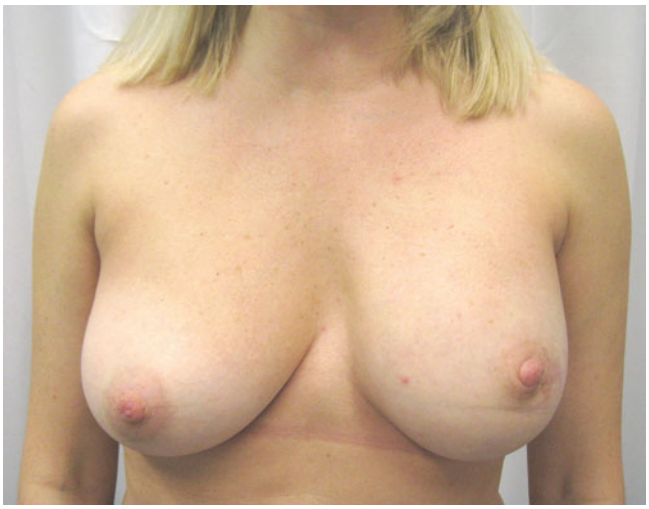

Fig. 25.5 Immediate breast reconstruction in a ptotic breast after nipple-sparing mastectomy

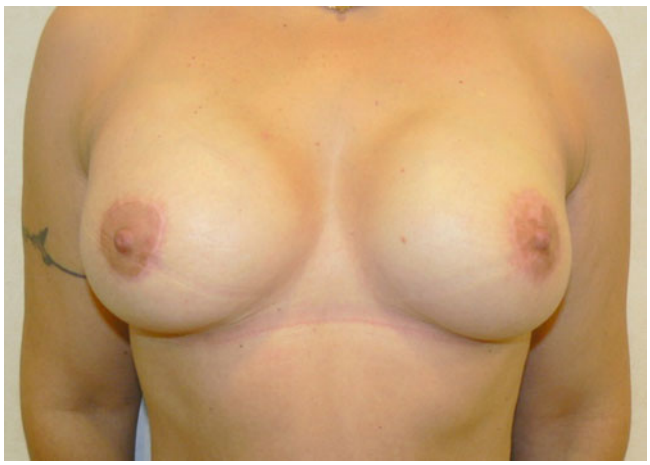

Fig. 25.6 Bilateral immediate breast reconstruction after nipple-sparing mastectomy

increases with the risk of skin necrosis and the size of the breast [22]. In our experience, deepithelialized autologous reconstruction can improve the blood supply of the NAC.

25.3 Complications

Infection and necrosis occur in 2–10 % of cases [11, 23, 24]. In our NSM series [11], total necrosis of the NAC was observed in 35 of the 1,001 NSM cases (3.5 %). Partial necrosis was observed in 55 cases (5.5 %). The NAC was removed in 50 cases (5.0 %).

Recently, we performed a prospective trial and measured the thickness of the mastectomy flap and NAC flap in 50 NSMs [12] (Fig. 25.7) We observed partial necrosis in 26.0 % of cases. Total necrosis was not observed.

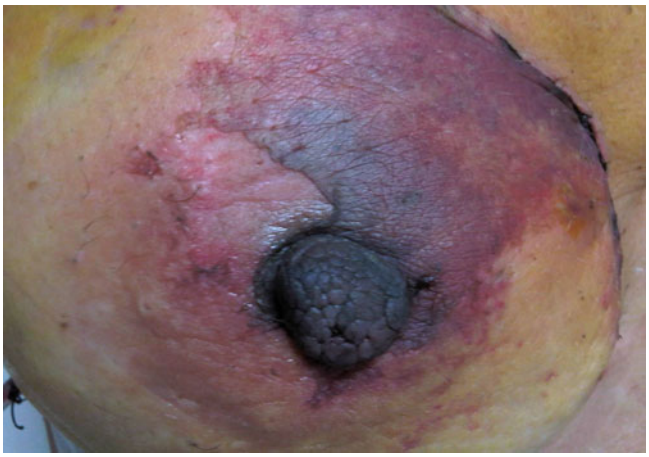

Fig. 25.7 NAC Necrosis

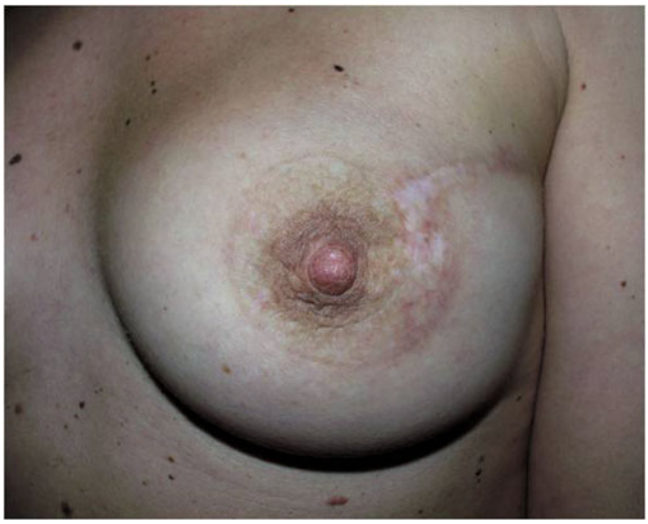

Fig. 25.8 Radiodystrophy

Superficial necrosis of the NAC and adjacent skin was observed. The necrosis involved the NAC and adjacent skin in 11 cases. In this recent series, the necrosis was also associated with young age (less than 45 years) and smoking. BMI, hypertension, diabetes mellitus and breast weight were not associated with necrosis. Moreover, the cut-off limit for the risk of necrosis was 5 mm.

In the same series, the specific ELIOT complication rate for severe radiodystrophy was 5.6 % [11] (Fig. 25.8).

25.4 Oncological Outcome

Boneti et al. [25] did not find any statistical differences when comparing NSM and skin-spring mastectomy for locoregional recurrence rate (6 % vs. 5.0 % $p = 0.89$). Gerber et al. [26] did not observe any difference between the locoregional recurrence rate of modified mastectomy, skin-sparing mastectomy and NSM: 11.5 % versus 10.4 % versus 11.7 %, respectively, at 8.4 years. The comparison of the results between the NSM series is questionable because of the different selection criteria (invasive or in situ, risk-reducing mastectomy included in the series), the different techniques (one-stage or delayed NSM), the use of intraoperative radiotherapy and the difference in follow-up.

In a recent study of 934 consecutive NSM patients during 2002–2007, median follow-up was 50 months. In 772 invasive carcinoma patients, the rate of locoregional recurrence in the breast and in the NAC was 3.6, and 0.8 %, respectively. In the 162 patients with intraepithelial neoplasia, the rate of locoregional recurrence in the breast and in the NAC was 4.9, and 2.9 %, respectively. The significant risk factors for locoregional recurrence in the breast for invasive carcinoma were grade, overexpression/amplification of human epidermal growth factor receptor 2 (HER2)/neu and breast cancer molecular subtype luminal B. In the intraepithelial neoplasia group, the risk factors for locoregional recurrence in the breast and in the NAC were age (less than 45 years), absence of oestrogen receptors, grade, HER2/neu overexpression and high Ki-67 level. We conclude that the locoregional recurrence rate after NSM in our series was low but the biological features of disease and young age should be taken into account when considering indications for NSM in breast cancer patients [27].

25.5 Cosmetic and Psychological Outcome

Cosmetic results are reported as good or satisfactory for patients in 75–85 % of cases [10, 11, 28, 29]. These results depend on the complications, mainly capsular contracture and necrosis. Cosmetic results after implant reconstruction worsen with time owing to capsular contracture and progressive asymmetry. Mosahebi et al. [28] compared the aesthetic results of the different techniques of NSM breast reconstruction. They concluded that for NSM patients who are likely to have postoperative radiotherapy, deep inferior epigastric perforator flap reconstruction achieved a better aesthetic outcome.

Our experience showed that the best cosmetic results are obtained with autologous flap reconstruction, avoiding asymmetry resulting from frequent change of the shape and the position of the areola related to the contracture after prosthesis reconstruction [11].

Psychological satisfaction is the main scope of the NSM protocol. In our Institute, Didier et al. [8] compared the results of a questionnaire investigating the satisfaction of patients after breast reconstruction with delayed NAC reconstruction and that of patients after NSM. They

observed better psychological recovery in the NSM group as well as a positive impact on patient satisfaction, body image and psychological adjustment. Yueh et al. [10] also found a high degree of satisfaction despite the low sensitivity of the NAC. Djohan et al. [9] published a detailed analysis of patient satisfaction following NSM with 8-year follow-up, demonstrating a high level of satisfaction except for NAC sensitivity and occurrence of late complications.

25.6 Conclusion

- NSM does not show any difference in the locoregional recurrence, survival and distant metastasis rates from SSM.
- Our experiences show NSM with immediate breast reconstruction improved the final cosmetic and psychological outcomes.
- Preoperative tumour histology and imaging along with intraoperative retroareolar tissue examination should be considered to select a suitable candidate for NSM.
- We found an 8.6 % false-negative rate of retroareolar tissue frozen section. In this situation, we can decide to remove the NAC with the patient under local anaesthesia or propose one-shot electron therapy immediately after the operation, in the case of NSM without ELIOT.
- The preventive role of intraoperative radiotherapy still needs to be demonstrated. Soon, the final decision to perform NSM will be based on the detailed histological, biological and molecular phenotype characteristics of the tumour and patient.

References

1. Fisher B, Anderson S, Bryant J, Margolese RG, Deutsch M et al (2002) Twenty-year follow-up of a randomized trial comparing total mastectomy, lumpectomy, and lumpectomy plus irradiation for the treatment of invasive breast cancer. N Engl J Med 347:1233–1241
2. Veronesi U, Saccozzi R, Del Vecchio M, Banfi A, Clemente C et al (1981) Comparing radical mastectomy with quadrantectomy, axillary dissection, and radiotherapy in patients with small cancers of the breast. N Engl J Med 305:6–11
3. Miller BT, Abbott AM, Tuttle TM (2011) The influence of preoperative MRI on breast cancer treatment. Ann Surg Oncol 19(2):536–540
4. Maxwell GP, Storm-Dickerson T, Whitworth P, Rubano C, Gabriel A (2011) Advances in nipple-sparing mastectomy: oncological safety and incision selection. Aesthet Surg J 31:310–319
5. Wellisch DK, Schain WS, Noone RB, Little JW 3rd (1987) The psychological contribution of nipple addition in breast reconstruction. Plast Reconstr Surg 80:699–704
6. Atisha D, Alderman AK, Lowery JC, Kuhn LE, Davis J et al (2008) Prospective analysis of long-term psychosocial outcomes in breast reconstruction: two-year postoperative results from the Michigan breast reconstruction outcomes study. Ann Surg 247: 1019–1028
7. Schain WS, Wellisch DK, Pasnau RO, Landsverk J (1985) The sooner the better: a study of psychological factors in women undergoing immediate versus delayed breast reconstruction. Am J Psychiatry 142:40–46
8. Didier F, Radice D, Gandini S, Bedolis R, Rotmensz N et al (2009) Does nipple preservation in mastectomy improve satisfaction with cosmetic results, psychological adjustment, body image and sexuality? Breast Cancer Res Treat 118:623–633
9. Djohan R, Gage E, Gatherwright J, Pavri S, Firouz J et al (2010) Patient satisfaction following nipple-sparing mastectomy and immediate breast reconstruction: an 8-year outcome study. Plast Reconstr Surg 125:818–829
10. Yueh JH, Houlihan MJ, Slavin SA, Lee BT, Pories SE et al (2009) Nipple-sparing mastectomy: evaluation of patient satisfaction, aesthetic results, and sensation. Ann Plast Surg 62:586–590
11. Petit JY, Veronesi U, Orecchia R, Rey P, Martella S et al (2009) Nipple sparing mastectomy with nipple areola intraoperative radiotherapy: one thousand and one cases of a five years experience at the European Institute of Oncology of Milan (EIO). Breast Cancer Res Treat 117:333–338
12. Algaithy ZK, Petit JY, Lohsiriwat V, Maisonneuve P, Rey PC et al (2011) Nipple sparing mastectomy: can we predict the factors predisposing to necrosis? Eur J Surg Oncol 38(2):125–129
13. Petit JY, Veronesi U, Lohsiriwat V, Rey P, Curigliano G, et al (2011) Nipple-sparing mastectomy–is it worth the risk? Nat Rev Clin Oncol 8(12):742–747
14. Lohsiriwat V, Rojananin S, Bhothisuwan K (2004) Prediction of nipple areolar complex Involvement in breast cancer. Thai J Surg 25:71–78
15. Benediktsson KP, Perbeck L (2008) Survival in breast cancer after nipple-sparing subcutaneous mastectomy and immediate reconstruction with implants: a prospective trial with 13 years median follow-up in 216 patients. Eur J Surg Oncol 34:143–148
16. Govindarajulu S, Narreddy S, Shere MH, Ibrahim NB, Sahu AK et al (2006) Preoperative mammotome biopsy of ducts beneath the nipple areola complex. Eur J Surg Oncol 32:410–412
17. Palmieri B, Baitchev G, Grappolini S, Costa A, Benuzzi G (2005) Delayed nipple-sparing modified subcutaneous mastectomy: rationale and technique. Breast J 11:173–178
18. Spear SL, Rottman SJ, Seiboth LA, Hannan CM (2012) Breast reconstruction using a staged nipple-sparing mastectomy following mastopexy or reduction. Plast Reconstr Surg 129(3):572–581
19. Intra M, Orecchia R, Veronesi U (2004) Intraoperative radiotherapy: the debate continues. Lancet Oncol 5:340
20. Orecchia R, Ciocca M, Lazzari R, Garibaldi C, Leonardi MC et al (2003) Intraoperative radiation therapy with electrons (ELIOT) in early-stage breast cancer. Breast 12:483–490
21. Veronesi U, Gatti G, Luini A, Intra M, Orecchia R et al (2003) Intraoperative radiation therapy for breast cancer: technical notes. Breast J 9:106–112
22. Spear SL (2009) Oncoplastic surgery. Plast Reconstr Surg 124:993–994
23. Petit JY, Veronesi U, Luini A, Orecchia R, Rey PC et al (2005) When mastectomy becomes inevitable: the nipple-sparing approach. Breast 14:527–531
24. Petit JY, Veronesi U, Orecchia R, Rey P, Didier F et al (2003) The nipple-sparing mastectomy: early results of a feasibility study of a new application of perioperative radiotherapy (ELIOT) in the treatment of breast cancer when mastectomy is indicated. Tumori 89:288–291
25. Boneti C, Yuen J, Santiago C, Diaz Z, Robertson Y, et al (2011) Oncologic safety of nipple skin-sparing or total skin-sparing mastectomies with immediate reconstruction. J Am Coll Surg 212:686–693; discussion 693–685

26. Gerber B, Krause A, Dieterich M, Kundt G, Reimer T (2009) The oncological safety of skin sparing mastectomy with conservation of the nipple-areola complex and autologous reconstruction: an extended follow-up study. Ann Surg 249:461–468
27. Petit JY, Veronesi U, Orecchia R, Curigliano G, Rey PC, et al (2012) Risk factors associated with recurrence after nipple-sparing mastectomy for invasive and intraepithelial neoplasia. Ann Oncol 23(8):2053–2058
28. Mosahebi A, Ramakrishnan V, Gittos M, Collier J (2007) Aesthetic outcome of different techniques of reconstruction following nipple-areola-preserving envelope mastectomy with immediate reconstruction. Plast Reconstr Surg 119:796–803
29. Mori H, Umeda T, Osanai T, Hata Y (2005) Esthetic evaluation of immediate breast reconstruction after nipple-sparing or skin-sparing mastectomy. Breast Cancer 12:299–303

Breast Reconstruction After Skin-Reducing Mastectomy

26

A. Gustavo Zucca-Matthes, Raphael Luis Haikel, and Angelo Matthes

26.1 Introduction

Breast cancer surgery has evolved from radical mastectomy, with excision of as much tissue as possible, to subcutaneous mastectomy, with sparing of as much tissue as possible (Table 26.1).

Notably, the choice of the procedure depends on both the location and the stage of the cancer. The development of diagnostic imaging techniques has increased the medical profession's awareness of breast cancer and has led to earlier diagnoses. Because a greater percentage of cancers are detected at earlier stages, the need for skin-sparing techniques has increased [13].

Skin-sparing mastectomy (SSM) is classified further by the type of incision used and the amount of skin removed (Fig. 26.1, Table 26.2). Type I SSM is used commonly for prophylactic purposes and for patients whose cancer was diagnosed by needle biopsy. Lateral extension of the incision may be necessary to improve exposure to the axillary tail. Type II SSM is used when the superficial tumor or previous biopsy was near the areola. Type III SSM is used when the superficial tumor or previous incision was remote from the areola. Type IV SSM is used in large, ptotic breasts when a reduction was planned on the opposite breast [14].

Type IV Wise-pattern SSM has had excellent results as immediate implant reconstruction in heavy- and pendulous-breasted patients who require a conspicuous reduction of the skin envelope and a contralateral reduction or mastopexy. However, on the side undergoing the SSM, the skin flaps are thin and wound-healing problems are well described, particularly skin necrosis at the ''T'' as frequently as 27 %, predisposing to prosthesis exposure and therefore limiting its utility [12]. Therefore, technique modifications that recruit local tissue to protect these areas of breakdown and support the implant have been proposed and the procedure has been called skin-reducing mastectomy (SRM; type V) [12, 15–17].

Reconstruction surgery in this subset of mastectomies can be performed by means of totally submuscular expanders or permanent prostheses rather than autologous flaps. Final scarring is similar to that from cosmetic surgery (inverted T) [12].

26.2 A Brief History

In different series of inverted-T mastectomies, relatively high morbidity (up to 27 %), which usually involved skin viability at the inverted-T junction, was reported [12]. In this way, many authors have tried to overcome necrosis and poor results using a modified Wise pattern rather than a subcutaneous pouch.

In 1990 Bostwick [18] tried to preserve a lower deepithelialized dermal flap during a Wise reduction pattern mastectomy to create a musculodermal pouch for the location of a definitive permanent silicone prosthesis that provided appropriate coverage of the implant. At that time there was no information about the possibility of saving skin during oncological procedures, so it was used for prophylactic mastectomies.

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Table 26.1 Evolution of breast cancer surgical treatment

Authors	Years	Surgery	Description
Halsted [1]	1894	Radical mastectomy	Removal of the breast, two muscles and axillary lymph nodes
Stewart [2]	1915	Radical modified mastectomy	Transverse incision, better aesthetic result
Urban [3]	1956	Ultraradical mastectomy	Removal of the breast, two muscles, axillary lymph nodes, and internal mammary lymphatic chain en bloc
Patey and Dyson [4]	1948	Radical modified mastectomy	Resection of the breast, pectoralis minor muscle, and axillary contents en bloc
Madden [5]	1965	Radical modified mastectomy	Resection of the breast and axillary contents en bloc, preserving both pectoral muscles
Fisher et al. [6]	1985	Breast conservative treatment	Tumor resection (lumpectomy and quadrantectomy), axillary dissection and radiotherapy
Veronesi et al. [7]	1986	Breast conservative treatment	Tumor resection (quadrantectomy), axillary dissection and radiotherapy
Toth and Lappert [8]	1991	Skin-sparing mastectomy	Mastectomy appeared in order to conserve skin as much as possible and facilitate breast reconstruction.
Audretsch et al. [9]	1994	Oncoplastic surgery	Association of plastic surgery techniques for conservative treatment
Giuliano et al. [10]	1994	Sentinel node biopsy	To avoid complete axillary dissection
Petit et al. [11]	2006	Nipple-sparing mastectomy	Mastectomy appeared in order to conserve skin the and nipple–areola complex, facilitating breast reconstruction. Associated with intraoperative radiotherapy of the nipple–areola complex
Nava et al. [12]	2006	Skin-reducing mastectomy	Combined flap technique to reconstruct large and medium-sized ptotic breasts in a single-stage operation by use of anatomical permanent implants

Hammond et al. [19] introduced Bostwick's method in the treatment of breast cancer, in most cases using a two-step surgical approach with temporary expanders, followed by a second operation for permanent insertion of implants.

In 2006, Nava et al. [12] described a modification of this last type of SSM, renamed skin-reducing mastectomy (SRM), by which mammary reconstruction in selected patients is done in a single stage in which an anatomical silicone gel implant is placed in a dermal muscle flap pocket. They aimed to avoid complications of the type IV operation, such as lack of space in the inferior and medial aspects of the submuscular pouch that sometimes requires release of the inferior insertions of pectoralis major muscle with an incision, leaving the implant subcutaneously with a high risk of exposure, particularly when it is put under the long (and possibly ischemic) superior mastectomy flap.

26.3 Definition

SRM is a single-stage technique that helps us to overcome the cosmetic inadequacy of a type IV Wise-pattern SSM (final inverted-T scar) in heavy and pendulous breasts by filling the lower medial quadrant with adequate volume.

Its virtue lies in the manner it provides adequate implant coverage using muscle and a deepithelialized dermal flap, thus reducing the risk of implant extrusion and providing a good inframammary contour [17].

SRM with a complete release of the pectoralis muscle inferiorly and the sparing of a lower dermal flap sculpted down to the inframammary fold allows the creation of a dermomuscular pouch, achieving total implant coverage and overcoming all of the inadequacies of type IV SSM (upper pole fullness and lack of projection). By augmentation of the pocket and provision of a new tissue layer at the lower pole of the breast, complications are reduced and aesthetic outcomes are improved compared with the traditional inverted-T mastectomies.

26.4 Indications

SRM was originally deemed most suitable for early-stage breast cancer and risk-reduction patients with medium-sized to large breasts; however, the indications for its use could be expanded.

Ongoing controversies continue to result in the issues of SSM and sparing of the nipple–areola complex being debated. These controversies are focused on problems of

Table 26.2 Modified classification of skin-sparing mastectomy

Type	Classification
I	Only nipple–areola complex removed
II	Nipple–areola complex, skin overlying superficial tumors, and previous biopsy incision removed in continuity with the nipple–areola complex
III	Nipple–areola complex removed, skin overlying superficial tumors, and previous biopsy incision removed without intervening skin
IV	Nipple–areola complex removed with an inverted or reduction pattern skin incision

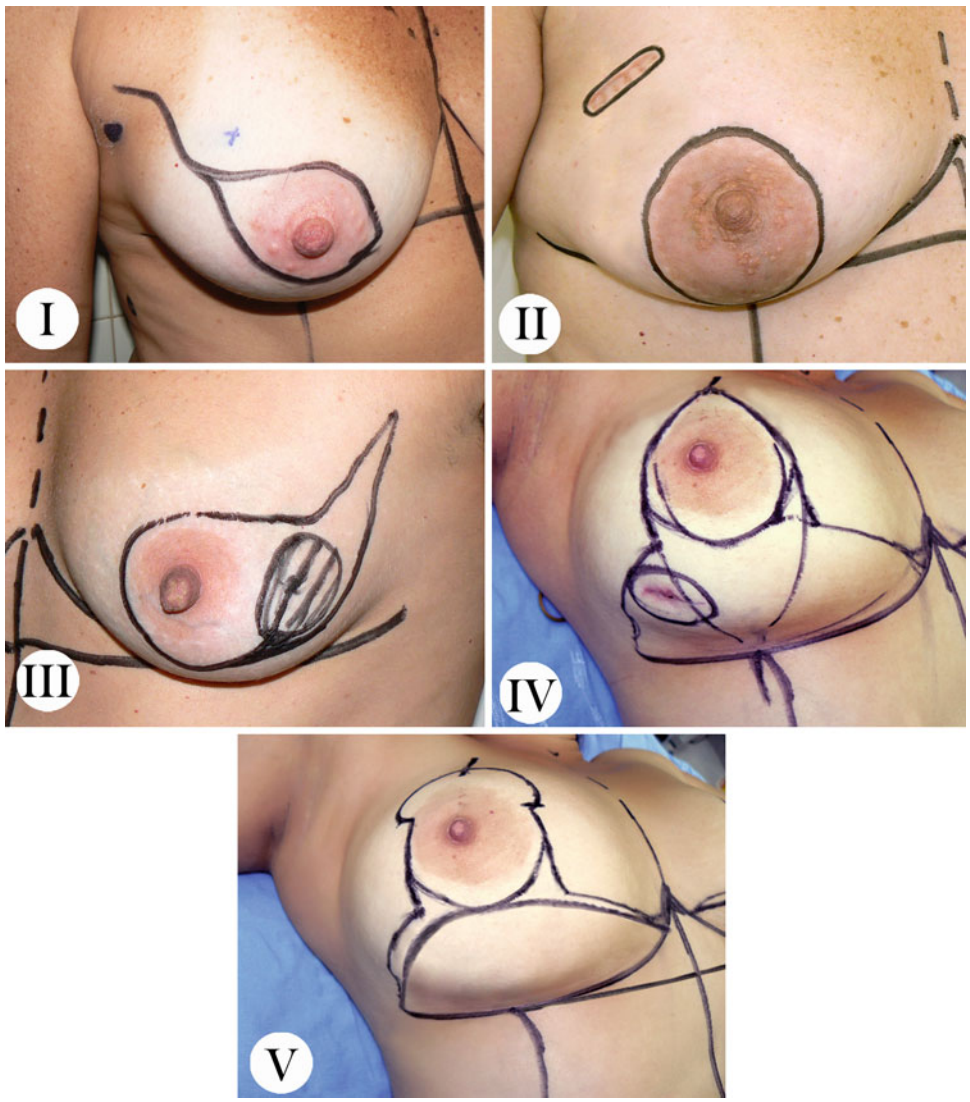

Fig. 26.1 Classification of skin-sparing mastectomy including skin-reducing mastectomy

nipple–areola complex survival and the reliability of methods from an oncologic point of view. Many published reports describe the reliability of subcutaneous mastectomy in certain indications. In early-stage breast cancer, immediate breast reconstruction after subcutaneous mastectomy is used with increasing frequency.

Recently, risk reducing mastectomy has been performed for patients displaying the following oncologic risk factors: a positive family history, *BRCA1* and *BRCA2* gene mutation, atypical ductal hyperplasia, a history of skin cancer, intensive lobular carcinoma in situ, and ductal carcinoma in situ, and even when there is an extreme fear of breast cancer. Risk reducing mastectomy has been performed increasingly owing to either patient demand or proposals by oncologic surgeons. Sparing of the nipple–areola complex is extremely important for aesthetic results and patient satisfaction in both early-stage breast cancer and high-risk groups [20–22]. Nair et al. [17, 23] reported their experience with SRM. They expanded

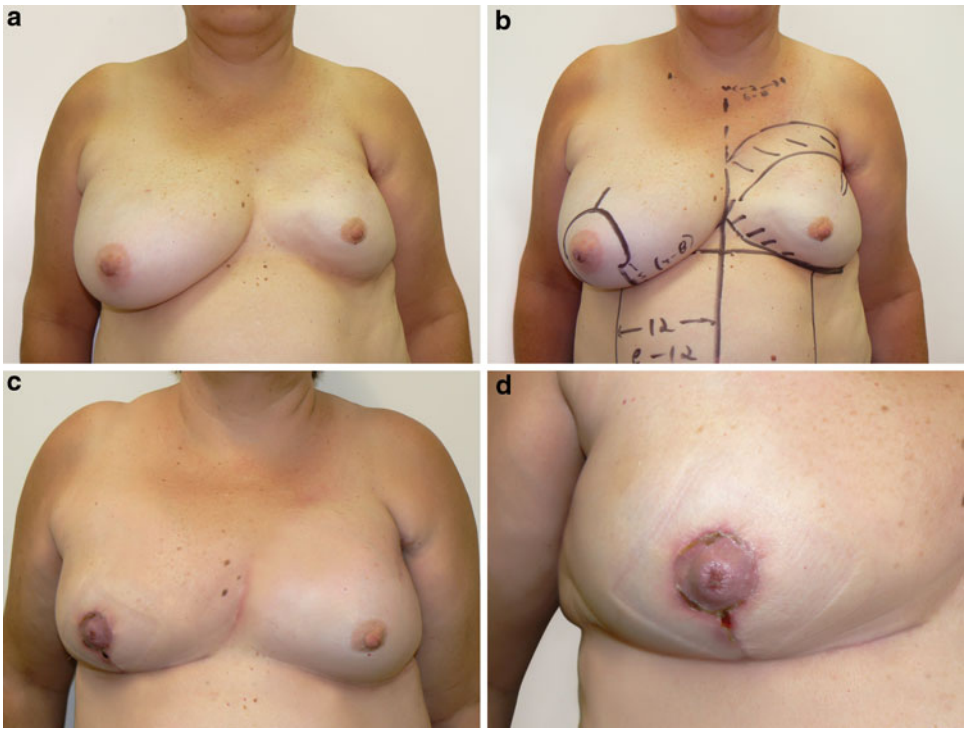

Fig. 26.2 **a** Preoperative image: bilateral breast cancer. *Left* bad results from previous breast reconstruction. *Right* medium-sized breast, 4 cm × 4 cm tumor at the upper outer quadrant, positive axillary nodes. **b** Preoperative drawing. *Left* prosthetic replacement and remodeling of the parenchyma. *Right* skin-reducing mastectomy. **c** Final result after 1 month. **d** Final result after 1 month. *Right* breast closer view

the indication for SRM to more locally advanced tumors (T3 and T4), eventually downstaged by neoadjuvant chemotherapy, and to small-volume nonptotic breasts by using expandable implants. Furthermore, they included patients who also need adjuvant radiotherapy.

To sum up, SRM can be performed for patients who have moderate-sized to large ptotic breasts, no history of previous reduction mammoplasties, and absence of tumor affecting the skin. Smokers (more than five cigarettes per day) and patients with microvascular problems (previous radiotherapy, diabetes) are be excluded [20].

26.5 Preoperative Planning

Breast ultrasonography and mammography are advised to encourage a perfect preoperative surgical planning.

All patients should be informed about the surgical procedure, the details of their breast disease, the risk factors associated with redundant breast tissue, and the possible advantages and disadvantages of the surgical technique.

Operation planning is performed with patients in the standing position. First, the region of the mass nearest the skin is marked, followed by marking of the inframammary fold. A distance of at least 4 cm (4–6 cm) between the inframammary sulcus (IMS) and the nipple is the projectional distance on the sternum. On the breast, it is 5–7 cm. The marking then follows the steps used for a normal breast reduction or mastopexy using a conventional Wise pattern. However, on the mastectomy side, some surgeons [12] erase the semicircular drawing representing the position of the new nipple–areola complex and extend the two vertical lines up to the new nipple position. The length of the two lines on this side depends on the degree of reduction we want to achieve and is usually between 5 and 7 cm, plus the 2-cm radius of the nipple–areola complex. The distal ends of the two lines are then extended medially and laterally with the patient lying in the supine position, so as to intercept the previously marked IMS.

At the beginning of planning, drawing the projection of the IMS on the sternum shows whether there is any vertical asymmetry with the thorax. Generally, 1–2 cm of asymmetry between the IMS and the thorax is common. Showing this situation is helpful in planning to achieve postoperative symmetry. The new nipple projection is drawn 4 cm above the IMS projection on the sternum. A horizontal line is drawn from this mark to the breast to determine the new nipple position. With use of this technique, much more breast skin reduction can be achieved, and the final scar is located at the inferior mammary fold.

An example case is illustrated in Fig. 26.2a–d.

26.6 Operative Procedure

The area between the marked incisions is deepithelialized except for the nipple–areola complex (diameter, 4–4.5 cm). Total subcutaneous mastectomy is performed from the lateral vertical incision via a full incision.

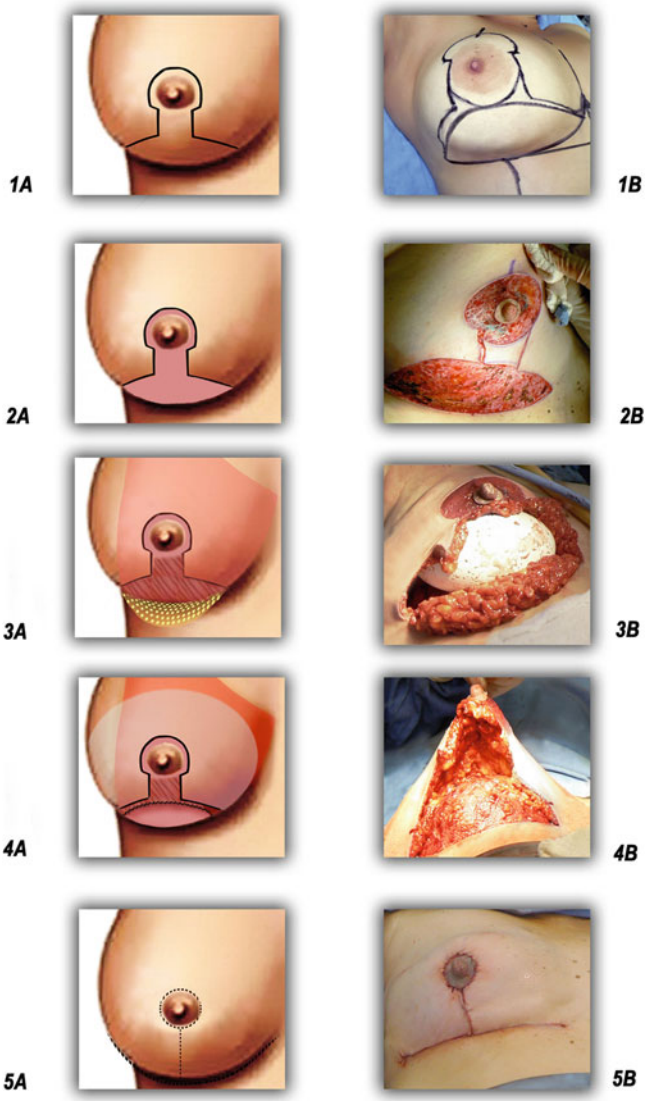

Fig. 26.3 Skin-reducing mastectomy: *1A* and *1B* Wise pattern. *2A* and *2B* dermal barrier flap (deepithelialized area). *3A* total subcutaneous mastectomy was performed from the lateral vertical incision via a full incision. *3B* prosthetic sizer among the flaps of skin-reducing mastectomy. *4A* and *4B* dermal barrier flap sutured to the muscular pocket to cover the implant. *5A* and *5B* final inverted-T scar

Before the mastectomy is started, the lower flap is sculpted down to the inframammary fold, whose anatomy must be always be identified to allow careful preservation. The gland has to be removed with accurate sparing of the superior flap's subdermal vascularization. Cooper's ligament, oncologically reliable and harmless for the subdermal plexus, is followed as a surgical plan during mastectomy. It allows one to minimize ischemia without compromising oncologic safety and complete removal of breast tissue.

This access usually allows easy axillary dissection or sentinel node identification and biopsy. The pathologic specimen beneath the nipple–areola complex is marked. There is still concern regarding the oncologic safety of nipple preservation in cancer patients. In this case, we normally perform frozen section analysis of retroareolar breast ducts.

We recommend with medium-profile and high-profile cohesive silicone gel filled anatomical breast implants when reconstructions are performed. The nipple–areola complex is moved to the planned position, and the deepithelialized skin surrounding it is sutured to its peripheral deepithelialized border. After the oncologic procedures have been completed, we start the reconstruction by incising along the lateral border of pectoralis major muscle. The inferior and lower medial insertions of this muscle are divided and sutured to the superior border of the dermal flap. The dermal barrier flap, this deepithelialized area in the mid-inferior region, is moved laterally without folding, and the lateral and medial incisions are sutured to each other. A large pouch is then created to accommodate an anatomically shaped permanent prosthesis.

From our point of view the choice of a total or partial muscular pocket to cover the implant depends on the scar position. If a scar remains over the pectoral muscle a total muscular pocket will not be necessary. On the other hand, if the incision is long and remains on the implant, covering with the serratus anterior muscle is essential.

Drains are inserted and left in place for about 5–10 days. Tight bandages or special bras are used for 4–6 weeks.

The procedure is illustrated schematically in Fig. 26.3.

26.7 Complications

Although subcutaneous mastectomy offers excellent cosmetic results with small breasts, obtaining optimum results for moderate-sized and large breasts is more challenging and requires repositioning of the areola as well as decreasing the breast skin surface area.

Wound-healing problems are usually not encountered during subcutaneous mastectomies with no skin reduction. Skin blood perfusion is jeopardized during breast-reduction mastectomy. Two mechanisms can be proposed that explain these wound-healing/perfusion issues: long flaps created as a result of skin excision and aggressive surgery that causes very thin skin and jeopardizes the subdermal plexus.

With SRM, full-cut incisions from only the lateral side and deepithelialization instead of skin excision reduces wound-healing problems at suture lines. Use of the inferior dermal barrier flap provides double-layered protection at the suture site and avoids implant exposure even when wound dehiscence occurs. Although the submuscular area is more protective of the prosthesis, it is not optimal for larger prostheses. Pressure on the prosthesis can cause low-level breast projection. In addition, preparation of the submuscular area increases the mean time for the surgical procedure.

Radiotherapy, if necessary, can be offered to women after mastectomy for breast cancer to decrease risk of local recurrence. Breast reconstruction with breast implants after radiotherapy can prove troublesome because of subsequent capsular contracture, infection, and unsatisfactory cosmetic results [23].

Patients should also nonetheless be advised of the risk of implant complications due to adjuvant therapy. There is thus a small but definite risk of needing revision surgery to achieve the final intended cosmetic outcome. Careful patient selection and improvement in the learning curve may reduce the complication rate. Special attention should be paid to smokers (more than five cigarettes per day) and patients with microvascular problems (previous radiotherapy, diabetes) [20].

Finally, exposure of the implant and failure of reconstruction are often inevitable [13].

26.8 Psychological Aspects

Immediate breast reconstruction after mastectomy has the potential to minimize the psychological insult associated with mastectomy alone. The applicability of immediate reconstruction has expanded in recent years with the understanding that such procedures do not affect the incidence or detection of breast cancer recurrence. Additionally, there is no appreciable delay in the institution of adjuvant therapy with this approach. Existing techniques of immediate implant-based breast reconstruction as well as SRM revolve around prosthesis placement in either subcutaneous or subpectoral planes.

In this context, patients with macromastia who require a combination of SSM and a degree of skin envelope reduction benefit from SRM because the Wise keyhole or inverted-T pattern can then be applied equally to both breasts to create symmetry, protecting with dermomuscular pocket the mastectomy site from scar breakdown and implant exposure [24].

Therefore, this technique allows greater safety and self-confidence for patients, with valuable repercussions during the recovery and adjuvant treatment.

26.9 Conclusion

SRM is a method of oncoplastic treatment used for immediate breast reconstruction derived from a Wise breast reduction incision pattern that enables immediate subpectoral implant placement after mastectomy and contralateral symmetry if necessary. It also conceals scars as an aesthetic operation and at the same time provides satisfactory and safe coverage of the implant. SRM provides good results for selected patients even in the case of advanced tumor stages. Patients should also nonetheless be advised of the risk of the small but definite rate of complications.

References

1. Halsted WS (1894) The results of operations for the cure of cancer of the breast performed at the Johns Hopkins Hospital from June, 1889, to January, 1894. Ann Surg 20(5):497–555
2. Stewart FT (1915) Amputation of the breast by a transverse incision. Ann Surg 62(2):250–251
3. Urban JA, Baker HW (1952) Radical mastectomy in continuity with en bloc resection of the internal mammary lymph-node chain; a new procedure for primary operable cancer of the breast. Cancer 5(5):992–1008
4. Patey DH, Dyson WH (1948) The prognosis of carcinoma of the breast in relation to the type of operation performed. Br J Cancer 2(1):7–13
5. Madden JL (1965) Modified radical mastectomy. Surg Gynecol Obstet 121(6):1221–1230
6. Fisher B, Bauer M, Margolese R, Poisson R, Pilch Y, Redmond C, Fisher E, Wolmark N, Deutsch M, Montague E et al (1985) Five-year results of a randomized clinical trial comparing total mastectomy and segmental mastectomy with or without radiation in the treatment of breast cancer. N Engl J Med 312(11):665–673
7. Veronesi U, Banfi A, Del Vecchio M, Saccozzi R, Clemente C, Greco M, Luini A, Marubini E, Muscolino G, Rilke F et al (1986) Comparison of Halsted mastectomy with quadrantectomy, axillary dissection, and radiotherapy in early breast cancer: long-term results. Eur J Cancer Clin Oncol 22(9):1085–1089
8. Toth BA, Lappert P (1991) Modified skin incisions for mastectomy: the need for plastic surgical input in preoperative planning. Plast Reconstr Surg 87(6):1048–1053
9. Audretsch W, Rezai M, Kolotas C et al (1994) Onco-plastic surgery: "target" volume reduction (BCT-mastopexy), lumpectomy, reconstruction (BCT-reconstruction), and flap-supported operability in breast cancer. Second European Congress on Senology, Breast Diseases, pp 139–157
10. Giuliano AE, Kirgan DM, Guenther JM, Morton DL (1994) Lymphatic mapping and sentinel lymphadenectomy for breast cancer. Ann Surg 220(3):391–398; discussion 398–401
11. Petit JY, Veronesi U, Orecchia R, Luini A, Rey P, Intra M, Didier F, Martella S, Rietjens M, Garusi C, DeLorenzi F, Gatti G, Leon ME, Casadio C (2006) Nipple-sparing mastectomy in association with intra operative radiotherapy (ELIOT): a new type of mastectomy for breast cancer treatment. Breast Cancer Res Treat 96(1):47–51. doi:10.1007/s10549-005-9033-7
12. Nava MB, Cortinovis U, Ottolenghi J, Riggio E, Pennati A, Catanuto G, Greco M, Rovere GQ (2006) Skin-reducing mastectomy. Plast Reconstr Surg 118(3):603–610; discussion 611–603. doi:10.1097/01.prs.0000233024.08392.14
13. Bayram Y, Kulahci Y, Irgil C, Calikapan M, Noyan N (2010) Skin-reducing subcutaneous mastectomy using a dermal barrier flap and immediate breast reconstruction with an implant: a new surgical design for reconstruction of early-stage breast cancer. Aesthetic Plast Surg 34(1):71–77. doi:10.1007/s00266-009-9452-7
14. Carlson GW, Bostwick J 3rd, Styblo TM, Moore B, Bried JT, Murray DR, Wood WC (1997) Skin-sparing mastectomy. Oncologic and reconstructive considerations. Ann Surg 225(5):570–575; discussion 575–578
15. Hammond DC, PA; Ozolins, EB et al (2002) Use of a skin-sparing reduction pattern to create a combination skin-muscle flap pocket in immediate breast reconstruction. Plast Reconstr Surg 110:8

16. Losken A, Collins BA, Carlson GW (2010) Dual-plane prosthetic reconstruction using the modified wise pattern mastectomy and fasciocutaneous flap in women with macromastia. Plast Reconstr Surg 126(3):731–738. doi:10.1097/PRS.0b013e3181e3b38a
17. Nair A, Jaleel S, Abbott N, Buxton P, Matey P (2010) Skin-reducing mastectomy with immediate implant reconstruction as an indispensable tool in the provision of oncoplastic breast services. Ann Surg Oncol 17(9):2480–2485. doi:10.1245/s10434-010-1058-4
18. Bostwick J (1990) Total mastectomy with breast skin and volume reduction using an inverted 'T' incision. Plastic and reconstructive breast surgery. Quality Medical Publishing, St Louis, pp 1048–1054
19. Hammond DC, Capraro PA, Ozolins EB, Arnold JF (2002) Use of a skin-sparing reduction pattern to create a combination skin-muscle flap pocket in immediate breast reconstruction. Plast Reconstr Surg 110(1):206–211
20. Colizzi L, Agostini T, Lazzeri D (2010) Should indications for skin-reducing mastectomy be expanded? Ann Surg Oncol. doi:10.1245/s10434-010-1297-4
21. Colizzi L, Lazzeri D, Agostini T, Giannotti G, Ghilli M, Gandini D, Pantaloni M, Roncella M (2011) Skin-reducing mastectomy: new refinements. J Plast Surg Hand Surg 44(6):296–301. doi:10.3109/2000656X.2010.517681
22. Edlich RF, Winters KL, Faulkner BC, Lin KY (2006) Risk-reducing mastectomy. J Long Term Eff Med Implants 16(4):301–314
23. Nair A, Matey P (2010) Authors reply to "Should indications for skin-reducing mastectomy be expanded?". Ann Surg Oncol. doi:10.1245/s10434-010-1298-3
24. Colizzi L, Lazzeri D, Agostini T, Ghilli M, Roncella M, Pantaloni M (2010) The favorable psychological approach of single-stage curative and prophylactic skin-reducing mastectomy in patients with macromastia. Plast Reconstr Surg 127(3):1389–1390; author reply 1390–1381. doi:10.1097/PRS.0b013e318206318f

Autologous Latissimus Dorsi Breast Reconstruction

27

Emmanuel Delay and Christophe Ho Quoc

27.1 Introduction

Breast reconstruction belongs to the treatment of breast cancer. An increasing number of patients benefit from immediate or delayed reconstruction. We use autologous tissue [1, 2] because it provides excellent and long-standing results (shape, consistency, sensitivity, integration in the body image).

The musculocutaneous latissimus dorsi flap was first described by Tansini [3] in 1906 for reconstruction of the chest wall after breast amputation. Under the influence of Halsted, who was hostile to plastic surgery, coverage or reconstruction using this flap fell into disuse. Rediscovered in 1976 by Olivari, the latissimus dorsi flap had become a major option in breast reconstruction by the end of the 1970s [4]. From the 1980s onward, various authors proposed using the latissimus dorsi as an autologous flap [5, 6] but this technique had few indications because the results were unsatisfactory and the dorsal sequelae were considered to be too marked. Since 1993, we have been using the technique of autologous latissimus dorsi breast reconstruction as described in our 1998 article [7]. As our experience increased and we evaluated our intensive practice of breast reconstruction (personal experience of more 100 reconstructions a year), our preference moved to autologous latissimus dorsi reconstruction, which is now our principal technique. However, the volume of the reconstructed breast may be insufficient if the patient is very slim or if there is marked atrophy of the flap. The classic solution in such cases was secondary insertion of an implant under the flap. Of course, the reconstruction was then no longer purely autologous, which had its own disadvantages, and the new breast was of less natural shape. The development in our department and use since 1998 of lipomodeling of the reconstructed breast [1, 2], which has many advantages and ideally completes autologous latissimus dorsi reconstruction, probably contributed to the predominant use of this flap.

In this chapter, we present our technique and its recent advances, the means of obtaining an autologous reconstruction, the indications and contraindications, the possible complications, the results which may be expected, and lastly the advantages and drawbacks of autologous latissimus dorsi breast reconstruction.

27.2 Surgical Anatomy of the Autologous Latissimus Dorsi Flap

27.2.1 The Latissimus Dorsi Muscle

The latissimus dorsi is a thin and wide muscle. It inserts anteriorly on the lower four ribs, where four attachments converge with the digitations of the obliquus externus abdominis. The medial and lower part of the muscle inserts on the thoracolumbar fascia, which extends over the spinous processes of the lower six thoracic vertebrae, the five lumbar vertebrae, the sacral vertebrae, and the posterior third of the iliac crest. Its upper border covers the inferior angle of the scapula, where an accessory bundle of teres major is often observed. Together with the latter, it defines the posterior wall of the axilla before ending its insertion at the bicipital groove of the humerus between the pectoralis major and the teres major tendons. Its deep aspect carries attachments which are common to the latissimus dorsi and serratus anterior.

The vascular supply to the latissimus dorsi is a type V in the classification of Mathes and Nahai, with a main thoracodorsal pedicle and accessory segmental pedicles arising from the intercostal and lumbar arteries. When the thoracodorsal pedicle penetrates in the deep aspect of the latissimus dorsi, it divides into two branches of equal importance: the descending branch and the transverse

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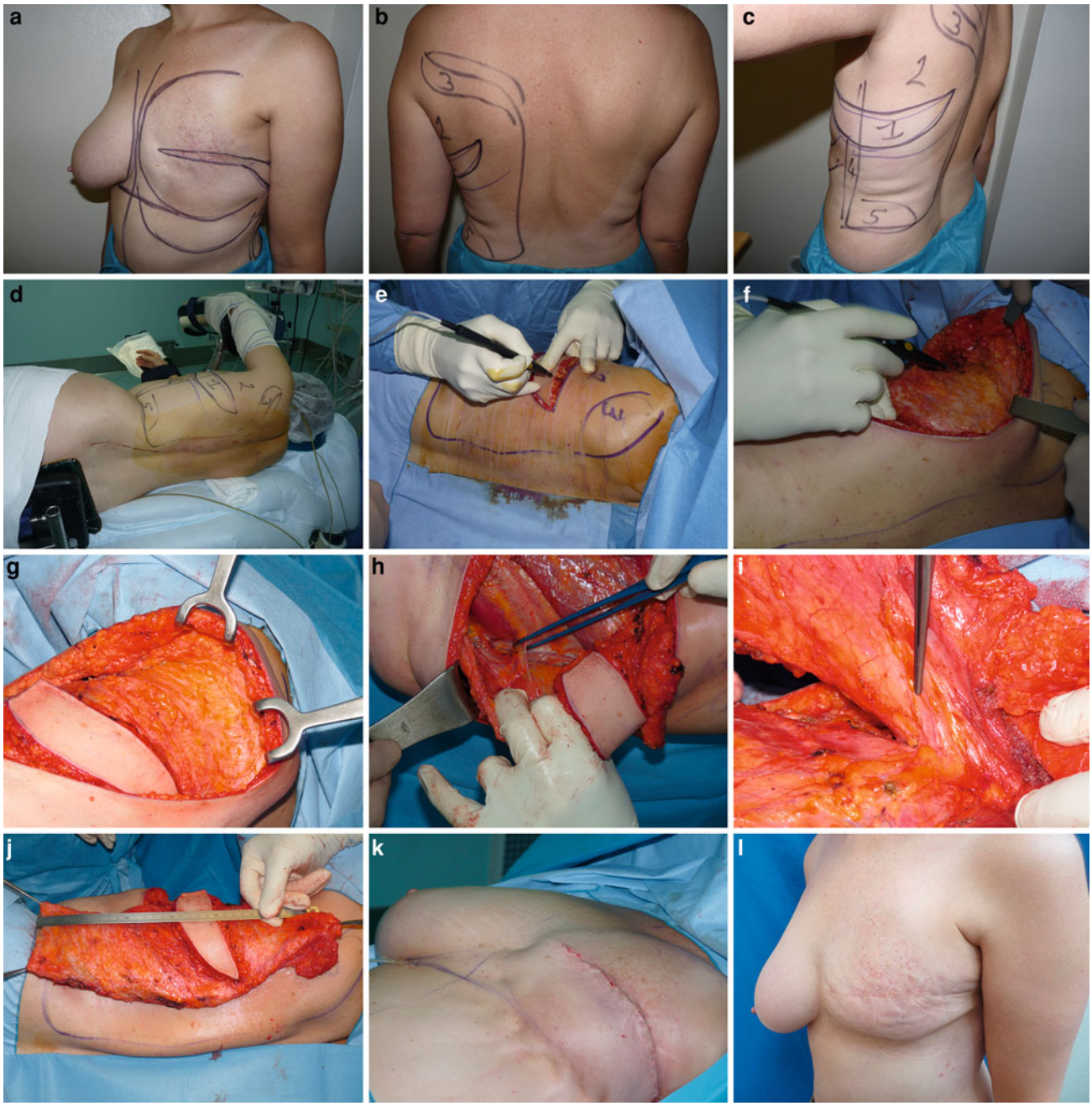

Fig. 27.1 Surgical procedure. **a** Preoperative thoracic wall preoperative marking. **b** Skin paddle and different fat pads harvested with the autologous latissimus dorsi flap (preoperative rear view). **c** Skin paddle and different fat pads harvested with the autologous latissimus dorsi flap (preoperative oblique view). **d** Patient in the lateral decubitus position for harvesting the latissimus dorsi flap. **e** Skin paddle incision. **f** Undermining in an upward direction in the plane of the fascia superficialis. **g** Elevation of the scapular fat flap (zone 3). **h** Coagulation of the accessory segmental pedicles using bipolar forceps. **i** Dissection of the pedicle. **j** Autologous latissimus dorsi flap harvested. **k** Result at the end of the procedure after total burial of the flap. **l** Postoperative oblique view

branch. The motor nerve of the latissimus dorsi arises from the thoracodorsal nerve originating from the posterior secondary trunk C6–C8. Its origin is about 3 cm more internal than the vascular pedicle, which it then rejoins before penetrating the muscle, except in cases in which the origin of the artery is more proximal, with the nerve lying between the artery and the vein.

The latissimus dorsi allows adduction, backward movement, and internal rotation of the arm. It is therefore involved in weight-bearing movements such as walking

with crutches, and in vertical traction with the arms raised above the head. Its removal has little effect on daily life or the practice of amateur sports, but its lack is more greatly felt in cross-country skiing and particularly in rock-climbing.

27.2.2 The Fatty Extensions of the Latissimus Dorsi Muscle

The autologous latissimus dorsi flap aims to increase the volume provided by the latissimus dorsi by incorporating fatty areas which are true extensions to the flap (Fig. 27.1a–c), because the muscle atrophies after transfer when it is no longer used. We have described six fatty areas [1] which are harvested as a complement to the muscle itself:

- Zone 1 corresponds to the fatty area of the crescent of the dorsal skin paddle.
- Zone 2 represents the deep layer of fat lying between the muscle and the fascia superficialis, and is left adherent over all the surface of the flap.
- Zone 3 consists of the scapular hinge flap, which continues on the upper margin of the muscle.
- Zone 4 lies just forward to its external margin, forming an anterior hinge flap.
- Zone 5 corresponds to the suprailiac fat deposits or "love handles."
- Zone 6 is the adipose tissue of the deep aspect of the muscle.

The amount of fatty tissue gained depends on the extent of the patient's fat deposits.

These zones are reliably vascularized by muscular perforating pedicles. Zone 3 has the advantage of a vascular plexus between the cutaneous branches (vertical branch of the circumflex scapular artery, intercostal branch, lateral thoracic branch) and two perforating pedicles of the thoracodorsal artery which anastomose between themselves.

27.3 Objectives of Breast Reconstruction

Both objectives of breast reconstruction are clear:

- To restore the skin, shape, volume, and consistency of the reconstructed breast
- To reestablish the symmetry and harmony of the two breasts.

From a technical viewpoint, the breast requires restoration of the container, or skin envelope, which must be recreated, and the content, or volume, which must be provided. In a second stage, 2 or 3 months later, when the reconstructed breast has found its new volume after atrophy of the muscle, it will be time to consider creating breast symmetry, when the nipple–areola complex is reconstructed.

27.4 Indications/Contraindications

The latissimus dorsi is the flap of choice because reconstruction with this muscle it is a safe and reliable technique. It can be used in the vast majority of clinical situations. Whether the patient is slim or overweight, her morphology is not in itself a contraindication to use of this technique. It can be used in delayed or immediate breast reconstruction. It can also be used even in an adjuvant radiotherapy context.

Contraindications are very rare: a lesion of both the latissimus dorsi pedicle and the serratus anterior pedicle, or a congenital absence of the latissimus dorsi. It is important to check for the existence of a muscular contraction by the resisted adduction test to ensure the presence of a functional latissimus dorsi with a preserved motor nerve. The preservation of the nerve is almost invariably accompanied by a patent thoracodorsal pedicle. Relative contraindications of the flap are dorsal pathologic abnormalities (scoliosis, chronic rachis wounds) and when patient refuses a scar in the back.

27.5 Surgical Procedure

27.5.1 Preoperative Planning

Preoperative assessment takes into account all data obtained during a visit prior to the procedure. Particular attention should be paid to the function of the latissimus dorsi [1], which if good generally indicates that the thoracodorsal pedicle is intact. Some items are important: skin and fat that can be harvested in the laterodorsal region, and assessing dorsal adiposity by pinching the natural laterodorsal pad. The volume obtainable should be compared with the desired volume of the breast. If the estimated volume, after atrophy of the muscle, is inadequate when compared with the volume of the opposite breast, secondary lipomodeling should be included in the operative planning. Patients are informed that there will be a horizontal, curved dorsal scar. More and more in delayed reconstruction, the thoracic scar from the mastectomy continues to a dorsal scar to decrease length of this scar.

27.5.2 Design

The reconstruction is designed (Fig. 27.1a) with the patient in a standing position [1]. She is asked to lean the bust

sideways (Fig. 27.1b, c) in order to reveal the natural folds of the skin and fat. The dorsal skin paddle follows these lines, forming a crescent with a concave upper curve (Fig. 27.1c). The amount of skin available should be carefully assessed using the pinch test so that closure can be performed entirely free from tension. The medial extremity of the paddle lies between the inferior angle of the scapula and the spine, whereas the lateral extremity may extend a few centimeters beyond the anterior margin of the muscle, depending on the patient's morphology. In delayed reconstructions with an important previous subaxillary dog ear from the mastectomy, it is useful to integrate the dog ear into the flap, to avoid a bigger dog ear after the abdominal advancement flap.

27.5.3 Surgical Technique

The patient is placed in a lateral decubitus position (Fig. 27.1d), with the arm in abduction to open the axillary hollow. Physiological saline infiltration is done in the dorsal area. This makes dissection under the fascia superficialis easier by making it more visible. The skin paddle is incised by a single cut down to the fascia superficialis (Fig. 27.1e, f). Dissection then follows the deep aspect of the fascia superficialis, taking care to leave the deep fat on the muscle (zone 2). The upper part of the undermined area reaches the inferior angle of the scapula. In the internal part, the fascia superficialis is undermined up to the trapezius. The whole area of fatty tissue (Fig. 27.1g) between the superior border of the latissimus dorsi, the trapezius, and the upper limit of undermining forms the surface of the scapular hinge flap (zone 3). Then, the flap is harvested with respect to the trapezius, teres major and rhomboid muscle. The cutaneous prolongation of the circumflex scapular pedicle should be carefully ligated. In the lower part, undermining should be a little wider than in the area of the latissimus dorsi to make it easier to release the muscle later. The lower limit lies a little above the iliac crests in order to harvest fat from the love handles (zone 5). In the medial part, the cutaneous perforators of the intercostal posterior arteries that lie above the transverse processes mark the limit. In the lateral part, dissection begins a few centimeters forward of the anterior margin of the latissimus dorsi in order to harvest fat in zone 4. The muscle is then separated at a deep level from the serratus anterior by starting at about 15 cm from the axilla, because dissection is easy there [1]. Submuscular undermining is continued by harvesting the deep fat (zone 6) and by carefully ligating or coagulating the accessory pedicles (Fig. 27.1h). When the latissimus dorsi has been completely undermined, its distal part is transected, from the deep part toward the surface, as horizontally as possible in order to include as much fat bulk as possible, in particular zone 5 of the flap. In the axillary region, the pedicle is then freed so that it can be transposed without tension or kinking, and the latissimus dorsi tendon is sectioned. The pedicle is approached posteriorly by releasing the teres major from the latissimus dorsi, in a distal to proximal direction. The origin of the latissimus dorsi pedicle (Fig. 27.1i) is identified by following the pedicle of the serratus anterior up to the Y-shaped bifurcation. The branch of the serratus anterior should be carefully preserved to ensure blood supply to the flap if there is a lesion of the thoracodorsal pedicle. To make flap transposition easier, the scapular angular artery is ligated. When the pedicle has been identified, a finger is passed under the tendon (between the pedicle and the tendon) to protect it during partial proximal section of the tendon. The flap is then ready (Fig. 27.1j) to be transposed to the breast area via a subcutaneous tunnel or directly if the thoracic/dorsal scar is to be continued. The donor site [8] is closed (quilting suture) after irrigation of the whole area of the undermining in order to obtain perfect hemostasis (one suction drain).

27.5.4 Positioning and Modeling of the Flap

Positioning and modeling of the flap differ according to two situations: delayed breast reconstruction and immediate breast reconstruction.

27.5.4.1 Delayed Reconstruction

To meet our objectives, in most cases we try to limit or rather to avoid using dorsal skin on the breast. The skin of the breast is reconstructed with adjacent skin from a thoracoabdominal advancement flap [9]. The flap is then placed in position in the newly created breast pocket. After it has been ensured that closure is possible without excessive tension, the decision is taken to totally bury the flap, and the skin is then entirely excised with removal of the dermis (dedermization). The flap is then modeled very simply by placing zone 1, with the dermis removed, in a vertical position oriented along the mammary axis, without folding or the need for any particular modeling (it is the cutaneous compartment which gives the breast its shape). Two suction drains are inserted and then closure is performed in two planes (Fig. 27.1k, l).

27.5.4.2 Immediate Reconstruction

We usually reserve immediate reconstruction for patients who will not receive complementary radiotherapy.

Modeling is begun by recreating the limits of the normal breast compartment. The inframammary fold and its axillary extension are the most important to recreate. The flap is secured at the upper limits of the mastectomy area by two absorbable sutures. The distal part of the muscle and its

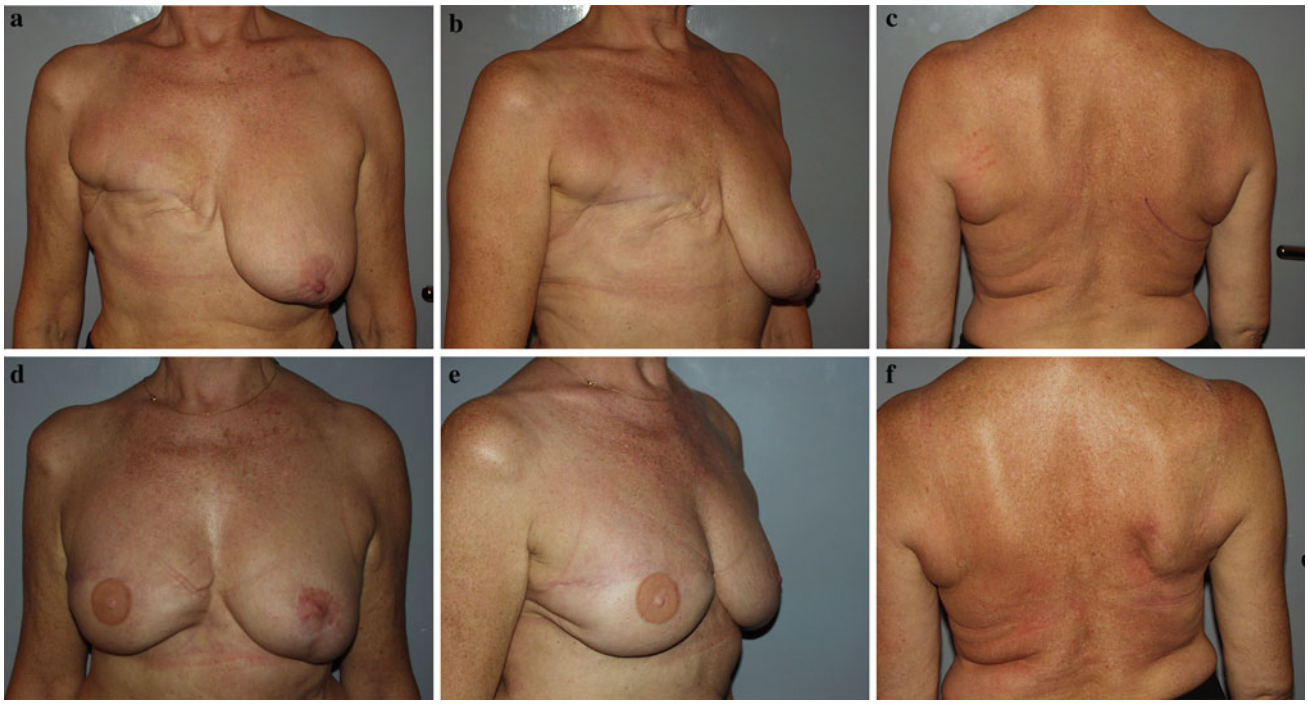

Fig. 27.2 Patient aged 61 years. Breast implant failure. Delayed right breast reconstruction combining an autologous latissimus dorsi flap with an abdominal advancement flap. Left breast mastopexy. Result at 12 months. **a** Preoperative frontal view, **b** preoperative oblique view, **c** preoperative rear view, **d** postoperative frontal view, **e** postoperative oblique view, and **f** postoperative rear view

underlying fat are folded under the breast mound to increase volume and projection. After the latissimus dorsi flap has been placed in position, the skin paddle is brought out through the mastectomy incision. It is shaped like an asymmetrical U and is sutured in that position. At the apex of this cone, two rectangular dermal-fat flaps with a central pedicle of about 2 cm × 1 cm (for a medium-sized nipple) are raised. The dorsal skin paddle (with its anterior extremity detached from the muscle for 3–4 cm) is folded above the areola to form a cone. As the position of the areola is predefined and since secondary nipple reconstruction using local flaps or composite nipple grafts is known to give disappointing results with flat nipples lacking projection, we tend to reconstruct the nipple at the same time as the breast. We reconstruct the nipple using the skin paddle of the latissimus dorsi flap (Fig. 27.4d, e). As previously described, a bifoliate design is used and the skin flaps are rolled around each other, recreating the nipple [10]. The reconstructed breast must be larger than the expected final result and the nipple–areola complex must be 1 cm higher at the end of the procedure [11]. Since 2007, to reduce operating time and avoid changing positions, we try to do all the modeling with the patient in the lateral decubitus position. But we finish the procedure with the patient in the lateral position and do the dorsal dressing. The patient is put in a sitting position to check the shape of the reconstructed breast: if the result is good, the procedure is finished; if it is not, we reopen the reconstructed breast to improve the modeling. This approach saves 30 min of operating time, and is useful for the very experienced surgeon.

27.6 Results

The results of breast reconstruction with the autologous latissimus dorsi flap were first evaluated in 1998, followed by a study of 400 cases in 2001. The assessment of the results by both patients and surgeons showed a very high satisfaction rate of 97 % (evaluated as very good in 87 % of cases by the surgeons and in 85 % of cases by the patients, good in 10 % of cases by the surgeons and in 12 % of cases by the patients). In no case was the reconstruction considered a failure. Residual scarring of the back was considered minimal by 96 % of patients, and moderate by 4 %. In addition to the satisfactory morphological result, autologous latissimus dorsi breast reconstruction enabled patients to better integrate their new body image and to feel more feminine, in particular because of the sensitive [12], supple, warm, and natural feeling of the flap. Lipomodeling also improves perception of the flap, by making it supple enough to recover the consistency of a natural breast.

We present some clinical cases with long-standing results in Figs. 27.2, 27.3, 27.4 and 27.5.

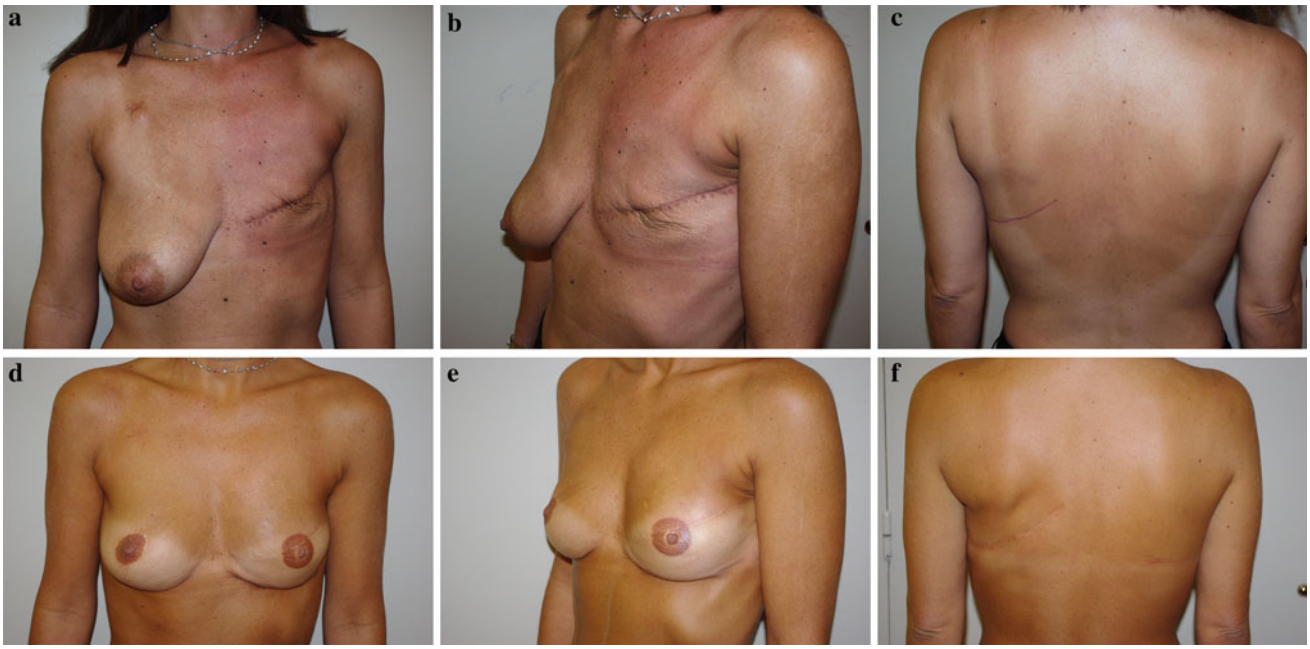

Fig. 27.3 Patient aged 45 years. Radiotherapy. Delayed left breast reconstruction in a slim patient: autologous latissimus dorsi reconstruction with an abdominal advancement flap. Right mastopexy and left lipomodeling (251 cm^3) at 5 months. Result 12 months after the last session. **a** Preoperative frontal view, **b** preoperative oblique view, **c** preoperative rear view, **d** postoperative frontal view, **e** postoperative oblique view, and **f** postoperative rear view

27.7 Complications

We describe the complications possibly associated with the procedure (1,000 surgical procedures done by the senior author), the strategies used to prevent their occurrence, and the techniques available for managing such complications when they occur.

27.7.1 Immediate Complications

- *Latissimus dorsi myocutaneous flap necrosis* one patient with complete flap necrosis (nonpatent vascular pedicle), and two patients with partial necrosis (maintenance of pure autologous reconstruction thanks to the lipomodeling procedure in the second stage). Early surgical reintervention was required on postoperative day 6 to remove the latissimus dorsi flap before onset of infection. Placement of a small abdominal advancement flap allowed subsequent breast reconstruction with subpectoral prosthesis implantation [1].
- *Postoperative dorsal hematoma* The risk of hematoma formation is related to the extent of the flap and is similar to that for patients undergoing classic latissimus dorsi flap harvest: less than 1 %. Careful ligation and cauterization of secondary segmental pedicles and compressive dressing of the wound are required to achieve good hemostatic control.
- *Infection* Owing to the autologous nature of the procedure and because the latissimus dorsi is highly vascularized, the risk of infection is extremely low (less than 1 %). Infection of the dorsal seroma is reported in approximately 1 % of cases. It is generally attributed to secondary superinfection in patients undergoing draining puncture.

27.7.2 Early Complications

- *Skin morbidity at the donor site* The extensive dorsal undermining required for elevating the pedicled myocutaneous latissimus dorsi flap can cause some compromise to the skin. The risk is relatively low (only 1 % in our patients). Skin necrosis happens when the flap harvested is too thick, with a dissection performed above the fascia superficialis [1]. Skin necrosis also occurs when an extensive dorsal paddle is harvested. We report no skin necrosis in our series.
- *Skin morbidity at the recipient site* In patients undergoing immediate breast reconstruction, the skin of the breast is preserved. Skin morbidity in these patients is thus not directly related to the technique used for reconstruction. In the case of delayed breast reconstruction with a thoracoabdominal advancement flap, marginal skin necrosis

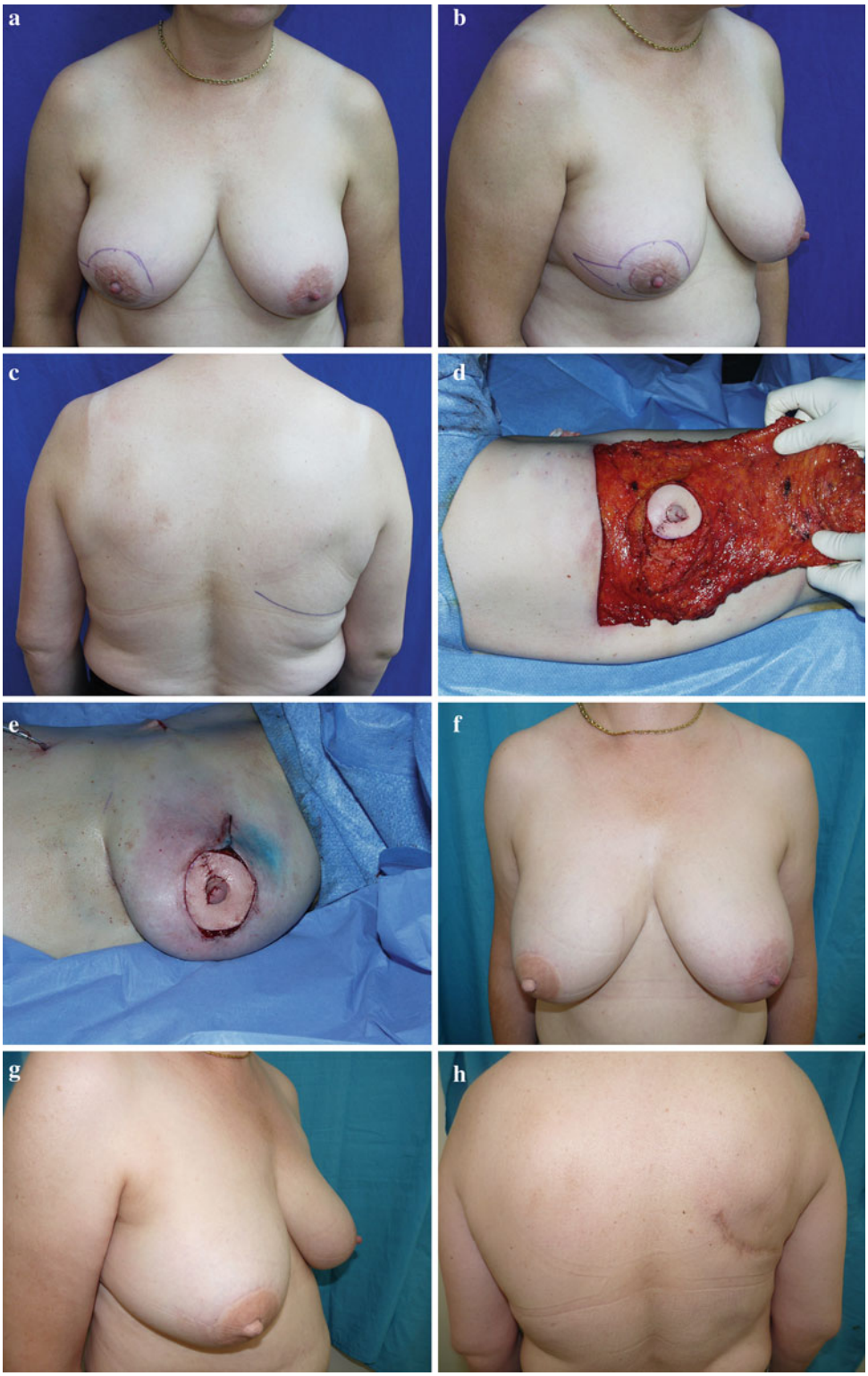

Fig. 27.4 Patient aged 43 years. Right immediate autologous latissimus dorsi breat reconstruction and immediate nipple reconstruction after skin-sparing mastectomy. Lipomodeling of the right breast (231 cm^3). Result 12 months after lipomodeling.
a Preoperative frontal view, **b** preoperative oblique view, **c** preoperative rear view, **d** perioperative latissimus dorsi flap, **e** perioperative nipple–areola complex reconstruction, **f** postoperative frontal view after latissimus dorsi reconstruction, **g** postoperative oblique view after latissimus dorsi reconstruction, and **h** postoperative rear view

is seen in approximately 5 % of patients. Marginal necrosis (0.5–1 cm) is amenable to excision and closure with the patient under local anesthesia, or secondary closure with insertion of a local flap.

- *Seroma formation at the donor site* This is the commonest and the mildest complication of the latissimus dorsi flap. In our experience seroma occurrence is more of a nuisance than a complication, and it has not

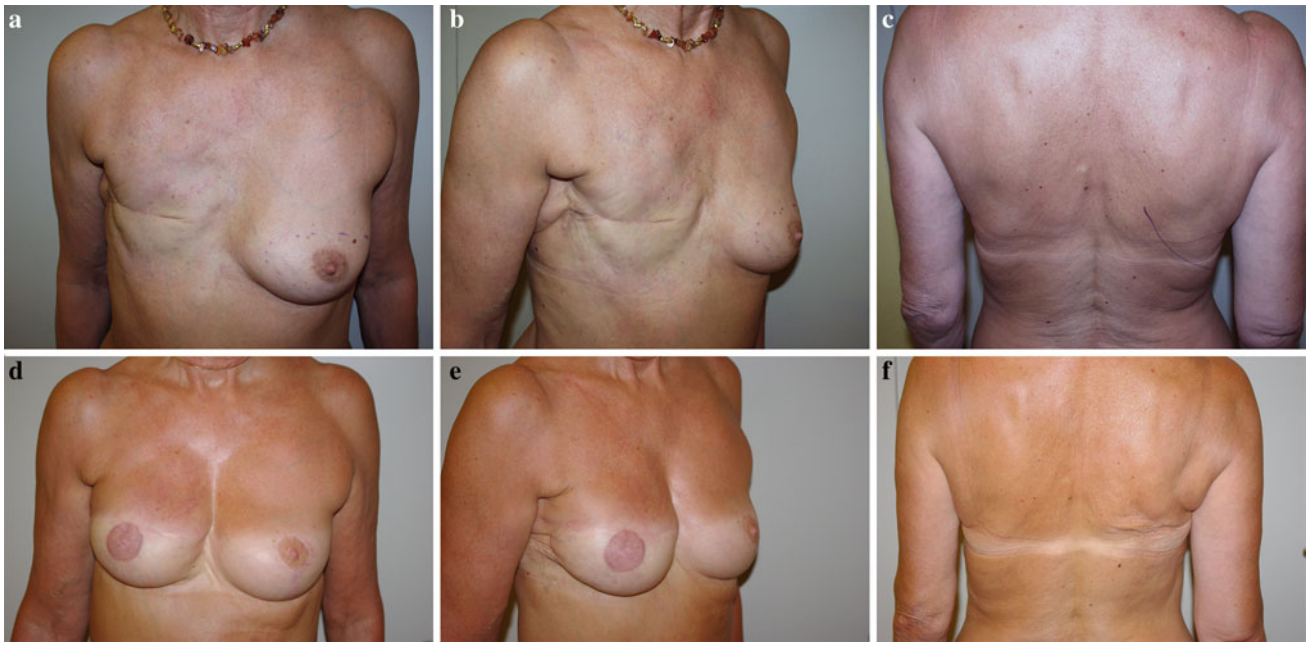

Fig. 27.5 Patient aged 48 years. Left immediate autologous latissimus dorsi breast reconstruction and immediate nipple reconstruction after skin-sparing mastectomy. Right autologous latissimus dorsi breast reconstruction, 6 months later. Lipomodeling of both reconstructed breasts (239 cm^3 *left breast*, 244 cm^3 *right breast*). Result 12 months after lipomodeling. **a** Preoperative frontal view, **b** preoperative oblique view, **c** preoperative rear view, **d** postoperative view after reconstruction, **e** postoperative oblique view after reconstruction, and **f** postoperative rear view after reconstruction

prevented the extensive development of the technique in our institution. Since early 2006, we have used quilting sutures systematically in our patients. The technique [8] consists in placing numerous stitches between the fascia superficialis and the thoracic wall (ten stitches on the upper cut dorsal flap, and nearly 16 stitches on the lower dorsal flap). Seroma incidence rates decreased from 21 to 9 % in our patient population.

- *Scapular sequelae* Latissimus dorsi muscle harvest may result in long-term deficit of shoulder function. However, the loss of the latissimus dorsi is well compensated by other muscles of the shoulder. In some rare cases (1 %), the patient may experience transient shoulder stiffness or even develop scapulohumeral periarthritis. This damage is more frequent after immediate postmastectomy breast reconstruction , when the constraints of reconstruction cumulate with those of mastectomy and axillary dissection, but it may also occur in patients undergoing mastectomy alone. Coping and psychological follow-up are very important to limit scapula and dorsal pains.

27.7.3 Late Complications

- *Loss or insufficient breast volume* There is usually a loss of breast volume in the 3 months following reconstruction [13]. Plastic surgeons involved in these procedures must have thorough knowledge of the outcome of fat grafting after autologous latissimus dorsi flap reconstruction. Lipomodeling [2, 13] should be offered to the patient after the autologous latissimus dorsi transfer. If the volume of the reconstructed breast decreases after a few months, it might be possible to improve the match with the natural breast by lipomodeling [14] with very good results in long-term follow-up. A transient overcorrection of the volume of the breast is necessary to obtain satisfactory results in the long term [15, 16]. When large breast augmentation is required, lipomodeling is repeated in several sessions [17, 18].
- *Dorsal pain* The intensity of pain may differ according to the patient's physical and psychological state, ranging from "no discomfort at all" to "intense pain." Pool physiotherapy is also a fundamental tool to achieve early and complete back and shoulder rehabilitation.
- *Dorsal hematoma* The late occurrence of a seroma–hematoma is reported in 2 % of our first 400 patients. Hematoma is caused by the collection of blood under the wound, at the donor site, possibly due to the rupture of a vein while making violent movements. Like dorsal seroma, this complication has decreased dramatically with the systematic use of quilting suture for the closure of dorsal wounds.

27.8 Conclusion

The autologous latissimus dorsi flap has become a procedure which is perfectly adapted to pure autologous breast reconstructions. After various technical improvements, its ease of use, versatility, reliability, acceptable constraints, and low complication rate make this technique our major surgical procedure for autologous breast reconstruction. Because of its excellent blood supply, the latissimus dorsi can be used in difficult reconstructions, in particular where there is marked radiation damage (recurrences after breast conservative treatment). A second stage with lipomodeling is indispensable to optimize the results by creating a reconstructed breast with volume, shape, and consistency close to those of a normal breast. We consider the autologous latissimus dorsi as an efficient recipient site for fat transfer (matrix for fat grafting).

This procedure needs a learning curve and specific training to produce best results. In our experience, this technique provides excellent long-term results in autologous breast reconstruction.

References

1. Delay E, Ho Quoc C, Garson S, Toussoun G, Sinna R (2010) Reconstruction mammaire autologue par lambeau musculo-cutanéo-graisseux de grand dorsal pédiculé. In : EMC (Elsevier Masson, Paris). Techniques chirurgicales—chirurgie plastique reconstructrice et esthétique, 45-665-C
2. Delay E, Moutran M, Toussoun G, Ho Quoc C, Garson S, Sinna R (2011) Apport des transferts graisseux en reconstruction mammaire. In: EMC (Elsevier Masson, Paris), Techniques chirurgicales—chirurgie plastique reconstructrice et esthétique, 45-665-D
3. Tansini I (1906) Sopra il moi nuovo processo di amputazione della mamella. Gazetta Medica Italiana 57:141
4. Olivari N (1979) Use of thirty latissimus dorsi flaps. Plast Reconstr Surg 64:654–661
5. Hokin JA (1983) Mastectomy reconstruction without a prosthetic implant. Plast Reconstr Surg 72:810–818
6. Marshall DR, Anstee EJ, Stapleton MJ (1984) Soft tissue reconstruction of the breast using an extended composite latissimus dorsi myocutaneous flap. Br J Plast Surg 37:361–368
7. Delay E, Gounot N, Bouillot A, Zlatoff P, Rivoire M (1998) Autologous latissimus breast reconstruction. A 3-year clinical experience with 100 patients. Plast Reconstr Surg 102:1461–1478
8. Gisquet H, Delay E, Toussoun G et al (2010) Efficacité du capitonnage dans la prévention du sérome après lambeau de grand dorsal. Ann Chir Plast Esthet 55:97–103
9. Delay E, Jorquera F, Pasi P, Gratadour AC (1999) Autologous latissimus breast reconstruction in association with the abdominal advancement flap: a new refinement in breast reconstruction. Ann Plast Surg 42:67–75
10. Delbaere M, Delaporte T, Toussoun G, Delay E (2008) Mastectomies avec conservation de l'étui cutané: comment éviter les souffrances cutanées? Ann Chir Plast Esthét 53:208–225
11. Delay E, Mojallal A, Vasseur C, Delaporte T (2006) Immediate nipple reconstruction during immediate autologous latissimus breast reconstruction. Plast Reconstr Surg 118:1303–1312
12. Delay E, Jorquera F, Lucas R et al (2000) Sensitivity of breasts reconstructed with the autologous latissimus dorsi flap. Plast Reconstr Surg 106:302–309
13. Delay E (2006) Lipomodeling of the reconstructed breast. In: Spear SE (ed) Surgery of the breast: principes and art, 2nd edn. Lippincott Williams and Wilkins, Philadelphia, pp 930–946
14. Delay E, Garson S, Tousson G, Sinna R (2009) Fat injection to the breast: technique, results, and indications based on 880 procedures over 10 years. Aesthet Surg J 29:360–376
15. Delay E (2010) Fat injections to the breast: the lipomodeling technique. In: Hall-Findlay E, Evans GRD (eds) Aesthetic and reconstructive surgery of the breast. Elsevier, New York
16. Delay E, Garson S, Tousson G, Sinna R (2009) Fat injection to the breast: technique, results, and indications based on 880 procedures over 10 years. Aesthet Surg J 29:360–376
17. Delay E (2009) Breast deformities. In: Coleman SR, Mazzola RF (eds) Fat injection: from filling to regeneration. Quality Medical Publishing, Saint Louis, pp 545–586
18. Sinna R, Delay E, Garson S, Delaporte T, Toussoun G (2010) Breast fat grafting (lipomodelling) after extended latissimus dorsi flap breast reconstruction: a preliminary report of 200 consecutive cases. J Plast Reconstr Aesthet Surg 63:1769–1777

Monopedicled TRAM Flap

28

Andrea Manconi

28.1 Introduction

The transverse rectus abdominis myocutaneous (TRAM) flap revolutionized breast reconstruction, allowing surgeons to create a breast that is soft, warm, and with a good and long-lasting result [1]. Despite advances in free flap breast reconstruction, pedicled TRAM flap breast reconstruction remains an excellent option for unilateral breast reconstructions. Unlike microsurgical breast reconstruction, the pedicled TRAM flap does not require sophisticated postoperative monitoring and can be performed efficiently in any hospital setting.

28.2 History

Robbins [2] described the use of a vertical rectus abdominis flap for breast reconstruction in 1979. Drever [3], Dinner et al. [4] and Sakai et al. [5] refined variations on the use of vertical rectus abdominis myocutaneous flaps for breast reconstruction, but initially Hartrampf observed during abdominoplasty procedures that the lower abdomen could survive as an island of tissue as long as the attachments to the rectus abdominis muscle were kept intact. Hartrampf et al. [6–8] took the bold step of changing the skin island orientation to a transverse one across the midabdomen, making a larger volume of tissue available for breast reconstruction with a cosmetically desirable donor site, describing in 1982 the TRAM flap as the use of the excess skin and subcutaneous fat that is routinely discarded in an aesthetic abdominoplasty for breast reconstruction. From these beginnings, the TRAM flap was destined to become the gold standard procedure for breast reconstruction, and nowadays it remains a very good surgical option. Subsequently, several free flap options have developed as refinements of the original pedicled technique, including the free TRAM, muscle-sparing free TRAM, and perforator flaps.

28.3 Anatomy

The skin and fat of the lower abdomen is supplied by five major sources:

1. Superior epigastric vessels arising from the termination of the internal mammary vessels
2. Deep inferior epigastric vessels
3. Superficial inferior epigastric vessels
4. Intercostal segmental vessels
5. The superficial and deep circumflex iliac vessels.

The predominant blood supply of these area is from the deep inferior epigastric system [9–11]. The vessels from both epigastric systems perforate the rectus abdominis muscles on their deep surfaces and travel as single or duplicated vessels up and down the flap, ascending to the skin in two rows, a medial one and a lateral one (Fig. 28.1). This system is cranially connected with the superior epigastric vessels, and represents the unique vascular pedicle used when raising a pedicled TRAM flap, even if the eighth intercostal vessels can be incorporated into the pedicle to augment blood supply if necessary.

Rectus abdominis muscles can be vascularized by three different patterns:

1. Type I: single superior and inferior arterial supply (29 %).
2. Type II: double-branched system from each source artery (57 %)
3. Type III: triple-branched system from each vessel (14 %).

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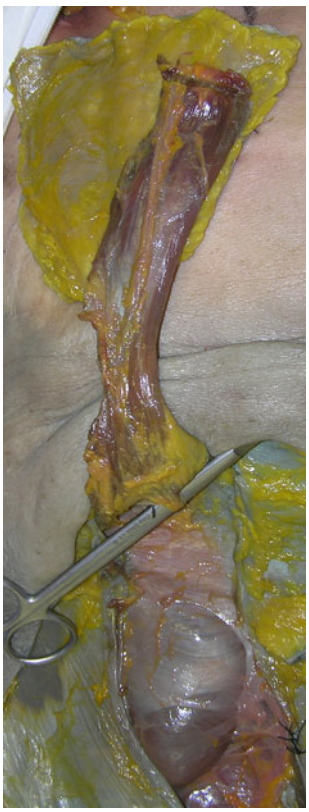

Fig. 28.1 Corpse dissection of a transverse rectus abdominis myocutaneous (TRAM) flap: scissors are collocated behind the superior pedicle and the flap is rotated toward the chest. The inferior pedicle running posteriorly to the rectus abdominis muscle is clearly visible

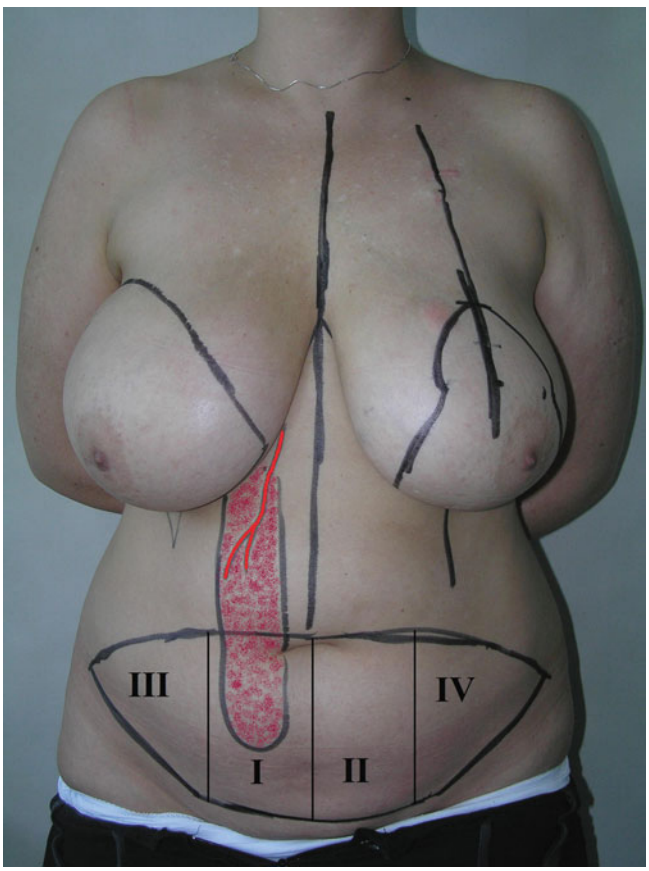

Fig. 28.2 TRAM flap vascular zone classification of Hartrampf

Symmetrical vascular pattern symmetry was described in only 2 % of patients.

Miller et al. [12] found that only 40–50 % of patients have macroscopic communication between the two systems, whereas 60 % of patients have choke vessels of microscopic caliber. The superior vessels pass into the muscle from the deep aspect of the costal margin and run inferiorly. The distal supply enters the posterolateral aspect of the muscle below the arcuate line and passes up to anastomose with the superior vessels in the periumbilical area. Major vascular supply is provided by the deep inferior vessel with venous drainage system supported by two large venae comitantes into the iliac vein. The inferior and the superior venous systems create an anastomotic web at the umbilical level. When a pedicled TRAM flap is raised, distal venous flow has to reverse and follow the drainage pattern of the superior veins, overcoming the venous valves within the choke system described by Moon and Taylor [11]. Arterial perforators arise in two rows aside the linea alba. The lateral row lies 2–3 cm within the lateral border of the rectus sheath, whereas the medial row lies 1–2 cm from the linea alba. These vessels differ significantly in both size and number; their caliber may vary up to several millimeters in diameter.

The anterior rectus sheath is tightly adherent to the muscle at the tendinous inscriptions. It is formed by two layers provided by external and internal oblique muscles in the lower rectus abdominis muscle and by a single layer in the upper rectus abdominis muscle. During flap elevation, it is possible to harvest a gentle strip of fascia within the muscle in order to keep it more resistant to tractions or to spare as much fascia as possible in order to provide a stabler closure of the door site [13]. A muscle-sparing technique can be used to leave a strips of muscle laterally and medially to assist in maintaining abdominal-wall strength, but it has been demonstrated that any muscular segment left loses neurovascular inputs [14, 15]. For these reasons nowadays the muscle-sparing pedicle TRAM flap can be considered obsolete. Two major vascular classifications exist for TRAM flap blood supply. The most classical description was introduced by Hartrampf (Fig. 28.2), who divided the supply into four zones:

1. Zone I: overlying the muscle pedicle
2. Zone II: lying across the midline, immediately adjacent to zone I
3. Zone III: lying lateral to zone I on the ipsilateral side
4. Zone IV: lying lateral to zone II on the contralateral side from the pedicle.

Zone I has been found to be the most reliable portion of the flap. The medial portion of zone III is the next most reliable portion of the flap, but its blood supply decreases close to the ipsilateral tip. The medial portion of zone II is

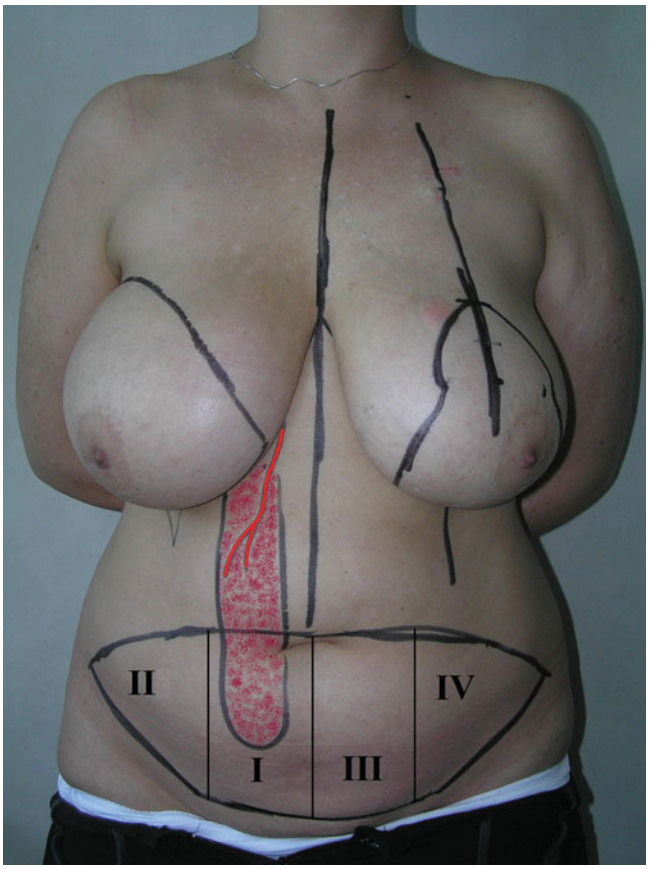

Fig. 28.3 TRAM flap vascular zone classification of Holm et al

also usually reliable, but the lateral part is less predictable. Finally, zone IV should always be considered as not vascularized and should be discarded routinely. Holm et al. [16] demonstrated that although zone I remains the most reliably perfused portion of the flap, any flow across the midline is more precarious than ipsilateral flow. So the classification of Holm et al. proposes that Hartrampf's zone III should be renamed zone II, and Hartrampf's zone II should be renamed zone III (Fig. 28.3).

Moon and Taylor [11] recommend surgical delay of the TRAM flap until 1 week before definitive elevation. The procedure focuses on ligation of the superficial and deep inferior epigastric systems in an outpatient setting. It increases arterial supply, but TRAM flap partial necrosis is often related to venous congestion rather than arterial inadequacy. A bigger flap can be raised with a bipedicled approach or as a free flap.

28.4 Surgical Technique

Appropriate patient selection is the key to achieving predictable results. Candidates for TRAM flap breast reconstruction must have sufficient lower abdominal tissue to achieve a successful reconstruction. Clinically, this can be evaluated by estimating the amount of superficial fat in the lower abdomen by squeezing the tissue between one's index finger and thumb (i.e., the "pinch test"). Patients with prior abdominal surgery should be carefully selected before undergoing TRAM flap reconstruction. A Pfannenstiel or McBurney incision is considered safe. The surgical technique for flap harvesting can be similar in immediate or delayed reconstruction. Preoperative markings consist in midline drawing (very effective in donor site closure to achieve a good symmetry and result) and cutaneous palette drawing. This is achieved by marking a suprapubic transverse straight or arcuate line from one inguinal fold to the other. Laterally, it continues upward in the inguinal fold or parallel to it up to the superior transverse mark. This line is drawn 1 or 2 cm above the navel and laterally it create an angle with the anterior superior iliac spine. Markings are variable in function of the amount of skin and fat available in the lower abdomen. Also inframammary folds are marked. Preoperative Doppler imaging is useful in order to find perforators but it is not mandatory. Recipient site markings are different in the case of immediate or delayed reconstruction. In immediate breast reconstruction, the breast undergoing mastectomy is marked with oncological patterns such as for Patey mastectomy, skin-sparing mastectomy, or nipple-sparing mastectomy.

In the case of delayed breast reconstruction, it is suggested to mark inframammary fold in the contralateral breast and to recreate the opposite one with the same footprint but 2 cm above: it will be lowered during the donor site closure by donor site suture tension. Skin between this marking and mastectomy scar should be removed in order to recreate a natural new inframammary fold but surrounding skin should be excised if there is radiodystropy. A tight mastectomy scar can also be cut in a Z-style incision to release skin tension is needed.

Perioperative assessment consists of heparin prophylaxis associated with pneumatic leg pumps. Blood transfusions can be required but should be prevented. The patient is positioned on a folding surgical bed.

Surgery starts by undermining the epigastric flap in a suprafascial plane. Skin is incised to the sheath with an upward 45° inclination in order to include as many perforators as possible and also in order to face the donor site skin flap with similar thickness (Fig. 28.4).

Rectus abdominis muscles are both individuated up to the rib arc and xiphoid. Rectus abdominis muscles and external oblique muscles are dissected on a suprafascial plane keeping a very thin layer of fat on the fascia in order to respect suprafascial vascularization as much as possible (Fig. 28.5).

Then, a tunnel is undermined to the breast. The tunnel should be large enough to let the surgeon's fist pass (Fig. 28.6). Before the flap dissection is continued, it is

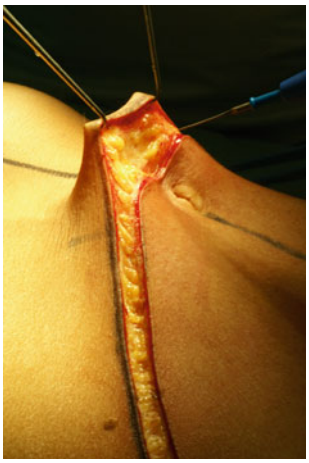

Fig. 28.4 Elevating the epigastric skin flap. A 45° initial incision can produce several improvements, such as better skin vascularization and better donor site closure with a nice aesthetic result

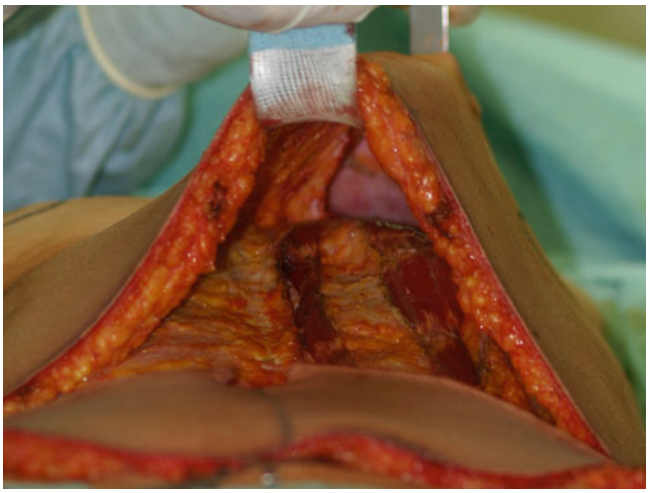

Fig. 28.6 A tunnel is undermined to transpose the flap to the chest. It should be large enough but it is suggested that dissection should not exceed the midline in order to respect the inframammary fold

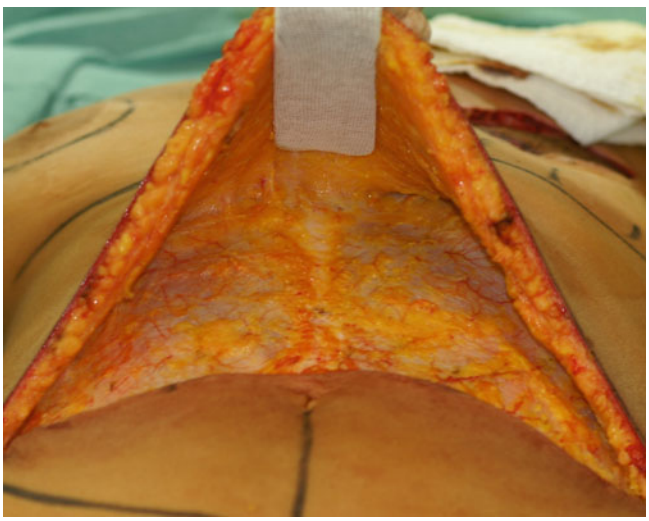

Fig. 28.5 Epigastric skin flap is elevated: the rectus abdominis muscles are both individuated up to the rib arc

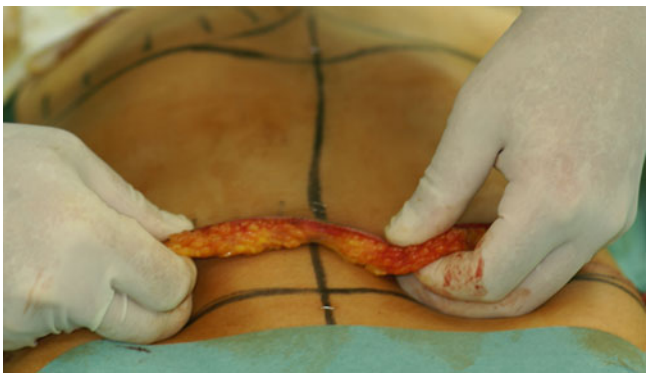

Fig. 28.7 Checking donor site closure. The patient can be moved to a slightly sitting position but skin tension should be avoided

helpful to tilt the patient in order to check donor site closure (Fig. 28.7). In case of excessive skin tension, it is possible to modify the preoperative lower markings.

Flap dissection continues with suprafascial dissection of the TRAM flap skin island from lateral to medial, identifying perforators (Fig. 28.8). The choice of an ipsilateral or a contralateral pedicle is based on the availability of good perforators. If possible, it is suggested to harvest an ipsilateral pedicle because it has been described as having better perfusion [17] and also a better arch of rotation. Also an ipsilateral pedicle avoids having a muscle bulge in the xiphoid after flap rotation.

Once it has been decided which side is to be dissected, the rectus sheath is incised all along its length medially the lateral border and a few millimeters laterally to the perforators. The fascia is also incised 1 cm laterally to the medial border of the muscle down to the skin palette (Fig. 28.9).

Muscle is dissected from the fascia and intercostal segmental vessels and nerves are ligated (Fig. 28.10). Main vessels run just beneath muscle so it is suggested that the posterior fascia should be dissected by fat surrounding main vessels.

Then, the inferior pedicle is ligated and muscle is divided downward the pedicle insertion in the muscle, if possible upward the arctuate line (Fig. 28.11).

The rectus sheath can be now incised from the inside, a few millimeters from the linea alba, in order to spare as much sheath as possible so as to repair the fascial defect more easily. Then, muscle perfusion should be checked: in the case of bad perfusion, it will be still possible to harvest a bipedicled TRAM flap; in the case of good muscular perfusion, the navel is isolated and cutaneous palette is

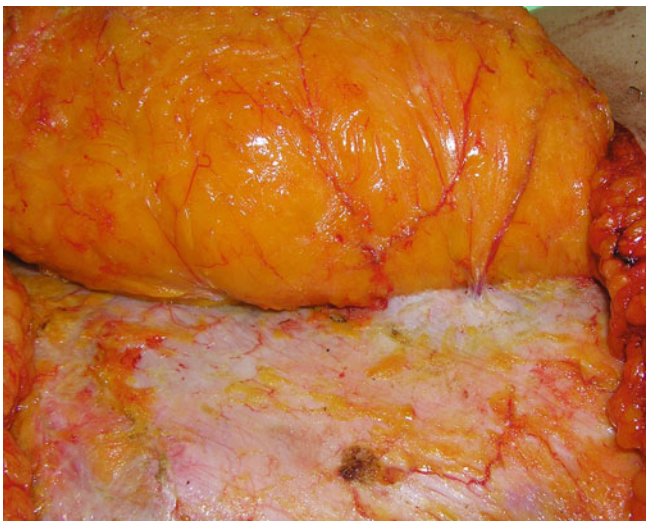

Fig. 28.8 Lateral view of the skin island after dissection. Perforators are usually identified in a row

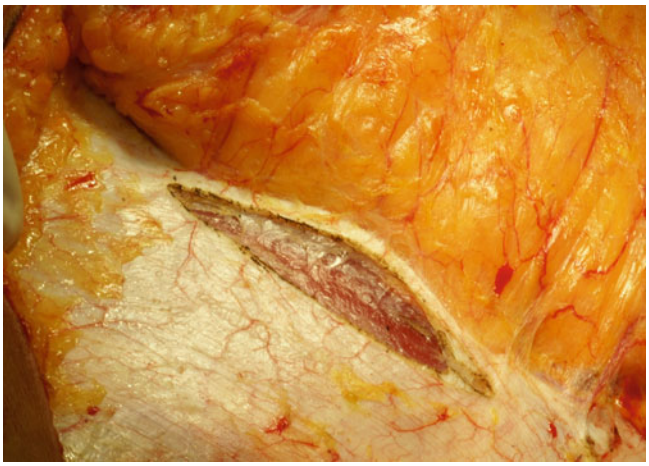

Fig. 28.9 Fascial dissection exposes rectus abdominis muscle

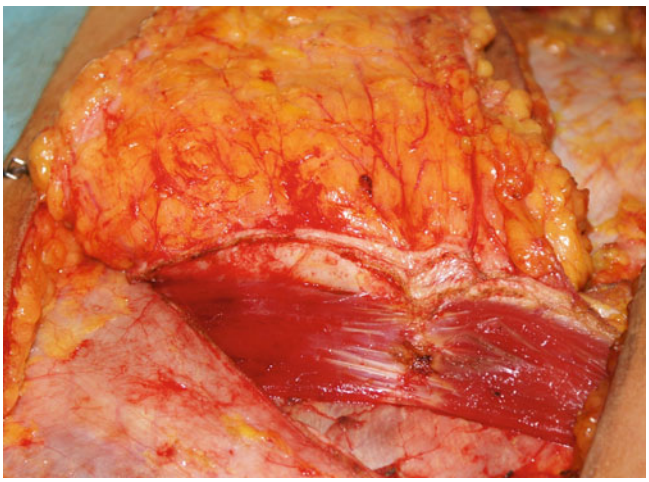

Fig. 28.10 Rectus abdominis muscle is exposed by surrounding aponeurosis

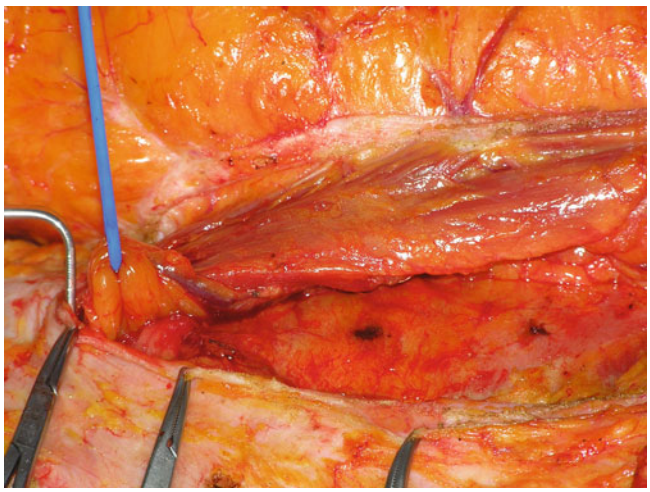

Fig. 28.11 Inferior pedicle is indentified (*blue marker*) and ligated before cutting the rectus abdominis muscle inferiorly

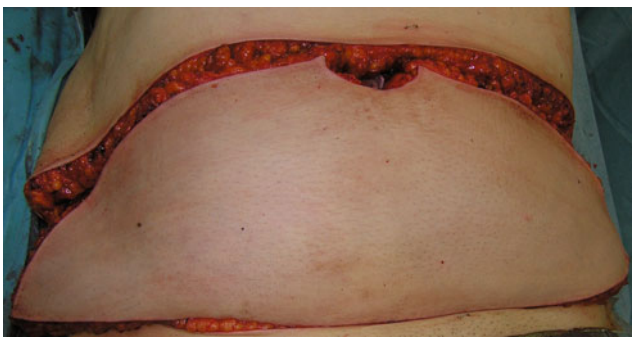

Fig. 28.12 TRAM flap skin island is congested after dissection. The skin color can be *reddish* or *bluish* and it is possible to identify the superficial vein net

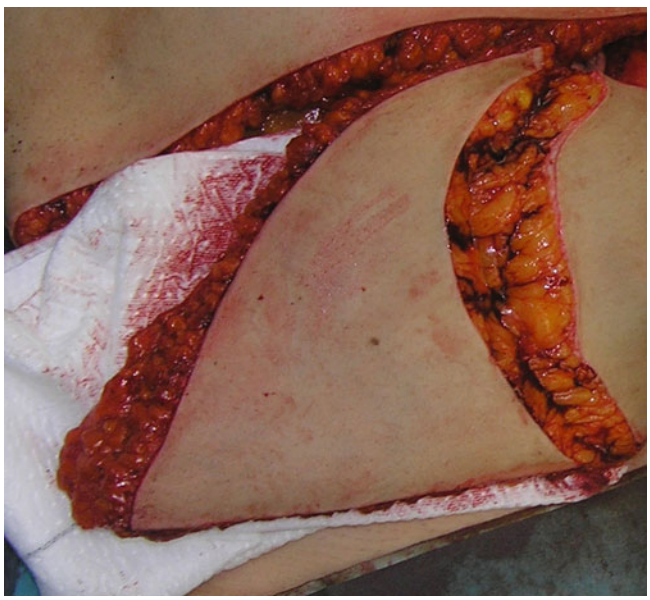

Fig. 28.13 TRAM flap extremities are less perfused, so it'd better to be excised. It is clearly visible a venous bleeding

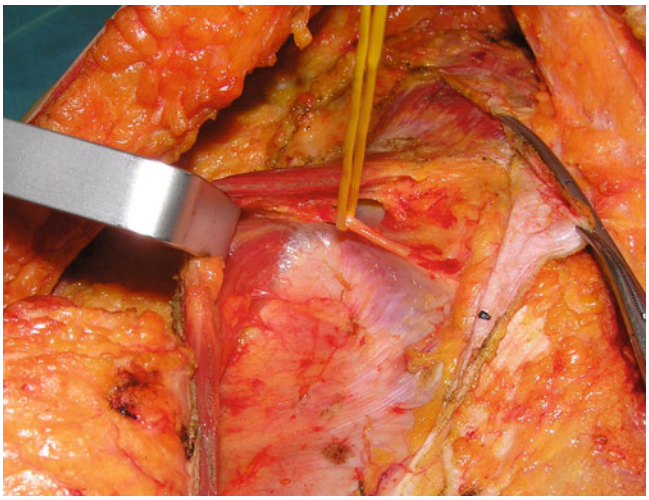

Fig. 28.14 The eighth intercostal nerve is isolated on the rib edge

dissected. Once the flap has been harvested, it can look congested but soon after it will achieve a well-perfused appearance (Fig. 28.12). This is a normal phenomenon, owing to the gradual opening of choke vessels that improves venous drain. Zone IV and partially zones II and III are resected and the flap is now ready to be transferred (Fig. 28.13).

It is essential to denervate the eighth intercostal nerve at the costal margin in order to avoid unpleasant muscle contraction after reconstruction (Fig. 28.14).

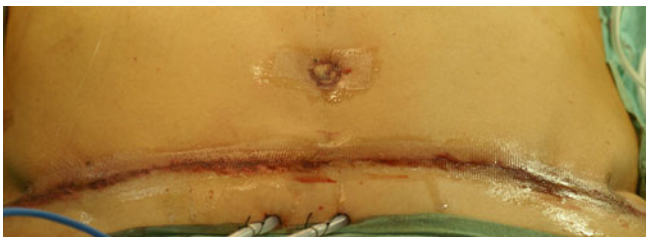

Fig. 28.16 Donor site closure with Prineo

28.5 Donor Site Repair and Closure

Competent rectus sheath closure is an essential procedure in any TRAM flap surgery because it should prevent the risk of hernia formation. It is essential to incorporate both the internal and the external oblique aponeuroses into the sheath closure [18]. We suggest incorporating a Mersilene mesh or an acellular matrix [19] in the closure, but some surgeons prefer not to use them, if not necessary, because of the risk of infection [20]. First, mesh is sutured to the medial edge of the remaining rectus fascia, then it is sutured laterally with single stitches transfixing external oblique muscle. Next, the lateral edge of remaining rectus fascia is sutured above the mesh in order to reinforce the closure (Fig. 28.15).

Before closure, the navel is repositioned in the midline, at the level of the ankle crease, defatting the epigastric flap. Quilting suture can avoid postoperative seroma formation

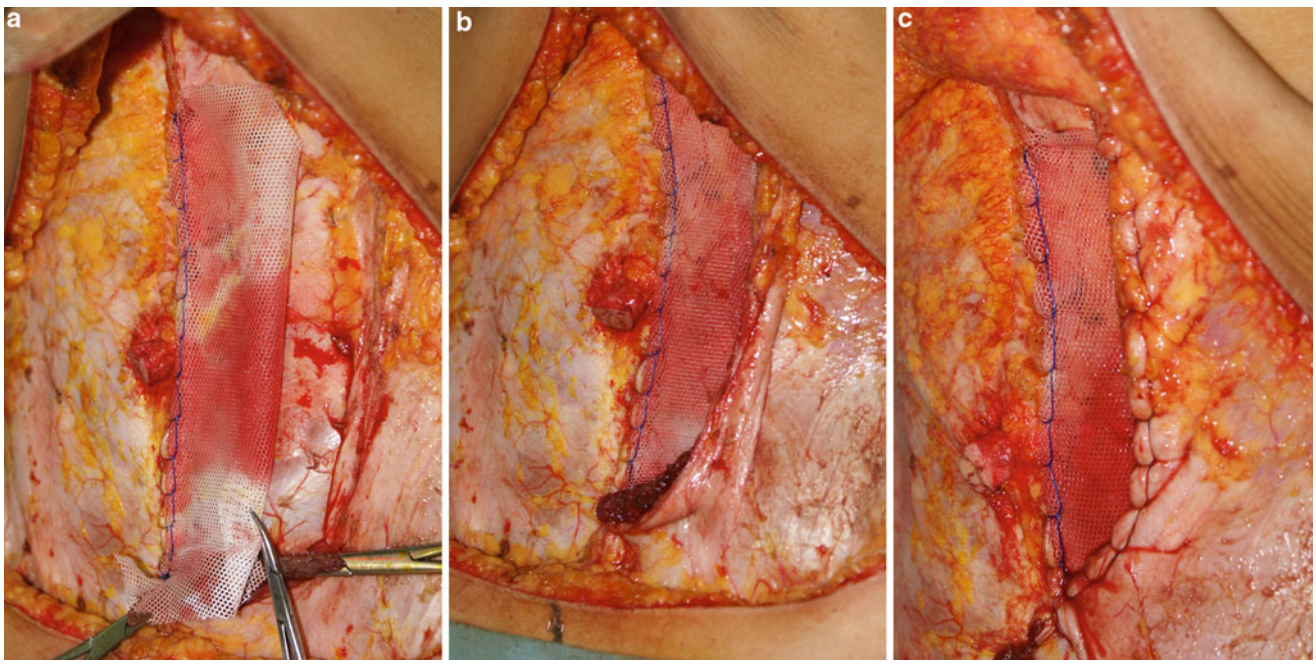

Fig. 28.15 Donor site repair with mesh. It is essential to suture the mesh to the residual rectus fascia in the midline, to fix it to the surrounding external oblique muscle compartment, and then to suture the rectus sheath edges to the mesh in a dual-layer approach

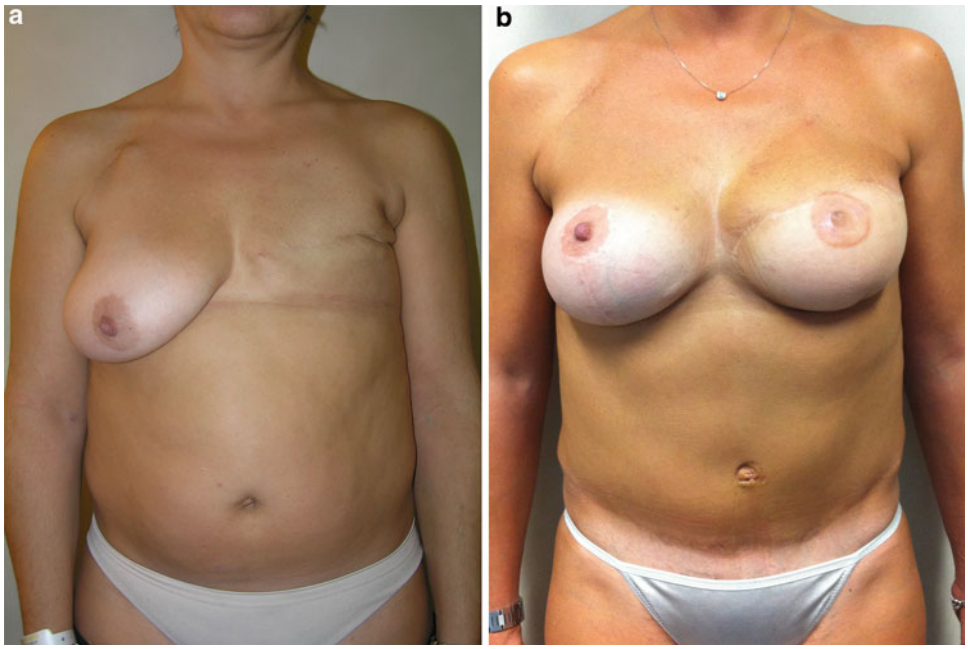

Fig. 28.17 TRAM flap and implant. A prosthesis is collocated under the pectoralis major muscle at the top and the rectus abdominis muscle at the bottom: intraoperative view of muscle suture

Table 28.1 Transverse rectus abdominis myocutaneous (TRAM) flap necrotic complication, European Institute of Oncology series 1994–2007

	Ipsilateral TRAM flap	Contralateral TRAM flap	Bipedicled TRAM flap	TRAM flap and implant
Partial necrosis (%)	12.22	14	3.26	7.89

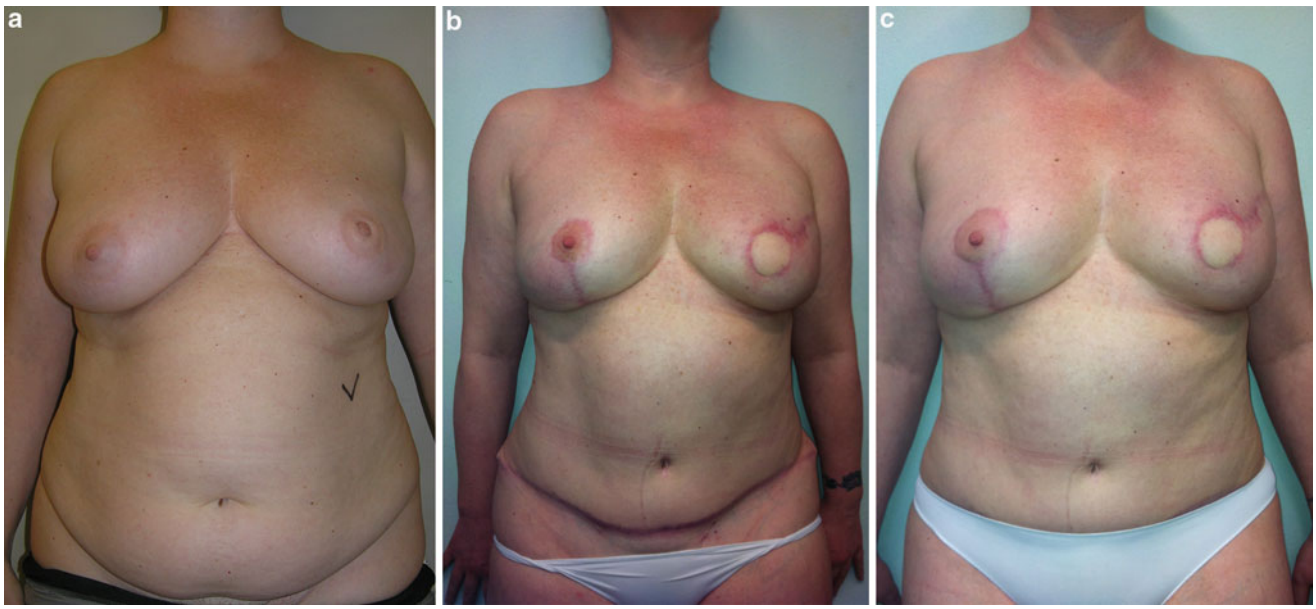

Fig. 28.18 Immediate left breast reconstruction with an ipsilateral pedicle TRAM flap after skin-sparing mastectomy: preoperative and postoperative images. Note that the abdominal scar can be easily hidden by panties

and also prevents tension in the abdominal triple-layer suture. Prineo is an automatic closure system that can be an effective and time-saving (Fig. 28.16). Note that donor site closure should be considered a very important phase of the procedure as good abdominal results are very important in demanding patients.

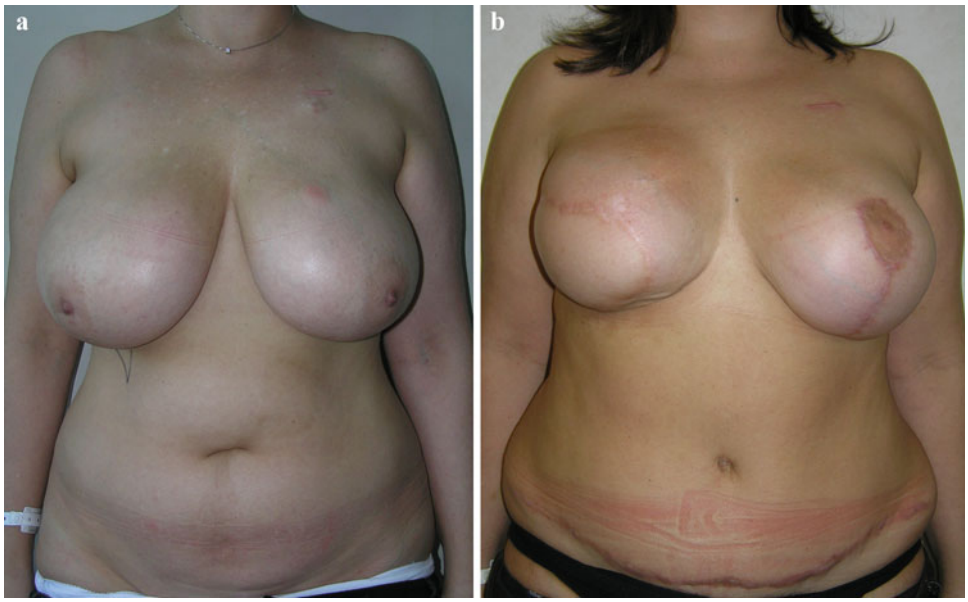

Fig. 28.19 Delayed left breast reconstruction with an ipsilateral TRAM flap: preoperative and postoperative images. Note the good symmetry but a lateral deviation of the navel and a little bulge to the side of it

28.6 Flap Remodeling

Once the flap had been harvested and transposed to the chest, the job is not yet completed: the following steps are probably the most important for patient satisfaction. We can distinguish different approaches in delayed or immediate reconstruction. In delayed reconstruction, scar should be excised and skin undermined in the whole breast footprint. It is important first of all to determine the new inframammary fold. It is possible to compare it with the contralateral side after donor site closure or to draw it in a line that will lie 1 or 2 cm above the contralateral inframmamary fold (that is because of the skin tension after donor site closure). A mastectomy scar can be a challenge because it can push the flap down to the chest wall with a retracted appearance. Mostly, the solution is to excise completely the retracted scar and also most of the inferior mastectomy skin flap. The skin paddle can be orientated in different ways, but the two principal suggestions are 180° and 90°. First, the skin paddle is fixed to the new inframammary fold and then the flap is put under mastectomy skin flaps after checking there is good bleeding all along the skin and fat margins. In the case of poor or venous bleeding, it is suggested to excise the less perfused area in order to avoid partial skin necrosis as much as possible. Contralateral symmetrization is often required. The volume should be compared to that of the contralateral breast (Fig. 28.17).

Once the symmetry has been achieved, the undermined flap skin is deepithelized and the flap can be sutured.

In the case of immediate breast reconstruction, breast reshaping is somewhat similar but it is easier in the case of nipple-sparing or skin sparing mastectomies, whereas the TRAM flap skin paddle is completely or almost totally deepithelized and then sutured to the chest wall, allowing easy remodeling like putting jelly in a mold. It is suggested to spare the original inframammary fold in order to keep the original ptotic appearance of the breast, creating a symmetrical result (Fig. 28.18).

28.7 TRAM Flap and Implant?

Somebody can identify a breast implant beneath a TRAM flap as an adulteration of a pure autologous reconstruction, but it is a very good indication in selected cases. It is indicated in cases such as the following:

- Patient requesting breast augmentation without the possibility to harvest a latissimus dorsi flap
- Patient refusing contralateral breast reduction
- Very large mastectomy or delayed breast reconstruction in patients with a wide radiodystrophic area to be excised
- Badly perfused flap.

If a bad blood supply is identified during dissection, it is suggested to harvest a bipedicled TRAM flap but, if the flap looks poorly perfused after transposition, the idea is to excise as much skin as needed. It does not matter how much volume you can lose because it can be replaced by an implant or an expander. In our series of patients with a TRAM flap and implant performed at the European Institute of Oncology, we obtained very good results in most cases (Fig. 28.19). A partial retropectoral pocket should be harvested, resecting pectoralis major muscle from rib and sternum insertions. In this way the implant can be collocated beyond the inferior free border of the pectoralis major muscle covering its upper pole and TRAM flap muscle

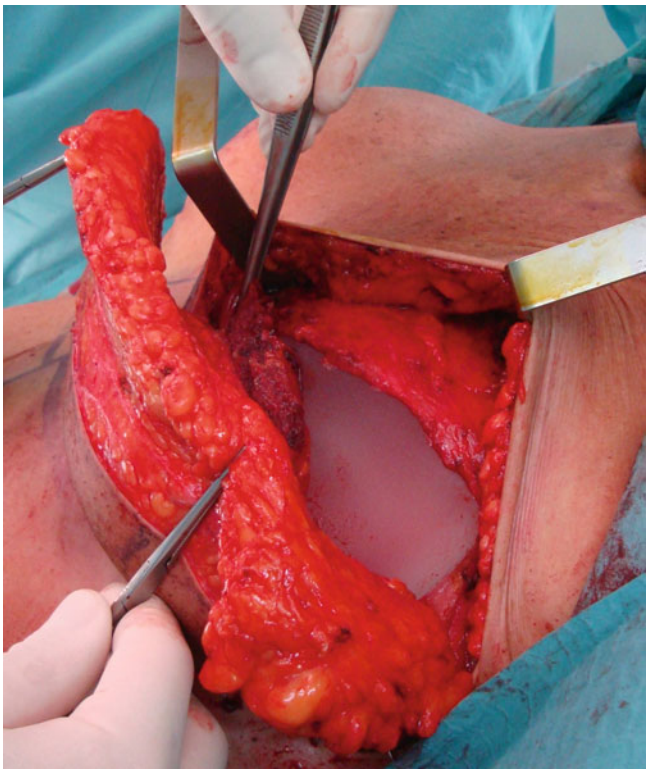

Fig. 28.20 Immediate breast reconstruction with a TRAM flap and implant: preoperative image and postoperative image after radiotherapy. In this case a mild capsular contraction can be observed

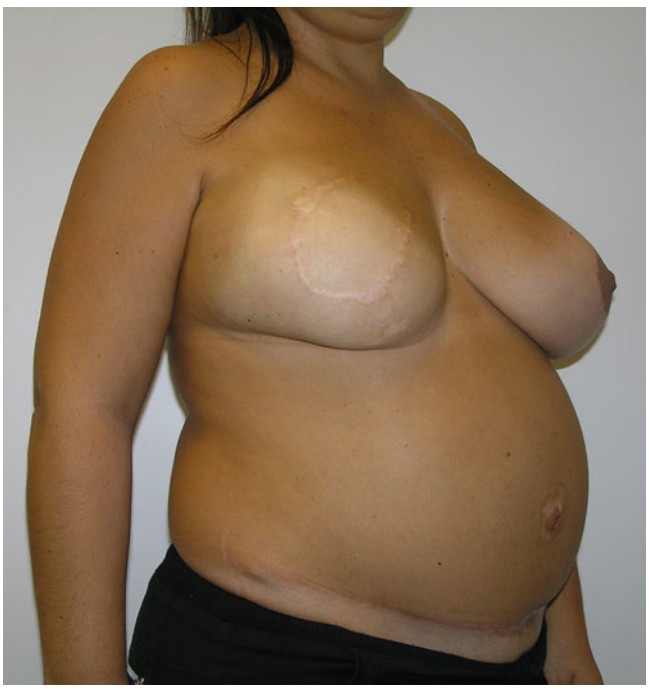

Fig. 28.21 Pregnancy after immediate reconstruction with a TRAM flap. This patient underwent cesarian delivery without complication for her or the newborn

covering the inferior one (Fig. 28.20). Delayed volume augmentation is still possible with an implant or fat grafting.

28.8 Complications

The major complications of delayed TRAM flap reconstruction include scarring, skin and fat necrosis, flap loss, hernia formation, deep venous thrombosis, asymmetry, abdominal tightness, and the psychosexual issues associated with breast reconstruction. Some degree of fat necrosis is common in any TRAM flap reconstruction whether free or pedicled. In our series we observed different rates of partial necrosis (requiring surgical debridement). Also, very rare total flap necrosis was observed (Table 28.1).

Donor site complications were observed but decreased as we improved the technique for donor site closure. In our series we observed an infection rate of 4.31 % and a rate of hernias or bulges of 4.15 % from 1996 to 2007 (Figs. 28.18, 28.19, 28.20).

28.9 TRAM Flap and Pregnancy

Despite the loss of muscle function after pedicled TRAM flap harvest, it is still possible for patients to conceive and carry a pregnancy to term as well as to achieve normal vaginal delivery [21]. Johnson et al. [22] described the successful vaginal delivery of monozygotic twins after bilateral pedicled TRAM flap reconstruction. Parodi et al. [23] caution against patients becoming pregnant within 12 months after TRAM flap surgery, reporting a single case of a woman becoming pregnant at 4 months postoperatively and developing a hernia. She delivered vaginally at term. We also observed some pregnancies after TRAM flap reconstruction without major diseases (Fig. 28.21).

References

1. Trabulsy PP, Anthony JP, Mathes SJ (1994) Changing trends in post mastectomy breast reconstruction: a 13 year experience. Plast Reconstr Surg 93(7):1418–1427
2. Robbins TH (1979) Rectus abdominis myocutaneous flap for breast reconstruction. Aust N Z J Surg 49(5):527–530
3. Drever JM (1977) Total breast reconstruction with either of two abdominal flaps. Plast Reconstr Surg 59(2):185–190
4. Dinner MI, Labandter HP, Dowden RV (1982) The role of the rectus abdominis myocutaneous flap in breast reconstruction. Plast Reconstr Surg 69(2):209–215
5. Sakai S, Takahashi H, Tanabe H (1989) The extended vertical rectus abdominis myocutaneous flap for breast reconstruction. Plast Reconstr Surg 83(6):1061–1067; discussion: 1068–1069

6. Hartrampf CR Jr (1988) The transverse abdominal island flap for breast reconstruction. A 7-year experience. Clin Plast Surg 15(4):703–716
7. Hartrampf CR Jr, Bennett GK (1987) Autogenous tissue reconstruction in the mastectomy patient. A critical review of 300 patients. Ann Surg 205(5):508–519
8. Scheflan M, Hartrampf CR, Black PW (1982) Breast reconstruction with a transverse abdominal island flap. Plast Reconstr Surg 69(5):908–909
9. Scheflan M, Dinner MI (1983) The transverse abdominal island flap: part I. Indications, contraindications, results, and complications. Ann Plast Surg 10(1):24–35
10. Taylor GI, Palmer JH (1987) The vascular territories (angiosomes) of the body: experimental study and clinical applications. Br J Plast Surg 40(2):113–141
11. Moon HK, Taylor GI (1988) The vascular anatomy of rectus abdominis musculocutaneous flaps based on the deep superior epigastric system. Plast Reconstr Surg 82(5):815–832
12. Miller LB et al (1988) The superiorly based rectus abdominis flap: predicting and enhancing its blood supply based on an anatomic and clinical study. Plast Reconstr Surg 81(5):713–724
13. Dinner MI, Dowden RV (1983) The value of the anterior rectus sheath in the transverse abdominal island flap. Plast Reconstr Surg 72(5):724–726
14. Suominen S et al (1996) Sequelae in the abdominal wall after pedicled or free TRAM flap surgery. Ann Plast Surg 36(6):629–636
15. Suominen S et al (1997) Magnetic resonance imaging of the TRAM flap donor site. Ann Plast Surg 38(1):23–28
16. Holm C et al (2006) Perfusion zones of the DIEP flap revisited: a clinical study. Plast Reconstr Surg 117(1):37–43
17. Clugston PA, Lennox PA, Thompson RP (1998 Dec) Intraoperative vascular monitoring of ipsilateral vs. contralateral TRAM flaps. Ann Plast Surg 41(6):623–628
18. Kroll SS, Schusterman MA, Mistry D (1995) The internal oblique repair of abdominal bulges secondary to TRAM flap breast reconstruction. Plast Reconstr Surg 96(1):100–104
19. Patel KM, Nahabedian MY, Gatti M, Bhanot P (2012) Indications and outcomes following complex abdominal reconstruction with component separation combined with porcine acellular dermal matrix reinforcement. Ann Plast Surg 69(4):394–398
20. Petit JY, Rietjens M, Garusi C, Giraldo A, De Lorenzi F, Rey P, Millen EC, Pace da Silva B, Bosco R, Youssef O (2003) Abdominal complications and sequelae after breast reconstruction with pedicled TRAM flap: is there still an indication for pedicled TRAM in the year 2003? Plast Reconstr Surg 112(4):1063–1065
21. Chen L, Hartrampf CR Jr, Bennett GK (1993) Successful pregnancies following TRAM flap surgery [comment]. Plast Reconstr Surg 91(1):69–71
22. Johnson RM, Barney LM, King JC (2002) Vaginal delivery of monozygotic twins after bilateral pedicle TRAM breast reconstruction. Plast Reconstr Surg 109(5):1653–1654
23. Parodi PC et al (2001) Pregnancy and tram-flap breast reconstruction after mastectomy: a case report. Scand J Plast Reconstr Surg Hand Surg 35(2):211–215

Bipedicled TRAM Flap

29

Paulo Roberto Leal

29.1 Introduction

Described by Hartrampf et al. [1] in 1982 and popularized by many authors during the last 30 years, the use of the transverse skin and fat harvested from the lower abdominal region, the so-called transverse rectus abdominis myocutaneous (TRAM) flap, is still considered by many to be the gold standard for breast reconstruction. It gives the surgeon the possibility to recreate a breast of a desirable size with controlled shape.

The pioneer publication suggested that use of the flap could be delayed to improve vascular perfusion (and the authors did this in their first three cases). In four cases the authors used preoperatively selective angiography in order to confirm the anatomic continuity between the internal thoracic and the deep epigastric system. Therefore, they recognized the potential incapacity for efficient blood perfusion of the total abdominal flap through a single pedicle.

This deficiency was demonstrated later by Moon and Taylor [2] in their radiographic studies of the deep superior epigastric artery. Their publication is considered to be a landmark in the breast reconstruction literature and created the basis for the understanding of the complex circulation of the TRAM flap.

It was shown that blood perfusion can be unpredictable beyond the midline. This potential difficulty was experienced by many surgeons. Fat and skin necrosis are frequently seen in different degrees when the flap is harvested in its total length.

Many suggestions were made to support a reliable blood supply to the entire flap. Delaying, supercharging, free flap transfer, and the bipedicled version of the TRAM flap are techniques that could effectively bring about better perfusion and therefore the possibility to enhance considerably the length of the abdominal flap [3–7].

The use of two pedicles for unilateral reconstructions has been demonstrated to be a simple way of improving the blood supply to the classic monopedicled TRAM flap. With this approach, theoretically, one could harvest the flap totally, beyond the safe zone [8] (Fig. 29.1).

Although currently I use the procedure only in very select cases, it is able to provide the surgeon with an excellent amount of well-perfused abdominal tissue comparable only to techniques using free flap transfer.

29.2 Indications

Its principal indication is to increase the circulation to the abdominal flap; therefore, the blood supply can be doubled and complications such as fat or cutaneous necrosis can be essentially minimized.

Maneuvers to improve the flap perfusion are used for patients with risk factors that can impair the perfect blood supply to the abdomen.

The most relevant risk factors are smoking, obesity, previous abdominal surgery, radiotherapy, and existence of systemic disease (diabetes, hypertension) [9] (Fig. 29.2).

29.3 Free Flap or Bipedicled TRAM Flap?

The apologists for the use of microsurgical technique to transfer the abdominal tissue for breast reconstruction (free TRAM flap, mastectomy flap, deep inferior epigastric perforator, DIEP, flap) are extremely emphatic when describing its many advantages.

The main one is the unquestionable better blood supply, once the flap nutrition is provided by the inferior epigastric system (it is the primary blood supply to the lower abdominal skin and subcutaneous fat). The second one

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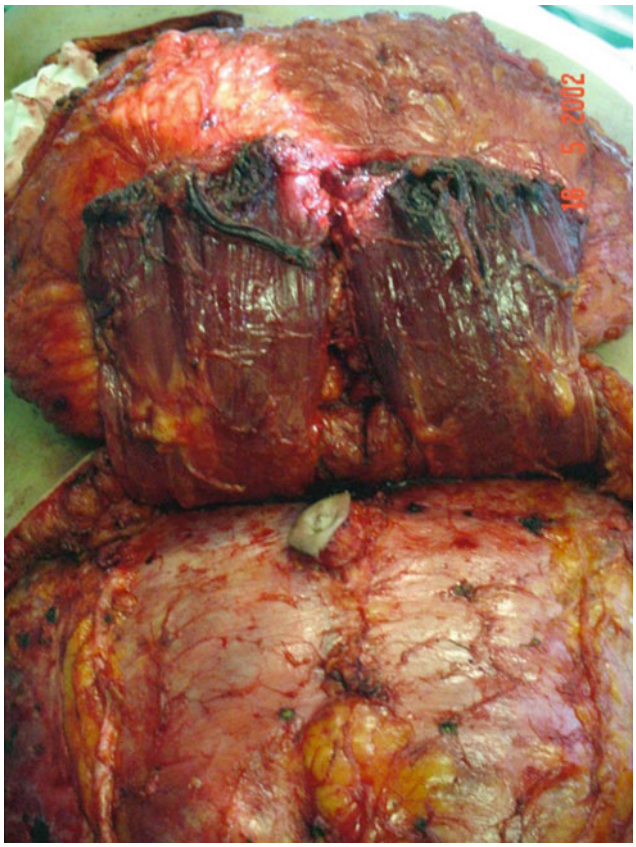

Fig. 29.1 The transverse rectus abdominis myocutaneous (TRAM) flap with its two pedicles

relates to the significant abdominal wall injury caused by the bilateral flap harvesting [10].

However, the free flap transfer demands especial skills of trained surgeons and nurses. The full control of the technique also depends on specialized staff to closely evaluate the patient during the postoperative period. Operating in a center where the patient can be safely taken to the operating room anytime for an urgent revision is also mandatory.

29.4 The Abdominal Wall Issue

It has been widely recognized that a unilateral or bilateral pedicled TRAM flap can lead to a considerable reduction of the abdominal strength (Fig. 29.3). Many publications on this subject witness the discomfort of authors with this topic.

An early study published by Hartrampf and Bennet [11] showed that the postoperative assessment of 300 women after bilateral harvesting resulted in a remarkable decrease of the abdominal strength, represented by an incapacity to perform sit-ups.

Also Petit et al. [12] in evaluating unilateral and bilateral pedicled TRAM flaps in 38 patients showed that 50 % of the single-pedicle transfers caused important impairment of the upper portion of the rectus and oblique muscles opposed to 60 % of the double-pedicle series.

The muscle-sparing technique (transferring only the central portion of the muscle, which contains the vessels) based on the work of Mizgala et al. [13] has not proved the expected efficiency in reducing the morbidity to the abdominal wall of the classic pedicled TRAM flap, unilateral or bilateral. On the other hand, splitting the muscle in pedicled flaps remains controversial and some surgeons [14] emphatically avoid doing this because of the vascular pattern of the epigastric system (choke vessels connect the superior and the inferior systems), where superficial to the rectus muscle an important net of arteries and veins can be injured during muscular division.

Finally, a recent study by Chun et al. [15] suggests there is no significant difference in donor site morbidity, functional outcomes and patient satisfaction when bipedicled TRAM or DIEP flaps are use din breast reconstruction, concluding that the technique remains a good choice for many patients who will undergo postmastectomy breast reconstruction with autologous tissue.

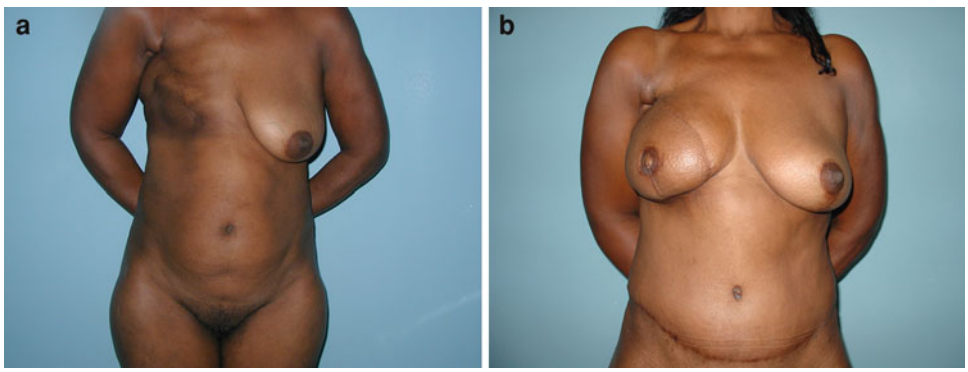

Fig. 29.2 Preoperative (**a**) and postoperative (**b**) delayed reconstruction on a patient with visible damage after radiotherapy. The bipedicled TRAM flap was a suitable option a with good outcome

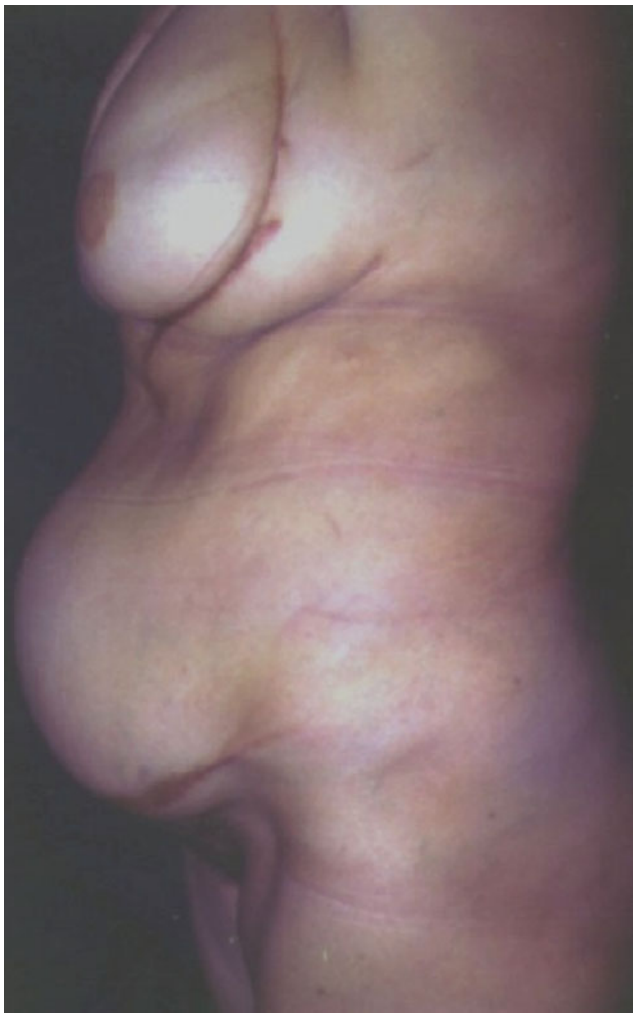

Fig. 29.3 Bulges and true hernias are more frequent with the bipedicled TRAM flap technique

29.5 Patient Selection

The success of the reconstruction employing the transfer of the lower abdominal tissue will ultimately depend on two factors: patient selection and the selection of the right procedure.

The patient is assessed for risk factors. Increased complication rates after TRAM breast reconstruction s are associated with the following risk factors: age (over 60 years), obesity (more than 25 % over ideal body weight), abdominal scars (primarily, Kocher, paramedian, or multiple abdominal surgical scars), diabetes mellitus, hypertension, previous radiotherapy applied to the chest wall, and smoking history.

I also consider it as indicated for patients who perform competitive high-impact sports or those who depend on intensive muscular dynamics at work (maids).

Anatomical assessment is also of paramount relevance, including abdominal contour and fat deposits (potbelly habitus patients are formally contraindicated for TRAM flaps).

The slender patient and those patients with poor abdominal strength or abdominal muscular laxity will not be considered for bipedicled TRAM flap reconstruction.

Preoperative testing by sit-ups is an easy and effective method to evaluate the abdominal strength. Patients who are not able to perform these movements are considered poor candidates too.

To select the right procedure, one simple question is mandatory: What are the patient's needs?

The primary indication for the bipedicled TRAM flap is the need for a large amount of abdominal tissue to replace a large breast (Fig. 29.4). The second is a need for increased vascularity. Patients who have risk factors will benefit from the technique. When we take as an example fat necrosis, a typical complication with its origin in poor vascular supply, for monopedicled flaps, patients with two or more risk factors have three times the incidence of those with no or one risk factor. Patients with two or more risk factors who had bipedicled TRAM flaps had no associated increased incidence of fat necrosis. For flap loss complications, similar findings have been noted.

29.6 Patient Education and Preoperative Care

The patient is clearly informed about the procedure. Postoperative pain and 4–5 days of hospitalization is emphasized. The presence of drains that can remain for 1 week and the need for a synthetic mesh to reinforce the abdominal wall are also pointed out.

The recovery time is roughly 6 weeks, and the patient is made aware of a long resting period of not less than 2 months. The patient is also informed of weakness of the abdominal wall, mainly patients who undergo bilateral TRAM flap reconstructions.

Finally, potential complications are discussed and it is important that the patient is confident in the capacity of her surgeon to solve every problem related to an incidental failed reconstruction.

I rarely do immediate bilateral or free TRAM flap reconstructions. The extension of the operation added to the mastectomy procedure is not appealing. Perhaps on an institutional basis with a very well trained team it could be beneficial to the patient.

I frequently use a two-stage operation, performing the permanent phase after a primary expansion simultaneously with the mastectomy; therefore, blood transfusion and clinical complications have been rare in my practice.

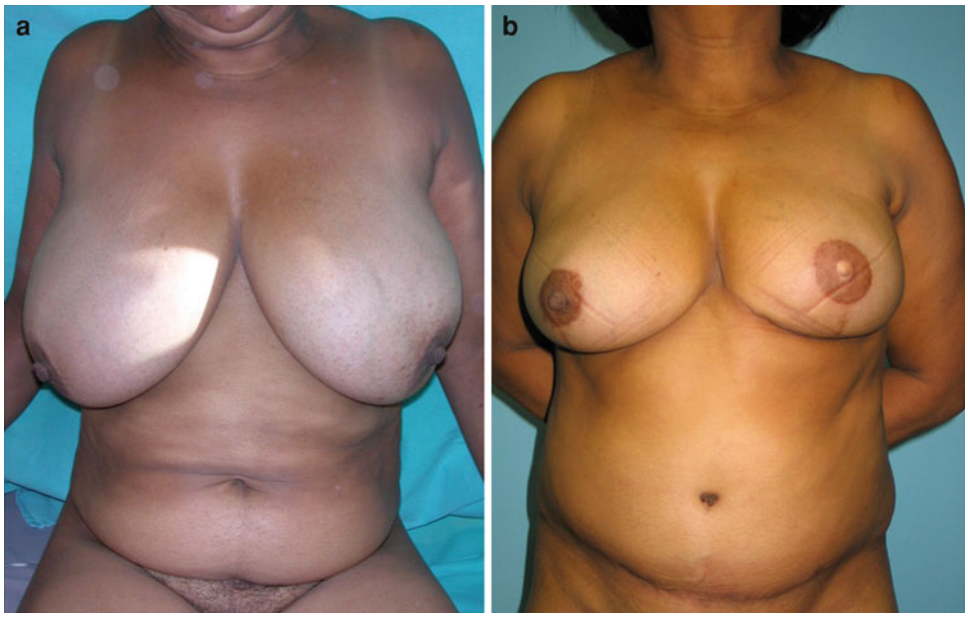

Fig. 29.4 Patients with large breasts benefit from double-pedicle harvesting. The whole abdominal flap can be safely raised

29.7 The Importance of an Image Profile for Safe Harvesting

Since my interest in the perforator-based TRAM flap began, I have found the necessity of imaging evidence, which can give me not only the dimensions but also flow measurements of the upper and lower epigastric vessels, both breasts, and the positions of the perforators. Initially, I found the color Doppler scan very illustrative. The evolution toward angiotomography was able to detail and locate very clearly the whole system and its perforators to the lower abdominal skin-fat paddle (Fig. 29.5).

Probably this is not so important for the evaluation of pedicled flaps but it can sharply define the circulation from the breast to the lower epigastric vessels, which can be useful in irradiated patients.

29.8 Surgical Technique

After a judicious selection of the technique and indication of the bipedicled TRAM flap, the flap is outlined on the abdominal wall. Two teams work simultaneously. One preparing the recipient site and other undermining the abdominal flap.

The concept of "breast footprint" popularized by Blondeel et al. [16] is applied here to create a pocket of the right size to receive the abdominal flap and match the remaining breast in shape and volume (Fig. 29.6).

All scar tissue must be removed. In irradiated patients, extra care is required with the mastectomy flaps in order to keep them well vascularized, avoiding any damaging maneuver. Attention has to be paid to the submammary fold, which must be kept at the same level as that of the opposite side.

The tunnel that connects both spaces should be large enough to permit the large flap to pass through. At this point gentle maneuvers are expected and compression or constriction must be strongly avoided.

The abdominal flap is marked previously with the patient in the standing and seated position. The possibility of flap donation is rechecked and confirmed. The incision is placed in the most cosmetic position according to the principles of safety for an ideal closure (Fig. 29.7).

During the abdominal detachment, the surgeon should avoid dissecting too far laterally in order to preserve the intercostal perforators responsible for the vascular nutrition of the flap.

After the upper abdominal flap elevation the rectus abdominis muscles are partially degloved from their sheath. A strip of fascia is kept attached to each muscle. I prefer to elevate the whole muscular unit. A better vascular supply is expected with this technique and the damage to the abdominal wall is apparently equivalent to that with the muscle-sparing technique.

The umbilicus is then outlined and released from the lower abdominal flap, making possible its future ascent to the thoracic wall.

Next, the identification and ligation of the lower deep epigastric artery and veins is performed. Next, the lower abdominal flap is entirely separated from the abdominal wall. This dissection is done with magnification (×2.5) and a sharp scalpel so many tiny subcutaneous vessels can be identified and preserved. The epigastric pedicle is observed and the point it enters the muscle is used as a landmark for

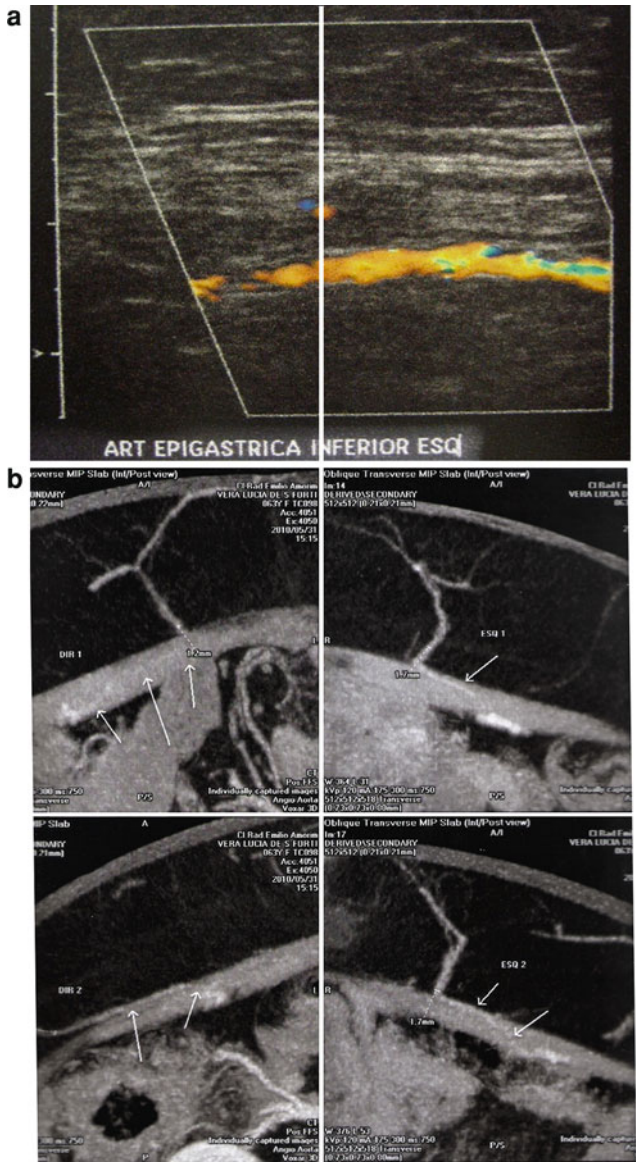

Fig. 29.5 Color Doppler scan (**a**) and angiotomography (**b**) allow the surgeon to locate very clearly the whole epigastric system and its perforators

its section. Usually this point is located above the arcuate ligament.

Both rectus abdominis muscles are sectioned and the whole flap is raised to its new location very carefully with gentle maneuvers.

Next, the upper abdominal flap is inset and stapled in the new site with the patient in the seated position. Now, the new breast is shaped. I have no rules for this exciting time. The skin and fat flap must fit the subcutaneous pocket in the most appropriate position according to the remaining breast "footprint", shape, and volume.

Once the surgeon feels the breast can be considered done, the patient returns to her normal decubitus position and the abdominal wall is repaired simultaneously to the breast suture.

I always use a Prolene mesh to repair the abdominal muscular deficit. The mesh is sutured to the remaining oblique muscles with polydioxanone 2-0 in two planes.

A vacuum drain is always used and kept in place for at least 5 days for the new breast and abdominal areas. The abdomen is finally sutured following a normal abdominoplasty pattern.

A surgical brassiere is used for the breast and a moderate compressive dressing for the abdomen is employed for 2 days.

29.9 Complications

Specific complications of the bipedicled TRAM flap are:

Fat necrosis is a late complication. It can appear after 12 months and is associated with an ischemic mechanism. Clinically, it presents as a subcutaneous firmness that can be confused with malignancy (recurrence or a new tumor). A biopsy is mandatory to clarify the diagnosis. A more extensive fat necrosis area can definitely compromise the cosmetic outcome.

Bipedicled TRAM flap and free flap transfer have significantly reduced the incidence of fat necrosis.

Partial flap loss is a complication that occurs in more than 10 % of all pedicled TRAM flaps. It can happen to different degrees. Light marginal necrosis due to venous deficiency can be revised later and does not compromise cosmetically the result. A remarkable reduction of this complication is observed when the bipedicled TRAM flap or free flap transfer is employed (Fig. 29.8).

Total flap loss can happen when free flap transfer is used, probably owing to arterial or venous thrombosis when salvage methods have failed. It is infrequent for pedicled flaps and is extremely rare when bipedicled flaps are used. In general, total flap loss corresponds to an important technical mistake.

These ischemic complications are often present in patients with more than two risk factors.

Hernias and abdominal laxity (bulges) are donor-site complications resulting from the bipedicle technique. From the mere incapacity to do sit-ups to real hernias and back pains, these are frequent complaints that afflict patients who underwent the technique.

In my personal series I have had less than 2 % of cases with abdominal laxity. I ascribe this low rate to respect for the arcuate line limits and closure in every case with only Prolene mesh.

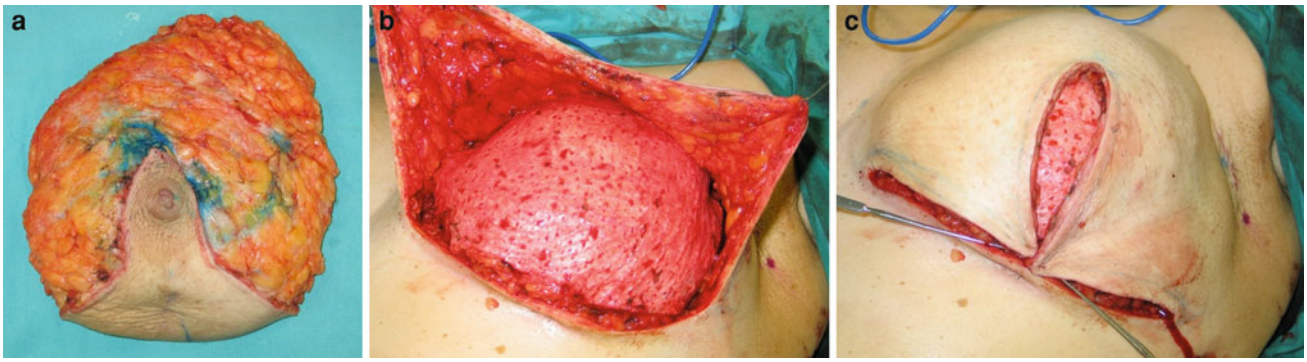

Fig. 29.6 The concept of breast "footprint" is clearly shown here: an inverted-T pattern mastoplasty is drawn over one dermal fat paddle of a TRAM flap

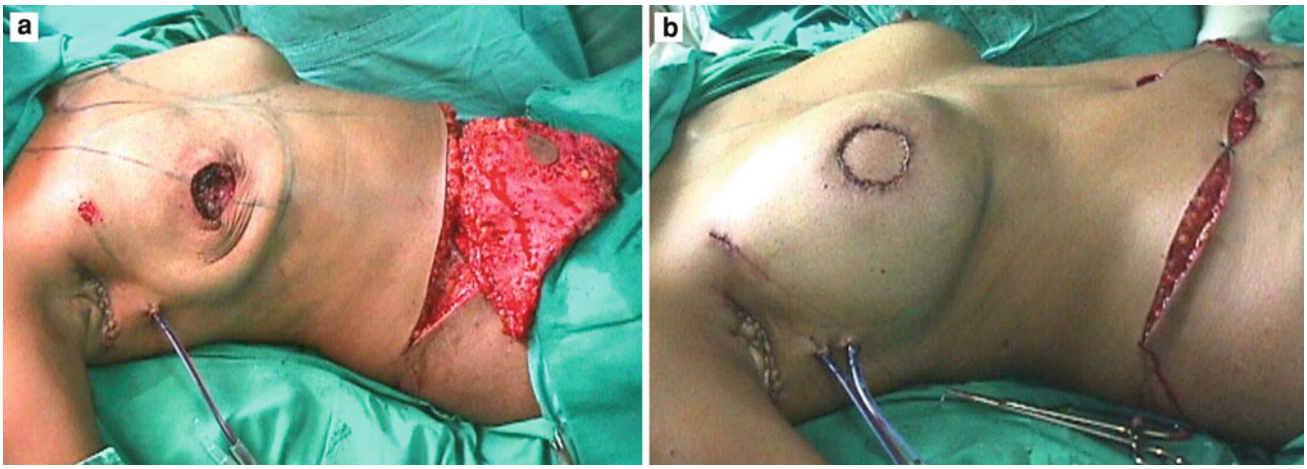

Fig. 29.7 The abdominal flap of a bipedicled TRAM flap ready to be transposed

Hematoma is minor complication. The rates of postoperative bleeding and subsequent hematoma have been lowered to practically zero thanks to the long-term drainage and changing of chemoprophylaxis for venous thromboembolism for intermittent leg compression perioperatively and postoperatively.

Seroma of the abdominal flap has also dramatically improved by regular tacking of the abdominal flap to the fascia, enhancing the contact and avoiding the sliding movements associated with the seroma.

Abdominal slough and necrosis are expected complications when extensive abdominal undermining is done. Limited dissection preserving the intercostal perforators is essential to avoid such complications.

For infections, prophylactic antibiotics are always used (according to the hospital protocol).

29.10 Discussion

Since its first description in 1982 by Hartrampf et al., the TRAM flap has been considered by many as the gold standard for breast reconstruction after mastectomy.

Technically it has evolved. Two issues propelled that evolution.

First, the blood supply. The classic pattern, monopedicled TRAM flap, has been demonstrated to be unreliable or at least unsteady when harvested beyond the midline.

Moon and Taylor [2] have elegantly and definitely demonstrated that the rectus abdominis's arterial and venous territories both present the same pattern. Blood has to traverse a multiple venous valvular system before reaching the deep superior epigastric territory. These valves frequently impair the venous drainage owing to obstructions, resulting in fat and skin necrosis. Several modifications, including a more cephalad flap, primary delays, and the free TRAM flap transfer, have minimized this problem.

The bipedicled TRAM flap also increased flap perfusion because of a dual artery inflow and similar venous outflow. Basically it is indicated when a large amount of tissue is required.

Partial flap loss and fat necrosis rates have been consistently reduced by the method.

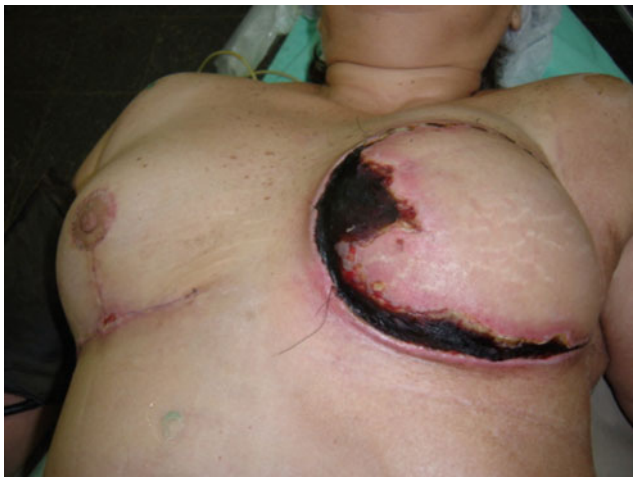

Fig. 29.8 Partial flap loss: marginal necrosis follows generally progressive venous impairment

The recognition of risk patients made the technique appealing and for patients with more than two factors, for many surgeons, mandatory.

The other important and controversial issue is the injury that the pedicled TRAM flap causes to the abdominal wall. Hernias and bulges have been shown, mainly when the two rectus abdominis muscles are used. To minimize the anatomic deficit provided by TRAM flap harvesting, muscle-sparing free TRAM flap and no muscle transfer, like perforator flaps (DIEP flap and superficial inferior epigastric artery flap), have been described and popularized worldwide especially in centers where highly trained microsurgeons master the technique and perform it in a conveniently short time.

Unfortunately this is not the general rule for many services where mastectomy is responsible for severe damage that needs to be fixed fast and safely.

Nonetheless, a study has been published comparing in a large series with a long follow-up patients who have undergone reconstructions with bilateral TRAM flaps with bilateral DIEP flaps. The results showed no significant differences in donor-site morbidity, functional outcome and patient satisfaction between bilateral TRAM flap and DIEP flap breast reconstruction.

The author's conclusion is although the perforator flap is technically an evolution, bilateral TRAM flap reconstruction is still a good option for autologous breast reconstruction

References

1. Hartrampf CR Jr, Scheflan M, Black PW (1982) Breast reconstruction with a transverse abdominal island flap. Plast Reconstr Surg 69:216
2. Moon HK, Taylor GI (1988) The vascular anatomy of rectus abdomini musculocutaneous flaps based on the deep superior epigastric system. Plas Reconstr Surg 82:815
3. Bostwick J, Nahai F, Watterson P et al (1993) TRAM flap delay for breast reconstruction in the right risk patient: definition of risk factors in 556 patients and evaluation of a 10 years experience with TRAM flap delay. Presented at the 72nd meeting of the American Association of Plastic Surgeons, Philadelphia, 1993
4. Sano K, Hallock GG, Rice DC (2000) Venous supercharging augments survival of the delayed rat TRAM flap. Ann Plast Surg 44:486–490
5. Grotting JC, Urist MM, Maddox WA, Vasconez LO (1989) Conventional TRAM versus free microvascular TRAM flap for immediate breast reconstruction. Plast Recontr Surg 83:828
6. Schusterman MA, Kroll SS, Weldon ME (1992) Immediate breast reconstruction: why the free over the conventional flap? Plast Reconstr Surg 90:255
7. Ishii CH, Bostwick J, Raine TT et al (1985) Double pedicle transverse rectus abdominis myocutaneous flap for unilateral breast and chest wall reconstruction. Plast Reconstr Surg 76(6):901–907
8. Watterson P, Bostwick J, Hester R, Bried JT, Tailor I (1995) TRAM flap anatomy correlated with a 10 year clinical experience with 556 patients. Plast Reconstr Surg 90:1191
9. Bostwick J (1983) Aesthetic and reconstructive breast surgery. Mosby, Saint Louis
10. Kroll SS, Marchi M (1992) Comparison of strategies for preventing abdominal weakness after TRAM flap breast reconstruction. Plast Reconstr Surg 889:1045–1053
11. Hartrampf CR Jr, Bennet GK (1987) Autogenous tissue reconstruction in the mastectomy patient: a critical review of 300 patients. Ann Surg 295:508–518
12. Petit JY, Rietjens M, Gatusi C et al (2003) Abdominal complications and sequelae after breast reconstruction with pedicled TRAM flap. Is there still an indication for pedicled TRAM in the year 2003. Plast Reconstr Surg 112:1063
13. Mizgala C, Hartrampf CR, BennetC (1994) Assessment of the abdominal wall after pedicle TRAM flap surgery. 5–7 year follow up of 150 patients. Plast Reconstr Surg 93: 998–1002
14. Miller M (2006) Surgery of the breast, 2nd edn, vol 1. Lippincott Williams and Wilkins, Philadelphia
15. Chun Y, Sinha I, Turko A, Yuhen J, Lipsitz S, Pribaz J, Lee B (2010) Comparison on morbidity, functional outcome and satisfaction following bilateral TRAM or bilateral DIEP flap breast reconstruction. Plast Reconstr Surg 126(4):1133–1141
16. Blondeel O, Depypere J, Roche N, Van der Lauduyt K, Plast R (2009) Shaping the breast in aesthetic and reconstructive breast surgery: an easy three-step principle. Reconstr Surg 123:455–462

Free Flaps

30

Eva M. Weiler-Mithoff and Ben K. Chew

30.1 Introduction

Breast reconstruction contributes substantially to a woman's physical, emotional and psychological recovery from breast cancer. It enables a woman to feel whole again, rebuilds her self-confidence and restores her body image and sense of sexual attractiveness. Reconstruction of a breast involves restoration of the skin envelope and volume with the goal of re-establishing the original or desired anatomy.

Autologous tissue remains the ideal material for the reconstruction of a soft and natural-feeling breast of enduring permanence with a natural inframammary fold and ptosis. Autologous tissue has natural dynamic movement and confers the greatest degree of symmetry to the contralateral normal breast, irrespective of postural position and whether in or not in a brassiere. Free from the comparative constraints of pedicled flaps, microsurgery allows the safe transfer of large amounts of tissue with a higher degree of freedom and flexibility, thereby facilitating the aim of autologous reconstruction. Despite routine application in many centres, free tissue transfer remains a major surgical procedure. Successful provision requires not just a surgeon competent in microsurgical techniques but also an appropriate operating theatre set-up, a high-powered operating microscope and trained theatre staff. 6–8 h of operating time may be required, with a subsequent hospital stay between 7 and 14 days unless patients are discharged early with drains in place. Postoperative recovery can take up to 2–3 months [1].

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The ideal patient for such a procedure is one who is physically fit and healthy, with an active lifestyle and committed to complete restoration of her body image. The advantages of free flap breast reconstruction include a wide choice of potentially available donor sites that can be selected appropriately and individualised to each patient, e.g. abdomen, buttocks, and thighs. There is freedom of design without the limitations imposed by pedicles. Large defects can be covered without the need for prostheses, and long-lasting results can be achieved (Fig. 30.1). In the long term, autologous reconstruction is also cost-efficient.

Free flap reconstruction can be associated with significant complications and morbidity. There is an increased risk of general complications such as deep vein thrombosis, pulmonary embolism, pneumonia and acute respiratory distress syndrome. Specific complications of free flaps include microsurgical problems requiring expedient re-exploration of the anastomosis, haematoma, fat necrosis and partial or total flap loss. Significant complications may add to logistical problems and increase healthcare costs. Donor site complications such as wound-healing problems and mesh infection may prolong the recovery process and increase the length of inpatient admission. Other problems include asymmetry, abdominal weakness, bulging and incisional hernia. The main disadvantage of autologous breast reconstruction is donor site morbidity, particularly with myocutaneous flaps, where despite a degree of expendability, harvest still leads to loss of function of the donor muscle. A high level of microsurgical expertise is imperative, and even with this, there always remains a small and quantifiable failure rate in free tissue transfer.

30.2 Indications

Autologous tissue can be used in both immediate and delayed breast reconstruction. Other indications include:

- Risk reducing mastectomy
- Large contralateral breast

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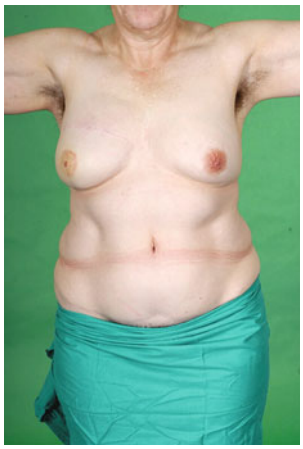


Fig. 30.1 Long-term result of breast reconstruction 13 years after free deep inferior epigastric perforator (DIEP) flap

- Substantial soft tissue defect
- Previous complications of implant-based reconstruction
- Latissimus dorsi muscle cannot be used because of atrophy or previous pedicle damage
- Salvage surgery for locally advanced or recurrent breast cancer.

Absolute contraindications for free tissue breast reconstruction include:

- Physiologically old
- Cardiorespiratory disorders
- Vasospastic disorders
- Significant thrombophilia
- Inadequate recipient vessels.

Relative contraindications include obesity, smoking, diabetes, autoimmune disease, psychosocial problems, distortion of vascular anatomy by previous scars, an inexperienced surgeon and unresectable locally advanced breast cancer [2, 3]. The potentially detrimental effects of adjuvant radiotherapy on autologous tissue breast reconstruction remain a subject of ongoing research and debate [4, 5]. The indications for postmastectomy radiotherapy are gradually expanding, and its effect on the reconstructed breast mound may increasingly become a matter of significant consideration particularly with respect to the decision of immediate versus delayed free flap reconstruction, as well as the appropriate timing of delayed reconstruction [6].

30.3 Recipient Vessels

Recipient vessels for microanastomosis of the free breast flaps include:

1. Subscapular axis
   - Circumflex scapular vessels
   - Thoracodorsal vessels
   - Serratus branch
2. Internal thoracic/mammary vessels
3. Perforator to perforator anastomosis.

30.4 Perforator Flaps

Free perforator flaps are perfused by fascial or myocutaneous perforators and evolved as a refinement of conventional myocutaneous free flaps. Flap harvest requires accurate dissection of perforator vessels, which are often small, through muscle or fascia to yield adipocutaneous flaps from a multitude of donor sites. Although an exacting technique, this enables tissue harvest without the need to sacrifice muscle or fascia [7].

Use of the patient's own tissues gives the most natural, durable and often finest cosmetic result in breast reconstruction. Donor site morbidity remains the most significant cost, and the ideal of minimising this has led to the evolution of myocutaneous to perforator flap design. Even with perforator flaps, a degree of donor site morbidity remains and due consideration should be given to this in preoperative selection. Traditional donor sites used for breast reconstruction such as the lower abdomen, upper lateral back, buttocks, peri-iliac and lateral thigh areas are ideally suited for the application of the perforator flap concept as tissue may be raised without the need to sacrifice underlying muscle or fascia. Only what is needed is harvested and the donor site anatomy and function are respected. Currently the most widely used perforator flaps for breast reconstruction are the free deep inferior epigastric perforator (DIEP) and superior gluteal artery perforator (S-GAP) or inferior gluteal artery perforator (I-GAP) flaps.

30.5 Breast Reconstruction with Lower Abdominal Tissue

The lower abdomen is typically the most abundant source of tissue for autologous breast reconstruction. In particular, with delayed breast reconstruction where a large amount of skin may be required to restore the original breast envelope, the lower abdomen is often the only donor area which can provide sufficient tissue in a single-stage operation. A large and natural-feeling breast mound can be created without the need for an implant by harvest of an area of tissue that is normally discarded in an aesthetic abdominoplasty procedure. The donor area is usually well accepted, and not uncommonly, it may even be a cosmetic improvement. Although this technique can provide excellent long-term results, donor site morbidity should not be underestimated [8, 9].

30.5.1 Anatomy of the Lower Abdomen

The lower abdominal soft tissue is supplied by myocutaneous perforators through the rectus abdominis muscle and direct cutaneous vessels from three main vascular axes (Fig. 30.2).

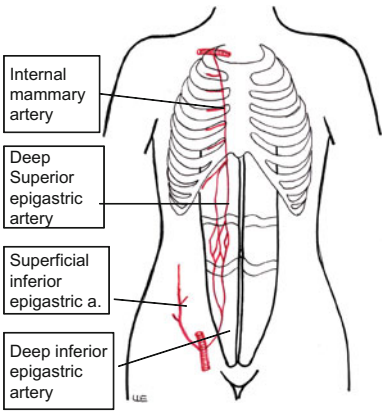


Fig. 30.2 Vascular supply of the lower abdominal apron

The deep inferior epigastric artery (DIEA), a branch of the external iliac vessel, is the primary source of vascular supply to the rectus abdominis muscle. The deep superior epigastric artery (DSEA), which is the terminal branch of the internal mammary artery, is a lesser vessel of supply and anastomoses with the DIEA within the substance of the muscle by means of microvascular communications (choke vessels) in the muscle segment cranial to the umbilicus. Additionally, direct cutaneous supply of the abdominal apron exists through the superficial inferior epigastric artery (SIEA). The triple blood supply to the lower abdominal tissue allows it to be used in a variety of techniques [10–16]:

- Pedicled transverse rectus abdominis myocutaneous (TRAM) flap
- Free TRAM flap
- Free DIEP flap
- Free SIEA flap.

The evolution from pedicled TRAM flaps to free perforator flaps has been driven by the aim to reduce donor site morbidity and to preserve the integrity and function of the anterior abdominal wall. The complications encountered with techniques using lower abdominal tissue for breast reconstruction are related to:

- Extent of muscle resection
- Extent of fascia resection
- Use of synthetic mesh to repair the abdominal wall.

These factors should be borne in mind when selecting the appropriate procedure for an individual patient (Table 30.1). Whichever variant of lower abdominal flap is used, sensory cutaneous innervation to the anterior abdominal wall is disrupted in all cases.

30.5.2 Pedicled TRAM Flap

The pedicled TRAM flap relies on blood supply through the deep superior epigastric vessels (DSEA) within the substance of the rectus abdominis muscle to supply a horizontal ellipse of lower abdominal skin and fat (Fig. 30.3). The flap is transferred to the chest wall through an appropriately sized subcutaneous tunnel [10–12]. This procedure is relatively short (3–4 h) and does not require microvascular transfer. However, perfusion of the flap relies on microscopic intramuscular connections between the DSEA and the DIEA, which results in reduced vascularity (particularly to the suprapubic area) and thereby limits the amount of tissue which can be transferred safely. The reported incidence of fat necrosis is up to 42 %.

Table 30.1 Flap survival and donor site morbidity after abdominal tissue breast reconstruction

	Pedicled TRAM flap (%)	Free TRAM flap (%)	Free DIEP flap (%)
Total flap loss	<1	5–7	1–5
Partial loss	28–60	6–8	6
Fat necrosis	27–40	7–13	6–10
Abdominal bulge	8–28	5–8	0.3–5
Abdominal hernia	>6	4–6	0–1.4

DIEP deep inferior epigastric perforator, *TRAM* transverse rectus abdominis myocutaneous

With bipedicled TRAM flaps or in bilateral reconstructions, both rectus abdominis muscles are sacrificed, causing a permanent, severe reduction of abdominal wall function which has been found to interfere with activities of daily living, sports and housework. This can also interfere with the biomechanics of the paravertebral musculature, resulting in a high incidence of back pain. Other specific complications of this procedure include an extended recovery time, intercostal nerve compression and complications related to prosthetic mesh where required to repair the abdominal wall following pedicled TRAM flap harvest [9, 17–19]. The development of reliable free tissue transfer techniques has provided an alternative to the pedicled TRAM flap in an attempt to reduce abdominal wall damage and lower the risk of partial flap necrosis. The bipedicled TRAM flap carries substantial and significant donor morbidity and its use should be avoided as far as possible [20].

30.5.3 Free TRAM Flap

The deep inferior epigastric vessels are the dominant blood supply for the free TRAM flap. The lower abdominal skin is transferred with a segment of rectus abdominis muscle (Fig. 30.4). The deep inferior epigastric vessels are of good length and calibre for anastomosis to branches of the subscapular axis or the internal mammary vessels (Fig. 30.5) [13]. Depending on the extent of fascial harvest, the rectus sheath may require insertion of prosthetic mesh for closure.

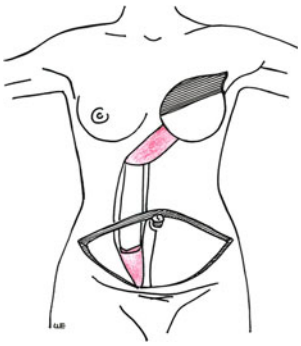


Fig. 30.3 Pedicled transverse rectus abdominis myocutaneous (TRAM) flap

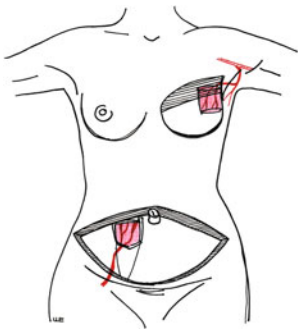


Fig. 30.4 Free TRAM flap

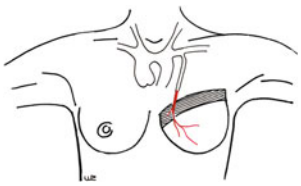


Fig. 30.5 Anastomosis to internal mammary vessels

This technique provides better tissue perfusion compared with the pedicled TRAM flap, and a larger portion of the abdominal apron can be transferred safely, with reduction in the risks of partial flap or fat necrosis. This consideration is particularly important for the reconstruction of a large breast. The amount of rectus abdominis muscle that is harvested can be reduced or minimised, thus causing less interference with abdominal wall function [21–26]. This technique requires a higher level of surgical expertise and microsurgical skills. The free TRAM flap has complications which include mesh infection, abdominal bulging and hernia formation.

30.5.4 Free DIEP Flap

The free DIEP flap spares the entirety of the rectus abdominis muscle. The lower abdominal skin ellipse is transferred by means of perforators of the deep inferior epigastric vessels dissected meticulously through a split in the rectus abdominis fascial sheath and muscle [14, 15, 27–29]. This technique is particularly indicated for young, athletic patients and in bilateral breast reconstruction (Fig. 30.6).

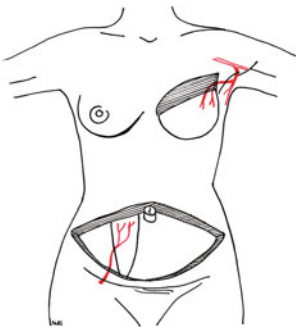


Fig. 30.6 Free DIEP flap

Although the DIEP flap still carries all the potential complications inherent in any free tissue transfer, donor site complications and morbidity are reduced. No muscle or fascia is harvested and synthetic mesh is not required for donor site closure. Preservation of the rectus sheath and muscle maintains abdominal and paravertebral muscle strength and reduces donor site morbidity, postoperative pain and in-hospital stay. The vascularity of the transferred tissue is not compromised, and the incidence of fat necrosis is no different from that with the conventional free TRAM flap [1, 7, 27–29].

Perfusion studies have been performed measuring the circulation in the DIEP flap using laser Doppler velocimetry as well as oxygen tension using implantable microcatheter probes. The perfusion of the DIEP flap has been found to be comparable to that of TRAM flaps. The muscle-sparing harvest does not jeopardise flap perfusion and survival even when the entire lower abdominal soft tissue ellipse is sustained on only one or a few perforators (Fig. 30.7) [30, 31].

Disadvantages include requirements for increased operating time, and an even higher level of surgical expertise owing to the technically exacting nature of perforator vessel dissection.

30.5.5 Free SIEA Flap

The lower abdominal skin ellipse can be transferred without muscle based on the SIEA and superficial inferior epigastric vein, a branch of the femoral vessels (Fig. 30.8) [32]. Since the free SIEA flap is raised without breach of the muscular or aponeurotic part of the abdominal wall, there is no risk of postoperative functional or mechanical weakness. Donor site morbidity is minimal and comparable to that for an abdominoplasty procedure. The operation is also substantially quicker, with a relatively simple dissection of the vascular pedicle. Unfortunately the SIEA has a high degree of anatomical variability in terms of its presence, course and calibre. It is absent in a third of patients, and the vascular pedicle is short, with a very small diameter of 1.5–2 mm. Because of its location, it is easily damaged by previous

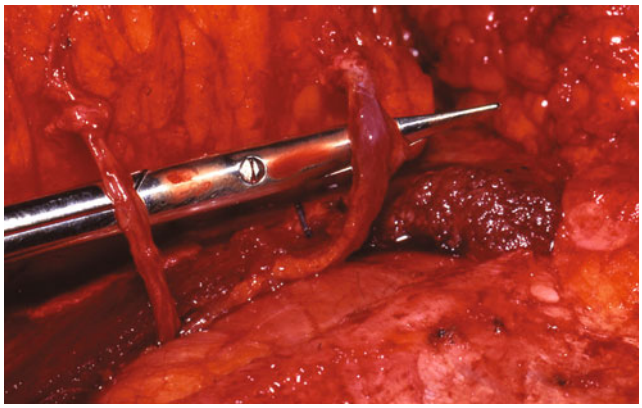
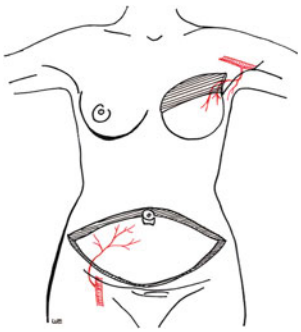


Fig. 30.7 Myocutaneous perforators of DIEP flap

Fig. 30.8 Free superficial inferior epigastric artery flap

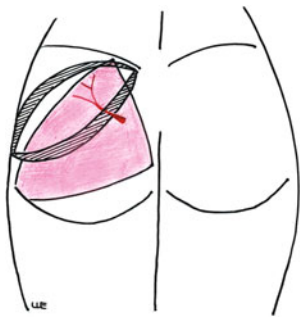


surgery in the inguinal region. The smaller vessel calibre may result in decreased flap perfusion with a higher risk of partial or total flap necrosis [32–34].

30.6 Breast Reconstruction with Buttock Tissue

When abdominal flaps are unavailable or inappropriate, a good second choice for free flap breast reconstruction is the skin and fat from the buttock area. The myocutaneous gluteal flaps have rarely been favoured in the past owing to their very short pedicle, awkward dissection, sizeable discrepancy in vessel diameter for anastomosis, potential for sciatic nerve damage and the need to sacrifice a significant portion of the gluteus maximus muscle. The gluteal perforator flaps are technical refinements which overcome the many disadvantages of the myocutaneous variant. Elimination of the muscle component of the traditional gluteal myocutaneous flap lengthens the vascular pedicle to approximately 8 cm. This improves intraoperative exposure and facilitates microvascular anastomosis to the internal mammary vessels or its perforators without the need for vein grafts [35–37]. Even thin patients with small breasts will usually have an adequate amount of fat in the gluteal region which enables this flap to be used. Donor site morbidity is relatively low, the scar is well hidden and postoperative recovery is quicker compared with abdominal flap harvest.

Fig. 30.9 Free superior gluteal artery flap



30.6.1 S-GAP Flap

The S-GAP flap comprises skin and fat harvested from the upper-third buttock area and leaves an acceptable donor site scar (Fig. 30.9). The maximum flap dimensions are 10 cm × 32 cm, with a weight of up to 800 g.

Flap harvest necessitates the patient being in the lateral decubitus position, which is technically more difficult, but still allows a two-team approach for raising of the flap and chest recipient vessels simultaneously. The skin ellipse is based on one or two perforators of the superior gluteal artery which are dissected through a split in the gluteus maximus muscle. The terminal part of the vessel dissection at the deepest aspect of the muscle is the most difficult part of flap harvest. The donor site is closed directly and the patient is repositioned supine for microvascular anastomosis and flap inset. The consistency of buttock fat is firmer owing to the presence of numerous septae within the flap, thereby making shaping of the flap more difficult.

30.6.2 I-GAP Flap

The I-GAP flap (Fig. 30.10) is raised from the lower-third buttock area and produces a donor scar at the gluteal fold. The inferior gluteal artery is closely related to the greater sciatic nerve, internal pudendal vessels and posterior femoral cutaneous nerve. Raising the I-GAP flap is therefore more technically demanding in comparison with the S-GAP flap, and the former is less frequently used.

30.7 Alternative Free Flap Donor Sites for Breast Reconstruction

There are further types of free flaps available for breast reconstruction, but much more expertise is required and the failure rates are potentially higher, particularly if these

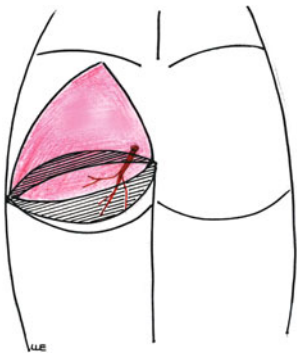


Fig. 30.10 Free inferior gluteal artery flap

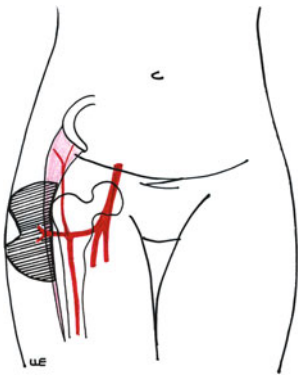


Fig. 30.11 Free lateral transverse thigh flap

procedures are not undertaken routinely. They should therefore be reserved for women in whom the more typical and frequently used flaps are either unavailable or inappropriate. These alternative free flaps may be indicated if the lower abdomen, back or buttocks have insufficient tissue, have already been used, cannot be used due because of disruption of the vascular pedicles or if the patient wishes to avoid scars in the conventional areas of flap harvest.

Alternative options for autologous tissue breast reconstruction include the lateral transverse thigh flap (LTTF), the Rubens peri-iliac fat pad flap, the transverse upper gracilis flap, the anterolateral thigh flap and the free latissimus dorsi flap from the contralateral side [38–40].

30.7.1 Lateral Transverse Thigh Flap

The LTTF is the horizontal variant of the more commonly used vertical tensor fasciae latae myocutaneous flap, and is based on the ascending branch of the lateral circumflex femoral artery, which enters the muscle 8–10 cm inferior to the anterior superior iliac spine (Fig. 30.11). This flap consists mostly of fat from the prominence of the upper lateral thigh, the area colloquially called the 'saddlebag'. The LTTF is raised with either a small portion of the tensor fasciae latae or entirely on the myocutaneous perforator, which is relatively constant in calibre and position. The amount of skin that can be harvested is limited to a height of 6–8 cm, which is the typical maximum that allows primary closure of the donor site. The length of the skin island can be up to 25 cm and the pedicle length is 6–9 cm [38]. The advantages of this flap include relatively long, peripherally placed vessels, reliable vascularity, good intrinsic projection of the flap, easier dissection than the gluteal flaps without the need to turn the patient, decreased postoperative morbidity and quicker recovery. Disadvantages are a much smaller skin island than the abdominal flaps, the location of the donor site scar, a contour defect on the upper lateral thigh which may require further refinement with liposuction and, occasionally, a balancing cosmetic procedure on the contralateral saddlebag. Postoperative seromas are common unless quilting techniques are used.

The flap is usually harvested on the same side as the mastectomy with the patient in a position between lateral decubitus and supine. Raising of the LTTF starts posteriorly and proceeds anteriorly towards the vascular pedicle. The flap is shaped as it is raised by bevelling subcutaneously to a greater extent cranially than caudally. It is then rotated 180° at inset.

30.7.2 Rubens Peri-iliac Fat Pad Flap

This flap uses the often sizeable fat deposit in the flank overlying the iliac crest as a secondary option in free flap breast reconstruction (Fig. 30.12). This tissue is perfused by myocutaneous perforators of the deep circumflex iliac artery and is normally still available after an abdominoplasty or TRAM flap. Advantages of this technique are easy positioning of the patient, good pedicle length and calibre, and an acceptable donor site. Disadvantages are a rather tedious donor site closure, the potential for postoperative hernia formation and the not uncommon need for a contralateral balancing aesthetic procedure in unilateral reconstructions. The maximum skin island with this flap is 20 cm × 9 cm. The pedicle dissection is best commenced proximal to distal via a transinguinal approach. The myocutaneous perforators are protected by subperiosteal dissection to include the periosteum over the iliac crest and a small cuff of the oblique muscles of the lateral abdominal wall underlying the skin island. The donor site must be closed meticulously in layers, and the abdominal wall muscles are re-inset onto the iliac crest with transosseous sutures to avoid postoperative hernia formation [39].

30.7.3 Transverse Upper Gracilis Flap

The transverse upper gracilis flap is a variant of the vertical myocutaneous flap. The dominant pedicle is the medial circumflex femoral artery that arises from the deep femoral artery. The pedicle length is 6 cm and the diameter of the artery is 1.6 mm. The pedicle courses between the long

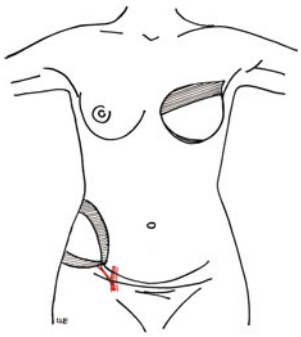


Fig. 30.12 Free Rubens fat pad flap

adductor muscle and the short adductor muscle and enters the gracilis muscle approximately 8–10 cm inferior to the pubic symphysis. To maximise length, the pedicle is dissected to its origin from the deep femoral artery. Transverse orientation of a crescentic skin paddle in the proximal third of the medial thigh improves the vascularity to the skin paddle and potentially provides an additional thigh lift when closing the donor site. The maximum size of the skin island is 25 cm × 10 cm (Fig. 30.13).

This flap is indicated for reconstruction of small or moderate-sized breasts, particularly in patients who have large hips and thighs and desire an additional thigh lift. Other advantages include the capacity for flap and recipient vessel raise with the patient in a supine position with a two-team approach, an inconspicuous donor site without functional deficit, the potential for re-innervation with a sensory branch of the obturator nerve, the potential for simultaneous bilateral harvest in bilateral reconstructions and the ease with which the flap tissues can be shaped on the breast. Disadvantages are the short pedicle, which enters at the centre of the flap and limits recipient vessel choice to the internal mammary vessels, the small diameter of the concomitant veins, and limited skin dimensions (particularly width) and volume in comparison with the abdominal flaps. Although there is minimal functional donor morbidity, postoperative seromas and delayed healing of the donor site scar are not uncommon [40, 41].

30.7.4 Anterolateral Thigh Flap

The anterolateral thigh flap is a skin and soft tissue flap based on the septocutaneous or myocutaneous perforators of the descending branch of the lateral circumflex femoral system that can be used for primary or secondary reconstruction of small breasts if other donor sites are not available [42]. Although the anterolateral thigh flap has become a workhorse flap in microsurgical reconstruction, its application in breast reconstruction is rare owing to the limited volume of tissue available. The maximum skin island is 22 cm × 8 cm and is determined by the capacity for primary donor site closure. Outward bevelling allows further

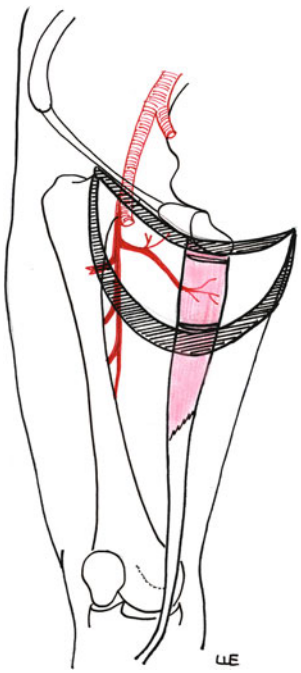


Fig. 30.13 Free transverse upper gracilis flap

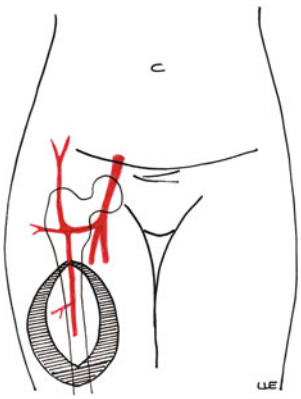


Fig. 30.14 Free anterolateral thigh flap

subcutaneous tissue harvest to extend the dimensions to 22 cm × 12 cm, with a weight of up to 400 g. The average length of the vascular pedicle is 11 cm and the diameter is suitable for anastomosis to the thoracodorsal or circumflex scapular vessels. Advantages of this technique are supine positioning of the patient for a two-team approach, minimal donor site morbidity, good pedicle length and reliable vascularity. Disadvantages are the position of the resulting donor scar and contour defect on the thigh as well as the limited availability of skin and adipose tissue for large breasts. There is a degree of variability in the position of the main perforator vessels, which are located typically at the midpoint or the one-third to two-third junction of a line drawn from the anterior superior iliac spine to the superolateral corner of the patella. Preoperative Doppler localisation of the perforating vessels aids in flap design and allows the skin island to be centred over the perforator with the long axis of the ellipse parallel to the thigh (Fig. 30.14).

Table 30.2 Free flap breast reconstruction: advantages and disadvantages

Flap type	Advantages	Disadvantages
TRAM	Donor defect	Abdominal wall weakness
	Supine positioning	Muscle and fascia loss
	Vessel diameter	Mesh infection
	Pedicle length	
DIEP	Donor defect	Difficult dissection
	Positioning	
	Vessel diameter	
	Pedicle length	
	Abdominal wall function	
SIEA	Donor defect	Inconsistent vessel
	Positioning	Short pedicle
	Abdominal wall function	Vessel diameter
S-GAP/I-GAP	Donor defect	Positioning
	Vessel diameter	Pedicle length
	Tissue availability	Consistency of tissue
	Muscle function	Risk of nerve damage (I-GAP flap)
Rubens	Positioning	Donor site closure
	Pedicle length	Tissue availability
	Donor deficit	Difficult dissection
		Contralateral surgery
LTT	Positioning	Donor defect
	Vessel diameter	Tissue availability
	Pedicle length	Small skin island
	Donor deficit	Contour defect
		Contralateral surgery
TUG	Positioning	Short central pedicle
	Donor site scar	Vessel diameter
	Donor deficit	Small skin island
	Tissue consistency	Tissue availability
ALT	Positioning	Donor site scar
	Pedicle length	Contour defect
	Vessel diameter	Tissue availability
	Donor deficit	
LD	Tissue availability	Positioning
	Pedicle length	Donor deficit
	Vessel diameter	Implant may be required
	Donor site scar	

ALT anterolateral thigh, *I-GAP* inferior gluteal artery, *LD* latissimus dorsi, *LTT* lateral transverse thigh, *S-GAP* superior gluteal artery, *SIEA* superficial inferior epigastric artery, *TUG* transverse upper gracilis

30.7.5 Free Latissimus Dorsi Flap

A free latissimus dorsi flap from the contralateral side can be used if the ipsilateral latissimus dorsi muscle is not available for pedicled transfer or has already been harvested previously. This technique should only be employed if no other donor sites are available and autologous reconstruction of the ipsilateral breast has already been performed by other means. Advantages are the large size of the skin island and volume of soft tissue available, as well as a long, anatomically consistent and reliable vascular pedicle of large calibre. Disadvantages are the need for lateral decubitus positioning of the patient

and the need for an implant unless the flap is harvested as an extended flap to include additional fat zones adjacent, overlying and deep to the muscle [2].

30.8 Simultaneous Microvascular Breast Reconstruction with Lymph Node Transfer

Upper-limb lymphoedema is an iatrogenic complication which occurs in 20 % of patients following mastectomy and axillary node clearance or radiotherapy. Microvascular lymph node transfer is an emerging development with promising results for this condition that has significant long-term consequences for quality of life. Good long-term outcomes have been demonstrated for inguinal lymph node flaps raised on the superficial circumflex iliac vessels and transferred to the subscapular axis vessels of the affected limb [43]. As a further evolution, simultaneous microvascular abdominal flap breast reconstruction and inguinal lymph node transfer has been performed in a series of 87 patients by means of a dual free flap incorporating a standard DIEP flap or muscle-sparing TRAM flap with an inguinal lymphatic flap based on the superficial circumflex iliac vessels [44].

30.9 Summary

Free tissue transfer provides autologous tissue for a natural-feeling postmastectomy breast reconstruction. There are many potential donor sites where a sizeable volume of tissue can be transferred safely and the original anatomy at both donor and recipient sites can be restored optimally. For every patient it is vital to carefully consider the advantages and disadvantages of any potential donor site (Table 30.2).

Perforator flaps are the ultimate refinement of free autologous tissue transfer and provide the necessary tissue for reconstruction whilst sparing the muscle through which the vascular pedicle traverses. Owing to their complexity and consequent prolonged operating time, patient selection is important and necessitates a high level of technical skill.

References

1. Weiler-Mithoff EM (2001) Breast reconstruction: techniques, timing and patient selection. CML-Breast Cancer 13:1–11
2. Bostwick J III (1990) Plastic and reconstructive breast surgery. Quality Medical Publishing, St. Louis
3. Hartrampf CR Jr (1988) The transverse abdominal island flap for breast reconstruction. A 7-year experience. Clin Plast Surg 15(4):703–716
4. Hunt KK, Baldwin BJ, Strom EA et al (1997) Feasibility of postmastectomy radiation therapy after TRAM flap breast reconstruction. Surg Oncol 4:377–384
5. Rodgers NE, Allen RJ (2002) Radiation effects on breast reconstruction with the deep inferior epigastric perforator flap. Plast Reconstr Surg 109:1919–1924
6. Baumann DP, Crosby MA, Selber JC et al (2011) Optimal timing of delayed free lower abdominal flap breast reconstruction after postmastectomy radiation therapy. Plast Reconstr Surg 127(3): 1100–1106
7. Weiler-Mithoff E, Hodgson ELB, Malata CM (2002) Perforator flap breast reconstruction. Breast Dis 16:93–106
8. Clough BC, O'Donoghue MJ, Fitoussi AD et al (2001) Prospective evaluation of late cosmetic results following breast reconstruction: II. TRAM flap reconstruction. Plast Reconstr Surg 107:1710–1716
9. Petit JY, Rietjens M, Ferreire MAR et al (1997) Abdominal sequelae after pedicled TRAM flap breast reconstruction. Plast Reconstr Surg 99:723–729
10. McCraw JB, Dibbell DG, Carraway JH (1977) Clinical definition of independent myocutaneous vascular territories. Plast Reconstr Surg 60:341–352
11. Robbins TH (1979) Rectus abdominis myocutaneous flap for breast reconstruction. Aust NZ J Surg 49:527–530
12. Hartrampf CR, Scheflan M, Black PW (1982) Breast reconstruction with a transverse abdominal island flap. Plast Reconstr Surg 69:216–225
13. Holmstrom H (1979) The free abdominoplasty flap and its use in breast reconstruction. An experimental study and clinical case report. Scand J Plast Reconst Surg 13:423–427
14. Koshima I, Soeda S (1989) Inferior epigastric artery skin flaps without rectus abdominis muscle. Br J Plast Surg 42:645–648
15. Allen RJ, Treece P (1994) Deep inferior epigastric perforator flap for breast reconstruction. Ann Plast Surg 32:32–38
16. Antia NH, Buch VI (1971) Transfer of an abdominal dermo-fat graft by direct anastomosis of blood vessels. BrJ Plast Surg 24:15–19
17. Mitzgala CL, Hartrampf CR, Bennett GK (1994) Abdominal wall function after pedicled TRAM flap surgery. Clin Plast Surg 21(2):255–272
18. Mizgala CL, Hartrampf CR Jr, Bennett GK (1994) Assessment of the abdominal wall after pedicled TRAM flap surgery: 5- to 7-year follow-up of 150 consecutive patients. Plast Reconstr Surg 93(5):988–1002
19. Lejour M, Dome M (1991) Abdominal wall function after pedicled rectus abdominis transfer. Plast Reconstr Surg 87:1054–1068
20. Jensen JA (1997) Is double pedicle TRAM flap reconstruction of a single breast within the standard of care? Plast Reconstr Surg 100:1592–1593
21. Arnez ZM, Bajec J, Bardsley AF et al (1991) Experience with 50 free TRAM flap breast reconstructions. Plast Reconstr Surg 87:470–478
22. Schusterman MA, Kroll SS, Weldon ME (1992) Immediate breast reconstruction: why the free TRAM over the conventional TRAM flap? Reconstr Surg 90:255–261
23. Grotting JC, Urist MM, Maddox WA et al (1989) Conventional TRAM flap versus free microsurgical TRAM flap for immediate breast reconstruction. Plast Reconstr Surg 83:828–841
24. Grotting JC (1994) Immediate breast reconstruction using the free TRAM flap. Clin Plast Surg 21:207–221
25. Kroll SS, Schusterman MA, Reece GP et al (1995) Abdominal wall strength, bulging and hernia after TRAM flap breast reconstruction. Plast Reconstr Surg 96:616–619
26. Feller AM (1994) Free TRAM: Results and abdominal wall function. Clin Plast Surg 21:223–232
27. Hamdi M, Weiler-Mithoff EM, Webster MHC (1999) Deep inferior epigastric perforator flap in breast reconstruction: experience with the first 50 flaps. Plast Reconstr Surg 103(1):86–95
28. Futter CM, Webster MHC, Hagen S et al (2000) A retrospective comparison of abdominal muscle strength following breast reconstruction with a free TRAM or DIEP flap. Br J Plast Surg 53:578–583

29. Blondeel N, Vanderstraeten GG, Monstrey SJ et al (1997) The donor site morbidity of free DIEP flaps and free TRAM flaps for breast reconstruction. Br J Plast Surg 50:322–330
30. Weiler-Mithoff EM (2002) Comparative laser Doppler perfusion studies in DIEP and TRAM flaps. Sixth International Course on Perforator Flaps, Gent, Belgium
31. Mathur BS, MacKay IR, Weiler-Mithoff EM (2001) Is there a difference in tissue perfusion between free DIEP and TRAM flaps? British Association of Plastic Surgeons Summer Meeting, Sterling, UK
32. Stern HS, Nahai F (1992) The versatile superficial inferior epigastric artery free flap. Br J Plast Surg 95:270–274
33. Arnez ZM, Khan U, Pogorelec D, Planinsek F (1999) Breast reconstruction using the free superficial inferior epigastric artery (SIEA) flap. Br J Plast Surg 52:276–279
34. Arnez ZM, Khan U, Pogorelec D, Planinsek F (1999) Rational selection of flaps from the abdomen in breast reconstruction to reduce donor site morbidity. Br J Plast Surg 52:351–354
35. Shaw WW (1983) Breast reconstruction by superior gluteal microvascular free flap without silicone implants. Plast Reconstr Surg 72:490–501
36. Boustred AM, Nahai F (1998) Inferior gluteal free flap breast reconstruction. Clin Plast Surg 25:275–282
37. Allen RJ, Tucker C Jr (1995) Superior gluteal artery perforator free flap for breast reconstruction. Plast Reconstr Surg 95:1207–1212
38. Elliot LF (1990) The lateral transverse thigh free flap: an alternative for autogenous tissue breast reconstruction. Plast Reconstr Surg 85:169–178
39. Hartrampf CR, Noel RT, Drazan L et al (1994) Ruben's fat pad for breast reconstruction: a peri-iliac soft-tissue free flap. Plast Reconstr Surg 93:402–407
40. Arnez ZM, Pogorelec D, Planisek F et al (2004) Breast reconstruction by the free transverse gracilis(TUG) flap. Br J Plast Surg 57:20–26
41. Wechselberger G, Schoeller T, Bauer T et al (2001) Surgical technique and clinical application of the transverse gracilis myocutaneous free flap. Br J Plast Surg 54:423–427
42. Wei F, Suominen S, Cheng M et al (2002) Anterolateral thigh flap for postmastectomy breast reconstruction. Plast Reconstr Surg 110:82–88
43. Becker C, Assouad J, Riquet M et al (2006) Postmastectomy lymphedema: long-term results following microsurgical lymph node transplantation. Ann Surg 243(3):313–315
44. Saaristo AM, Niemi TS, Viitanen TP et al (2012) Microvascular breast reconstruction and lymph node transfer for postmastectomy lymphedema patients. Ann Surg 255(3):468–473

Delayed Breast Reconstruction with Temporary Expanders and Definitive Implants

31

Cicero Urban, Mario Rietjens, Pedro Vinicius Staziaki and Vanessa Fiorini Furtado

31.1 Introduction

Delayed breast reconstruction is considered to be the technique of choice for restoring the physical integrity of mastectomized patients. However, some decades ago, breast reconstruction could not be performed until 2 years or even 5 years after oncologic treatment. Doubts as to whether the reconstruction would cause negatively affect the proper clinical follow-up of patients remained at that time. This changed in the 1980s, when earlier delayed breast reconstruction techniques began to disseminate, as it was proved that surgery before 5 years postoperatively had no additional oncologic risk for the patient [1, 2]. Many reconstructive options were developed following this period, culminating with autologous tissue reconstruction, which is one of the most important techniques in delayed breast reconstructions [3, 4].

Nevertheless, autologous tissue reconstruction is not always possible, owing to the patient's anatomy or preferences, the latter of which takes into account the relative magnitude of the procedure in terms of invasiveness and morbidity. This renders implant-based breast reconstruction notable for its surgical simplicity and applicability. Thus, implant-based breast reconstruction is a straightforward, less invasive approach, capable of resulting in reasonable outcomes in reconstruction, with a faster recovery time [5]. Implant-based breast reconstruction comprises two techniques: definitive implant (primary or one-stage implant) and tissue expander/implant (secondary or two-stage expander/implant reconstruction). These techniques can be combined or not combined with autologous tissue reconstruction.

Despite the fact that implant-based delayed breast reconstruction is already widely used, there are some patients who still do not benefit from this procedure. The aim of this chapter is to describe the indications, preoperative evaluation, operative technique, and complications related to implant-based delayed breast reconstruction.

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31.2 Indications and Selection of Patients

31.2.1 Timing of Reconstruction

As already described in this book, a reconstructive technique can be employed during a mastectomy (immediate) or in a subsequent operation (delayed). Delayed reconstructions can be performed at any time, given that the wound has healed and adjuvant therapy has already been completed. Also, prior to the procedure, the postirradiation acute skin lesions and the hematologic effects of chemotherapy should have ceased [6]. Different from the immediate approach, the delayed one is correctly indicated for patients who have impaired perfusion of skin flaps after mastectomy or traumatized tissue [7]. Therefore, it is useful for the patient who has medical comorbidities such as active smoking, obesity, and cardiopulmonary disease, as these conditions might predispose to poor perfusion of tissues. The physician is compelled to consider the risks and benefits of the delayed timing. Advantageous points to be taken into consideration are that delayed reconstruction allows one to be certain of clear margins prior to the procedure, minimizes the effect of poorly perfused mastectomy skin flaps on the quality of the reconstruction, and permits the

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completion of the adjuvant chemotherapy. Moreover, there are series demonstrating that delayed reconstruction has fewer complications than immediate reconstruction [8]. However, the technique might entail another surgery in order to ameliorate the esthetics, thus prolonging the overall treatment of the patient, because it provides poorer cosmetic quality than immediate reconstruction [7]. Furthermore, delayed reconstruction has limited reconstructive options following radiotherapy.

31.2.2 Implant-Based or Autologous Techniques

Delayed reconstruction can be implant-based or autologous-flap-based. The implant-based reconstruction involves the use of silicone-filled or saline-filled implants or a tissue expansion device beneath the remaining mastectomy skin flaps and the pectoralis major muscle. Autologous-flap-based reconstruction uses musculocutaneous flaps, which consist of a segment of vascularized muscle with the overlying skin and fat, which are perfused by perforating vessels from the underlying muscle. Although the result is overall more pleasing in appearance with a musculocutaneous flap [3, 4, 7], there are some disadvantages, which include longer surgical duration and prolonged postoperative recovery when compared to implant-based reconstruction. The advantages of the implant-based over the flap-based technique are surgical simplicity, the absence of donor site morbidity, reduced operating time, and more rapid postoperative recovery when compared with purely autologous reconstructions [9, 10].

31.2.3 Definitive Implants or Expander/Implants

The definitive implant is also termed "primary implant reconstruction" and, although correctly applied in an immediate setting, it is useful as a one-stage delayed implant reconstruction. The expander/implant or secondary reconstruction differs in that it occurs in a two-stage approach. The indication for the appropriate surgical technique requires two important clinical evaluations: the musculocutaneous condition of the thoracic wall subsequent to the mastectomy and the size and ptosis of the contralateral breast. For instance, the complete absence of the pectoral muscles owing to a mastectomy using the Halsted technique [11] and postoperative radiotherapy are two clinical conditions which may contraindicate reconstruction with definitive implants or temporary tissue expanders. The reason for this is that there is an increased risk of an unsatisfactory esthetic result—asymmetry, contracture, and pigmentation [12]—associated with the additional risk of postoperative complications.

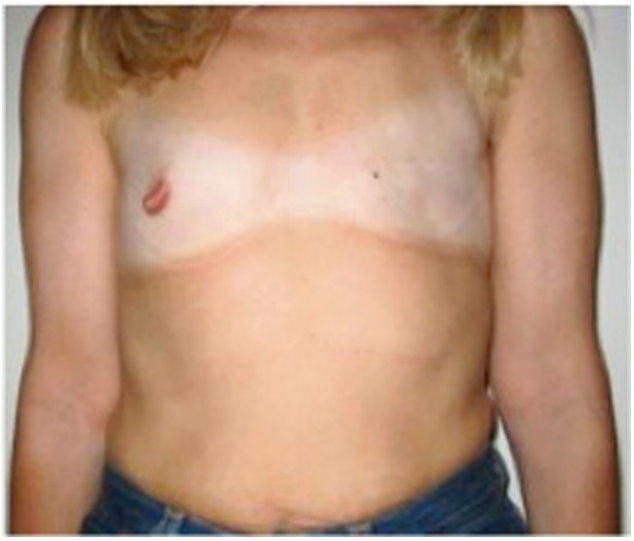

Fig. 31.1 Example of a case with good local conditions for delayed breast reconstruction with definitive implants

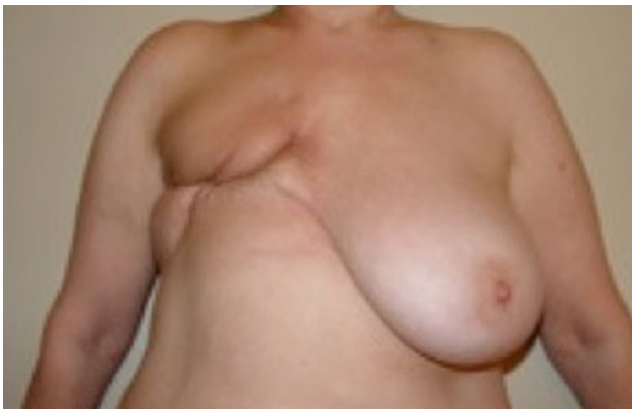

Fig. 31.2 Example of a case in which reconstruction with a definitive implant is contraindicated owing to late side effects of radiotherapy

31.2.3.1 Indications for Definitive Implants

Patients who are allowed to undergo definitive implant delayed breast reconstruction should have a preserved pectoralis major muscle, sufficient amount of skin, and preserved subcutaneous tissue flaps resulting from mastectomy, and should not have had radiotherapy. Additionally, the contralateral breast must be small to medium-sized and minimally ptotic or nonptotic (brassiere size A cup or B cup). It is also indicated for those patients whose breasts have been previously augmented, as the skin and soft tissues have already expanded (Fig. 31.1) [13].

31.2.3.2 Contraindications for Definitive Implants

Patients in this group have an absent pectoralis major muscle, rather tense cutaneous flaps, scars from very wide mastectomies, previous radiotherapy or a large, ptotic contralateral breast (Fig. 31.2). Such women need greater

expansion and possibly require a contralateral breast procedure to improve the outcome.

31.2.3.3 Indications for Temporary Expanders

Tissue expansion prior to the definitive implant is the first stage in the two-stage technique. The expander is used to distend the cutaneous flaps and to obtain more volume when the definitive prosthesis is inserted. It is indicated in a similar fashion to definitive implants. Also, older patients, those with significant medical comorbidity, and women with minimal abdominal tissue, in whom the autologous technique would be unsuitable, also benefit from this technique. Besides, the expander/implant technique is indicated for those patients devoid of sufficient skin or preserved subcutaneous tissue in flaps resulting from mastectomy. This may occur when there is little elasticity of the cutaneous flaps from mastectomy or in the case of a contralateral breast with a rather large volume. In these situations, the two-stage implant reconstruction usually yields esthetically superior results (Fig. 31.3).

31.2.3.4 Contraindications for Temporary Expanders

These are basically the same as those for the use of definitive implants, with even more emphasis on the risk of expanders after radiotherapy [14]. A large number of authors have realized that several postoperative complications can ensue when attempting to distend previously irradiated tissues [12, 14–16], since the radiation decreases the elastic distension capacity of the tissue. In these cases, the most frequent complications are painful and difficult expansion with possible extrusion of the expansion device or periprosthetic capsule (Table 31.1). Even though one achieves the final stage of expansion, the cutaneous coverage of the prosthesis becomes too thin and fragile to protect the definitive implant (Fig. 31.4).

31.3 Preoperative Evaluation

The primary objective in breast reconstruction is to obtain symmetry [17, 18]. For this reason, it is essential to prepare a preoperative plan that includes a detailed analysis of the healthy breast's characteristics and the most suitable technique for treating this breast [19]. The aim is to obtain a breast with low projection in the upper pole, with no ptosis or tear shape. These characteristics are fundamental in order to achieve a successful reconstruction result (Fig. 31.5). Firstly, a clinical and radiologic preoperative evaluation is fundamental in order to properly choose the surgical technique. Secondly, apart from all the standardized examinations required in the anesthesiological preoperative appointment, it is also important that an oncologic evaluation be performed, surveying the following topics: type and size of tumor; number of positive lymph nodes; type of surgical procedure to be performed; chemotherapy, radiotherapy or hormone therapy procedures the patient is

Table 31.1 Indications and contraindications of delayed breast reconstruction with temporary expanders and implants

Indications	Contraindications
Patient preference	Previous radiotherapy
Good quality of skin	Previous failure of breast reconstruction with implants
Bilateral mastectomy	Morbid obesity
	Smokers

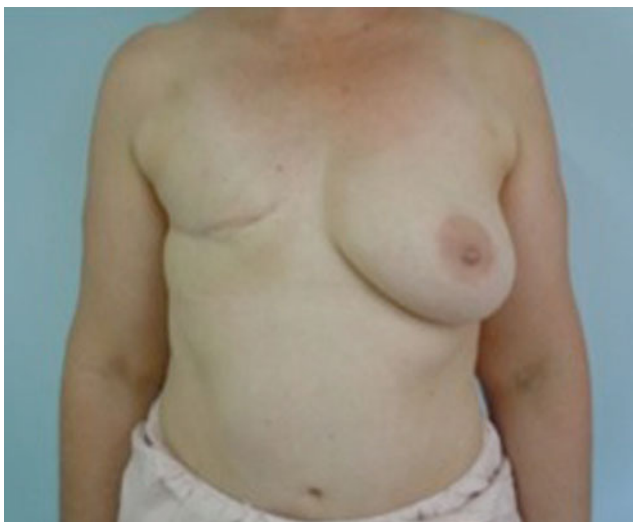

Fig. 31.3 Example of case with good local conditions for reconstruction with a tissue expansion device

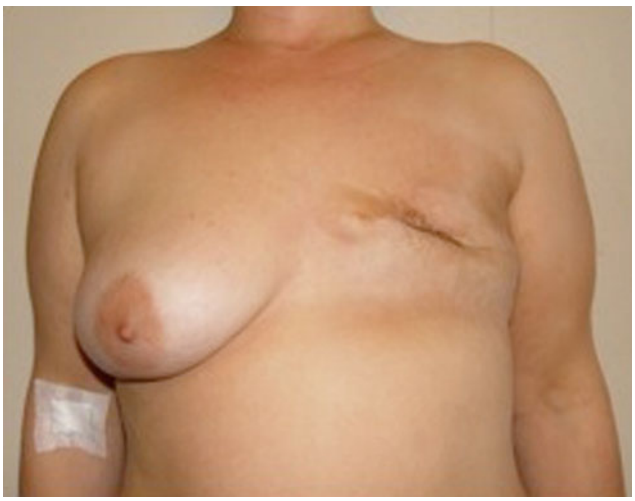

Fig. 31.4 Example of case in which reconstruction with a temporary expander is contraindicated

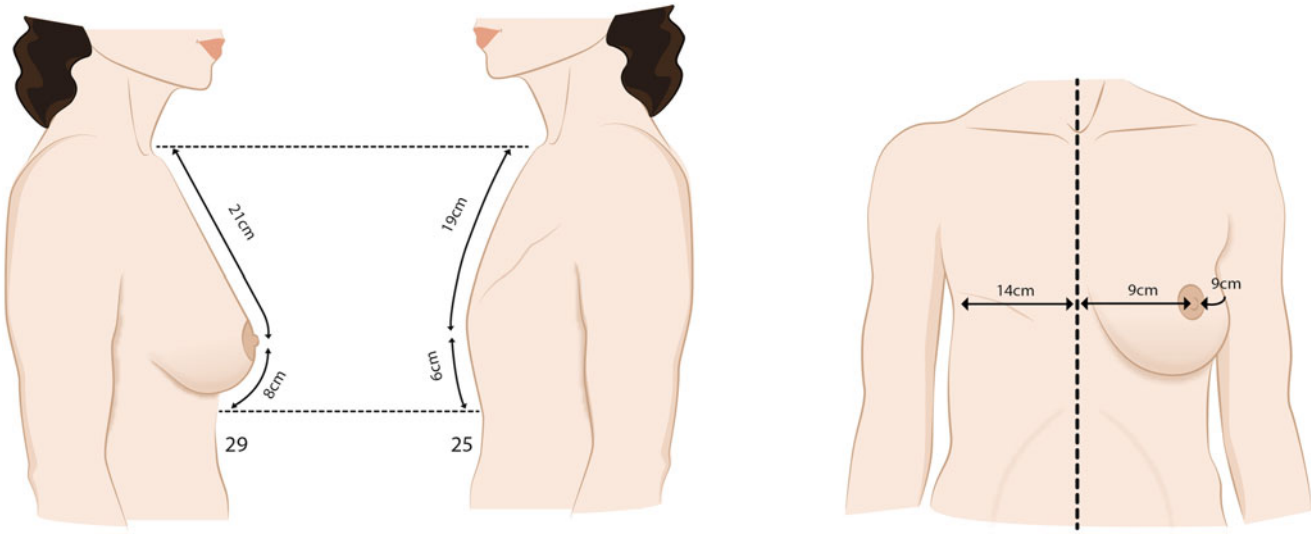

Fig. 31.5 Preoperative breast measurements

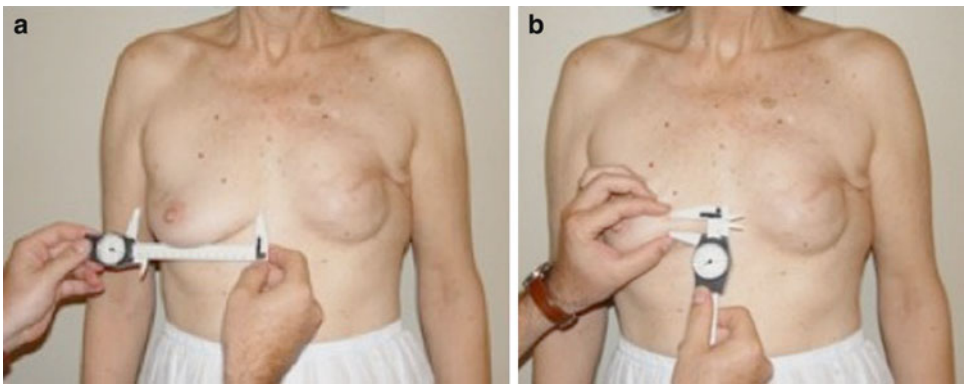

Fig. 31.6 **a** Example of taking the measurement of the base of contralateral breast for the choice of model and size of prosthesis to be used. **b** Example of "pinch" measurement, which gauges the thickness of the cutaneous and the subcutaneous tissue

adherent; follow-up period; and the most recently performed radiologic examinations and blood tests. Furthermore, the evaluation of the contralateral breast is also mandatory in order to exclude bilateral neoplasm and should include mammographic and ultrasound examinations. It should also be noted that contralateral breast surgery—a reductive mastoplasty, a mastopexy, or an additive mastoplasty—is frequently required to obtain a pleasing symmetry. Moreover, the contralateral breast evaluation should also aim to examine any palpable nodule or any mammographic alteration, such as microcalcifications or imaging patterns consistent with a suspicious lesion. Finally, it is important to state that no therapy of any sort is permitted prior to the surgical procedure itself aside from the prophylactic endovenous antibiotic administration of a first-generation or second-generation cephalosporin before skin incision.

31.4 Operative Outline

31.4.1 Before the Operation

Firstly, the preoperative outline is designed on the day before the operation and the whole of the procedure is explained to the patient again so that informed consent is obtained. The patient is then placed standing and photographs are taken of the patient in profile and in a forward-facing position. It is

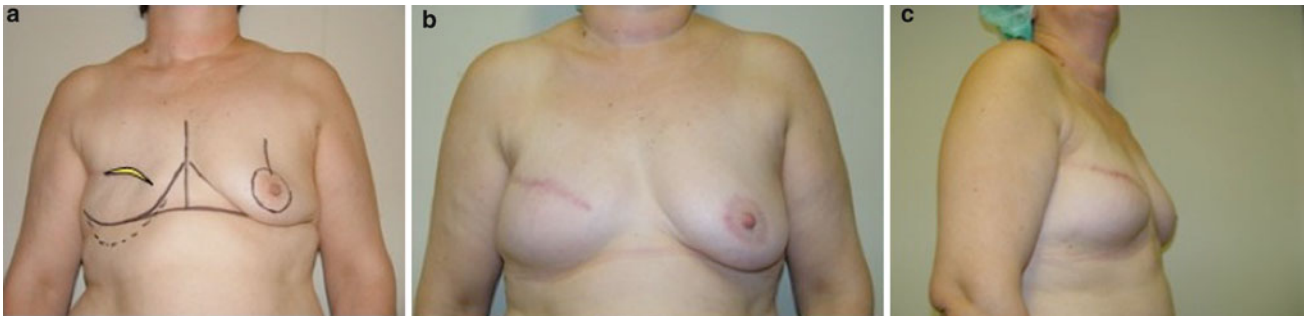

Fig. 31.7 **a** Preoperative example of placement of a cutaneous incision into the pectoralis major muscle in order to achieve better protection of the prosthesis coating after suturing. A left augmentation mammoplasty procedure with a periareolar incision was also planned. **b** Frontal image and **c** lateral image 3 months postoperatively

very useful to make precise measurements of the contralateral breast on this occasion, such as base width, thickness of subcutaneous adipose tissue, height, and anterior projection.

31.4.2 Choosing the Implant

To help decide which implant one should use, it is important to compare the contralateral breast with the future implant with regard to the parameters of base, height, and anterior projection. This is done during the preoperative period in order to choose two or three models and sizes of implants that are most likely to be used during the surgical procedure (Fig. 31.6). The final decision can be made at the intraoperative stage, sometimes after the use of a sample. Surgeons should pay attention to whether the use of samples is prohibited in the country in which they work. In the European Union, for instance, the resterilization of samples is strictly forbidden. Nevertheless nonsterilized implants can be thoroughly coated with a highly adherent and resistant sterile plastic envelope, therefore permitting their repeated use. This technique for choosing the implants based on the aforementioned measures is much more precise and useful in cases in which it is necessary to use an expander and, subsequently, perform a contralateral augmentation mammoplasty. In cases that require breast augmentation surgery, we can use highly cohesive anatomic implants [20–22] or round implants. In cases of definitive implants with mastopexy or reductive mammoplasty of the contralateral breast, the decision as to the type and volume of the implant must also take into consideration the volume reduction, the change of shape, and the size reduction of the breast base. These calculations are based on augmentation mammoplasty articles [20, 23] which employed these methods to calculate the volume and shape of implants for esthetic improvement.

31.4.3 Surgical Markings

Afterwards, lines are drawn on the patient's chest to ensure the correct understanding of the anatomic condition. A median line should be drawn from the sternal notch to the xiphoid appendix, and the inframammary fold should be placed at the same height as for the contralateral breast. In the operating room, the patient is placed supine and with her arms parallel to her trunk. The operating table must be set in a way that the patient can be placed in a 90° position, i.e., sitting, at the end of the procedure.

31.4.4 Skin Incision and Scar Excision

The incision into which the implant will be inserted is made in the preceding mastectomy scar and, if possible, in the pectoralis major muscle. This technical detail allows a safer suture of the prosthetic pocket in two layers, namely, the muscular and the cutaneous layers. If a contralateral mammoplasty is required, the drawing is performed according to the technique chosen (Fig. 31.7). The skin incision with either partial or complete removal of the scar is chosen on the basis of three clinical situations:

1. *Wide scar with a great amount of skin*. An exeresis of the scar is located on the pectoralis muscle and it does not cause any technical problem when inserting the definitive prosthesis or the expander.
2. *Narrow scar with little skin*. The decision whether to remove the scar must be discussed with the patient, because it might change the intraoperative indication for a definitive prosthesis or for an expansion device.
3. *Wide scars without much skin when it has already been decided to use an expander*. The scar can be removed completely or almost completely but extra care must be

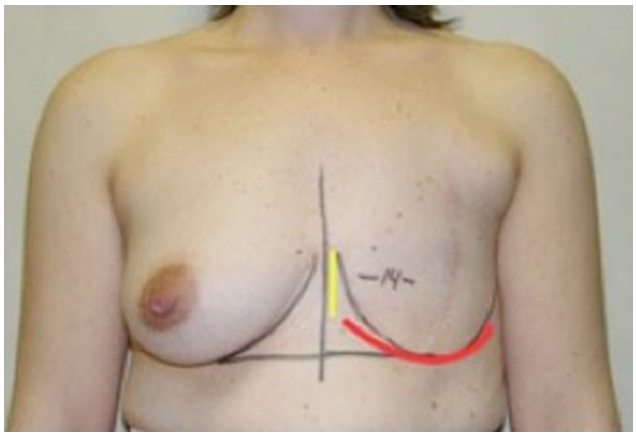

Fig. 31.8 Example of preoperative drawings with medial delimitation of the detachment of muscular fibers of the pectoralis major muscle; the aponeurosis of the left rectus abdominis muscle will be inferiorly sectioned and the superficial aponeurosis will be laterally sectioned

taken when expansion is performed, as a too sudden distension could widen the scar again.

31.4.5 Operative Technique

After the skin has been incised, an inferior lateral subcutaneous undermining must be performed from this region to the contour of the inframammary fold. This is required in order to set the prosthetic pocket, which can be located subcutaneously in this region or under the serratus muscle, in case the skin or the adipose subcutaneous tissue in the inferior lateral region is too fragile. As a result of this maneuver, one can see the lateral edge of the pectoralis major muscle, which is then lifted to set the submuscular pocket. This pocket can be made via a digital undermining in the upper portion, where no perforating vessels are found. In the inferior medial region, a light retractor is required so that efficient hemostasis of large internal mammary pedicles found in this region is performed. The pectoralis major muscle must then be completely detached from the costal surgical plan about 4 or 5 cm above the medial extremity of the inframammary fold. This dissection procedure is mandatory so that a nonesthetic movement of the implant can be prevented when the pectoralis major muscle contracts (Fig. 31.8). Preparation of the inframammary fold demands great technical attention, as it is an anatomic landmark crucial to the long-term esthetic result [5]. There are two possible variants:

1. *Without an upper abdominal skin flap*. This is used in cases when there is great elasticity of the skin, which allows the insertion of a definitive prosthesis or, if a decision has been made for a reconstruction in two surgical steps, with an expander. In such cases, the subpectoral dissection must reach no more than the inframammary fold level, and then an incision into the aponeurosis of the rectus abdominis muscle must be performed to achieve a better projection of the lower mammary pole. There is no need for an undermining maneuver lower than the projection of the inframammary fold, otherwise the prosthesis might end up being placed below the inframammary sulcus, consequently producing asymmetry.
2. *Using an upper abdominal skin flap*. This autologous tissue reconstruction technique mentioned at the beginning of the chapter is recommended for those patients in which a definitive implant is applied and the skin flaps from a mastectomy are not very elastic. An aponeurosis of the rectus abdominis muscle can be used if there is good elasticity of the skin in the upper abdominal area (just below the inframammary fold). The subpectoral dissection must reach the inframammary fold level, followed by incision of the undermining of the supra-aponeurotic region 2–3 cm below the inframammary fold. A cutaneous advancement flap can be easily performed if the patient is placed in a semisitting position. The inframammary fold is reconstructed with spread stitches of nonabsorbable thread, suturing the superficial aponeurosis at the upper limit of the aponeurosis of the rectus abdominis muscle medially and laterally at the serratus muscle (Fig. 31.9).

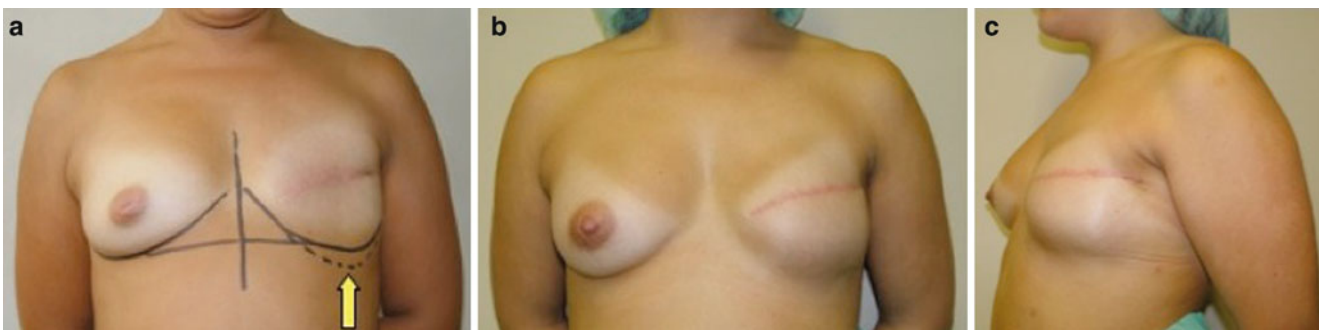

Fig. 31.9 **a** Preoperative example in which an abdominal cutaneous flap is planned to be used in order to improve the shape of the reconstructed breast. **b** Frontal image and **c** lateral image 3 months postoperatively

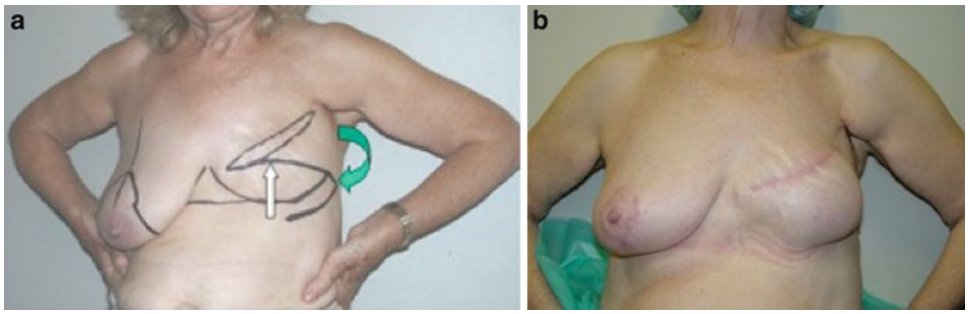

Fig. 31.10 **a** Preoperative drawings of Holmstrom's fasciocutaneous flap. **b** Frontal image 3 months postoperatively

31.4.6 Insertion of a Definitive Implant or a Tissue Expander

After the prosthetic pocket is set up, internal irrigation is performed with either pure saline solution or with saline solution containing an antiseptic. At this point, rigorous skin cleaning and change of gloves by the whole team before contact with the implant is mandatory. Such care helps to reduce the risk of microcontamination of the implants and therefore reduces the risk of postoperative infection or the formation and development of a periprosthetic capsule [24]. The implant, i.e., either the definitive implant or the expansion device, is carefully inserted into the prosthetic pocket.

31.4.7 Sutures and Closure

Finally, a tubular multiperforated aspirating drain is inserted into the prosthetic pocket as a safety measure. Then, suture is done in two planes. The first suture is done with the external edge of the pectoralis major muscle in the subcutaneous tissue with absorbable 3-0 monofilament stitches, and the second suture is an intradermal cutaneous suture with absorbable 4-0 monofilaments.

31.4.8 After the Operation

Some surgeons apply a dressing with elastic straps, causing a moderate compression for 3 days. Others choose a lighter dressing with no compression and also advise the patient to wear a sports bra (medium compression) immediately on the first postoperative day. This second option allows easier control of a possible postoperative hematoma and avoids risks of allergy and cutaneous lesions that might occur when adhesive elastic straps are used. The drain is removed when the drained fluid is serous and its volume is less than 50 mL in the previous 24 h. If a tissue expansion device is used, expansion with a variable volume of saline solution is usually recommended every 3 weeks. The correctly instilled volume should not cause tightness or erythema, or disrupt the patient's comfort or skin quality. As the aim of the expansion is to surpass the quality of a one-stage definitive implant reconstruction, augmentation of 25 % is needed to achieve this purpose, with ideal skin drape and recoil [5].

31.5 Association with a Fasciocutaneous Thoracodorsal Flap

This technique was initially described by Holmstrom (Fig. 31.10), who advocates the use of a rotational fasciocutaneous thoracic dorsal flap to improve the projection of the lower pole of the reconstructed breast. This technique can be applied in the case of an oblique mastectomy scar and the graft must be grounded on epigastric vascular pedicles, which cross the anterior aponeurosis of the rectus abdominis muscle. The flap must be designed with two-thirds of the base above the future inframammary fold and one-third below. After the preparation of the fasciocutaneous flap, an upper rotation of the flap is performed and the donor zone is covered with the inferior rotation of the lateral triangular flap together with the advancing of the upper abdominal skin flap. The implant is inserted below the pectoralis major muscle in the upper internal region and below the flap in the inferior lateral region (Fig. 31.10). This technique is not routine owing to the vascular fragility of the flap. It can be used when applying more complex techniques such as when the latissimus dorsi or the transverse rectus abdominis myocutaneous flaps are contraindicated.

31.6 Complications

Complications related to breast reconstruction with any type of implant can be classified into immediate (until 2 months after the surgery) or secondary (after the aforementioned period) [5]. The most frequent complications comprise hematomas, seromas, infection, and capsular contracture—discussed in other chapters in this book. Capsular contracture rates may be lessened by the use of implants with a textured shell rather than a smooth shell, by placement of the implant in a submuscular rather than a subcutaneous location, and by avoiding use of this technique in women

who need radiotherapy [16, 25]. Studies claim obesity, age older than 65 years, smoking, and hypertension are risk factors for complications following tissue expander reconstructions, smoking status, obesity, and hypertension (but not older age) also being predictive of surgical failure [26]. Obesity is also a risk factor in the situation of a definitive implant reconstruction [8].

31.7 Conclusions

Delayed breast reconstruction with implants can achieve satisfactory cosmetic outcomes and low morbidity. It is a surgical procedure that has minor risks, and in many cases can be performed as day surgery. Overall, this is the most used technique owing to its practicability, lower risk of complications than musculocutaneous flaps, and satisfactory esthetic outcomes with the various anatomic implants available nowadays.

References

1. Petit JY, Le MG, Mouriesse H et al (1994) Can breast reconstruction with gel-filled silicone implants increase the risk of death and second primary cancer in patients treated by mastectomyfor breast cancer? Plast Reconstr Surg 94:115–119
2. Petit JY, Le MG, Rietjens M et al (1998) Does long-term exposure to gel-filled silicone implants increase the risk of relapse after breast cancer? Tumori 84:525–528
3. Spear SL, Mesbahi AN (2007) Implant-based reconstruction. Clin Plastic Surg 34:63–73
4. Spear SL, Newman MK, Bedford MS, Schwartz KA, Cohen M, Schwartz JS (2008) A retrospective analysis of outcomes using three common methods for immediate breast reconstruction. Plast Reconstr Surg 122:340–347
5. Disa JJ, Mccarthy CM (2005) Breast reconstruction: a comparison of autogenous and prosthetic techniques. Adv Surg 39:97–119
6. Hu E, Alderman AK (2007) Breast reconstruction. Health Care 87:453–467. doi:10.1016/j.suc.2007.01.004
7. Nahabedian M (2011) Breast reconstruction in women with breast cancer. http://www.uptodate.com/contents/breast-reconstruction-in-women-with-breast-cancer?source=search_result&search=breast+reconstruction&selectedTitle=1~78#H16. Accessed 10 March 2012
8. Alderman AK, Wilkins E, Kim M et al (2002) Complications in post-mastectomy breast reconstruction: two year results of the Michigan breast reconstruction outcome study. Plast Reconstr Surg 109:2265–2274
9. Spear SL, Boehmler J (2006) Immediate two-stage breast reconstruction utilizing a tissue expander and implant. In: Spear SL (ed) Surgery of the breast: principles and art. Lippincott, Williams and Wilkins, Philadelphia, p 463
10. Beasley ME (2006) Delayed two-stage expander/implant reconstruction. In: Spear SL (ed) Surgery of the breast: principles and art. Lippincott, Williams and Wilkins, p 489
11. Halsted WS (1907) The results of radical operations for the cure on carcinoma of the breast. Ann Surg 46:1
12. Cordeiro PG, Pusic AL, Disa JJ, McCormick B, VanZee K (2004) Irradiation after immediate tissue expander/implant breast reconstruction: outcomes, complications, esthetic results and satisfaction among 156 patients. Plast Reconstr Surg 113:877–891
13. Carmine S, Gian A, Campus V, Puddu A, Mazzocchi M (2011) Multicenter study on breast reconstruction outcome using Becker implants. Breast. doi:10.1007/s00266-010-9559-x
14. Chawla A, Kachnic L, Taghian A et al (2002) Radiotherapy and breast reconstruction: complications and cosmesis with TRAM versus tissue expander/implant. Int J Radiat Oncol Biol Phys 54(2):520–526
15. Berry T, Brooks S, Sydow N, Djohan R, Nutter B, Lyons J et al (2010) Complication rates of radiation on tissue expander and autologous tissue breast reconstruction. Ann Surg Oncol 17S3:202–210
16. Krueger EA, Wilkins EG, Strawderman M et al (2001) Complications and patient satisfaction following expander/implant breast reconstruction with and without radiotherapy. Int J Radiat Oncol Biol Phys 49:713–721
17. Clough KB, O'Donoghue JM, Fitoussi AD, Nos C, Falcou MC (2001) Prospective evaluation of late cosmetic results following breast reconstruction: I. Implant reconstruction. Plast Reconstr Surg 107:1702
18. Cordeiro PG, McCarthy CM (2006) A single surgeon's 12-year experience with tissue expander/implant breast reconstruction: part II. An analysis of long-term complications, esthetic outcomes, and patient satisfaction. Plast Reconstr Surg 118:832–839
19. Mayo F, Vecino MG (2009) Esthetic remodeling of the healthy breast in breast reconstruction using expanders and implants. Aesthetic Plast Surg. doi:10.1007/s00266-008-9300-1
20. Heden P, Jernbeck J, Hober M (2001) Breast augmentation with anatomical cohesive gel implants: the world's largest current experience. Clin Plast Reconstr Surg 28:531–552
21. Tebbetts JB (2002) Breast implant selection based on patient's tissue characteristics and dynamics: the TEPID approach. Plast Reconstr Surg 190:1396
22. Tebbets JB (2001) Dual-plane (DP) breast augmentation: optimizing implant–soft tissue relationships in a wide range of breast types. Plast Reconstr Surg 107:1255–1272
23. Tebbetts JB (2002) A system for breast implant selection based on patient tissue characteristics and implant-soft tissue dynamics. Plast Reconstr Surg 109:1396–1409
24. Pajkos A, Deva AK, Vickery K et al (2003) Detection of subclinical infection in significant breast implant capsules. Plast Reconstr Surg 111:1605–1611
25. Spear SL, Onyewu C (2000) Staged breast reconstruction with saline-filled implants in the irradiated breast: recent trends and therapeutic implications. Plast Reconstr Surg 105:930
26. McCarthy CM, Mehrara BJ, Riedel E et al (2008) Predicting complications following expander/implant breast reconstruction: an outcomes analysis based on preoperative clinical risk. Plast Reconstr Surg 121:1889–1892

Part IV

Management of Complications

Implant Exposure and Extrusion

32

Christina Garusi and Visnu Lohsiriwat

32.1 Introduction

Breast implant exposure is due to insufficient soft tissue or muscle tissue coverage. Being a foreign material, the breast implant will become infected as soon as it is exposed, and it will therefore have to be removed. There are three situations:

1. Implant exposed but not infected
2. Implant exposed and infected
3. Implant extruded.

All these conditions can occur in patients who have had reconstruction after mastectomy as well as in patients who had an aesthetic breast implant.

32.2 Breast Augmentation and Implant Exposed

The situation is very rare, and is difficult to explain. The reason could be an infection or the presence of very thin tissue coverage. Most cases need temporary removal of the implant and secondary breast implant reconstruction.

Among the potential complications associated with the use of a breast implant are the risks of implant infection and device extrusion, with an infection rate following breast augmentation ranging from 1 to 2 % [1, 2]. There are a few reports of salvage of an infected and exposed breast device, such as the report of Gatti et al. [3], where the salvage of the infected breast cosmetic implant was obtained in a case report thanks to intravenous administration of an antibiotic, local irrigation with an antibiotic, hyperbaric oxygen therapy, and subsequent capsulotomy and implant exchange. Fodor et al. [4] described their experience treating six patients (eight breast implants) with silicone prosthesis exposure after cosmetic augmentation. In the original surgery, the implant was placed in the subglandular plane through an inframammary incision. The exposure occurred 10–14 days postoperatively through the incision line. The size of the exposure site ranged between 0.5 and 3 cm. The women were offered two options: immediate removal of the implant and reimplantation at a later stage or antibiotic treatment with an attempt to close the exposed area after the discharge stops. All patients chose the latter option. Antibiotic treatment was started on the day of exposure until 2 weeks after closure. Wound washing was performed three times per day. A sterile dressing was placed over the wound. When the discharge stopped, sterile strips were applied to keep the wound closed. Four of eight implants were saved. The authors had to remove the other four. According to this series, 50 % of eight exposed breast implants could be saved with conservative treatment.

Although there are very few cases of infection and exposure of the implant in aesthetic breast augmentation, recently some surgeons have experienced this when using acellular dermal matrix especially in revision procedures [5, 6]. However, there is still a need to evaluate the benefits and complications associated with the use of implants, and the best practices for surgeons.

32.3 Breast Reconstruction and Implant Exposed

Regarding breast reconstruction, there are different reasons for implant exposure [7]:

1. Immediate breast reconstruction with mastectomy skin necrosis and partial muscle pocket reconstruction
2. Immediate breast reconstruction on previous irradiated tissue

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3. High-grade capsular contraction on thin mastectomy flaps and risk of exposure
4. Skin diastasis with an underlying implant that becomes exposed.

Yii and Khoo [8] proposed a combination of capsulectomy and continuous irrigation with saline and intermittent antibiotic instillation to salvage infected expanders in breast reconstruction. Spear et al. [9] developed treatment guidelines for implant infections, threatened device exposure, and actual device exposure. They submitted patients with severe implant infection and actual exposure (from both reconstruction and mammoplasty) to device removal, and achieved a 0 % salvage rate. Chun and Schulman [10] described the successful salvage of nine consecutive severely infected breast prostheses after mastectomy reconstruction, adopting a technique of immediate intravenous administration of antibiotics followed by early device exchange and a long course of postoperative antibiotics.

The rate of exposure has been reported to be between 0–0.29 % for breast augmentation and between 0.25 and 8.3 % for device-based breast reconstruction [11–14].

In the past, common practice was the immediate removal of the infected and exposed breast prosthesis; however, the more recent plastic surgery literature has explored options for device salvage. Methods for salvaging an infected device have included systemic antibiotics combined with conservative wound drainage, antibiotic lavage, capsulotomy and device exchange, and antibiotic lavage followed by capsule curettage and device exchange.

Despite a number of reports focusing on management of the infected or exposed breast implant, there is still disagreement regarding the wisdom of and indications for device salvage and the optimal timing, setting, or technique. Device explantation is a traumatic event and, for practical purposes, results in the loss of a breast. Successful device salvage offered to properly selected patients with the greatest possibility of success would be a highly desirable alternative to loss of an implant.

Spear and Seruya presented a single surgeon's 15 years' experience of 87 events of breast device infections and or exposures from 69 patients [11]. Thirty-four cases involved breast prostheses with mild infection and all of patients were treated conservatively with 100 % success rate. Twenty-six cases were considered as severe infection and in eight patients (30.8 %) the implant was salvaged.

In a group of six patients the implant was exposed but not infected and the implant was preserved, and in a group of three patients the implant was exposed and there was mild infection, the implant being preserved in two of three cases. Further, in a group of five patients with an exposed implant and severe infection there was a 40 % salvage rate. A group of six patients had exposure of the implant and mild infection, the implant being preserved in four of six cases.

The strategy of immediate postmastectomy implant breast reconstruction with single-stage and tissue expander approaches has been compared in terms of complications. The rates of complications in 18 months are comparable; however, the approaches should be more strictly evaluated in controlled clinical studies [15].

The unfavorable effects of radiation on implant-based breast reconstruction in patients have been widely recognized. The surgeon should be aware of this issue especially in the era of increasing skin-sparing mastectomy, nipple-sparing mastectomy, and radiotherapy. Some patients should have been offered flap-based reconstruction. If the previous procedure was implant-based reconstruction, the patient can have the conversion procedure to autologous flap reconstruction to reduce the number of implant-related complications [16, 17]. However, a cohort study showed the acceptable rate of early complications in patients who have had prior breast conservation therapy who require salvage mastectomy can successfully complete with the rate for postmastectomy tissue expander/implant reconstruction [18]. There is a study showing that the ideal irradiated patient would have a BMI less than 30 and be younger than 50 years of age to maximize the likelihood of a successful tissue expander/implant reconstruction [19].

Acellular dermal matrices are increasingly being used to reinforce the lower pole of the breast during tissue expander/implant breast reconstruction. Their use is preferred by some surgeons who are undertaking a thin skin flap or revision procedure. Their use is claimed to have a low complication rate in immediate single-stage implant reconstruction [20–22]. However, a recent meta-analysis shows that the use of human acellular dermal matrix may increase complication rates. From the analysis it is also suggested to weigh this disadvantage against its advantages in enhancing cosmesis and ameliorating contracture [23].

32.4 Clinical Cases

32.4.1 Case 1: Immediate Breast Reconstruction on Previously Irradiated Tissue

The need for immediate breast reconstruction in a patient with previous conservative surgery and in actual need of nipple-sparing mastectomy is very high; therefore, complete muscle coverage is mandatory.

Irradiated tissue can have poor skin perfusion, skin atrophy, and fibrosis [24–26] with augmented risk of wound breakdown and implant exposure. As soon as the implant is exposed, we can consider it is infected and therefore needs to be removed. The patient can be offered a concomitant breast reconstruction with use of a flap.

This is a case where an extended latissimus dorsi flap, which is the flap that has been extended the harvest area of

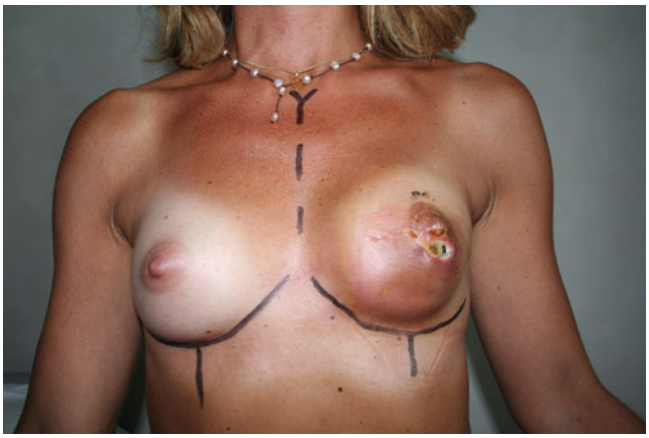

Fig. 32.1 Implant exposure in a previous irradiated breast treated with nipple-sparing mastectomy and immediate implant reconstruction and contralateral augmentation

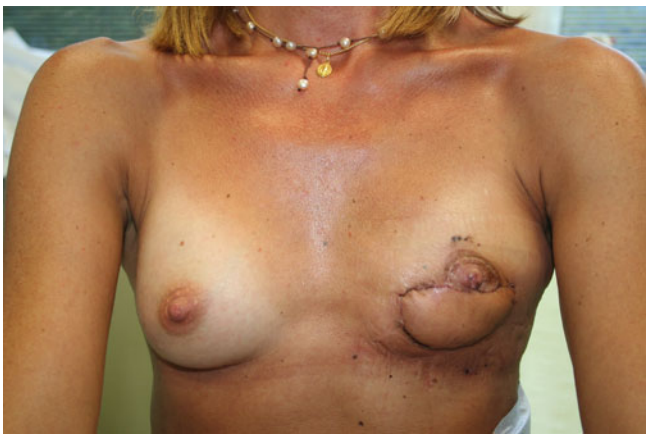

Fig. 32.2 Immediate result 15 days after surgery

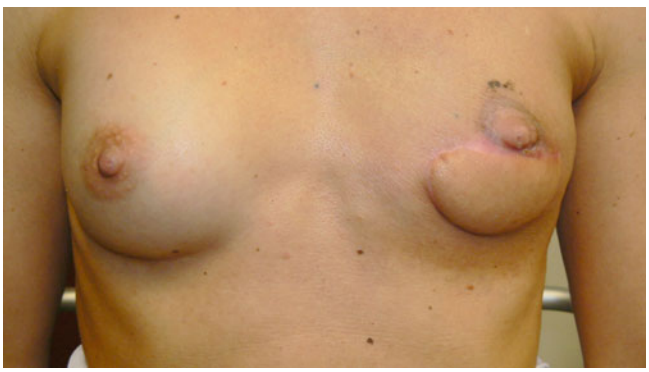

Fig. 32.3 Result 4 months after surgery

overlying adipofascial layer more than the classical latissimus dorsi flap was used at the time of exposed implant removal in order to preserve the mastectomy flap and start reconstructing the breast (Figs. 32.1, 32.2, 32.3, 32.4, 32.5 and 32.6).

This is not the normal practice but the use of well-vascularized tissue can improve the irradiated tissue itself [13].

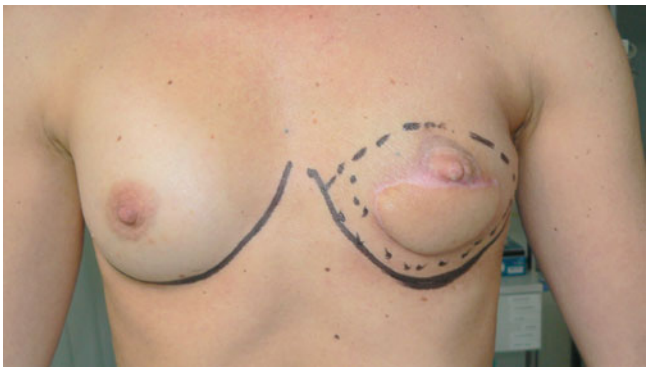

Fig. 32.4 Result 6 months from the time of the first lipofilling

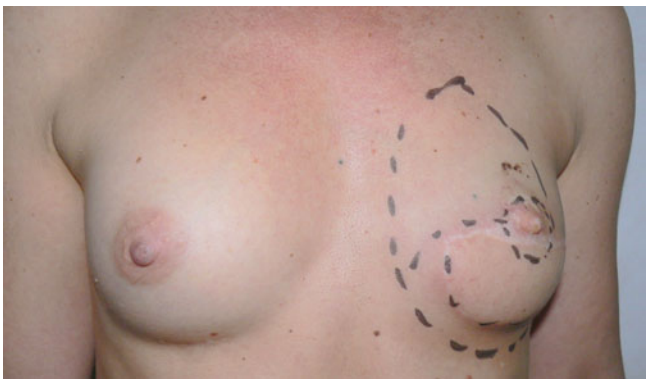

Fig. 32.5 Result at 10 months when the second lipofilling is planned

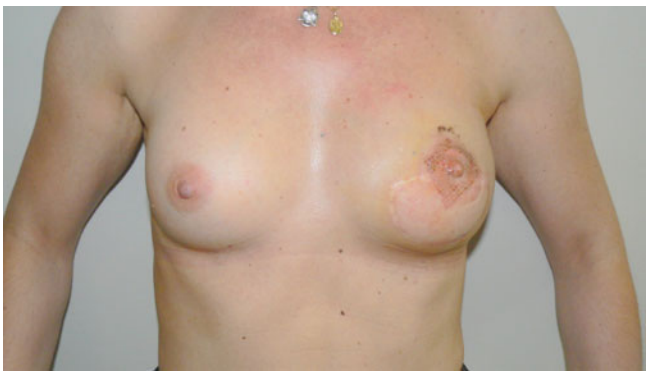

Fig. 32.6 Result 2 months from the last lipofilling at the time of the third lipofilling and tattooing

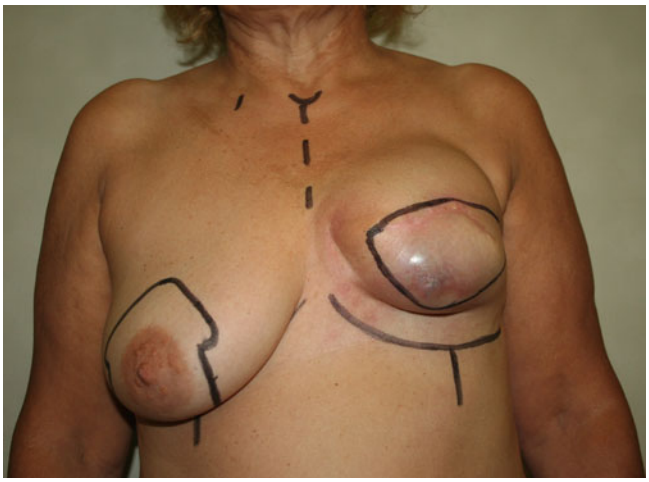

Fig. 32.7 Patient presents with high-grade capsular contraction

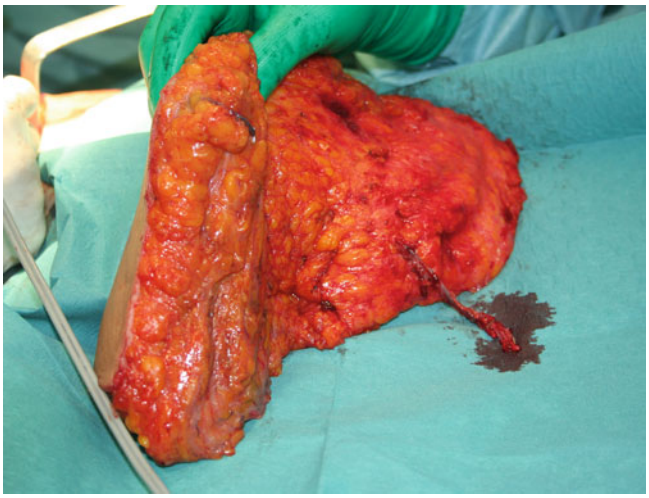

Fig. 32.9 Intraoperative assessment of the DIEP flap

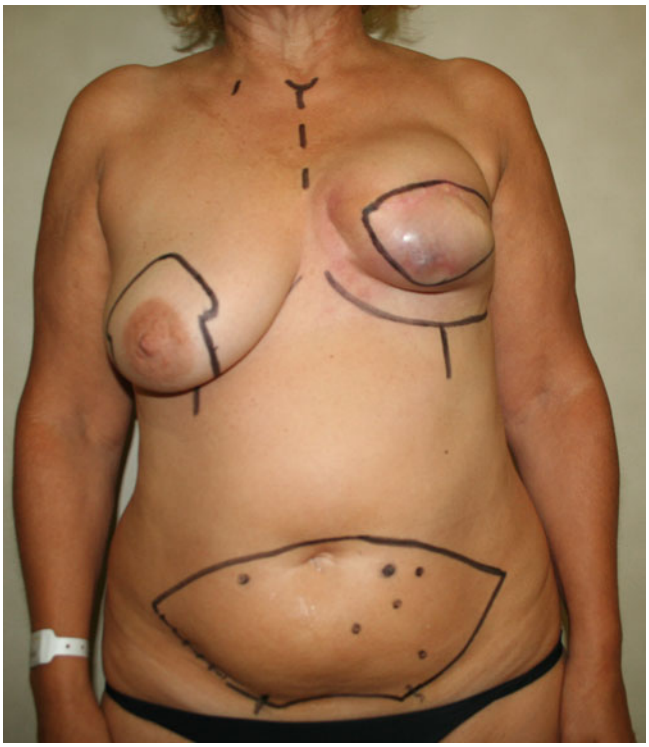

Fig. 32.8 Preoperative planning for deep inferior epigastric perforator (DIEP) flap reconstruction

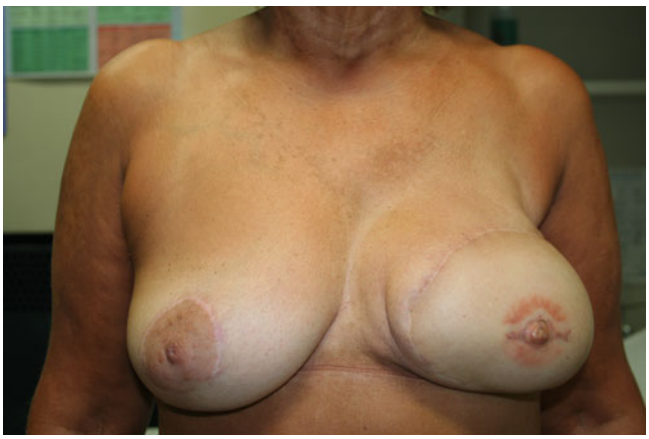

Fig. 32.10 Final result

32.4.2 Case 2: High-Grade Capsular Contraction in Very Thin Mastectomy Skin Flaps

This situation needs an urgent solution. The presence of both capsular contraction and very thin tissue will require a flap in order to offer the patient an immediate solution.

In this case a deep inferior epigastric perforator flap was offered to solve the problem with contralateral breast reduction at the same time (Figs. 32.7, 32.8, 32.9 and 32.10).

The final aesthetic outcome was acceptable, but there was a previous periprosthetic capsule remained at the parasternal part. So lipofilling was suggested as a possible improvement.

32.4.3 Case 3: Expander Decubitus

This is another case of a patient who originally underwent immediate reconstruction with an expander. The reason for using the expander was because of the presence of a very thin mastectomy skin flap; it can be considered an emergency reconstruction.

During the expansion there was a decubitus of the expander and the procedure was changed to autologous reconstruction with a deep inferior epigastric perforator flap (Fig. 32.11).

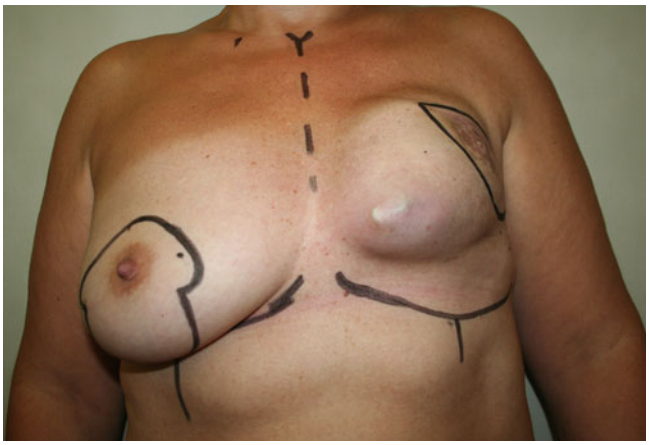

Fig. 32.11 Patient with a decubitus of the expander and planning for DIEP flap reconstruction

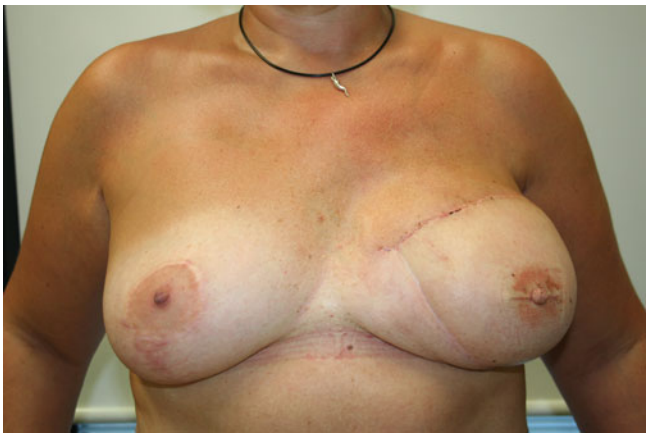

Fig. 32.12 Final result

The final result at the time of nipple–areola reconstruction is shown in Fig. 32.12.

32.5 Conclusion

The salvage of the infected and or exposed breast prosthesis remains a challenging but viable option for a subset of patients.

Keys to success include culture-directed antibiotics, capsulectomy, device exchange, and adequate soft tissue coverage. Relative contraindications to breast device salvage include atypical pathogens on wound culture, such as Gram-negative rods, methicillin-resistant S*taphylococcus* aureus, and *Candida parapsilosis*.

Patients with a prior device infection and exposure and a history of either radiotherapy or *S. aureus* on wound culture should be closely monitored for signs of recurrent breast prosthesis infection/exposure and managed cautiously in the setting of elective breast surgery.

References

1. Handel N, Jensen JA, Black Q et al (1995) The fate of breast implants: a critical analysis of complications and outcomes. Plast Reconstr Surg 96:1521–1533
2. Araco A, Gravante G, Araco F et al (2007) A retrospective analysis of 3,000 primary aesthetic breast augmentations: postoperative complications and associated factors. Aesthetic Plast Surg 31:532–539
3. Gatti GL, Lazzeri D, Stabile M et al (2010) Salvage of an infected and exposed breast device with implant retention and delayed exchange. Plast Reconstr Surg 125:19e–20e
4. Fodor L, Ramon Y, Ullmann Y et al (2003) Fate of exposed breast implants in augmentation mammoplasty. Ann Plast Surg 50:447–449
5. Gabriel A, Maxwell GP (2011) Evolving role of alloderm in breast surgery. Plast Surg Nurs 31:141–150
6. Maxwell GP, Gabriel A (2011) Acellular dermal matrix in aesthetic revisionary breast surgery. Aesthet Surg J 31:65S–76S
7. Cordeiro PG, McCarthy CM (2006) A single surgeon's 12-year experience with tissue expander/implant breast reconstruction: part I. A prospective analysis of early complications. Plast Reconstr Surg 118:825–831
8. Yii NW, Khoo CT (2003) Salvage of infected expander prostheses in breast reconstruction. Plast Reconstr Surg 111:1087–1092
9. Spear SL, Howard MA, Boehmler JH et al (2004) The infected or exposed breast implant: management and treatment strategies. Plast Reconstr Surg 113:1634–1644
10. Chun JK, Schulman MR (2007) The infected breast prosthesis after mastectomy reconstruction: successful salvage of nine implants in eight consecutive patients. Plast Reconstr Surg 120:581–589
11. Spear SL, Seruya M (2010) Management of the infected or exposed breast prosthesis: a single surgeon's 15-year experience with 69 patients. Plast Reconstr Surg 125:1074–1084
12. Nahabedian MY, Tsangaris T, Momen B, Manson PN (2003) Infectious complications following breast reconstruction with expanders and implants. Plast Reconstr Surg 112:467–476
13. Rempel JH (1978) Treatment of an exposed breast implant by muscle flap and by fascia graft. Ann Plast Surg 1:229–232
14. Perras C (1965) The prevention and treatment of infections following breast implants. Plast Reconstr Surg 35:649–656
15. Singh N, Reaven NL, Funk SE (2012) Immediate 1-stage vs. tissue expander postmastectomy implant breast reconstructions: A retrospective real-world comparison over 18 months. J Plast Reconstr Aesthet Surg 65(7):917–923
16. Hughes K, Brown C, Perez V et al (2012) The effect of radiotherapy on implant-based breast reconstruction in the setting of skin-sparing mastectomy: clinical series and review of complications. Anticancer Res 32:553–557
17. Hirsch EM, Seth AK, Dumanian GA et al (2012) Outcomes of tissue expander/implant breast reconstruction in the setting of prereconstruction radiation. Plast Reconstr Surg 129:354–361
18. Cordeiro PG, Snell L, Heerdt A, McCarthy C (2012) Immediate tissue expander/implast breast reconstruction after salvage mastectomy for cancer recurrence following lumpectomy/irradiation. Plast Reconstr Surg 129:341–350
19. Brooks S, Djohan R, Tendulkar R et al (2012) Risk factors for complications of radiation therapy on tissue expander breast reconstructions. Breast J 18:28–34
20. Glasberg SB, Light D (2012) AlloDerm and Strattice in breast reconstruction: a comparison and techniques for optimizing outcomes. Plast Reconstr Surg 129(6):1223–1233
21. Colwell AS, Damjanovic B, Zahedi B et al (2011) Retrospective review of 331 consecutive immediate single-stage implant

reconstructions with acellular dermal matrix: indications, complications, trends, and costs. Plast Reconstr Surg 128:1170–1178
22. Shestak KC (2011) Acellular dermal matrix inlays to correct significant implant malposition in patients with compromised local tissues. Aesthet Surg J 31:85S–94S
23. Kim JY, Davila AA, Persing S et al (2012) A meta-analysis of human acellular dermis and submuscular tissue expander breast reconstruction. Plast Reconstr Surg 129:28–41
24. Wang J, Boerma M, Fu Q, Hauer-Jensen M (2006) Radiation responses in skin and connective tissues: effect on wound healing and surgical outcome. Hernia 10:502–506
25. Tokarek R, Bernstein EF, Sullivan F et al (1994) Effect of therapeutic radiation on wound healing. Clin Dermatol 12:57–70
26. Gieringer M, Gosepath J, Naim R (2011) Radiotherapy and wound healing: principles, management and prospects (review). Oncol Rep 26:299–307

Implant Rupture

33

Mauricio Resende, Cicero Urban and Mario Rietjens

33.1 Introduction

Failure of a breast implant means either a deflation of a saline implant or rupture of a silicone gel device. Although rupture is one of the main causes of implant removal, its real rate is difficult to quantify, especially in breast reconstruction. Most of the ruptures have no obvious traumatic origin, and are silent or intracapsular, thus asymptomatic, and difficult to diagnose with conventional examinations (mammography and ultrasonography) [1].

Rupture is clinically defined as a breach of any size in the implant shell. All implants are susceptible to silicone bleeding. However, because of the high molecular weight molecules of the silicone, the gel cannot diffuse through the shell and the gel does not appear outside the implant, unless the shell has ruptured. Rupture has been suspected to occur as a result of biochemical degradation of the silicone, physical trauma to the elastomer at the time of implantation, fold-flaw failures, or as a result of mechanical injuries during mammograms, closed capsulotomies, or accidents. Loss of integrity of the implant shell is diagnosed when silicone gel is present outside the implant but within the intact fibrous capsule (intracapsular rupture). Extracapsular implant rupture is less common and is defined as rupture of both the implant shell and the fibrous capsule with leakage of silicone into surrounding tissues. Both require implant removal and removal of as much of the silicone as possible [2, 3].

More than 93,000 breast reconstructions were performed in 2010 in the USA according to American Society of Plastic Surgeons [4]. Esthetic results have improved with the FDA reapproval of silicone implants in 2006 and the introduction of a variety of new implant types. Cohesive silicone gel breast implants are composed of a textured silicone elastomer shell and are filled with cohesive silicone gel. Cohesive gel is formed by increasing the number of cross-links between gel molecules, which results in an implant that has better retention of shape and is less likely to fold or collapse, especially in the upper pole. In consequence, implant-based breast reconstruction (IBBR) is now the main technique for breast reconstruction [5].

In 2012, the worldwide crisis with Poly Implant Prosthèse implants occurred, and this exposed the need for better evidence regarding effectiveness and safety of these devices [6]. The aim of this chapter is to address the incidence, evaluation, and management of implant rupture in breast reconstruction.

33.2 Incidence

The incidence of implant rupture ranges widely from 0.3 to 77 %, and remains a controversial issue. Different methods to evaluate and diagnose rupture can explain this discrepancy [7–12]. Marotta et al. [12] conducted a large cohort meta-analysis for explanted silicone-gel-filled breast implants (8,000 explants from 35 studies) and found a statistically significant correlation between implant duration and elastomer shell failure (25 % within 3.9 years and 71.6 % at 18.9 years). An updated reanalysis (9,774 explanted implants from 42 studies) revealed 26 % failure at 3.9 years, 47 % at 10.3 years, and 69 % at 17.8 years [6].

The fact that the prevalence of rupture increases over time is not surprising since prevalence is a cumulative measure at a given moment of time. This, however, does not

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imply that the probability of rupture during a specified time period (incidence) increases with increasing implant age, a conclusion that cannot be drawn from the selected cross-sectional data. In addition, damage to implants during explantation can also lead to an overestimation of in vivo prevalence. According to Slavin and Goldwyn [13], as many as 24 % of ruptures identified at the time of explantation occurred as a direct result of the procedure to remove the implant.

So it is difficult to compare the results of many cross-sectional rupture prevalence studies, for several reasons. Studies often include women with first-, second-, and third-generation implants, saline and silicone implants, and implants made by different manufacturers. Moreover, studies show data on women with different follow-up periods, and determination of rupture has been based on different detection methods, such as explantation, ultrasonography, mammography, magnetic resonance imaging (MRI), and clinical survey in patient cohorts. Specific analyses in IBBR are rare. Henriksen et al. [14] found three cases of implant rupture (0.4 cases per 1,000 implant-months) 2 years after breast reconstruction using silicone implants ($n = 1{,}610$). Although there are limited data, less capsular contracture and implant rupture are expected with recent generations of breast implants, and the rupture rate could be between 12 and 15 % [1–14]. There are no long-term conclusive data on IBBR or on the influence of radiotherapy.

33.3 Diagnosis

Clinical diagnosis is difficult, being based solely on non-specific findings such as palpable nodules (silicone granuloma), asymmetry, and tenderness. Free silicone has in, rare cases, spread to distant body regions, giving rise to symptoms. If implant rupture is accompanied by loss of the shape of the breast, diagnosis at a physical examination is feasible. Breast pain is a strong indicator of rupture, but the absence of pain does not exclude rupture. Contour deformity (44 %) is the commonest symptom, followed by displacement (20 %) and mass formation (17 %). Physical examination fails to diagnose implant rupture in more than 50 % of cases. Rupture of a silicone implant, for most women, is a harmless condition which does not appear to progress or to produce significant clinical symptoms [1–18] (Figs. 33.1, 33.2 and 33.3).

Ultrasonography has a low sensitivity to detect silicone implant rupture. According to Caskey et al. [15], 41 % of women with implant rupture have no detectable changes on ultrasonography. The most reliable sign of extracapsular rupture is a group of focal nodules with a generalized increase in echogenicity of the breast tissue and loss of normal parenchymal interface resulting from dispersion of the ultrasound beam [16]. The nodules are silicone granulomas. Many of them are located in the axillae.

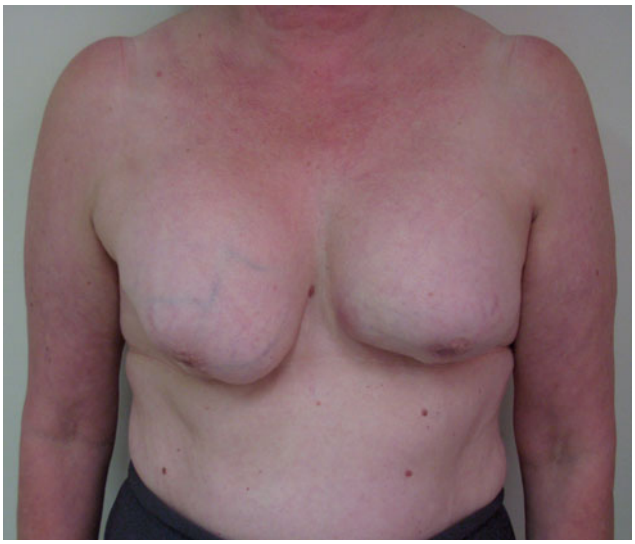

Fig. 33.1 Long-term clinical consequences of a ruptured implant as a result of a patient's negligence showing bilateral breast deformity

MRI is the most accurate technique in the evaluation of implant integrity. Its sensitivity for rupture is between 80 and 90 %, and its specificity is between 90 and 97 % (Figs. 33.4 and 33.5). The use of contrast agents in MRI studies for assessment of breast implant integrity is not recommended. Silicone leakage progressing to herniation of silicone within the fibrous capsule, migration from the intracapsular space into the surrounding tissue, or progression of extracapsular silicone can be observed by MRI. There is no increase in autoantibody levels and no increase in reported breast hardness. Normally women do not have visible breast changes and do not have significant clinical symptoms. Thus, MRI is the gold standard to detect and follow-up breast implant ruptures, and the linguine sign is often present with extracapsular ruptures [17, 18]. Mammography is of little value in the assessment of implant integrity, although it may be useful for the assessment of the surrounding breast tissue. Several cases of silicone implant rupture from compression during a mammogram have been reported. They most probably occurred in women who had intracapsular ruptures previous to the mammogram.

33.4 Treatment

Explantation is the gold standard treatment used for silicone implant rupture, with the removal of as much silicone as possible, but it is not the only possibility. Hölmich et al. [9] studied 64 patients with at least one rupture on MRI. There was progress of silicone in 11 % of them as a conversion

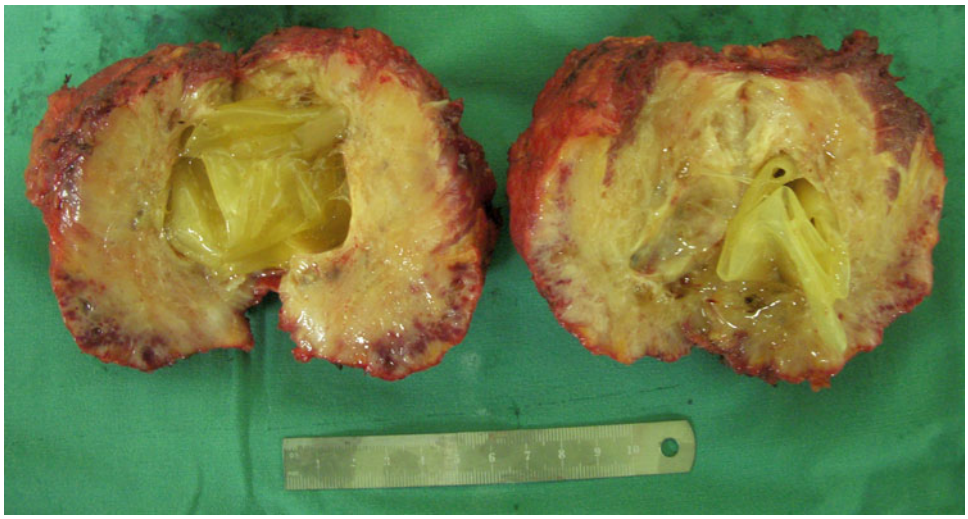

Fig. 33.2 Silicone bilaterally infiltrating breast tissue (explanted from the patient in the Fig. 33.1)

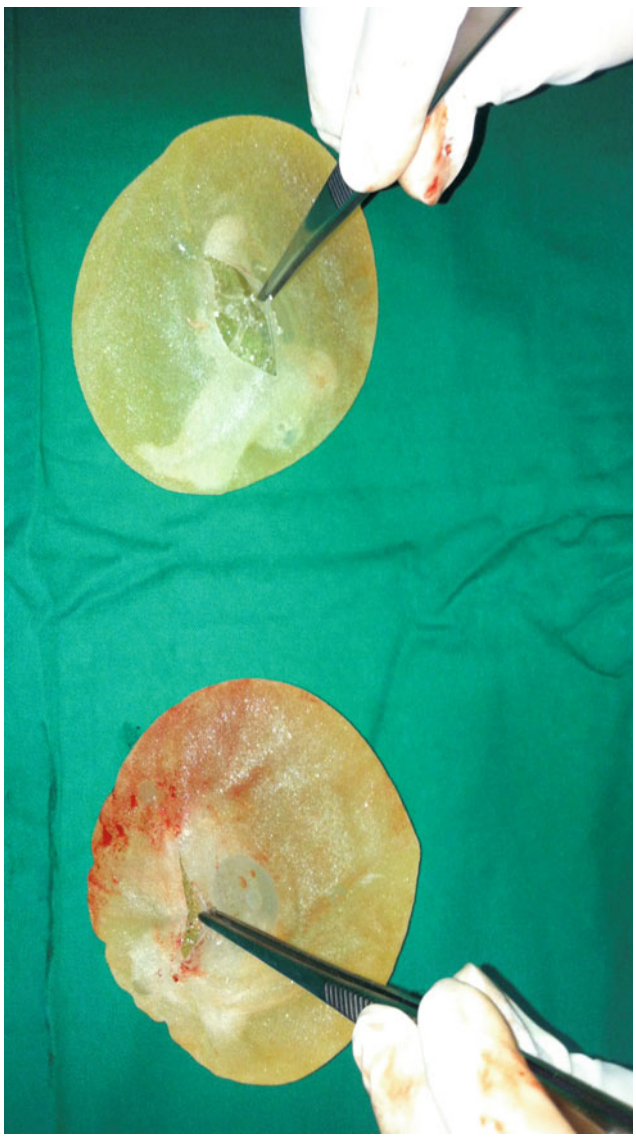

Fig. 33.3 Bilateral rupture 4 years after immediate breast reconstruction with form-stable anatomic breast implants

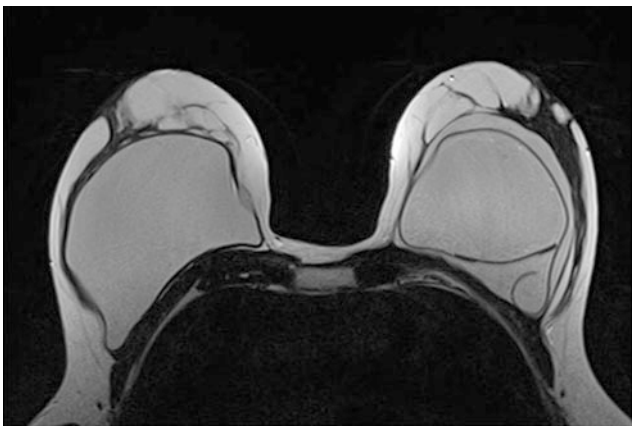

Fig. 33.4 Magnetic resonance image showing intracapsular rupture in a second-generation implant in the left breast (linguine sign)

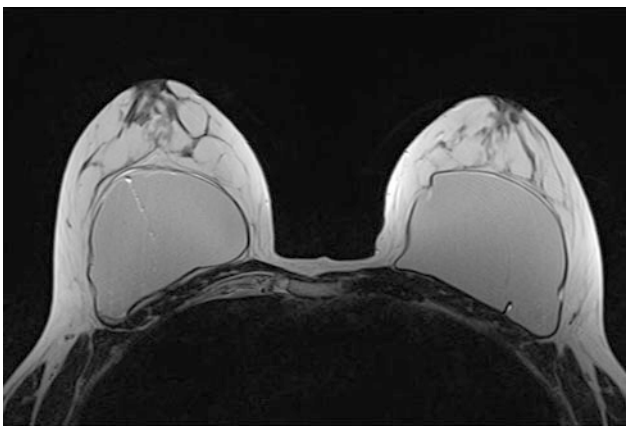

Fig. 33.5 Magnetic resonance image showing intracapsular rupture in a third-generation implant in the right breast

from intracapsular into extracapsular ruptures. There was no increase in the levels of autoantibodies during the study. Because of the small risk of spread of silicone, women with implant rupture could be followed clinically, if not

(preferentially) operated on. Residual silicone inside the breast of a breast cancer patient is a risk because a mass in the breast could add difficulties in differential diagnosis with recurrence. Some authors suggest a relationship between implant rupture and fibromyalgia, but this remains an unsolved question. There is no evidence that silicone breast implant rupture can cause long-term serious diseases, such as breast cancer or connective tissue diseases [4, 11].

33.5 Conclusions

IBBR is the main technique in breast cancer reconstruction. Rupture rates in these cases are not well known, although early diagnosis and prompt surgical management are expected to prevent major local problems, and silicone is not expected to result in any systemic consequence for the patient. MRI is the most accurate method for diagnosis of implant failure, but long-term cohort studies are necessary to evaluate integrity rates of these devices to better support their indications, follow-up, and limitations in breast reconstruction.

References

1. Shestak KC (ed) (2006) Reoperative plastic surgery of the breast. Lippincott Williams & Wilkins, Philadelphia
2. Hölmich LR, Vejborg IM, Conrad C et al (2004) Untreated silicone breast implant rupture. Plast Reconstr Surg 114(1): 204–214
3. Juanpere S, Perez E, Huc O et al (2011) Imaging breast implants—a pictorial review. Insights Imaging 2(6):653–670
4. Lee BT, Duggan MM, Keenan MT et al (2011) Commonwealth of Massachusetts Board of Registration in medicine expert panel on immediate implant-based breast reconstruction following mastectomy for cancer: executive summary, June 2011. J Am Coll Surg 213(6):800–805
5. Brown MH, Shenker R, Silver SA (2005) Cohesive silicone gel breast implants in aesthetic and reconstructive breast surgery. Plast Reconstr Surg 116:768–779
6. Heneghan C (2012) The saga of Poly Implant Prosthèse breast implants. BMJ 344:e306
7. Hedén P, Nava MB, van Tetering JPB et al (2006) Prevalence of rupture in Inamed silicone breast implants. Plast Reconstr Surg 118:303–308
8. Hedén P, Boné B, Murphy DK, Slicton A, Walker PS (2006) Style 410 cohesive silicone breast implants: safety and effectiveness at 5 to 9 years after implantation. Plast Reconstr Surg 118:1281–1287
9. Hölmich LR, Friis S, Fryzek JP et al (2003) Incidence of silicone breast implant rupture. Arch Surg 138:801–806
10. McLaughlin JK, Lipworth L, Murphy DK, Walker PS (2007) The safety of silicone gel-filled breast implants. Ann Plast Surg 59:569–580
11. Puskas JE, Luebbers MT (2011) Breast implants: the good, the bad and the ugly. Can nanotechnology improve implants? WIREs Nanomed Natobiotechnol. doi:10.1002/wnan.164
12. Marotta JS, Goldberg EP, Habal MB et al (2002) Silicone gel breast implant failure: evaluation of properties of shells and gels for explanted prostheses and meta-analyses of literature rupture data. Ann Plast Surg 49:227–242
13. Slavin SA, Goldwyn RM (1995) Silicone gel implant explantation: reasons, results and admonitions. Plast Reconstr Surg 95:63–66
14. Henriksen TF, Frysek JP, Hölmich LB et al (2005) Reconstructive breast implantation after mastectomy for breast cancer. Arch Surg 140:1152–1159
15. Caskey CI, Berg WA, Anderson ND, Sheth S, Chang BW, Hamper UM (1994) Breast implant rupture: diagnosis with US. Radiology 190:819–823
16. Venta LA, Salomon CG, Flisak ME, Venta ER, Izquierdo R, Angelats J (1996) Sonographic signs of breast implant rupture. AJR 166:1413–1419
17. Monticciolo DL, Nelson RC, Dixon WT, Bostwick III, Mukudan S, Hester TR (1994) MR detection of leakage from silicone breast implants: value of a silicone-selective pulse sequence. AJR 163:51–56
18. Gorczyca DP, Gorczyca SM, Gorczyca KL (2007) The diagnosis of silicone breast implant rupture. Plastic Reconstr Surg 120: 49S–61S

Inframammary Fold Reconstruction

34

Fernando Schuh, Rodrigo Cericatto, Ana Cristina Bittelbrunn, José Antônio Cavalheiro, and Jorge Villanova Biazús

34.1 Introduction

The inframammary fold is the lower boundary between the breast and the chest wall. It is usually located between the fifth or the sixth intercostal space. The inframammary fold is approximately 5–7 cm from the areola in small breasts and 7–9 cm in large breasts [1].

Anatomists and surgeons have differing opinions regarding the anatomy of the inframammary fold. Whereas anatomists do not see the inframammary fold as a specific anatomical structure, but as part of the superficial fascia of the breast, surgeons believe in the existence of a true inframammary ligament [1, 2].

The most significant factors for defining breast aesthetics are the inframammary fold combined with the position of the nipple–areola complex and breast contour and projection [3].

Creating a well-defined inframammary fold is very important for the success of breast reconstruction, regardless of the surgical technique used. The symmetry with the contralateral breast is determined not only by breast shape, volume, and degree of ptosis, but also by a well-defined position of the fold (Fig. 34.1) [1, 3].

It is important to preserve the inframammary fold in oncologic breast surgical procedures whenever possible. In certain situations, the fold can be moved to a lower or upper position. Therefore, during a mastectomy, surgeons should prevent the dissection from extending far beyond the inframammary fold, thus preventing the creation of an undefined fold. For this reason, special attention should be paid to the ptosis of the reconstructed breast and inframammary fold positioning in postmastectomy reconstructions [3, 4].

34.2 When Should Reconstruction Be Performed?

In general, inframammary fold reconstruction should only be performed after the skin overlying the chest wall achieves good mobility. Thus, fold reconstruction should be performed 4–6 months after late postmastectomy breast reconstruction, using a tissue expander, a direct prosthesis or a myocutaneous flap. In surgical procedures initially using a tissue expander, fold reconstruction should be performed only when the expander is replaced with the prosthesis. The need to improve fold definition is then considered [1, 4, 5].

34.3 Indications for Inframammary Fold Reconstruction

Inframammary fold reconstruction is mainly performed in the case of late postmastectomy breast reconstruction. The anatomical landmark of the original fold site cannot be preserved because of large skin excision and upward dislocation of the inframammary fold as a result of skin closure. A poorly defined inframammary fold is usually created as a consequence of the use of a tissue expander or direct prosthesis placement (in the case of smaller breast volume), or even when using myocutaneous flaps, resulting in an unnatural appearance of the new breast in terms of shape and ptosis. Late effects of additional radiotherapy may also interfere with the position and the definition of the inframammary fold (Fig. 34.2). The result often seems satisfactory when each breast is assessed individually, but not when considering the symmetry with the opposite breast [4].

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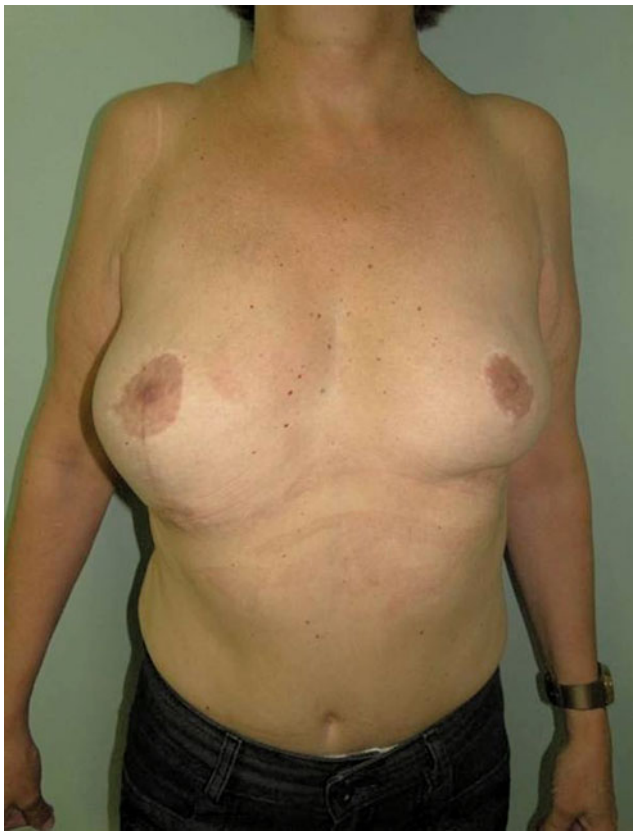


Fig. 34.1 Mammary asymmetry: a 60-year-old patient who had in situ ductal carcinoma in the left breast in 2003 and who underwent conservative surgery, radiotherapy, and mastoplasty in the opposite breast. Photograph taken in 2012 showing asymmetric volume and position of the inframammary fold (photograph from Rodrigo Cericatto)

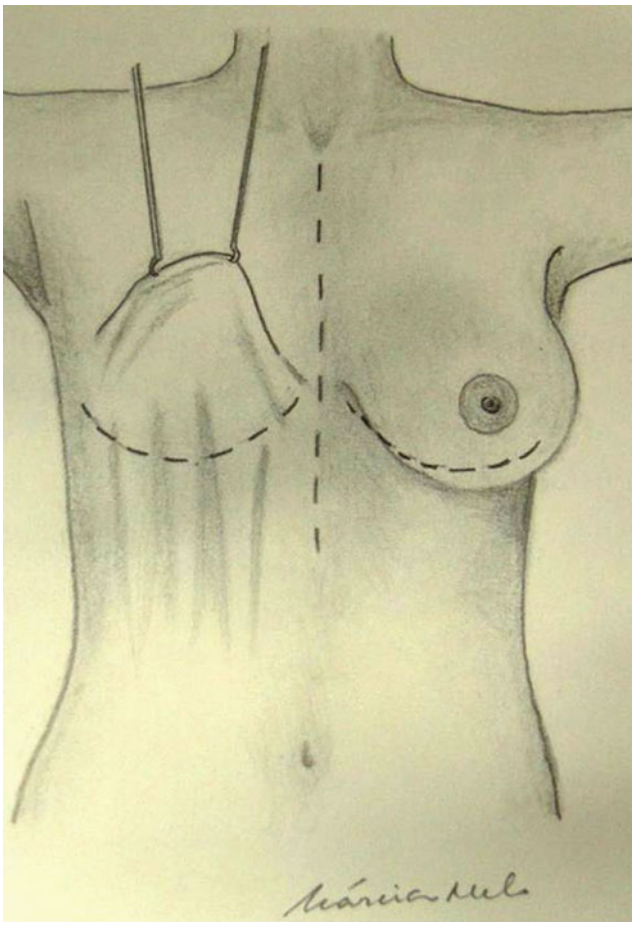
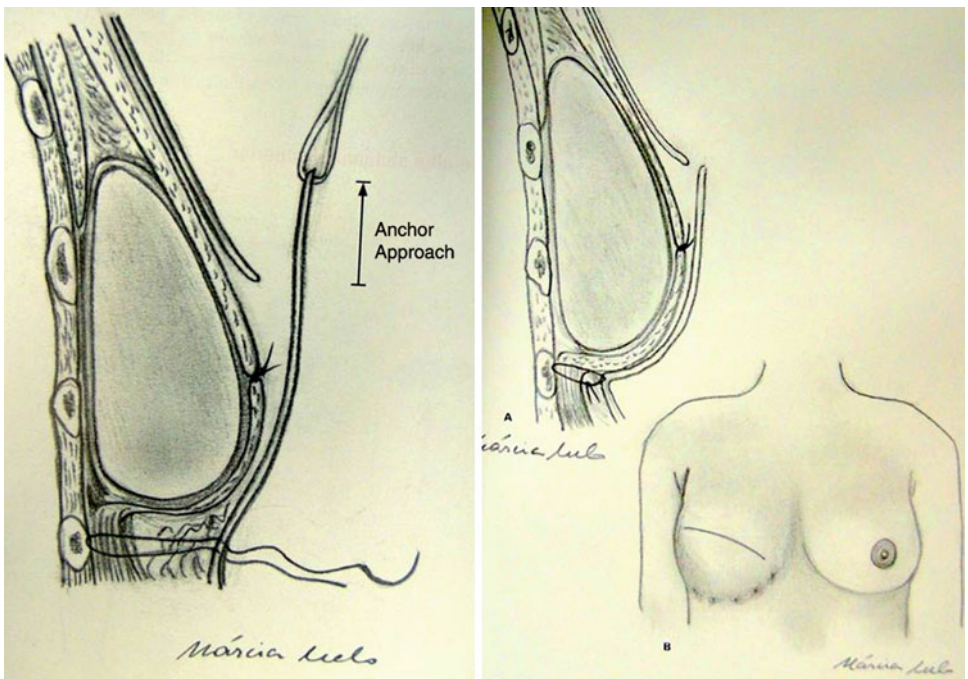


Fig. 34.2 Planning late breast reconstruction and inframammary fold projection (from Biazús et al. [6])

Fig. 34.3 Anchor points with abdominal flap advance (from Biazús et al. [6])



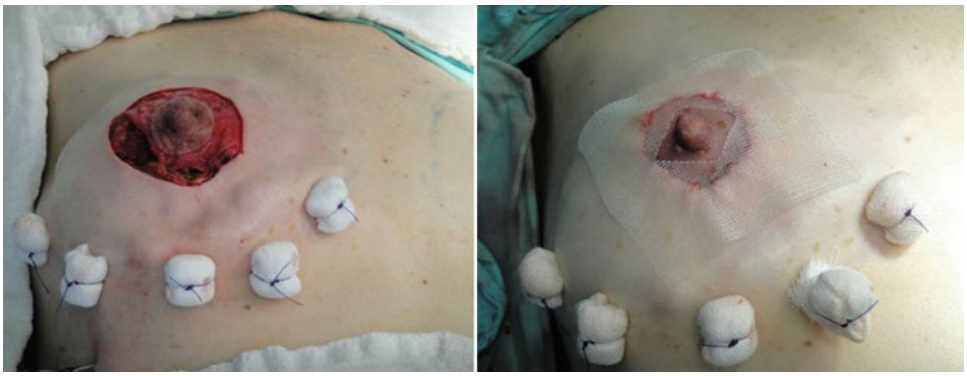


Fig. 34.4 Anchor points (photographs from Jorge Biazus)

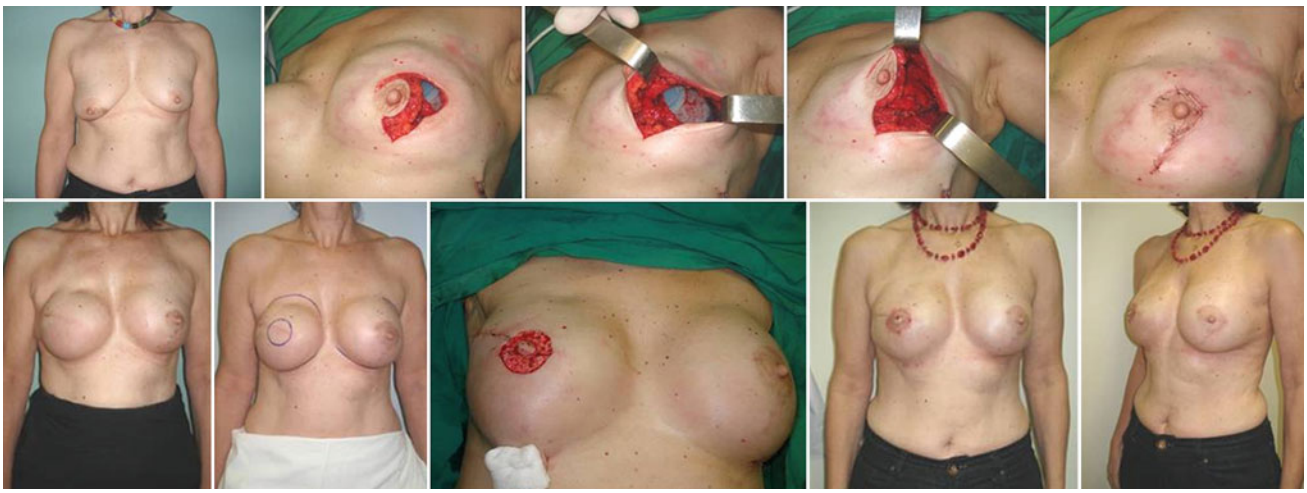


Fig. 34.5 Anchor points. Bilateral mastectomy with reconstruction using tissue expanders. Asymmetric fold position. When expanders are replaced with a silicone prosthesis, external anchor points recreate the new fold when they are fixed to the periosteum of the sixth rib (photographs from Rodrigo Cericatto)

34.4 Surgical Planning

After the technique to be used for inframammary fold reconstruction has been chosen, skin marking is performed with the patient in a sitting or standing position, in the preoperative setting (Fig. 34.3) [3, 6].

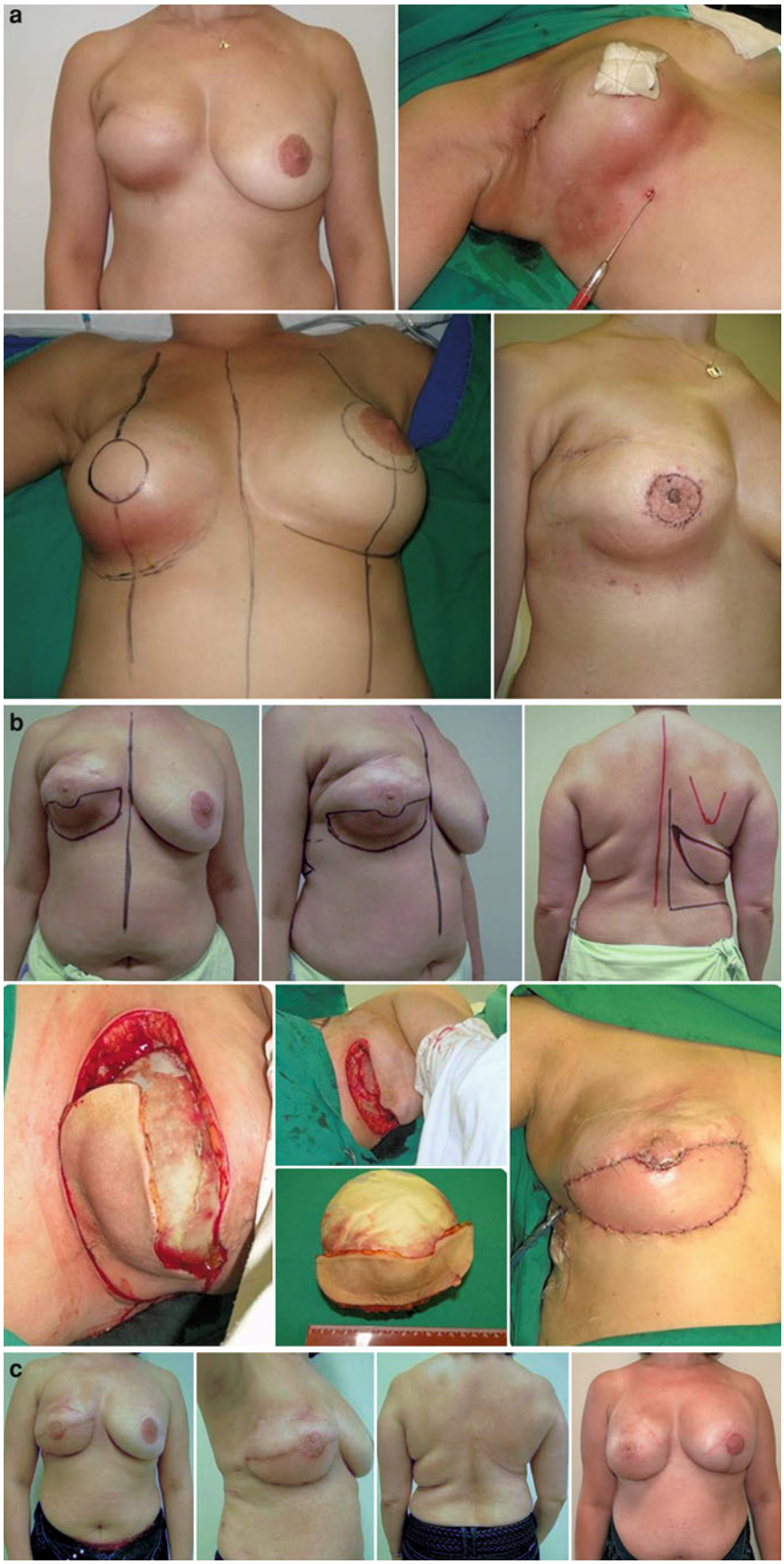
The patient can be instructed to bring her external prosthesis bra to assist with the skin marking of the fold site. After the fold position has been marked with the patient wearing her bra, it is taken off, and the marked breast is compared with the contralateral breast. Marking is usually located on or immediately below the sixth rib along the breast meridian line [4].

34.5 Surgical Techniques

Several surgical techniques have been described for both creation and correction or better definition of the inframammary fold. These techniques involve surgery with the patient under general anesthesia and they may be used during primary breast reconstruction or later, in the case of reconstruction when the tissue expander is replaced with a prosthesis or myocutaneous flaps. Occasionally, these techniques may be associated with liposuction or lipofilling, with late correction of poorly defined folds [1, 3, 4, 5].

34.5.1 External Approach

This technique was described by Ryan in 1982 and it offers the possibility of using a portion of the upper abdominal skin to cover the prosthesis while defining and stabilizing the inframammary fold. It involves creating a new scar at the definitive site of the inframammary fold. In the case of reconstruction involving direct prosthesis placement, a second marking is performed below the prior marking of the site where the fold should be located with the purpose of pulling a skin flap upward to cover the lower portion of the prosthesis. Usually 1 cm for each 100 ml of prosthesis is used as the measure below the fold


a
b
c

◀ **Fig. 34.6** Fold reconstruction using a latissimus dorsi flap: **a** Radical mastectomy (right breast) with tissue expander reconstruction and adjuvant radiotherapy. Expander replaced with a silicone prosthesis. **b** Significant capsular contracture, fold retraction, and thinned skin in the lower quadrants. **c** Inframammary fold reconstructed using a latissimus dorsi flap and a silicone prosthesis (photographs from Rodrigo Cericatto)

for the new marking along the breast meridian line. A new 1-cm crescent marking is performed over this lower marking. During the surgery, this crescent is deepithelized. An incision is made in the center of this crescent (reaching the hypodermis). Next, skin is detached with the purpose of creating a skin flap and fixing the lower flap on the site of the definitive fold. This lower flap is then fixed on the chest wall. After prosthesis placement, the upper skin flap is fixed on the edge of the lower flap. This technique has been criticized for creating a new scar in addition to the mastectomy scar and for making it difficult to accurately determine the amount of tissue that has to be moved upward. It is also more difficult to implement this technique in very thin patients or in those who have very thick subcutaneous tissue [4].

34.5.2 Internal Approach

This technique is especially used in cases where breast reconstruction was planned to be conducted at two different times. The internal approach can be used in cases in which the final volume is achieved using a tissue expander and where the inframammary fold is poorly defined or lower than the contralateral breast. A capsulotomy is performed where the fold will be placed using the same incision through which the expander is removed. The inferior margin of the capsule is sutured to the chest wall at this same level. Then, the definitive breast prosthesis is placed. With use of this technique, it is possible to reconstruct the inframammary fold at a higher position, and the prosthesis achieves some degree of ptosis without the need for a second incision or a skin incision on the corrected inframammary fold [5].

34.5.3 Anchor Approach

Similarly to the internal approach, correction is performed through the same incision used for placing the definitive prosthesis (Figs. 34.4, 34.5 and 34.6). The inferior edge of the pectoralis major is anchored and it partially covers the breast prosthesis by being sutured to the skin of the site where the fold will be placed. The suture is externally anchored to the skin, which is then protected with swabs [6].

34.5.4 Allograft Approach

More recently, immediate or late breast reconstruction using implants has been performed in North America and in some European countries with the use of allografts, especially to cover the lower quadrants of the breast implants and to define the inframammary fold. The malleability of allografts makes it possible to achieve good definition of breast contour and projection [7].

References

1. Nava M, Quattrone P, Riggio E (1998) Focus on the breast fascial system: a new approach for inframammary fold reconstruction. Plast Reconstr Surg 102:1034–1045
2. Vasconez L (2001) Princípios em reconstruçao mamária. In: Cavalcante Ribeiro R, Saltz R (eds) Cirurgia da Mama: estética e reconstrutiva. Revinter, Rio de Janeiro, pp 109–114
3. Chun YS, Pribaz JJ (2005) A simple guide to inframammary-fold reconstruction. Ann Plast Surg 55:8–11
4. Ryan JJ (1998) Recreating the inframammary fold: the external approach. In: Spear SL (ed) Surgery of the breast. Lippincott-Raven Publishers, Philadelphia, pp 492–496
5. Spear SL, Mesbahi AN, Beckenstein M (1998) Re-creating the inframammary fold: the internal approach. In: Spear SL (ed) Surgery of the breast. Lippincott-Raven Publishers, Philadelphia, pp 497–511
6. Biazús JV, Zucatto AE, Melo MP (2011) Cirurgia reconstrutora da mama com utilizaçao de próteses. In: Biazús JV, Zucatto AE, Melo MP (eds) Cirurgia da mama. Artmed, Porto Alegre, pp 332–333
7. Becker S, Saint-Cyr M, Wong C, Dauwe P et al (2009) AlloDerm versus DermaMatrixin immediate expander-based breast reconstruction: a preliminary comparison of complication profiles and material compliance. Plast Reconstr Surg 123:1–6

35 Complications of Unipedicled TRAM Flap Reconstruction: Treatment and Prevention (and Their Influence on the Choice of the Reconstruction)

Jean-Marc Piat

35.1 Introduction

After a description of the technique in 1982 [1], Carl Hartrampf was the pioneer and promoter of unipedicled transverse rectus abdominis myocutaneous (TRAM) flap breast reconstruction. The principles of pedicled TRAM flap (unipedicled or bipedicled) reconstruction with preparation of the flap by ligation of the inferior epigastric vessels (delayed TRAM flap) and strengthening of the vascularization by microanastomoses of the inferior epigastric vessels (supercharged TRAM flap) and the principles of free TRAM flap reconstruction by microanastomoses of the deep inferior epigastric vessels were quickly proposed [2, 3].

Subsequently new techniques of reconstruction with TRAM flap microanastomoses were developed in order to preserve the abdominal fascia. The deep inferior epigastric perforator (DIEP) flap reconstruction leaves the right rectus abdominis muscle totally in place the [4]. The superficial inferior epigastric artery (SIEA) reconstruction avoids a fascial incision [5]. These techniques give excellent results in referral centers for surgeons trained in microsurgery.

TRAM flap reconstruction is a technique of choice because it allows reconstructing a breast without a prosthesis, with a natural look, and which is easily improvable by lipomodeling and is very stable over time regardless of changes in the weight of the patient [6]. Specific complications are mainly necrosis of the flap and the weakening of the abdominal wall, which can cause a hernia or bulge. There are also less specific complications such as infection, which must be taken into account when choosing the technique (whether or not to use mesh at the wall).

The TRAM technique is used routinely by many surgeons all over the world. The choice of the technique (unipedicled, bipedicled, or microanastomoses) depends largely on individual experience, but proportionally few surgeons are experienced in microsurgery. Each TRAM technique has advantages and disadvantages, with a risk of partial or total necrosis, and a risk of more or less important parietal complications. The risk of complications is dominated by parietal complications for pedicled TRAM flap reconstruction and the total loss of the TRAM flap for microanastomoses [7, 8].

Since being trained in the technique of unipedicled TRAM flap reconstruction by Madeleine Lejour in Brussels in 1989, I have acquired a personal experience of more than 500 such reconstructions. The beginning was marked by an important rate of partial necrosis of 8 % during the first 60 TRAM flap reconstructions without this being clearly explainable by a technical problem or a specific risk factor related to the patient. Then we became more selective with patients and improved the technology to make it more reliable. A study of 192 consecutive unipedicled TRAM flap reconstructions done between 2003 and 2009 was used to analyze these complications and their preventive measures. The use of delayed TRAM flap reconstruction has reduced very significantly the rate of partial necrosis to 3 %. Similarly, the rate of parietal complications of about 10 % at the beginning of the study was reduced to 4.6 % owing to the technical reconstruction of the wall adapted to each patient.

35.2 Complications of Unipedicled TRAM Flap Reconstruction and their Treatment

35.2.1 Necrosis

Necrosis is linked to a lack of blood supply to part of the flap, resulting more in peripheral venous congestion followed by thrombosis than arterial ischemia. In fact, at the time of the decision to retain more or less area of the surface level of the flap, it is quite simple to evaluate the arterial supply to the flap, deepithelializing the surrounding area to be observed. On the other hand, it is more difficult to assess the quality of venous return in the periphery of the flap. It may

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seem to be of poor quality at the beginning, with a rather important stasis at the time of the lifting of the flap in the epigastric region, which then improves spontaneously after having the patient sit in order to close the abdominoplasty. Two mechanical reasons could explain this:

1. The slope of the venous return obtained by having the patient sit
2. The relaxing of anti-reflux valves in the veins, once they are dilated by the initial venous stasis that they caused.

After the surgery and in the early postoperative hours, the capillary refill is the best indirect evidence of vascularization of the flap. If it is less than 2 s in the peripheral zone, the least well vascularized, we can expect a favorable outcome. If it is more than 2 s, the flap should be monitored very carefully. If it is more than 3 s, necrosis is a concern.

Some propose putting a temporary drain in place during the operation, intubating one of the epigastric inferior veins with an angiocatheter to drain the flap when the degree of venous congestion is very high [9].

35.2.1.1 Important Flap Loss (Greater Than 25 % of the Flap)

The total loss of the flap is exceptional in cases of unipedicled TRAM flap reconstruction. It may be related to a problem of notification as it has only happened once in our experience This was a 65-year-old woman who had had two Pfannenstiel incisions (one for a hysterectomy and one for a prolapse), which were much more traumatic for perforating vessels than a Pfannenstiel incision made for a caesarean section. As the patient showed abdominal excess compatible with TRAM flap reconstruction and moreover was very adamant about having the operation, TRAM flap reconstruction was chosen, knowing that there was a risk associated with her age and surgical history. The appearance of the flap after surgery was satisfactory. The results were marked by progressive thrombosis of the flap causing extensive necrosis of more than 50 %, as well as a pulmonary embolism occurring on the fifteenth postoperative day which required the removal of the flap on postoperative day 21 (Fig. 35.1). The patient reported spontaneous thrombosis related to a factor V Leiden anomaly in her daughter. Additional tests showed the existence in her case of a factor V Leiden anomaly, which is known to be a risk factor for necrosis of the TRAM flap [10].

Apart from high-risk situations (smoking, obese, or diabetic patients), which are for some only relative contraindications to unipedicled TRAM flap reconstruction, significant necrosis of the flap can occur owing to a technical error during the intraoperative harvesting injuring the superior epigastric vessels as in following case. This was an obese patient of 52 years of age for whom unipedicled TRAM flap reconstruction was chosen despite a BMI of 31 to correct a faulty immediate reconstruction with an expander (infection). The operation was marked by a spontaneous and

Fig. 35.1 Total flap loss

complete tear of one of the two pedicles of the upper division epigastric vessels before it entered the posterior face of the right rectus abdominis muscle. This occurred as a result of traction on the pedicle (which was attached to the rib cage) by the particularly heavy flap of this patient while it was being shifted upward. Microsurgical repair of the injured pedicle (artery and vein) was performed to save the flap, but partially failed. Further surgery was done 48 h later to resect about 25 % of skin tissue developing necrosis (Fig. 35.2a), with good progress after 1 month (Fig. 35.2b) but fat melting was recorded later (Fig. 35.2c). In these situations of significant loss of surface and volume of the flap, the secondary correction requires the use of a prosthesis or another flap. A proposal for recovery with an autologous latissimus dorsi flap associated with lipofilling was made to the patient.

35.2.1.2 Moderate Flap Loss (Between 5 and 25 % of the Flap)

This complication occurs more frequently, from 3 to 15 % in published series [11, 12]. Early treatment is performed to save as much as of the flap as possible and a later treatment is proposed to correct the sequelae of this necrosis.

Often related to venous congestion (which will be the cause of necrosis), an established necrosis requires us to perform further surgery on the second postoperative day when the limits of the cutaneous vein thrombosis are well marked and before thrombosis spreads to a larger portion of the flap. It is generally found in patients whose blood supply to the flap was overestimated intraoperatively, especially in its periphery and the side opposite the pedicle muscle. In this case the removal of thrombosed tissue requires a complete remodeling of the flap, which is easy to perform on the second postoperative day before scar tissue fibrosis occurs as is shown in the case in Fig. 35.3.

It is better to intervene early rather than let necrosis evolve naturally, for several reasons:

- Early intervention saves more volume of the flap (before the necrosis spreads).
- Spontaneous evolution of the necrosis can last several months with important localized health treatment, which can lower the patient's morale.
- In some cases there is a risk of infection of necrotic tissue that may extend to the whole flap.
- The final result with a retractile fibrosis and a defect located on the edge of the flap is more difficult to correct

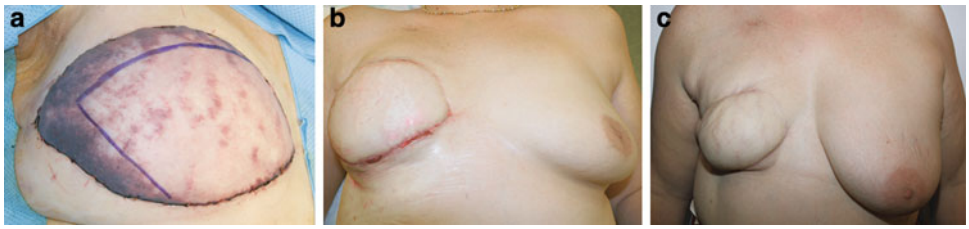

Fig. 35.2 **a** Resection of thrombosed tissues after 48 h. **b** Result after 1 month. **c** Result after 1 year and fat melting

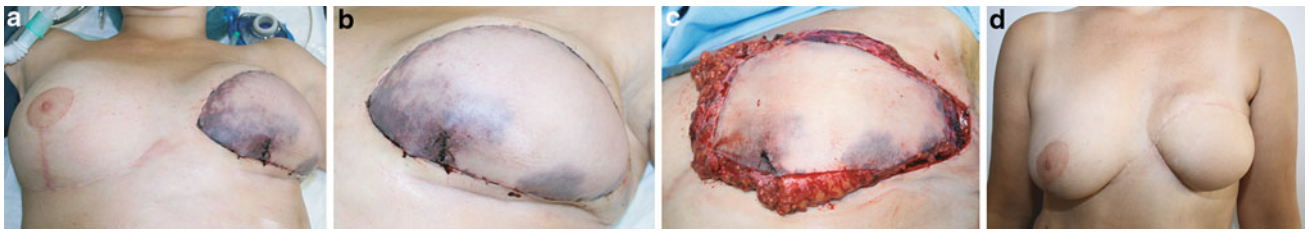

Fig. 35.3 **a**, **b** Images showing the thrombosed tissues after 48 h. **c** Removal of thrombosed tissues and complete remodeling of the flap. **d** Result 9 months later

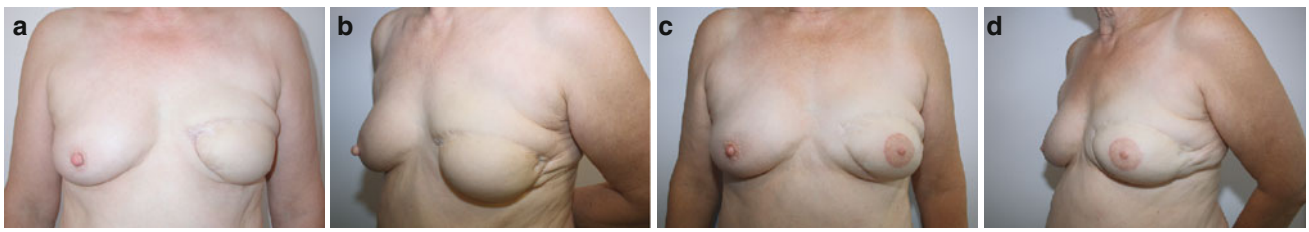

Fig. 35.4 **a** Frontal view and **b** oblique view 1 year after necrosis of both extremities of the flap. **c** Frontal view and **d** oblique view after two lipofillings (140 and 120 cm^3) and nipple–areola reconstruction

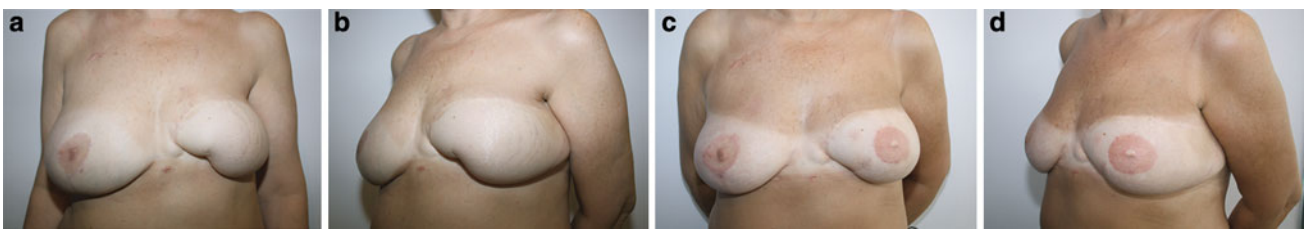

Fig. 35.5 **a** Frontal view and **b** oblique view 7 years after necrosis of the inferointernal region of the flap. **c** Frontal view and **d** oblique view after remodeling of the flap, two lipofillings (110 and 160 cm^3), nipple–areola reconstruction, and reduction of the contralateral breast (170 g)

than one treated after an early intervention leaving the residual flap smoother.

The necessary correction in the long run may call for a prosthesis or another flap to make up the volume. If the patient has suitable donor areas, a correction of the flap can be done more simply by skin remodeling associated with lipofilling and symmetrization of the contralateral breast and without (Fig. 35.4) or with (Fig. 35.5) remodeling of the flap.

35.2.1.3 Minimal Skin Necrosis (Less Than 5 % of the Flap)

This does not require early new surgery. Its boundaries are difficult to assess in the first few days after surgery and can be treated by allowing the lesion to evolve spontaneously as postoperative care is then simple and can be done by the patient herself without too much trouble. It leaves a zone of residual underlying fat necrosis. It is often associated with a

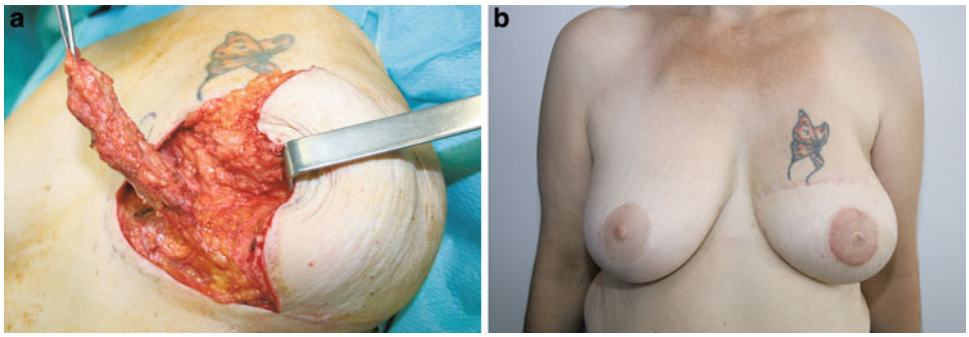

Fig. 35.6 **a** Removal of internal fat necrosis (10 × 2 × 1.5 cm), remodeling of the flap, and areola reconstruction 8 months after transverse rectus abdominis myocutaneous (TRAM) flap reconstruction. **b** Result 8 months later

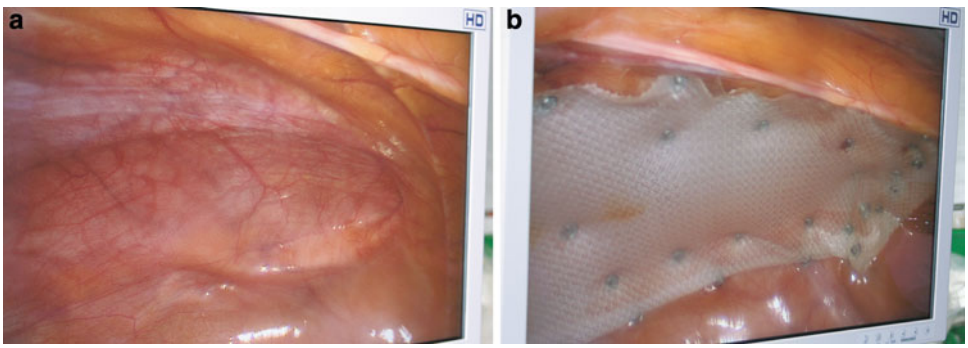

Fig. 35.7 **a** Laparoscopic view showing abdominal infraumbilical hernia 2 years after unipedicled TRAM flap reconstruction without preaponeurotic mesh. **b** Repair using intraperitoneal mesh

small skin necrosis of the abdominal scar, reflecting a general vascular status of the patient that is not optimal.

35.2.2 Fat Necrosis

Fat necrosis is associated with skin necrosis but can also occur without evidence of skin necrosis. Its frequency ranges from 4 to 35 % depending on the series [7, 13, 14]. It is troublesome if it is large and the cause of a large induration perceived by the patient. It can, as in the case shown in Fig. 35.6, be corrected by an excision followed by remodeling of the flap done in conjunction with the areolar reconstruction.

If the fat necrosis cannot be resected without distorting the reconstruction, or if it is minimal, it can be left in place with reassurance given to the patient. A simple lipofilling can potentially improve the consistency of the flap or remove a superficial skin retraction.

35.2.3 The Parietal Complications

35.2.3.1 Mechanical

All types of complications can occur following a relaxation of the fascial suture in 4–29 % of cases depending on the series [15–17].

The most troublesome are the abdominal hernias, which can be localized in the epigastric region (transition zone of the flap) or below the umbilical region (area of weakness below the arcuate line). They should be treated as if they are symptomatic. The placement of a mesh by laparoscopy is the most elegant treatment (Fig. 35.7).

The commonest complication is weakness of the fascia in the infraumbilical region (laxity or bulge), which can be corrected later, if the patient wishes, by a complete detachment of the wall followed by plication of the fascia (for re-tension) and the establishment of a reinforcing preaponeurotic mesh.

35.2.3.2 Infections

Infections of the flap are rare outside necrosis cases.

Acute and significant postoperative infections of the abdominal wall require removal of the prefascia mesh, followed by monitored wound healing and later cosmetic correction away from the abdominal scar (Fig. 35.8).

Infections of the abdominal wall in relation to a dehiscence abdominal scar after a deficit of blood supply to the lips are handled by local treatment without removal of the parietal prosthesis.

Some infections such as those occurring away from a hematoma or seroma of the abdominal wall can cause a chronic skin fistula problem. If the prosthesis located deep in the sheath of the right rectus abdominis muscle is affected

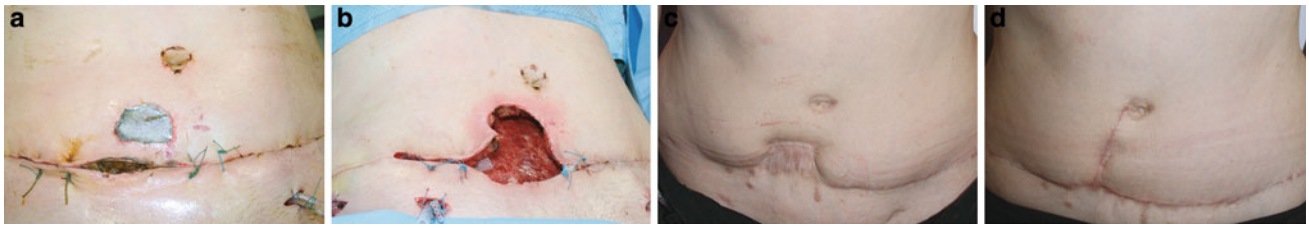

Fig. 35.8 **a** Drainage of acute infection with anaerobic germs of the abdominal infraumbilical skin 8 days after TRAM flap reconstruction. **b** Removal of the infected tissues and the prefascia mesh 15 days after TRAM flap reconstruction. **c** Result 6 months later, after important localized health treatment. **d** Result 1 year later after correction of the scarring sequelae

by germs, superficial debridement of the wound, even combined with appropriate antibiotic therapy, is inadequate. The final treatment of the infection requires removal of the underlying contaminated prosthesis, which can weaken the wall, with a risk of secondary eventration. The use of a dermal matrix prosthesis can be of great help to obtain proper healing and a solid wall in a septic environment.

35.3 Our Series

We performed 192 unipedicled TRAM flap reconstructions in our unit between October 2003 and October 2009. I participated as a principal surgeon (in most cases) or as an assistant. The analysis was done from medical records (hospitalization and outpatient) and also from questionnaires sent to patients (77 % responded). In our experience, unipedicled TRAM flap reconstruction is the preferred secondary breast reconstruction technique when the morphology of the patient permits. In some cases it is done by default, even if the morphology of the patient is not ideal (with a flap of moderate size) owing to the impossibility of making a prosthesis for breast reconstruction and weighing the pros and cons with respect to the use of a latissimus dorsi flap. The patient is then warned of the risk of postoperative prolonged tension of the abdominal wall.

When possible, we use the unipedicled TRAM flap by a taking a sample of the contralateral right rectus abdominis muscle. Preparation by ligation of inferior epigastric vessels is routinely performed at least 3 months before the completion of the TRAM flap reconstruction.

We do not often use TRAM flap reconstruction for immediate reconstruction (3 % of cases), given the risk of additional treatment in cases of invasive cancer. We also systematically insist on a 3-month period after preparation, and it is difficult to delay a mastectomy for cancer, even in situ, for that period of time. Our immediate TRAM flap reconstruction involves prophylactic mastectomy.

In this series, the rate of specific complications was low. As shown in Table 35.1, there were six cases of flap necrosis (3 %), of which three cases were necroses greater than 5 % requiring further surgery: one for an intraoperative problem already described (Fig. 35.2) and two related to the overevaluation of the intraoperative vascularization of the flap, treated by removal of areas of necrosis at 48 h, with subsequent correction of asymmetry.

Table 35.1 Cases of necrosis observed (among 192 cases)

Flap loss > 25 %	1 case
Flap loss of 5–25 %	2 cases
Flap loss < 5 %	3 cases
Fat necrosis < 10 %	17 cases

Table 35.2 Cases of mechanical complications observed

Abdominal hernia	3 cases
Abdominal laxity	6 cases

As shown in Table 35.2, there were nine cases of mechanical complications of the wall (4.5 %), of which six cases were bulges and three cases were abdominal hernia requiring further surgery by laparoscopy(1.5 %).

Five infections of the abdominal wall, of which two of the more important required removal of the preaponeurotic mesh, had to be treated

The loss of hemoglobin was on an average 2.5 g per 100 ml (between the preoperative samples and those obtained on the third postoperative day). Four patients had to be transfused, a rate of 2 %.

This low rate of complications is explained by three factors:

1. The careful selection of patients
2. The vascular preparation of the TRAM flap
3. The careful refection of the abdominal wall.

35.3.1 Selection of Patients

Apart from the classic contraindications for TRAM flap reconstruction, three factors should be discussed on the basis of the risk of complications related to them.

35.3.1.1 Age

The average patient age was 48 years. In younger patients, the pedicled TRAM flap reconstruction is ruled out when the patient desires to become pregnant later [18]. For older patients, the theoretical upper age limit is set at 60 years but can be overturned on a case-by-case basis depending on the general condition of each patient. Our oldest patient (73 years old) had perfectly simple follow-ups.

35.3.1.2 Tobacco

We found early in our experience, and as reported throughout the literature [19], that tobacco intoxication was a major risk factor for complications owing to a decrease in the arterial supply leading to necrosis of the flap and also more complications in terms of scar abdominoplasty. These necroses can then cause infections. Because of this we operate, and this is our strict condition, only on nonsmokers or patients who stopped smoking at least 6 months before the TRAM flap reconstruction. In most cases this formal condition allows patients who want a TRAM flap reconstruction to be even more aware of the harmfulness of tobacco. Most quit smoking and are also grateful for doing so in the long run. If the patient will not stop smoking, we offer another method of reconstruction safer than a latissimus dorsi flap.

35.3.1.3 Obesity

Obesity is also a complicating factor in the type of flap necrosis, mechanical complications in the abdominal wall, and infection [20].

Obesity is in itself is a risk factor for vascular complications. Too great a thickness of the flap results in a lower skin vascularization with an increased risk of necrosis after surgery. It is also often associated with metabolic risk of poor vascularization (high cholesterol level, diabetes, etc.), promoting arthritis, thus further increasing the risk of necrosis. Obesity also increases the mechanical complications favoring an abdominal hernia or laxity.

For these different reasons, we do not perform TRAM flap interventions in patients with a BMI higher than 30. By properly explaining these risks, and also with the help of a dietician, we can in most cases help these patients to lose weight to get to a BMI under 30. In our series, the average BMI was 24, with a range from 20 to 31.

35.3.2 Vascular Preparation (Delayed TRAM Flap Reconstruction)

Early in our experience, we observed, as have others [21], unexplained flap necrosis occurring without any risk factor. Following the first publications on delayed TRAM flap reconstruction [22, 23], and researching a method to make the results less random, we gradually began a vascular preparation in our patients. Faced with the obvious clinical improvement of the vascularization of the flap, this preparation has become routine and was performed in the same way in all patients in the series studied.

The procedure is done bilaterally with the patient under general anesthesia. The goal is to improve the blood supply of the future flap, in particular in segments III and IV opposed to the pedicle muscle as in the classification of Ninkovic [24], segment II being adjacent to outer segment I, which remains the part of flap best vascularized, in front of the preserved pedicle muscle. The technique is the same on both sides. After an incision in the lateropubian fold, leaving a very discreet scar, the superficial inferior epigastric vessels which vascularize some of segments II and IV of the flap are reached at their origin and are cut between ligatures. These vessels are inconstant (especially the artery), but they are easily found, when they exist, at the bottom or at the external part of the incision. We then open the aponeurosis of the external abdominal oblique muscle in the direction of its fibers at the external inguinal ring. The internal inguinal ring is reached and the deep inferior epigastric vessels, found after a short incision in the fascia transversalis, are linked (the vein is always present lower and below the artery).

A minimum period of 3 months is required before doing the TRAM flap reconstruction. At first it was 15 days as in the published series, but after having established from a clinical standpoint that the longer the delay, the better the vascularization of the flap, we opted for a minimum period of 3 months.

This intervention occurred at the same time as a total mastectomy in 19 % of cases and a contralateral reduction plasty in 15 % of cases, thus avoiding an additional procedure.

35.3.3 Wall Repair

This has to be meticulous. The fascia of the rectus abdominis muscle is preserved as much as possible to reduce side wall tension, which explains much of the postoperative pain. We leave a strip of 5 mm in the region above the umbilicus in the middle of the right rectus abdominis muscle, which is removed in its entirety. In the infraumbilical region, the quality of perforating vessels is evaluated during the initial dissection of the flap, which is done down to the centerline on the opposite side to the removed muscle. If these perforating vessels are numerous and consistent, especially the perforating vessels of the periumbilical and central region, the perforating vessels of the outermost side of the sample can be linked, thus preserving more fascia. Otherwise these vessels must be maintained, resulting in a higher secondary tension of the fascia in the subumbilical fascia.

A flexible polyester mesh, Parietex, is always anchored in the sheath of the rectus abdominis muscle to improve the wall tension in a longitudinal direction (to facilitate subsequent movements of flexion of the torso). The fascia of the rectus abdominis muscle is then sutured with slowly absorbable thread. Plication of the contralateral wall is performed to improve symmetry of the wall and bring the umbilicus in a more central position. Depending on the strength of the fascial suture (variable from one patient to another depending on the quality of tissue and the size of the sample taken from the fascial flap), a second mesh can be put in place in the prefascia to reduce the risk of hernia and later bulge. In our series, this was necessary in 59 % of cases, and among those the mesh was placed over the entire surface of the wall in 78 % of cases, only in the epigastric region in 19 % of cases, and only in the infraumbilical region in 3 % of cases.

35.4 Discussion

35.4.1 Delayed TRAM Flap Reconstruction

The effectiveness of the preparation is a matter of discussion. It is criticized because it involves a supplemental intervention and can cause local complications, making reconstruction more complicated later. For some it is remarkably effective to obtain a quality of vascularization of the flap similar to that of a free TRAM flap [25].

In our series, preparation has reduced our rate of partial necrosis of 8 % before using this technique to 3 %. There is an excellent sign of the indirect contribution of the preparation, during surgery, i.e., the existence of an inferior epigastric pedicle pulsatility with the flow from the superior epigastric vessels, after section of the inferior epigastric pedicle.

But it is very difficult to demonstrate the value of preparation because the performance criteria are mainly clinical. Also, when one is sure, one does not want to penalize the patient for whom the preparation is not done because of the framework of a randomized study. When a classic pedicled TRAM flap reconstruction is performed, there is very good blood supply to segment I, quite good blood supply to segment II, and adequate blood supply to segment III of the flap. After preparation, the blood supply of vascular segments I and II is very good, that of segment III is quite good, and that of segment IV is inconstant [26]. In our series the entire TRAM flap including segment IV of the TRAM flap has been or could have been (without that being necessary) kept partially or completely in about 20 % of cases, which is particularly interesting, mainly in flaps of moderate volume. When the volume of the TRAM flap is not sufficient, complementary lipofilling can be proposed [27].

The advantage of the method we use is its simplicity for any surgeon, and there is minimal scarring, compared with a direct inguinal incision. It also permits us to use the same incision for the superficial and deep inferior epigastric vessels. The remote location of the incision made, relative to the incision made at the future lower flap, avoids local complications, which are the cause of fibrous scars in the future flap and also increase the risk of postoperative wall infection. This is also why we have not opted for an associated skin delay like others have [28].

One disadvantage of delayed TRAM flap reconstruction is that it requires an additional intervention. This can be avoided by making the preparations at the same time as the mastectomy or at the same time as contralateral plastic breast surgery is performed. Given the delay of 3 months that we respect between preparation and reconstruction, it is not feasible in the case of immediate TRAM flap reconstruction except for a preventive mastectomy.

Some practice delayed TRAM flap reconstruction by a laparoscopic approach [29]. After trying this method, we have not adopted it, because research of inferior epigastric vessels has sometimes been difficult, with a bleeding risk, which may be responsible for specific complications and because this technique does not allow ligation of superficial inferior epigastric vessels. Moreover, the incision used in our method is very discreet, thus reducing the relative contribution of laparoscopy.

35.4.2 Abdominal Wall

The TRAM flap, whatever the technique, can improve the aesthetic appearance of the abdomen. In our series, 75 % of patients were satisfied with the cosmetic result of the abdominoplasty with an improvement compared with their previous situation. The consequences of a unipedicled TRAM flap at the abdominal wall are both mechanical and functional.

The risk of mechanical complication in our series was small compared with the risk reported in te literature. This low rate of parietal complications can be partly explained by the relatively short time period studied, and especially by the introduction of a mesh when the fascia closure is fragile. This is easily found during surgery where there is significant tension of the suture and where the sutures tend to tear the tissue. The disadvantage of this preaponeurotic mesh is the risk of compromising the treatment of a potential postoperative wall infection. In borderline cases, in front of a major abdominal skin tension with subsequent risk of dehiscence, or if poor vascularization of the skin of the abdomen is found, this risk must be taken into account by avoiding, if possible, putting in a preaponeurotic mesh.

Compared with the bipedicled TRAM flap, where use of preaponeurotic mesh is mandatory, the parietal consequences are much lower with the unipedicled TRAM flap [16]. The risk of eventration and functional consequences (going back to normal activity and residual discomfort) are much lower. The quality of the blood supply to the bipedicled TRAM flap, however, is better, which makes this technique more reliable for some, especially in borderline cases (patients who are moderate smokers, or obese patients, or reconstruction of a large volume). Because of the rigorous selection of patients and the preparation, the lack of blood supply was detrimental in our series in only three cases (1.5 %) of partial necrosis of more than 5 %, making performing a bipedicled TRAM flap reconstruction unnecessary outside bilateral reconstructions.

Compared with the free TRAM flap reconstruction, preparation seems to result in the same level of vascularization. The risk of parietal complications is essentially the same after a unipedicled TRAM flap reconstruction [2]. The delayed TRAM flap reconstruction is a technique that is much simpler than microsurgery, and can be performed by all surgeons. It is preferable considering the duration of the intervention and the risk of total failure with the free TRAM flap.

With DIEP and SIEA flaps, without taking the muscle, the risk of complete necrosis is higher than with the unipedicled TRAM flap, ranging from 1 to 5 % depending on the experience of the surgeons and the centers where they work. Although for DIEP flap reconstruction the risk of partial necrosis seems to be the same as that after delayed TRAM flap reconstruction, the risk of fat necrosis is higher in some series [12, 13]. In contrast, the functional consequences are clearly less important in the abdominal wall [5].

In our series the functional aspect has been studied through answers to the questionnaire:

- Resuming a professional life (if not physical work) occurred on average 2 months after the unipedicled TRAM flap reconstruction.
- Sports activities were resumed after 5 months for 70 % of patients who exercised before surgery; most of the other 30 % had no athletic activity.
- Only two patients, i.e., 1 %, later regretted having unipedicled TRAM flap reconstruction because of their inability to resume the active sports activities they had previously practiced.
- For 40 % of patients there were, however, some physical activities that were no longer feasible after the procedure.
- Residual discomfort was significant for 16 % of patients.

However, 95 % of patients were satisfied or very satisfied with the reconstruction, thus putting the residual functional discomfort in perspective.

35.5 Conclusion

If an adequate treatment is to be implemented before any complication of unipedicled TRAM flap reconstruction, the best treatment is prevention.

Delayed TRAM flap reconstruction brings a lot of security to unipedicled TRAM flap reconstruction. It is feasible in the case of secondary reconstruction. If immediate reconstruction is possible (for us then there are no preoperative or intraoperative criteria in favor of postoperative radiotherapy), we offer the patient who wants a TRAM flap the immediate insertion of an expander prosthesis at the same time as mastectomy and preparation of the TRAM flap. The unipedicled TRAM flap can then be implemented in the form of a flap deepithelialized a few months later.

Although careful closure of the abdominal wall minimizes the risk of parietal complications after a pedicled TRAM flap reconstruction, the DIEP and SIEA flaps need to be offered preferentially to patients needing the integrity of the abdominal wall: as in young women who can become pregnant later, very athletic women, and those who must carry heavy loads in their professional activities. In this situation, it is best to refer the patient to a center experienced in using this technique regularly rather than one that uses it occasionally.

In summary, unipedicled TRAM flap reconstruction, after a rigorous selection of patients, routine vascular preparation , and reconstruction of the wall proper is a technique within the reach of many oncoplastic surgeons, and is very reliable and suitable for most patients seeking breast reconstruction by means of a TRAM flap.

References

1. Hartrampf CR Jr, Scheflan M, Black PW (1982) Breast reconstruction with a transverse abdominal island flap. Plast Reconstr Surg 69:216–225
2. Grotting JC, Urist MM, Maddox WA et al (1989) Conventional TRAM flap versus free microsurgical TRAM flap for immediate breast reconstruction. Plast Reconstr Surg 83:828–839
3. Schusterman MA, Kroll SS, Miller MJ et al (1994) The free transverse rectus abdominis musculocutaneous flap for breast reconstruction: one center's experience with 211 consecutive cases. Ann Plast Surg 32:234–241
4. Blondeel PN (1999) One hundred free DIEP flap breast reconstructions: a personal experience. Br J Plast Surg 52:104–111
5. Chevray PM (2004) Breast reconstruction with superficial inferior epigastric artery flaps: a prospective comparison with TRAM and DIEP flaps. Plast Reconstr Surg 114:1077–1083
6. Clough K, O'Donoghue J, Fitoussi A et al (2001) Prospective evaluation of late cosmetic results following breast reconstruction. Plast Reconstr Surg 107:1710–1716
7. Jones G (2007) The pedicled TRAM Flap in breast reconstruction. Clin Plast Surg 34:83–104

8. Granzowa JW, Levineb JL, Chiub ES, Allen RJ (2006) Breast reconstruction with the deep inferior epigastric perforator flap: history and an update on current technique. J Plast Reconstr Aesthet Surg 59:571–579
9. Caplin DA, Nathan CR, Couper SG (2000) Salvage of TRAM flaps with compromised venous outflow. Plast Reconstr Surg 106:400–401
10. Olsson E, Höijer P (2005) Activated protein C resistance due to factor V Leiden, elevated coagulation factor VIII and postoperative deep vein thrombosis in late breast reconstruction with a free TRAM flap: a report of two cases. Br J Plast Surg 58:720–723
11. Kroll SS, Gherardini G, Martin JE et al (1998) Flap necroses in free and pedicled TRAM flaps. Plast Reconstr Surg 102:1502–1507
12. Garvey PB, Buchel EW et al (2006) DIEP and pedicled TRAM flaps: a comparison of outcomes. Plast Reconstr Surg 117:1711–1719
13. Kroll SS (2000) Fat necrosis in free transverse rectus abdominis myocutaneous and deep inferior epigastric perforator flaps. Plast Reconstr Surg 106:576–583
14. Bozikov K, Arnez T, Hertl K et al (2009) Fat necrosis in free DIEP flaps: incidence, risk, and predictor factors. Ann Plast Surg 63:138–142
15. Petit JY, Rietgens M, Garusi C et al (2003) Abdominal complications with pedicled TRAM flap: is there still an indication for pedicled TRAM in the year 2003? Plast Reconstr Surg 112:1063–1065
16. Ascherman JA, Seruya M et al (2008) Abdominal wall morbidity following unilateral and bilateral breast reconstruction with pedicled TRAM flaps: an outcome analysis of 117 consecutive patients. Plast Reconstr Surg 121:1–8
17. Man LX, Selber JC, Serletti JM (2009) Abdominal wall following free TRAM or DIEP flap reconstruction: a meta-analysis and critical review. Plast Reconstr Surg 124:752–764
18. Bhat W, Akhtar S, Akali A (2010) Pregnancy in the early stages following DIEP flap breast reconstruction: a review and case report. J Plast Reconstr Aesthet Surg 63:782–784
19. Padubidri AN, Yetman R, Browne E et al (2001) Complications of postmastectomy breast reconstructions in smokers, ex-smokers, and nonsmokers. Plast Reconstr Surg 107:342–349
20. Spear SL, Ducic I, Cuoco F, Taylor N (2007) Effect of obesity on flap and donor-site complications in pedicled TRAM flap breast reconstruction. Plast Reconstr Surg 119:788–795
21. Wallace AM, Evans GRD, Goldberg DP et al (1996) Unexpected vascular compromise in transverse rectus abdominis musculocutaneous (TRAM) flap reconstruction. A report of two patients. Ann Plat Surg 36:246–250
22. Codner MA, Bostwick J, Nahai F et al (1995) TRAM flap vascular delay for high risk breast reconstruction. Plast Reconstr Surg 96:1615–1622
23. Taylor GI, Corlett RJ, Caddy CM, Zelt RG (1992) An anatomic review of the delay phenomenon: II. Clinical applications. Plast Reconstr Surg 89:408–417
24. Holm C, Mayr M, Hofter E, Ninkovic M (2006) Perfusion zones of the DIEP flap revisited: a clinical study. Plast Reconstr Surg 117:37–43
25. Taylor GI (1999) The delayed TRAM flap for breast reconstruction: why, when, and how? Operat Techn Plast Reconstr Surg 6:74–82
26. O'Shaugnessy K, Mustoe T (2008) The surgical TRAM flap delay: reliability of zone III using a simplified technique under local anesthesia. Plast Reconstr Surg 122:1627–1633
27. Spear SL, Wilson HB, Lockwood MD (2005) Fat injection to correct contour deformities in the reconstructed breast. Plast Reconstr Surg 116(5):1300–1305
28. Restifo RJ, Ward BA, Scoutt LM, Brown JM, Taylor KJW (1997) Timing, magnitude, and utility of surgical delay in the TRAM flap: II. Clinical studies. Plast Reconstr Surg 99:1217–1223
29. Restifo RJ, Ahmed SS, Rosser J et al (1998) TRAM flap perforator ligation and the delay phenomenon: development of an endoscopic/laparoscopic delay procedure. Plast Reconstr Surg 101:1503–1511

Part V

Refinements After Breast Reconstruction

Treatment and Care of Scars in Breast Reconstruction

36

Christina Garusi and Visnu Lohsiriwat

36.1 Introduction

Immediate breast reconstruction or an oncoplastic technique has been widely performed as an integral step in breast cancer surgery [1, 2]. The contralateral breast can be operated on in a symmetrical procedure or in an exploration step for tissue diagnosis [3]. Besides general considerations and management of scar tissue, in breast cancer surgery one must also consider the location of the scar (breast or donor site of autologous tissue), the timing of the scar (immediate or delayed), adjuvant therapy given to the individual cancer patient (e.g., radiotherapy and chemotherapy), and cancer prognosis. In this chapter, we discuss the specific characteristics and problems of each scar. We mainly categorize scar regarding the location of the primary incision.

36.2 Location

Breast-related scars result from both ipsilateral and contralateral breast surgery. The contralateral scar pattern can be categorized the same as the ipsilateral one. The incisions which are frequently used can be divided into incisions related to breast conservative treatment (BCT) and total mastectomy.

36.2.1 Breast Conservative Treatment

36.2.1.1 Without Oncoplastic Technique

This refers to an incision which is used in general for tumorectomy, lumpectomy, or wide excision. Its location usually corresponds to the location and quadrant of primary tumor. The overlying skin may or may not be removes depending on the distance of the tumor from the skin and the technique used by the surgeon. The incision can be radial, curvilinear, or circumareolar. The incision should be placed with the respect to the aesthetic unit of the breast [4].

36.2.1.2 With Oncoplastic Technique

The incisions for BCT with an oncoplastic procedure usually resemble those of mastopexy or a breast-reduction procedure. The incisions most commonly used are a periareolar incision, a vertical incision, and an inverted-T incision.

Management of these scars usually depends on radiotherapy, which is almost always integrated in BCT. However, radiotherapy probably plays a positive role for scar remodeling and formation [5]. Despite the oncoplastic technique resulting in more scars, it produces more symmetry and a better aesthetic result for the patient. Moreover, if the incision for oncoplastic surgery is well planned, it can be hidden in a less visible area. Another special consideration of scar management for BCT is if there is scar contracture. This may lead to malpositioning of the nipple and an unpleasant configuration of the entire preserved breast. The contracture occurs especially from the scar tissue in the breast itself.

36.2.2 Total Mastectomy

36.2.2.1 Skin-Sparing Mastectomy

The incisions usually performed for skin-sparing mastectomy are an elliptical incision, a racquet incision, or a circumareolar incision. The breast mound is immediately reconstructed by an expander–prosthesis or an autogenous base. Scar from skin-sparing mastectomy can be revised

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during the secondary procedure of nipple–areola complex (NAC) reconstruction.

36.2.2.2 Nipple-Sparing Mastectomy

The incisions which are recommended by European Institute of Oncology (EIO) are a superolateral radial incision, an inferolateral radial incision, a superior circumareolar incision, and periareolar incisions [6]. Regardless to the type of incision, the unique concern in this procedure is the location of the NAC. Scar from a radial incision can displace the NAC toward the vector of scar contracture.

36.2.2.3 Scar After Conventional Mastectomy or Delayed Mastectomy Scar

The scar from this category tends to have the poorest aesthetic outcome. The scar usually attaches to the chest wall and there is lack of adjacent healthy skin and subcutaneous tissue, especially after external radiotherapy.

36.2.3 NAC Area

We should pay special attention to the scar in NAC area because it can affect the final outcome of the reconstruction. The scar in this area may distort the disk-shaped areolar and nipple projection.

36.3 Method of Scar Improvement

36.3.1 Medical Ointment and Cream

Scar pruritus is common, especially in burn patients, and the reported incidence is between 25 and 100 % [7, 8]. Long-term scrubbing and rubbing lead to secondary skin lesions with additional release of inflammatory mediators that can aggravate the pruritus and cause abnormal scarring. Beside systemic administration of first-generation H1 antihistamine, encouraging results were obtained when targeting the central nervous system with systemically administered agents, including gabapentin, naltrexon, and ondansetron. Also topical administration of various substances has been reported to decrease itching sensation. Cooling, menthol, and icilin can relieve experimentally induced itching. A topical antihistamine agent such as doxepin was demonstrated to highly effective as an antipruritic cream in an itching wound. Capsaicin is a vanilloid which leads to depolarization and release of secretory granules which contain substance P or calcitonin gene related peptide. This action leads to desensitization of nerve fibers, inhibition of neuropeptide accumulation, and suppression of painful and itching sensation. Cannabinoids are known for their analgesic potency upon administration. A pilot trial with palmitoylethanolamine-containing cream should that it relieved pruritus in hemodialysis, prurigo nodularis, and lichen simplex.

Corticosteroids have been demonstrated to inhibit extracellular matrix production and deposition of excessive collagen. Moreover, the inflammatory response is suppressed by decreased proinflammatory cytokine production and inhibition of angiogenesis. However, treatment of hypertrophic scar with topical steroids failed to show any improvement in scar management.

A few studies on imiquimod, an immunomodulator, reported favorable results of keloid treatment after surgery. Long-term application is advised only 1 year after surgery.

36.3.2 Physical Treatment

Manual massage with or without cream is believed to have beneficial effects on scar, such as drainage of edema, reduction of pruritus, and skin moisturization [9–13]. The massage relaxing effect can result in improve tolerance of and compliance wit rehabilitation treatments. However, this technique should be performed with caution in immature and fragile scar. The friction from massaging can cause a painful, blistering skin effect, prolonged inflammation, and additional hypertrophic scarring.

Physiotherapy is considered a necessary part of the rehabilitation program especially with splinting and stretching. The principle of splinting is to maintain the normal range of motion especially when the scar crosses a joint. There are dynamic and static splints which can be used in different stages of scar treatment.

Shock wave therapy is an externally applied controlled regimen of mechanical force in the form of pressure disturbances. It has been shown to decrease fibroblast to myofibroblast transdifferentiation and also to break down overproduced collagen. Its use still lacks scientific support in clinical scar management. The contraindications include pregnancy, anticoagulant medication, varicose veins, and open wounds.

Thermal therapy with high-pressure water and air therapy are used in scar treatment. The combination effects of pressure and a thermal bath can improve the scar. However, it is recommended when the epidermis is strong enough and there is no infection or wound. Pain can be a side effect of using high-pressure water.

36.3.3 Pressure Garment

Pressure therapy is used mainly for treatment of hypertrophic scar s and keloids, especially after burn injury and prophylactically in wounds that take more than 14 days to heal spontaneously [14–16]. It is usually applied when the

wound is fully closed and the patient is able to tolerate the pressure. Although the mechanism is poorly understood, there is much theoretical support, including negative balance in collagen turnover and decreasing edema. Theoretically, the pressure garment should be applied for 18–24 h each day for a minimum 4 months for up to 24 months. However the compliance with long-term therapy is poor owing to the discomfort caused by the pressure device. Adjusting and relaxing the garment can result in the maximum benefit from therapy and reduce the discomfort. Pressure-gradient garments are designed to exert a pressure of 25–40 mmHg on the underlying tissue. However, many authors claim that pressures less than 25 mmHg can be effective in scar treatment and pressures over 40 mmHg can be harmful and cause complications. The compliance with pressure therapy decreases over time, especially for a long-term treatment protocol.

36.3.4 Silicone

Silicone has become one of the first lines of therapy and the gold standard for hypertrophic scar treatment and prevention [17–19]. It is manufactured in many forms and combined with other dressing media or devices. Silicone is an entirely cross-linked polymer of dimethylsiloxane. Different levels of polymer cross-linking determine the physical and chemical properties of the silicone. In general, as the degree of cross-linking increases, the silicone becomes more durable, but less adherent. Most research has been performed on the therapeutic efficacy of silicone gel sheeting. There are more than 70 silicone products available on the market, and the commonest form is silicone gel sheet. It is a soft, semiocclusive sheet made from medical grade silicone and reinforced with a silicone membrane backing. Some manufactures use other technologies to make the silicone sheet more durable and flexible and to increase breathability. The silicone sheet can be self-adhesive or fixed with adhesive tape or wrap with a bandage. It should only be used on intact skin and should be applied at least 12 h daily for up to 3–6 months. The adverse effects are minor, such as pruritus, maceration, skin irritation, and breakdown. Many clinical trials were conducted to assess the benefit of silicone sheet, but there were some limitations owing to the subjective scar measurement methods. The combination of silicone and pressure therapy is used. The commonest combination is applying silicone gel sheet with a classic pressure garment. There are several manufacturers and designs; however, skin hygiene should be monitored and followed with extra care.

The mechanism of action of silicone remains unclear. Histological analysis revealed no evidence of silicone leakage into the epidermis and no direct activity of silicone on fibroblast function or survival. The characteristic of fluid impermeability and temperature increase might be important. Also, development of a static electric field may be involved in scar involution. The slight increase in temperature caused by silicone gel sheeting can increase collagenase activity, leading to collagen breakdown. Additionally, there is a silicone elastomer sheet that has high oxygen permeability, allowing adequate oxygen tension in the stratum corneum layer. The question remains whether this is of any physiological importance.

36.3.5 Injectable Substances

36.3.5.1 Intralesional Corticosteroids

This method is a long-term standard and the most commonly used therapeutic modality for hypertrophic and keloid scars [20–23]. It has been shown to inhibit α_2-macroglobulin, resulting in collagen degradation, reduction of collagen synthesis, synthesis of glycoaminoglycans, and expression of inflammatory mediators. It can also prohibit proliferative scars by inhibiting cell proliferation and transforming growth factor (TGF) β_1 expression and inducing apoptosis. Triamcinolone acetonide (10–40 mg/ml) is the commonest corticosteroid used for scar treatment. The recommended dosage for monotherapy is 40 mg/ml every 2–4 weeks until the scar is flat. It should be injected in the papillary dermis, where collagenase is produced. Subcutaneous injection must be avoided because it may cause atrophy of underlying fat. The main disadvantage is the pain during injection. Tropical analgesia or intralesional administration of lidocaine or short general anesthesia can be performed if required. The side effects are subcutaneous atrophy, hypopigmentation, and telangiectasias but systemic reactions are uncommon. A large controlled study is still needed to determine the definitive protocol for intralesional corticosteroid injection (Figs. 36.1, 36.2, 36.3, 36.4).

36.3.5.2 Bleomycin

This can cause necrosis of keratinocytes with a mixed inflammatory infiltrate in skin of healthy subjects. In keloid and hypertrophic scars, the effect of bleomycin may be due to a reduction of collagenase synthesis and/or increased destruction owing to inhibition of lysyl oxidase or TGF-β_1. Despite the mechanism being unclear and lack of evidence, a few clinical trials showed a high regression rate, minimum complications, and recurrence in scar treatment with the multipuncture method. Bleomycin is often combined with triamcinolone for intralesional injection.

36.3.5.3 5-Fluorouracil

The effects on scar are due to inhibition of fibroblast proliferation. Combined injection with triamcinolone acetonide

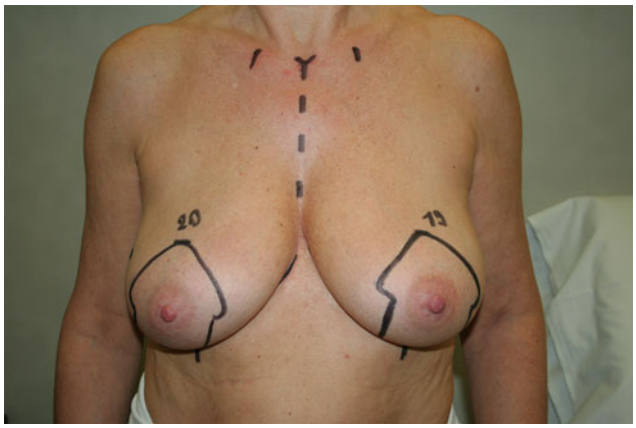

Fig. 36.1 Preoperative view of the patient before inferior right breast quadrantectomy, intraoperative radiotherapy, and bilateral reshaping

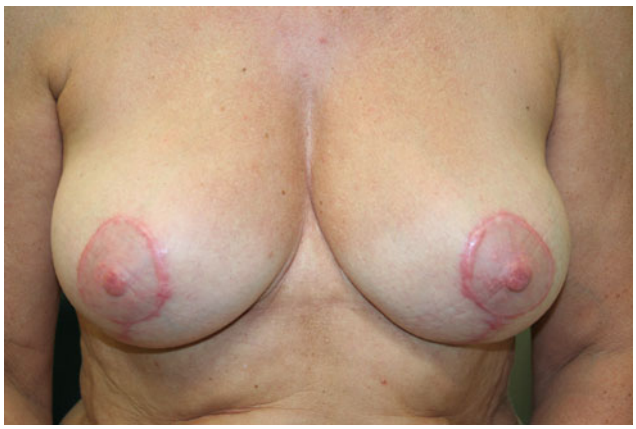

Fig. 36.2 Result at 7 months after the surgery with bilateral hypertrophic scars

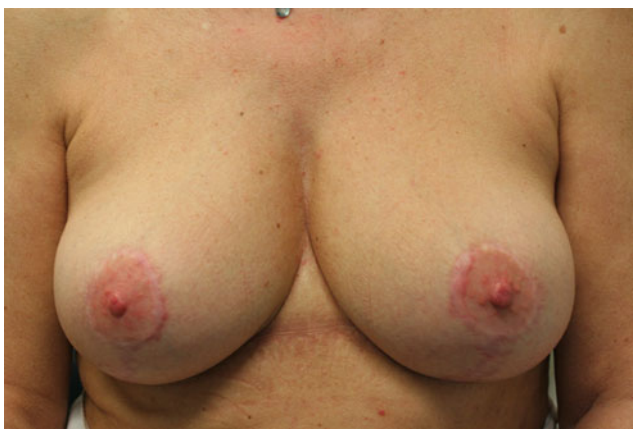

Fig. 36.3 Result at 2 years after three sessions of intralesional corticosteroid injections

is often performed to reduce the dose of 5-fluorouracil. Injection of 5-fluorouracil is also combined with surgical excision. However, it is contraindicated in young women with the possibility of pregnancy and age under 18 years.

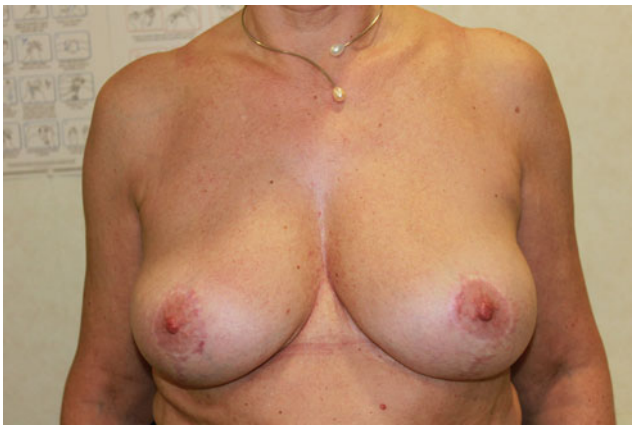

Fig. 36.4 Final result at 4 years

Subcutaneous injection should be avoided. The side effects include a burning sensation and purpura formation.

36.3.5.4 Verapamil

This is a calcium channel antagonist, which can decrease collagen synthesis in extracellular matrix. It stimulates synthesis of the collagen-degradation enzyme procollagenase and increases TGF-β activity. It can be used as a monotherapy or combined with surgery or pressure therapy for keloid treatment. The data on the concentration and complications are limited and should be verified.

36.3.6 Laser

There are several laser applications for scar treatments, as a monotherapy or in combination with other modalities [24–26]. The effects of the laser on scar are mainly limited to the depth and the superficial layer action. Many types of laser used, including ablative lasers, dermal remodeling nonablative lasers, vascular lasers, ultraviolet-B lasers, and intense pulsed light lasers. In general, the selection of laser therapy depends essentially on the patient and the characteristics of the scars. The skin photo type is very important because melanin has a wide absorption spectrum and can be targeted by visible, ultraviolet and infrared light. Isotretinoin affects collagen metabolism and wound repair and its use must be avoided for the 6 months prior to an ablative laser procedure. Anticoagulant and antiplatelet therapies should be discontinued to prevent postlaser purpura. Fractional nonablative laser therapy has been reported with significant improvement in clinical and histopathological appearance [27] in a broad range of posttraumatic scars and surgical scars.

36.3.7 Surgery

A surgeon can improve the scar in both form and more importantly function. Wound management should be

considered as a systematic role from preoperative planning, the intraoperative procedure, and immediate postoperative care until late follow-up [28, 29].

In scar contracture, the principal role of the surgeon is to restore the functions of the patient. Scar contracture release should be performed together with an intense rehabilitation program and if possible other scar therapeutic modalities to prevent contracture recurrence. Surgical management of scar release includes scar revisions, split-thickness skin grafts, full-thickness skin grafts, local flaps, pedicle flaps, and distant microsurgical flaps. The selection of this reconstructive ladder depends on the patient and the scar characteristics. A free flap or perforator flap can give a favorable result in a massive area, deep scarring tissue, and poor surrounding tissue. Dermabrasion, minor scar revision, or simple serial excision with or without tissue expansion can be an effective option in scar management.

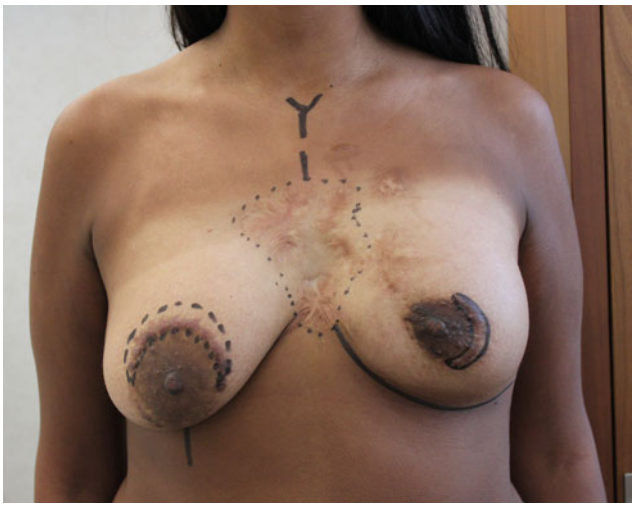

Fig. 36.5 Preoperative result with bilateral keloid scars

36.3.8 Lipofilling

The lipofilling technique has been used for many years and has rapidly become popular especially in aesthetic surgery [30]. In the era of tissue engineering, progenitor and stem cells are being studied and are rapidly gaining interest. The fat is removed by liposuction from the subcutaneous tissue, usually from the abdomen or from the thighs according to the morphology of the patient. The specimen obtained is subjected to soft centrifugation to remove blood cell contaminants and obtain an adipocyte-enriched preparation. Recently, a number of new techniques have been described, mostly based on enzymatic treatments, with the ultimate goal to improve adipocyte purification. After harvesting and processing, the purified fat is injected into the scar area. The lipofilling procedure claims not only to improve the volume deficit but also to improve the color and surface of the scar area.

36.3.9 Radiotherapy

The employment of radiotherapy in the treatment of benign skin disorders, including keloids, is presently allowed only under certain conditions and is subject to compliance with strict protection rules [31, 32]. A series of studies have demonstrated the efficacy and preliminary safety of ionizing radiation beams in their protocols. The combination of surgical and radiotherapeutic treatment causes a synergistic effect relating to scar treatment. Radiotherapy can be delivered at a time when connective tissue is more radiosensitive, by decreasing fibroblast proliferation and causing a rapid mast cell degranulation which reduces histamine levels and is capable of accelerating collagen formation. The total doses of ionizing radiation differ among the different protocols reported in the literature. However, an

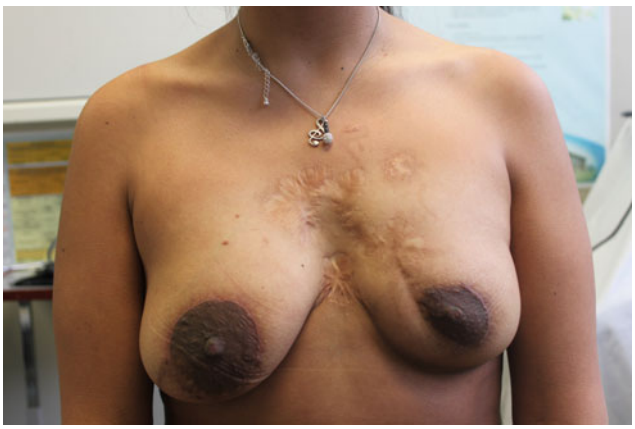

Fig. 36.6 Result after 3 months after scar revision and brachytherapy treatment

increase of the total dose of ionizing radiation administered could theoretically enhance the risk of radiogenic skin cancer for the patients treated. There is a report debating the risk of radiotherapy in the treatment of keloids with regard to the carcinogenicity of radiation. However, no clinical trial has demonstrated this finding in an analytic study despite the potential theoretical risk outlined. Regular X-ray irradiation, electron beam irradiation, and brachytherapy after excision of keloid are performed with favorable outcomes.

36.4 European Institute of Oncology Experience

Hypertrophic scar has been treated surgically followed by brachytherapy according to two different techniques. A total of 51 patients with breast scar are included in the database, and in the first period low-dose radiation (with isolation of the patient) was used in 31 patients, whereas recently a

group of 20 patients were treated with high-dose radiation (without isolation). The recurrence rate was 15.7 % (eight patients), with the global aesthetic result considered as good in 58 % of cases (Figs. 36.5, 36.6).

36.5 Conclusion

In conclusion; several methods, either singly or in combination, can be used for scar treatment and prevention. The position and risk of scar development should be planned before choosing the incision. The biology of cancer and the postoperative adjuvant used in breast cancer treatment must be considered when offering scar management. In the future, genetic therapy and tissue engineering may play roles in primary scar management, treatment, and prevention, which may lead clinicians and patients to achieve maximum satisfaction.

Acknowledgments We thank Middelkoop et al. [33] for providing study contents and references as well as key advices to contribute this chapter.

References

1. Petit JY, Gentilini O, Rotmensz N, Rey P, Rietjens M, Garusi C et al (2008) Oncological results of immediate breast reconstruction: long term follow-up of a large series at a single institution. Breast Cancer Res Treat 112(3):545–549
2. Petit JY, De Lorenzi F, Rietjens M, Intra M, Martella S, Garusi C et al (2007) Technical tricks to improve the cosmetic results of breast-conserving treatment. Breast 16(1):13–16
3. Petit JY, Rietjens M, Contesso G, Bertin F, Gilles R (1997) Contralateral mastoplasty for breast reconstruction: a good opportunity for glandular exploration and occult carcinomas diagnosis. Ann Surg Oncol 4(6):511–515
4. Pulzl P, Schoeller T, Wechselberger G (2006) Respecting the aesthetic unit in autologous breast reconstruction improves the outcome. Plast Reconstr Surg 117(6):1685–1691; discussion 92–93
5. Olascoaga A, Vilar-Compte D, Poitevin-Chacon A, Contreras-Ruiz J (2008) Wound healing in radiated skin: pathophysiology and treatment options. Int Wound J 5(2):246–257
6. Petit JY, Veronesi U, Lohsiriwat V, Rey P, Curigliano G, Martella S et al (2011) Nipple-sparing mastectomy—is it worth the risk? Nat Rev Clin Oncol 8(12):742–747
7. Goutos I, Dziewulski P, Richardson PM (2009) Pruritus in burns: review article. J Burn Care Res 30(2):221–228
8. Cohen IK, Diegelmann RF (1977) The biology of keloid and hypertrophic scar and the influence of corticosteroids. Clin Plast Surg 4(2):297–299
9. Shin TM, Bordeaux JS (2011) The role of massage in scar management: a literature review. Dermatol Surg 38(3):414–423
10. Hallam MJ, Shirley R, Dheansa B, Coker O (2009) Scar massage therapy: a new technique. J Wound Care 18(6):258
11. Richard R, Schall S, Staley M, Miller S (1994) Hand burn splint fabrication: correction for bandage thickness. J Burn Care Rehabil 15(4):369–371
12. Wang CJ, Huang HY, Pai CH (2002) Shock wave-enhanced neovascularization at the tendon-bone junction: an experiment in dogs. J Foot Ankle Surg 41(1):16–22
13. Hess CL, Howard MA, Attinger CE (2003) A review of mechanical adjuncts in wound healing: hydrotherapy, ultrasound, negative pressure therapy, hyperbaric oxygen, and electrostimulation. Ann Plast Surg 51(2):210–218
14. Steinstraesser L, Flak E, Witte B, Ring A, Tilkorn D, Hauser J et al (2011) Pressure garment therapy alone and in combination with silicone for the prevention of hypertrophic scarring: randomized controlled trial with intraindividual comparison. Plast Reconstr Surg 128(4):306e–313e
15. Anzarut A, Olson J, Singh P, Rowe BH, Tredget EE (2009) The effectiveness of pressure garment therapy for the prevention of abnormal scarring after burn injury: a meta-analysis. J Plast Reconstr Aesthet Surg 62(1):77–84
16. Van den Kerckhove E, Stappaerts K, Fieuws S, Laperre J, Massage P, Flour M et al (2005) The assessment of erythema and thickness on burn related scars during pressure garment therapy as a preventive measure for hypertrophic scarring. Burns 31(6):696–702
17. van der Wal MB, van Zuijlen PP, van de Ven P, Middelkoop E (2010) Topical silicone gel versus placebo in promoting the maturation of burn scars: a randomized controlled trial. Plast Reconstr Surg 126(2):524–531
18. Mustoe TA, Cooter RD, Gold MH, Hobbs FD, Ramelet AA, Shakespeare PG et al (2002) International clinical recommendations on scar management. Plast Reconstr Surg 110(2):560–571
19. Schmidt A, Gassmueller J, Hughes-Formella B, Bielfeldt S (2001) Treating hypertrophic scars for 12 or 24 hours with a self-adhesive hydroactive polyurethane dressing. J Wound Care 10(5):149–153
20. Naeini FF, Najafian J, Ahmadpour K (2006) Bleomycin tattooing as a promising therapeutic modality in large keloids and hypertrophic scars. Dermatol Surg 32(8):1023–1029; discussion 9–30
21. Davison SP, Dayan JH, Clemens MW, Sonni S, Wang A, Crane A (2009) Efficacy of intralesional 5-fluorouracil and triamcinolone in the treatment of keloids. Aesthet Surg J 29(1):40–46
22. Giugliano G, Pasquali D, Notaro A, Brongo S, Nicoletti G, D'Andrea F et al (2003) Verapamil inhibits interleukin-6 and vascular endothelial growth factor production in primary cultures of keloid fibroblasts. Br J Plast Surg 56(8):804–809
23. Jung JY, Roh MR, Kwon YS, Chung KY (2009) Surgery and perioperative intralesional corticosteroid injection for treating earlobe keloids: a Korean experience. Ann Dermatol 21(3): 221–225
24. Jared Christophel J, Elm C, Endrizzi BT, Hilger PA, Zelickson B (2012) A randomized controlled trial of fractional laser therapy and dermabrasion for scar resurfacing. Dermatol Surg. doi: http://10.1111/j.1524-4725.2011.02283.x [Epub ahead of print]
25. Lee SJ, Kim JH, Lee SE, Chung WS, Oh SH, Cho SB (2011) Hypertrophic scarring after burn scar treatment with a 10,600-nm carbon dioxide fractional laser. Dermatol Surg 37(8):1168–1172
26. Cho SB, Lee SJ, Chung WS, Kang JM, Kim YK (2010) Treatment of burn scar using a carbon dioxide fractional laser. J Drugs Dermatol 9(2):173–175
27. Vasily DB, Cerino ME, Ziselman EM, Zeina ST (2009) Non-ablative fractional resurfacing of surgical and post-traumatic scars. J Drugs Dermatol 8(11):998–1005
28. Holevich Y, Matev I (1962) Surgical treatment of scar contractures of the hand and fingers following burns. Acta Chir Plast 4:144–155
29. Hazrati E (1959) Break-down of old scar tissue in army recruits and its surgical treatment. Rev Int Serv Sante Armees 32(1):10–13
30. Lohsiriwat V, Curigliano G, Rietjens M, Goldhirsch A, Petit JY (2011) Autologous fat transplantation in patients with breast

cancer: “silencing” or “fueling” cancer recurrence? Breast 20(4):351–357
31. Caccialanza M, Piccinno R, Schiera A (2002) Postoperative radiotherapy of keloids: a twenty-year experience. Eur J Dermatol 12(1):58–62
32. Botwood N, Lewanski C, Lowdell C (1999) The risks of treating keloids with radiotherapy. Br J Radiol 72(864):1222–1224
33. Middelkoop E, Monstrey S, Teot L, Vranckx JJ (ed) (2011) Scar management, practical guide lines, 2011. Maca-Cloetens, Elsene

Fat Grafting in Breast Reconstruction

37

Mario Rietjens, Visnu Lohsiriwat, Andrea Manconi, and Cícero Urban

37.1 Introduction

Lipofilling is an autologous technique used in breast reconstruction. It is also known as "fat transfer,", "lipotransfer," "fat injection," or "fat transplantation" as well as many other terms. The procedure consists of two major steps: these are liposuction and lipoinjection of the patient's own fat tissue and other tissue elements, either with or without specific preparation processes before lipoinjection. It is considered to be a minimally invasive procedure which can be effectively performed with the patient under local or general anesthesia.

This technique was initially introduced for aesthetic and scar correction purposes especially for the face and hands [1–6]. Recently, it has also been widely applied for breast indications including micromastia, postaugmentation deformity, tuberous breast, Poland's syndrome, postlumpectomy deformity, postmastectomy deformity, deficits caused by conservative treatment or reconstruction with implants and/or flaps, tissue damaged by radiotherapy, and nipple reconstruction augmentation [7].

Despite various indications related to breast reconstruction after breast cancer treatment, there are different strategies for performing lipofilling procedures in different countries, without international consensus [8]. Up to now, the literature has provided evidence of only expert experience and clinical series trying to demonstrate the oncological safety and efficacy of lipofilling for the breast cancer patient. Nonetheless, there are fundamental and clinical researchers at the European Institute of Oncology who are dedicated to the oncological safety and technical application of lipofilling [9–12].

37.2 Biology of the Lipoaspirated Specimen

The fat specimen when injected into the breast is not just a physical filler or framework, but contains a significant number of cells which can survive and function. Viable and dead adipocytes, adipose-derived stromal cells, vascular endothelial cells, fibroblasts, hematopoietic cells, blood cells, and other cells can be found in the lipoaspirated specimen [13, 14]. Laboratory research from European Institue of Oncology also found that adipose tissue is a very rich reservoir of vascular progenitor cells. The current literature provides data on the endocrine, paracrine, and autocrine activities of the transplanted fat tissues. It is also interesting that in the future of medical bioengineering, stem cell culture and expansion may alter the composition and biology of the fat injection specimen.

37.3 Lipofilling and Oncological Concerns

When lipofilling was introduced for scar correction and aesthetic indications, there was rarely a question of cancer risk or cancer incidence. On the other hand, the concern for oncological safety obviously important becomes when performing lipofilling for the breast cancer patient. Theoretically, the "tumor–stroma interaction" can potentially induce cancer reappearance by "fueling" dormant breast cancer cells in the tumor bed. Our experimental findings also suggest that purified progenitor cells from

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liposuction specimens can stimulate angiogenesis, cell growth, and metastasis in animal models. No study on the effects of lipotransfer on human cancer breast cells in vivo is available [10].

In our clinical experience [8, 9, 11, 12], we have demonstrated that there is no increased risk of local recurrence in the invasive breast cancer patient who is treated with lipofilling. However, we recommend close oncological follow-up in this particular group, especially in the carcinoma in situ patient. If abnormal clinical or radiological signs are detected during follow-up, prompt pathological examination is highly recommended. We propose surgeons who perform lipofilling do a complete preoperative oncological examination and create a database of fat grafting patients.

37.4 Surgical Technique

37.4.1 Donor Site

The harvesting procedure can be performed with the patient under local or general anesthesia, depending on the patient's clinical condition and risks. Local anesthesia is our preference, whereas general anesthesia is recommended in the case of harvesting a large amount of fat tissue or combined multiple procedures. The preferred donor sites are the abdomen and flank areas, outer thighs, buttocks, inner thighs, and knees. The donor site selection is based on excess fat tissue in the area, and then the amount of fat that can be removed without aesthetic damage of the donor site. The selected donor site is infiltrated with Klein solution, which consists of 1 ml of epinephrine diluted in 500 ml of 0.001 % lactate Ringer solution. Mepivacaine (2 %) is added in the solution if lipofilling with the patient under local anesthesia is indicated (Fig. 37.1).

The amount of solution injected is double the volume of the preestimated fat tissue requirement. The whole procedure of fat harvesting and "lipofilling" is performed according to Coleman's technique [15]. After the injection of the diluted solution, a two-hole, 3-mm-diameter Coleman cannula with a blunt tip attached to a 10-ml Luer-Lok syringe is inserted through the small incision. A combination of slight negative pressure and the curetting action of the cannula through the tissues allows fat harvesting [2] (Fig. 37.2). The method of liposuction with different machine models or a manual syringe and different sizes and numbers of cannula holes has been not proven to affect fat cell survival. However, the "nontraumatic" blunt cannula technique is preferred rather than a sharp cannula technique [16–19]. Other harvesting techniques such as water-assisted liposuction or the Body-Jet system [20], Cytori Therapeutics's Celution system [21], and Adivive's Lipokit system

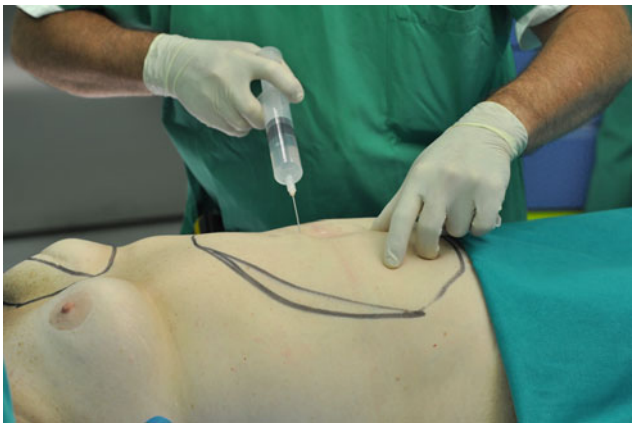

Fig. 37.1 Infiltrating the donor site with Klein solution

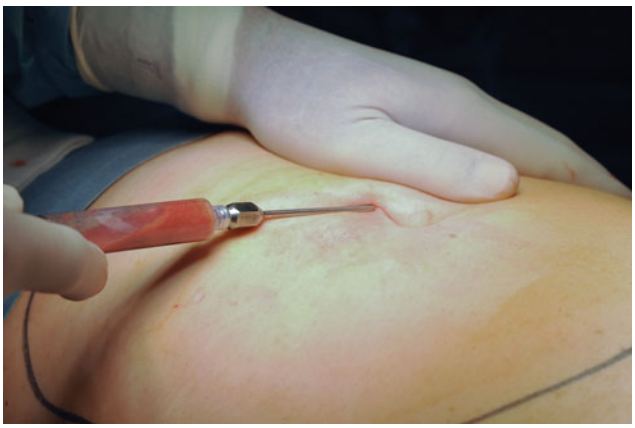

Fig. 37.2 Harvesting the fat tissue with a Coleman cannula

are also available. There is a debate between open-system and closed-system techniques but there is no definite conclusion regarding the difference in fat cell survival and clinical results in each group. At the end of the lipoaspiration procedure, the access site of the cannula is sutured with fine absorbable material and a pressure dressing is applied.

There are different methods to process and purify the fat before grafting. The choice depends on several factors, such as the surgeon's preference, costs, higher concentration of adipose-derived stem cells, volume requirement, and injection. Different techniques can be used:

1. *No preparation*. This no-touch technique allows surgeons to inject the lipoaspirated fat into the recipient site without any preparation [22]. The advantages are that the specimen remains in a closed system and that it allows a shorter operating time compared with other techniques. However, it is suitable only when performing lipoinjection with small volume requirements, e.g., a few cubic centimeters to make a reconstructed nipple projection or a small linear scar correction. The disadvantage is the

Fig. 37.3 Medical device for fat centrifugation

increase risk of calcification and cyst formation, because the oil is not eliminated.

2. *Mechanical preparation* (*centrifugation*, *decantation*, *or washing technique*). The purpose of this technique is to remove cell debris, serum, tumescence solution, and the oily component from the adipocytes and the derivative cells. Centrifugation is the technique currently used by the authors [11, 12]. In our setting, the fat is centrifuged at 3,000 rpm for 3 min until the oily part and fluid are separated from adipose tissue (Fig. 37.3). The speed and duration of the centrifugation have no effect on adipocyte survival, but greater force seems to be better in removing oil and cell debris than lower centrifugal forces as was demonstrated by some authors [23]. Other authors prefer lower speeds and a shorter duration to avoid adipocyte damage [24] (Figs. 37.4 and 37.5). After the top (oily) layer and the bottom (fluid) layer have been removed, the middle (cellular) layer, which contains the adipocytes, endothelial cells, and mesenchymal stem cells, is immediately transferred to a 1-ml Luer-Lok syringe and prepared for injection [11, 12, 25].

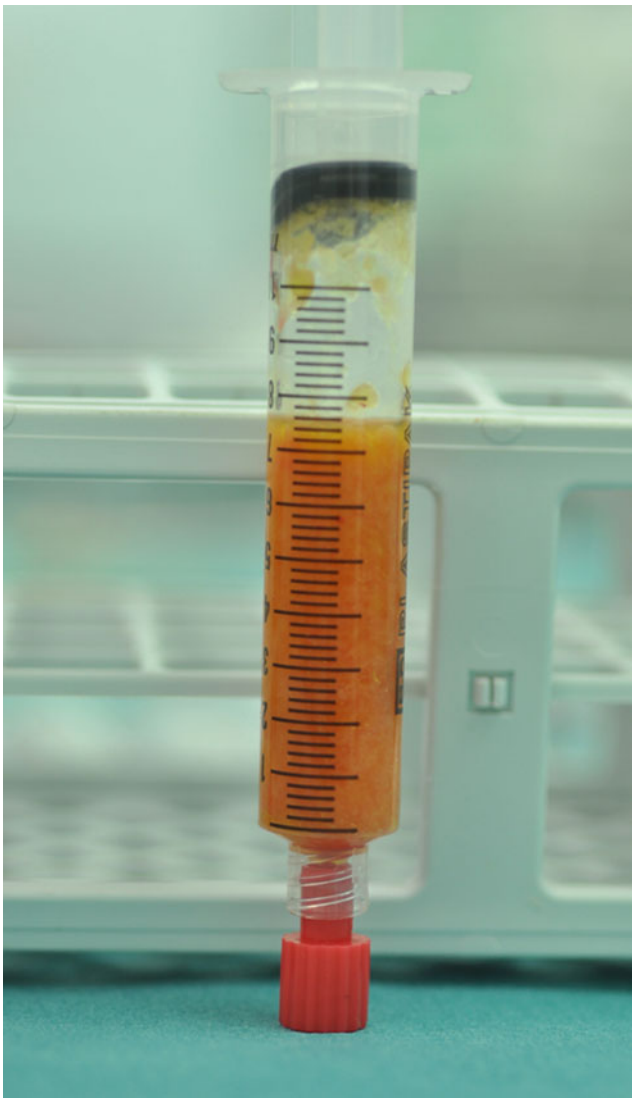

Fig. 37.4 Specimen before centrifugation

3. *Other methods of preparation* (*enzymatic and biological preparation*). Some scientists try to enhance fat graft survival with fibroblast growth factor β [26]. Some surgeons divide the lipoaspirate specimen in half and prepare each half separately before putting them together and performing lipoinjection. An example of this technique is called cell-assisted lipotransfer. This process increases the number of adipose-derived stromal cells before fat injection [27, 28]. Cytori Therapeutics's Celution system also prepares the fat by separation of two equal parts of a lipoaspirate specimen before mixing them together [21].

37.4.2 Recipient Site

The recipient site is prepared by preoperative marking and estimating the area which is required for lipoinjection. A

Fig. 37.5 Specimen after centrifugation

suitable local anesthetic agent is injected around the defect prior to the injection of purified fat if the procedure is done with the patient under local anesthesia. Prepared cellular component is then injected into the defect area through a blunt Coleman cannula. Retrograde injection with a thin-layer, multiple-tunnel and fan or cylindrical shape technique is performed (Fig. 37.6). We avoid placing the fat as an excessive deposit, which may result in liponecrosis and graft loss. We judge the amount of fat needed to be grafted in each individual case on the bass of the tissue quality and the shape and size of the defect. If the anatomical site allows, we try to avoid intraparenchymal injection. In the case of tight fibrosis from a surgical scar or irradiated tissue, a sharp needle is inserted to break up the fibrotic scar and create a space for lipoinjection (Fig. 37.7). In general, we overcorrect the volume deficit by approximately 30–40 % depending on the reconstructive indication and recipient site tissue quality. After finishing the injection, we suture the entrance site of the injection cannula in a conventional fashion.

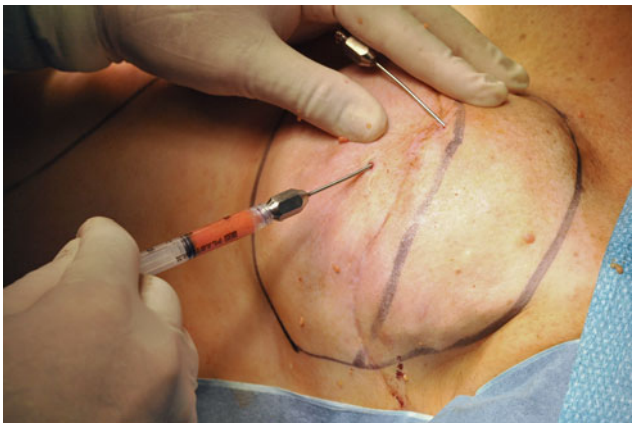

Fig. 37.6 Fat injection in the recipient site

Some authors have proposed the use of an external suction machine on the donor site to produce subcutaneous tissue expansion and allow a larger volume of fat to be harvested and injected. This machine (Brava system) is not comfortable for patients and needs to be used during the night 1 month before and after the procedure [29].

37.5 Indications

37.5.1 Breast Conservative Surgery Defect Correction

A patient with breast conservative treatment usually receives conventional radiotherapy and this therefore leads to difficulty in selecting a reconstructive procedure. However, lipofilling offers a simple and reliable method which does not increase the complication rates in the breast conservative treatment patient.

- *Immediate reconstruction after breast conservative treatment*. Lipofilling can be used for reshaping of the breast immediately after conservative surgery as a sole procedure or in combination with other oncoplastic procedures. A good indication would be in the case of a small breast and an upper quadrant tumor. A quadrantectomy can be performed and the defect can be closed with glandular sutures. The defect created by these sutures can be repaired by fat grafting in the subcutaneous space. Circumcavity injection is recommended and intracavity injection should be avoided.
- *Delayed reconstruction after breast conservative treatment*. This is one of the major indications for lipofilling performed by the authors. It is possible to correct the defects and also increase the skin quality after radiotherapy damage. Depending on the dimensions of the defect, the correction can be done in one or more sessions. The procedure can be performed with the patient

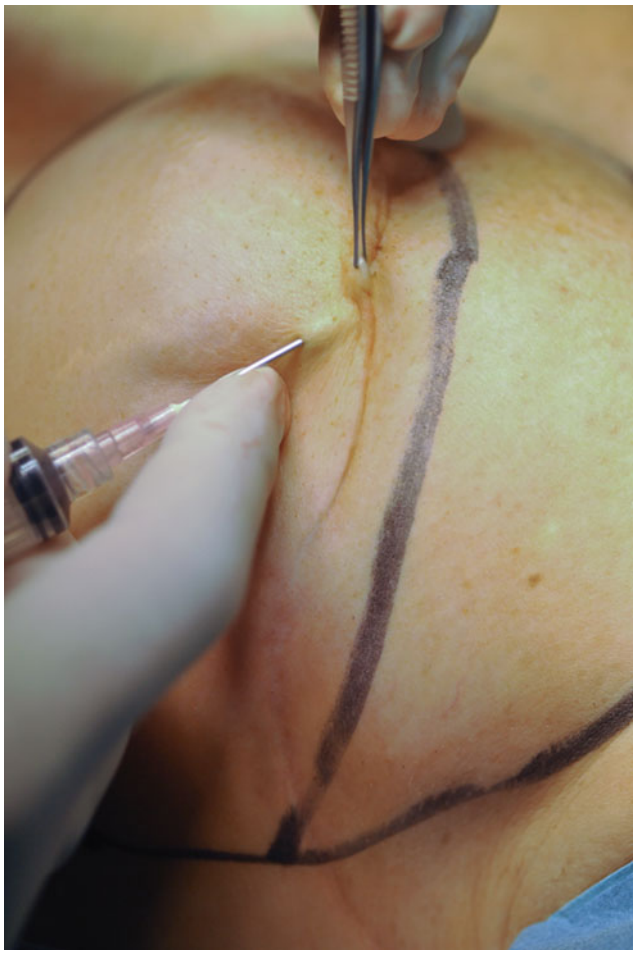

Fig. 37.7 A sharp needle is used to release fibrotic scars

under local anesthesia in the case of a monolateral procedure and with the patient under general anesthesia in cases that need a contralateral procedure, such as a reduction mammaplasty (Figs. 37.8 and 37.9).

37.5.2 Defects After Mastectomy and Breast Reconstruction

Lipofilling is a main technique in breast reconstruction after mastectomy and is indicated in the following situations:

- Immediate breast reconstruction, Lipofilling in immediate reconstruction is very difficult owing to the lack of a surgical plane for fat implantation. In special cases with a small breast and huge flank lipodystrophy, an implant can be positioned at the same time as the mastectomy. After complete expansion, the reconstructive steps start with deflation of the expander and fat grafting to twice the volume deflated. After two or three fat grafting sessions, the expander can be removed and the nipple and areola can be reconstructed to achieve the final result without an implant (Figs. 37.10, 37.11, and 37.12),

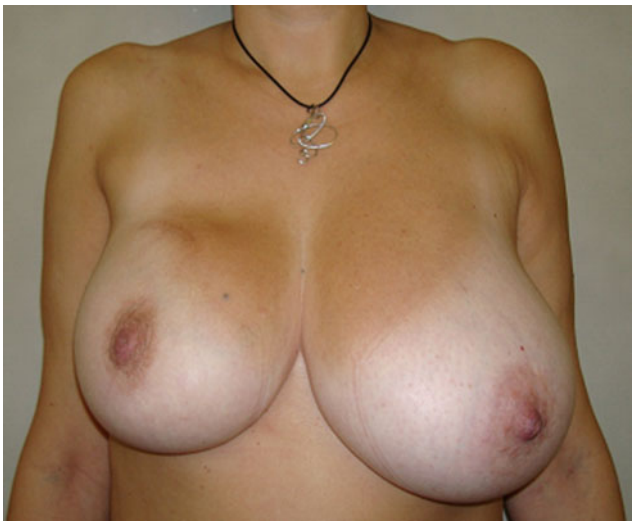

Fig. 37.8 Patient with huge asymmetry after right breast conservative surgery and radiotherapy

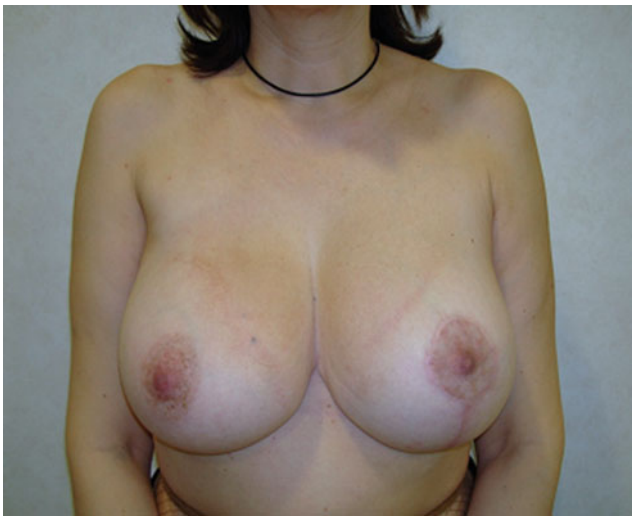

Fig. 37.9 Postoperative view after 250 cm^3 of fat grafting in the *right side* and *left* reduction mammaplasty

- Secondary total breast reconstruction using lipofilling as the primary reconstructive procedure. This is still an early procedure done in a few surgical centers and is usually performed with pre-expansion or vacuum systems [30–33]. It allows delayed total breast reconstruction with autologous fat tissue; however, the procedure can rarely be completed in a single stage. It is also difficult to obtain a good skin envelope, good definition of the inframammary fold, and a good breast mound.
- Secondary defect corrections after breast reconstruction with implants or autologous flaps. Lipofilling can be used to correct upper breast fullness in the case of an anatomical implant defect, or also to correct the lower pole fullness (Figs. 37.13 and 37.14). It can also be used for

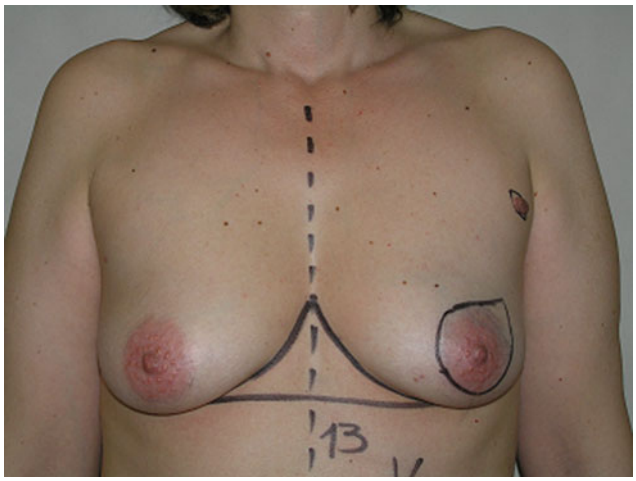

Fig. 37.10 Preoperative view before mastectomy and immediate breast reconstruction with a tissue expander

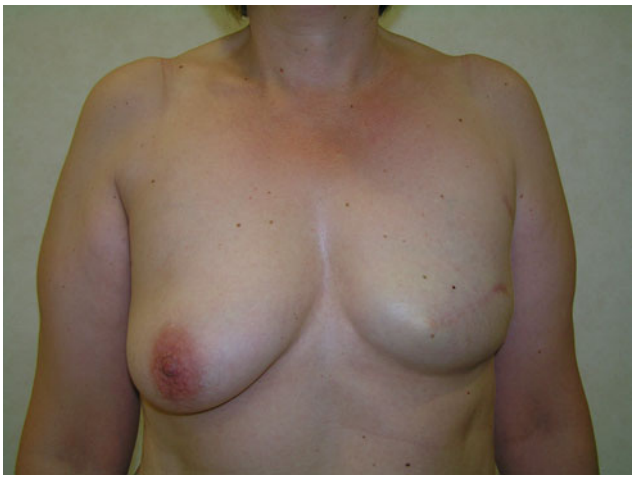

Fig. 37.12 Postoperative view after expander removal and a second session of 250 cm^3 of fat grafting without any implant

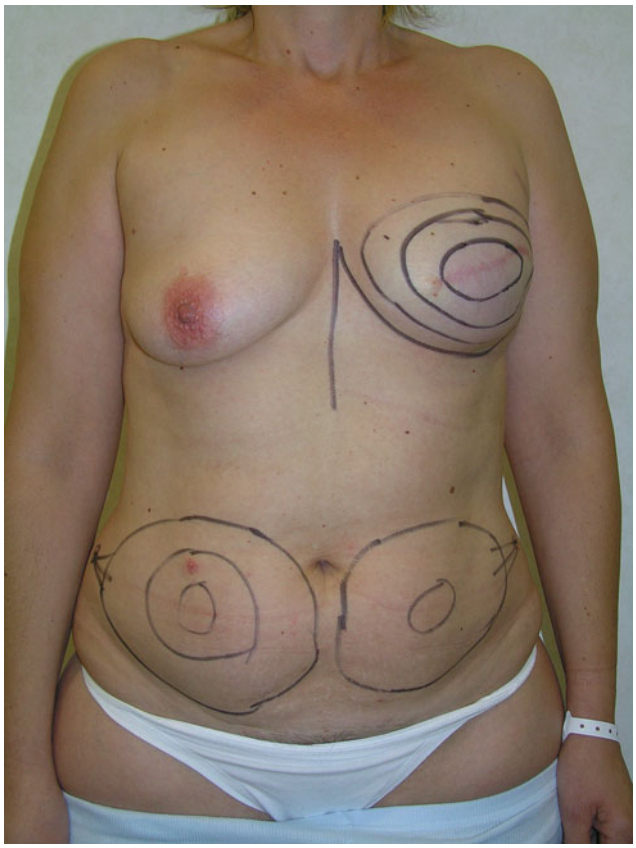

Fig. 37.11 Preoperative view before 280 cm^3 of fat grafting and deflating the expander

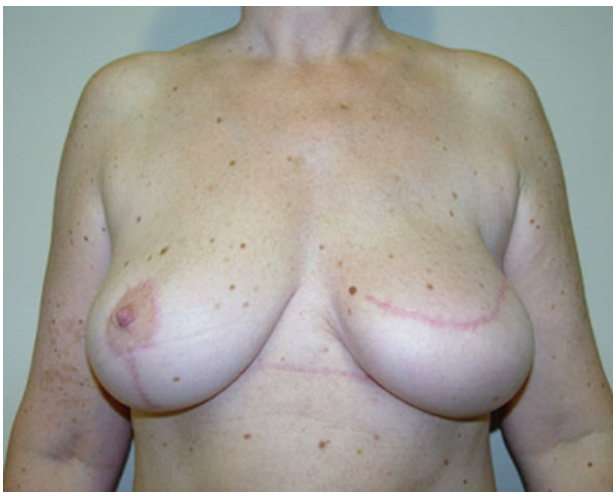

Fig. 37.13 *Upper* breast fullness after immediate *left* breast reconstruction with an anatomical implant

secondary defects of reconstructions done with autologous flap procedures [34]. When an autologous flap reconstruction develops an early or delayed complication such as partial flap necrosis or delayed flap atrophy, especially for extended latissimus dorsi flap reconstructions, lipofilling can replace volume deficit without requiring flap or microvascular procedures (Figs. 37.15, 37.16, 37.17, and 37.18).

37.5.3 Unusual Indications

- *Rippling correction* To correct visible rippling after implant-based reconstruction (Figs. 37.19 and 37.20).
- *Capsular contracture* Fat grafting around the implant and especially around the capsule can correct a visible rippling appearance by increasing the thickness of the capsular wall. Moreover, the effect of adipose-derived stromal cells in the cellular component of the lipoinjection may cause biological tissue remodeling of the cellular structure in the contracted capsule (Figs. 37.21 and 37.22).

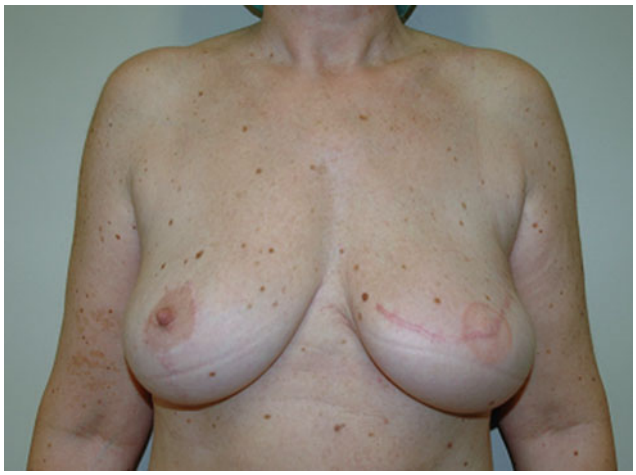

Fig. 37.14 Postoperative view after 80 cm^3 of fat grafting in the upper pole of the left breast

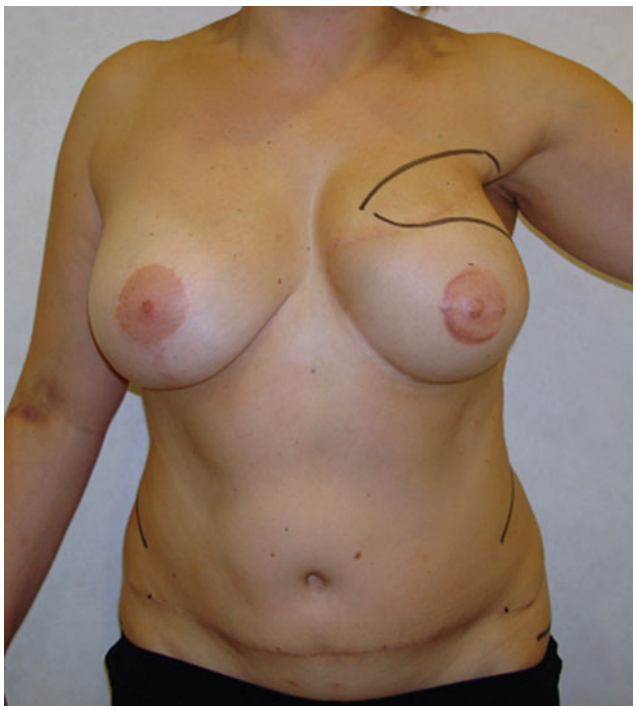

Fig. 37.15 Upper outer defect after delayed reconstruction with a monopedicled transverse rectus abdominis myocutaneous flap

- *Nonspecific pain therapy*. There is still no clear explanation for this mechanism of action. Adipose tissue is a rich source of various types of progenitor, endothelial, and mesenchymal stem cells. Some of them have angiogenic potential which may resolve the nonspecific pain.
- *Improvement of irradiated local tissue damage* (*including postradiotherapy ulcer*). The cellular component in the lipofilling specimen has angiogenic potential and is able to generate new stromal and cellular matrix, which

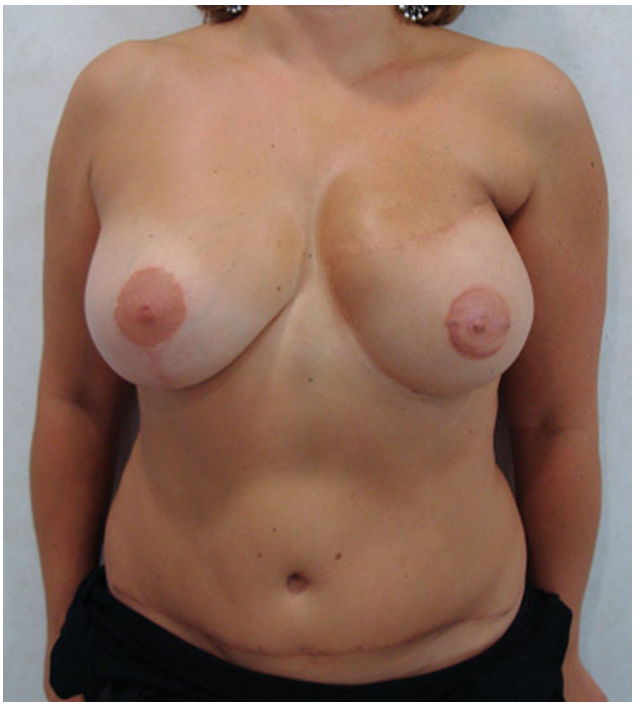

Fig. 37.16 Cosmetic results 6 months after lipofilling

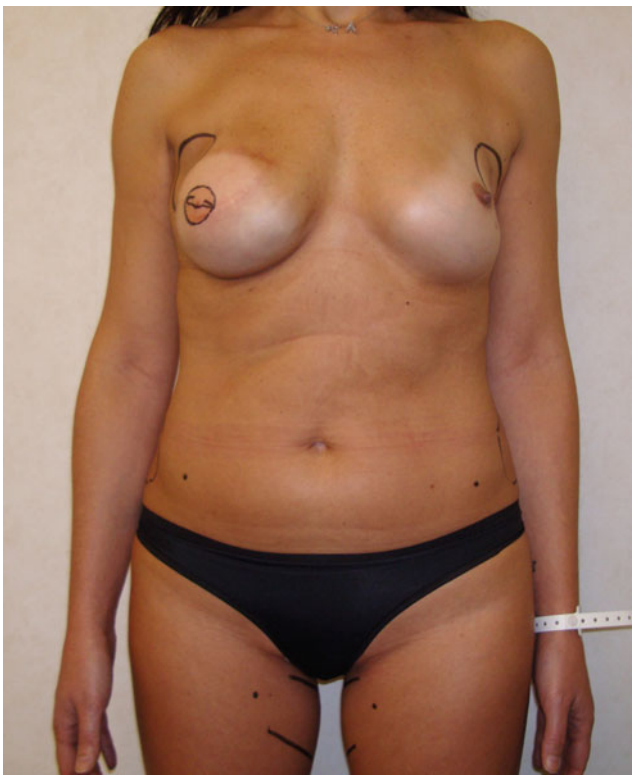

Fig. 37.17 Cosmetic results 6 months after immediate *right* breast reconstruction with a latissimus dorsi flap plus an implant and prophylactic mastectomy of the *left* breast and immediate breast reconstruction with a definitive implant. A bilateral upper outer lipofilling was performed with the inner thighs as the donor site

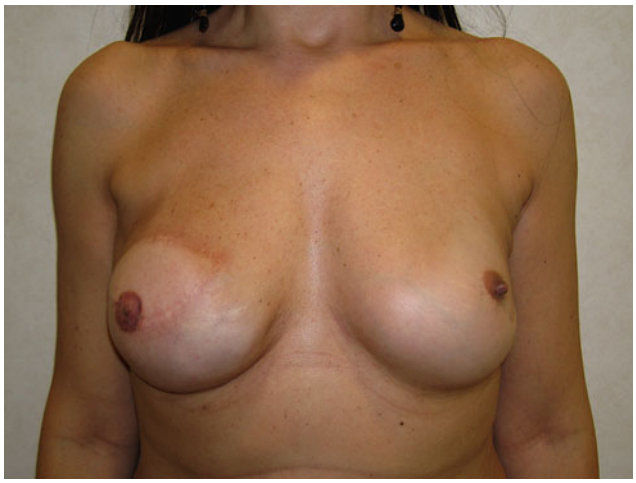

Fig. 37.18 Final cosmetic results after 6 months

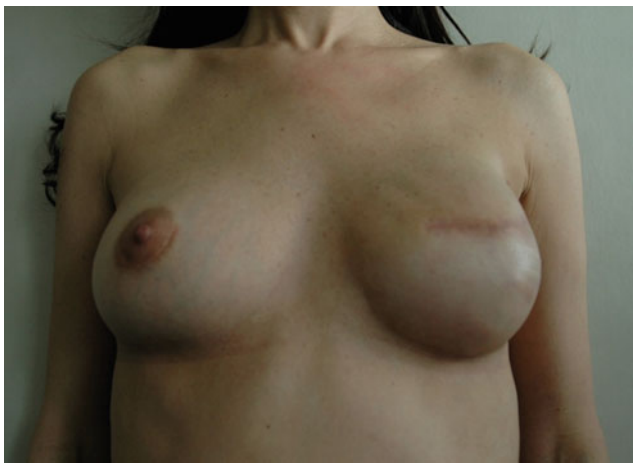

Fig. 37.19 *Upper* pole rippling after immediate *left* breast reconstruction with ab implant

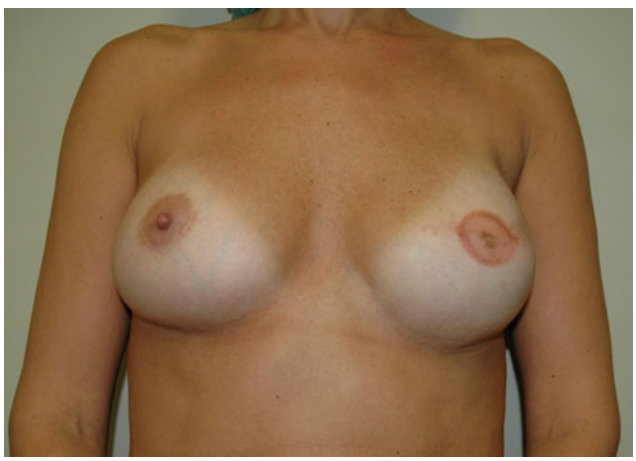

Fig. 37.20 Cosmetic results at 6 months after injection of 50 cm^3 of fat in the upper pole of the *left* breast

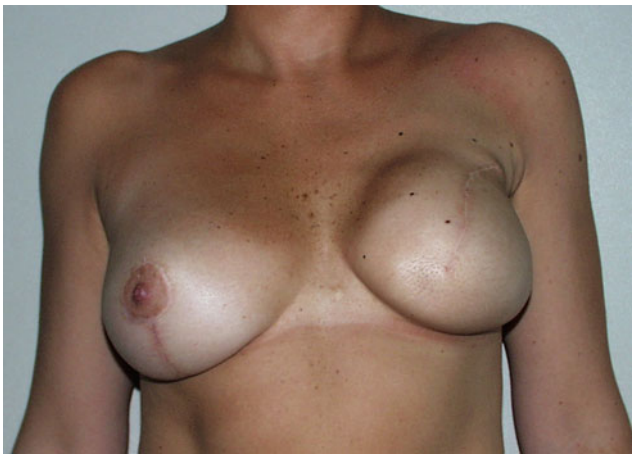

Fig. 37.21 Patient with Baker IV capsula contracture after mastectomy and immediate breast reconstruction with a definitive implant

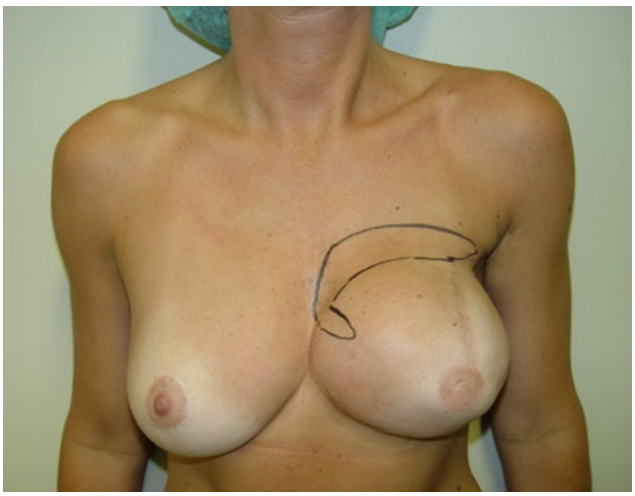

Fig. 37.22 Cosmetic result after four sessions of *left* breast lipofilling

benefits the chronic wound-healing process and irradiated tissue.

- *Contralateral symmetrical procedure*. Lipofilling can also be used on the contralateral side to produce symmetry either immediately with the oncological procedure or later after reconstruction.

37.6 Complications and Sequelae

- Immediate complications include seroma, hematoma, cellulitis, abscess, and liponecrosis. In published data from the European Institute of Oncology, we reported a rate of complications ranging from 2.8 to 3.6 % [11, 12]. The type of oncological resection, the type of reconstruction, and the type of radiation do not affect the occurrence of immediate complications.

- Late complications include fat reabsorption, scar retraction, and donor site deformity. Donor site deformity can be avoided by the selection of the appropriate donor sites, obtaining the optimum volume of lipoaspiration, and avoiding superficial planes of lipoaspiration. Fat reabsorption is an expected sequela after lipoinjection and is estimated at 30–60 % in the first year [35]. However, a stable result may start to be observed at 6 months. The reabsorption also depends on the injection technique, recipient tissue quality, volume of injection, and methods of preparation. We prefer to perform more than one session of lipofilling in the case of large-volume defects.

37.7 Future Trends

The ease and simplicity of lipofilling techniques combined with the broadened indications for lipofilling is attracting the interest of many surgeons who want to improve aesthetic results after breast cancer treatment. We are also looking forward to having the maximum stable volume without reabsorption and the least number of complications and to proving the oncological safety of lipofilling. Especially in the tissue engineering era, adipose tissue is being experimented upon and used by many scientists and companies worldwide. Some novel products and machines may need approval and well-performed clinical studies before being accepted in surgery on a daily basis [36].

References

1. Coleman SR (1998) Structural fat grafting. Aesthet Surg J 18(5):386, 388
2. Coleman SR (2002) Hand rejuvenation with structural fat grafting. Plast Reconstr Surg 110(7):1731–1744; discussion 45–47
3. Coleman SR (2006) Facial augmentation with structural fat grafting. Clin Plast Surg 33(4):567–577
4. von Heimburg D, Pallua N (2001) Two-year histological outcome of facial lipofilling. Ann Plast Surg 46(6):644–646
5. Andre P (2002) Facial lipoatrophy secondary to a new synthetic filler device (Profill) treated by lipofilling. J Cosmet Dermatol 1(2):59–61
6. Bertossi D, Zancanaro C, Trevisiol L, Albanese M, Ferrari F, Nocini PF (2003) Lipofilling of the lips: ultrastructural evaluation by transmission electron microscopy of injected adipose tissue. Arch Facial Plast Surg 5(5):392–398
7. Gutowski KA (2009) Current applications and safety of autologous fat grafts: a report of the ASPS fat graft task force. Plast Reconstr Surg 124(1):272–280
8. Petit JY, Clough K, Sarfati I, Lohsiriwat V, de Lorenzi F, Rietjens M (2010) Lipofilling in breast cancer patients: from surgical technique to oncologic point of view. Plast Reconstr Surg 126(5):262e–263e
9. Petit JY, Botteri E, Lohsiriwat V, Rietjens M, De Lorenzi F, Garusi C et al (2012) Locoregional recurrence risk after lipofilling in breast cancer patients. Ann Oncol 23(3):582–588
10. Lohsiriwat V, Curigliano G, Rietjens M, Goldhirsch A, Petit JY (2011) Autologous fat transplantation in patients with breast cancer: "silencing" or "fueling" cancer recurrence? Breast 20(4):351–357
11. Petit JY, Lohsiriwat V, Clough KB, Sarfati I, Ihrai T, Rietjens M et al (2011) The oncologic outcome and immediate surgical complications of lipofilling in breast cancer patients: a multicenter study—Milan-Paris-Lyon experience of 646 lipofilling procedures. Plast Reconstr Surg 128(2):341–346
12. Rietjens M, De Lorenzi F, Rossetto F, Brenelli F, Manconi A, Martella S et al (2011) Safety of fat grafting in secondary breast reconstruction after cancer. J Plast Reconstr Aesthet Surg 64(4):477–483
13. Eto H, Suga H, Matsumoto D, Inoue K, Aoi N, Kato H et al (2009) Characterization of structure and cellular components of aspirated and excised adipose tissue. Plast Reconstr Surg 124(4):1087–1097
14. Suga H, Matsumoto D, Inoue K, Shigeura T, Eto H, Aoi N et al (2008) Numerical measurement of viable and nonviable adipocytes and other cellular components in aspirated fat tissue. Plast Reconstr Surg 122(1):103–114
15. Coleman SR (1995) Long-term survival of fat transplants: controlled demonstrations. Aesthetic Plast Surg 19(5):421–425
16. Sommer B, Sattler G (2000) Current concepts of fat graft survival: histology of aspirated adipose tissue and review of the literature. Dermatol Surg 26(12):1159–1166
17. Kaufman MR, Miller TA, Huang C, Roostaeian J, Wasson KL, Ashley RK et al (2007) Autologous fat transfer for facial recontouring: is there science behind the art? Plast Reconstr Surg 119(7):2287–2296
18. Gonzalez AM, Lobocki C, Kelly CP, Jackson IT (2007) An alternative method for harvest and processing fat grafts: an in vitro study of cell viability and survival. Plast Reconstr Surg 120(1):285–294
19. Erdim M, Tezel E, Numanoglu A, Sav A (2009) The effects of the size of liposuction cannula on adipocyte survival and the optimum temperature for fat graft storage: an experimental study. J Plast Reconstr Aesthet Surg 62(9):1210–1214
20. Sasaki GH (2011) Water-assisted liposuction for body contouring and lipoharvesting: safety and efficacy in 41 consecutive patients. Aesthet Surg J 31(1):76–88
21. Fraser JK, Zhu M, Wulur I, Alfonso Z (2008) Adipose-derived stem cells. Methods Mol Biol 449:59–67
22. Karacalar A, Orak I, Kaplan S, Yildirim S (2004) No-touch technique for autologous fat harvesting. Aesthetic Plast Surg 28(3):158–164
23. Pulsfort AK, Wolter TP, Pallua N (2011) The effect of centrifugal forces on viability of adipocytes in centrifuged lipoaspirates. Ann Plast Surg 66(3):292–295
24. Kim IH, Yang JD, Lee DG, Chung HY, Cho BC (2009) Evaluation of centrifugation technique and effect of epinephrine on fat cell viability in autologous fat injection. Aesthet Surg J 29(1):35–39
25. Conde-Green A, Baptista LS, de Amorin NF, de Oliveira ED, da Silva KR, Pedrosa Cda S et al (2010) Effects of centrifugation on cell composition and viability of aspirated adipose tissue processed for transplantation. Aesthet Surg J 30(2):249–255
26. Hong SJ, Lee JH, Hong SM, Park CH (2010) Enhancing the viability of fat grafts using new transfer medium containing insulin and beta-fibroblast growth factor in autologous fat transplantation. J Plast Reconstr Aesthet Surg 63(7):1202–1208
27. Yoshimura K, Sato K, Aoi N, Kurita M, Hirohi T, Harii K (2008) Cell-assisted lipotransfer for cosmetic breast augmentation: supportive use of adipose-derived stem/stromal cells. Aesthetic Plast Surg 32(1):48–55; discussion 6–7
28. Matsumoto D, Sato K, Gonda K, Takaki Y, Shigeura T, Sato T et al (2006) Cell-assisted lipotransfer: supportive use of human

adipose-derived cells for soft tissue augmentation with lipoinjection. Tissue Eng 12(12):3375–3382
29. Smith CJ, Khouri RK, Baker TJ (2002) Initial experience with the Brava nonsurgical system of breast enhancement. Plast Reconstr Surg 110(6):1593–1595; author reply 5–8
30. Babovic S (2010) Complete breast reconstruction with autologous fat graft—a case report. J Plast Reconstr Aesthet Surg 63(7):e561–e563
31. Alexander Del Vecchio D, Bucky LP (2010) Breast augmentation using pre-expansion and autologous fat transplantation—a clinical radiological study. Plast Reconstr Surg 126:68–69
32. Del Vecchio D (2009) Breast reconstruction for breast asymmetry using recipient site pre-expansion and autologous fat grafting: a case report. Ann Plast Surg 62(5):523–527
33. Khouri R, Del Vecchio D (2009) Breast reconstruction and augmentation using pre-expansion and autologous fat transplantation. Clin Plast Surg 36(2):269–280, viii
34. Hamdi M, Andrades P, Thiessen F, Stillaert F, Roche N, Van Landuyt K et al (2010) Is a second free flap still an option in a failed free flap breast reconstruction? Plast Reconstr Surg 126(2):375–384
35. Zocchi ML, Zuliani F (2008) Bicompartmental breast lipostructuring. Aesthetic Plast Surg 32(2):313–328
36. Martin-Padura I, Gregato G, Marighetti P, Mancuso P, Calleri A, Corsini C et al (2012) The white adipose tissue used in lipotransfer procedures is a rich reservoir of CD34+ progenitors able to promote cancer progression. Cancer Res 72:325–334

Nipple and Areola Complex Reconstruction

38

Francesca de Lorenzi and Visnu Lohsiriwat

38.1 Introduction

The reconstruction of the nipple–areola complex (NAC) is an integral part of breast cancer treatment after after mastectomy or central quadrantectomy, transforming the reconstructed mound into a breast. The final result becomes pleasing and natural. NAC reconstruction has a positive psychological impact on breast cancer patients; it may cover part of the mastectomy scar [1]. However, not all women desire the reconstruction; generally, older patients do not.

38.2 When Should the NAC Reconstruction Be Performed?

NAC reconstruction is generally planned at least 3–6 months after breast reconstruction with either definitive implants or flaps or after the contralateral symmetry procedure (if not performed simultaneously with the reconstruction). In fact, it should be delayed until after the breast has settled down to its final shape and position. In the earlier period, it is probably not possible to determine the right position of the new areola, resulting in disturbing asymmetries.

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38.3 Where is the NAC?

The planning of the new NAC should be performed with the patient in the upright position, with the opposite healthy breast being used as a guide. Specific anatomical landmarks help to determine the proper position, such as the sternal notch, the midline, and the imaginary intersection line through the healthy nipple. The distance between the healthy spared areola (if present, not in bilateral reconstructions) and the sternal notch, inframammary fold, and midline can be measured to reproduce the ideal position on the reconstructed mound. More often, the new areola simply looks in the right position eventhough its measurements are not exactly matched with the contralateral side. Proper appearance takes precedence over measurements, which can merely confirm the accuracy of the visual positioning.

Other advice regards the distance between the two nipples, which is maintained between 18 and 22 cm on average, therefore avoiding an unaesthetic medial areola position. Moreover, the NAC should be positioned on the maximum projection of the reconstructed breast.

38.4 How Should the NAC Be Reconstructed?

Several surgical techniques have been described over the past 30 years for the reconstruction of the NAC. The new NAC tissue can be harvested from local or distant tissues. A combination of different methods can also be used, as can combination with alloplastic material or filler injection. Each of these methods has its own advantages and limitations. Most of them yield good results transiently, but in a few cases nipple definition and projection is guaranteed with time. For this reason no method has become the favorite. The decision between different methods depends both on the anatomical local conditions and on both the surgeon's and the patient's preferences.

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We will consider separately the reconstruction of the areola and the nipple.

38.4.1 The Reconstruction of the Areola

38.4.1.1 The Grafts

Skin grafts were used for a long time as the method of choice before the introduction of "tattooing." Currently the technique of tattooing is more popular than traditional grafting.

Dermoepidermal full-thickness grafts can be harvested from the inguinal region, the retroauricular area, and the vulvar region according to the natural color of the healthy areola. The procedure consists in skin harvesting from the donor site and transfer to the recipient site. The diameter and shape depend on the size and features of the contralateral areola. If the skin of the reconstructed breast is under tension, we have to consider that when we deepithelialize the new areola, its diameter will increase by about 5–10 % from the original areolar plan. This is due to the lack of its epidermis.

If the healthy areola is large enough, we can perform "areola sharing" with the concentric circle method, which involves removing a strip of the outer portion of the areola and transferring it to the recipient site. This method results in symmetrical small areolas. Generally, the areolar graft strip is quite thin and it must be placed in a spiral form.

Mostly, the upper thigh is selected as a donor site. The color of the graft from this region turns light brown when it is transferred into the recipient site. Grafts harvested from the labia majora are more pigmented. In the case of a pale pink areola, it is better to harvest grafts from the retroauricular region.

The disadvantages of this method include the donor site morbidity (infection, wound dehiscence, unpleasant scar, etc.) and the risk of partial/total necrosis of the graft. Clinically, there is a lack of nipple projection as the areolar area is completely flat.

38.4.1.2 Tattooing

The widening indication for this method is mainly due to the simplicity of the procedure, the absence of donor site scar, and the availability of several colored pigments with color similar to that of the natural areola [2–6].

The basic equipment needed for tattooing includes the tattoo machine, generally running at 10,000 rpm, sterile pigments, and needles. We suggest using a needle assembly that uses nine points to accelerate the proper application of pigments. This extremity can be made sterile. By rotating the cap of the needle assembly, one can regulate how deep the needles penetrate (Figs. 38.1 and 38.2).

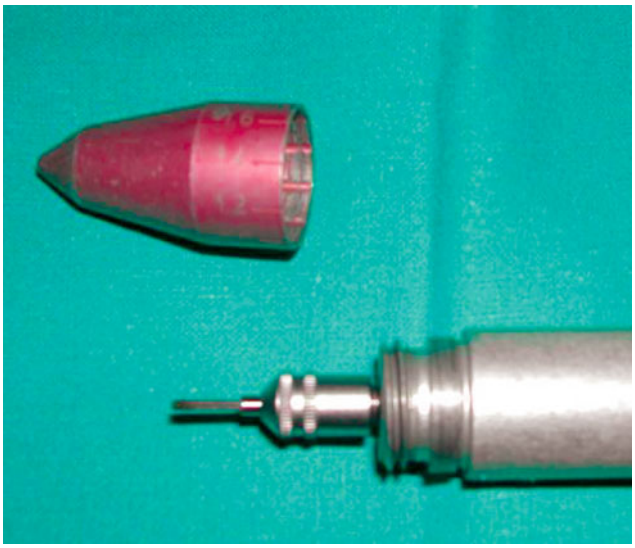

Fig. 38.1 Tattoo machine (needle assembly)

Permanent and semipermanent sterile pigments are available, and they can be mixed together to achieve the desired tone. The selected color is typically one or two shadows darker than the native areola because the color tends to fade and discolor with time. The needles are dipped into the pigment and are applied in a radial and circular pattern.

Postoperative care of tattooing includes a dressing with non adhesive paraffin gauzes or fatty gauzes. The patient may remove her dressing after 1 week/10 days and shower. She is instructed to remove the dressing carefully and not to peel off scabs because this will remove the tattoo pigment. Use of sunscreens for 6 months after tattooing is suggested.

38.4.2 The Reconstruction of the Nipple

Different methods have been described for the reconstruction of the nipple, including the use of external prostheses, simple tattooing, and surgical reconstruction. Nowadays, the use of external prostheses has been abandoned completely because glue adhesion problems and allergy have been described [7–9]. Tattooing alone gives no projection and therefore gives unsatisfactory results. Surgical reconstruction is the most used method and involves the use of grafts or local flaps.

38.4.2.1 The Grafts

If the nipple of the contralateral breast is large enough, the method of choice is "nipple sharing," which transfers part the opposite healthy nipple to the reconstructed breast. It is ideal in color and bulk, but it can be employed satisfactorily only when the native nipple is large. Sharing can be

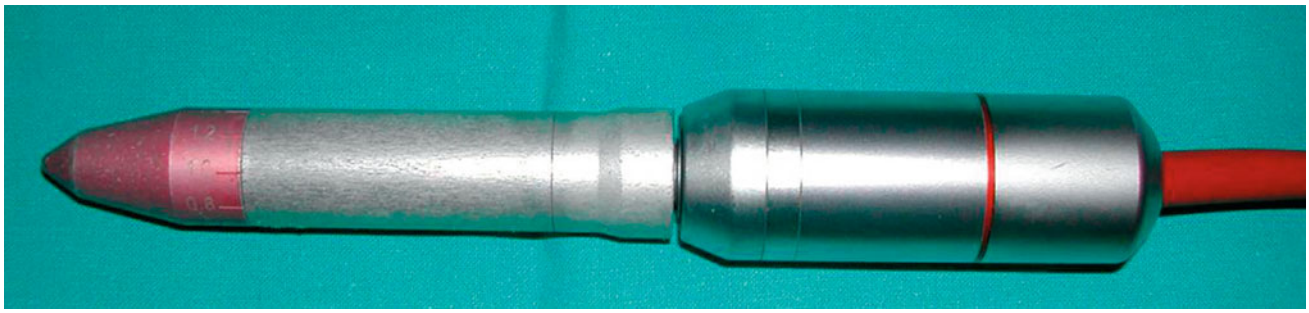

Fig. 38.2 Tattoo machine

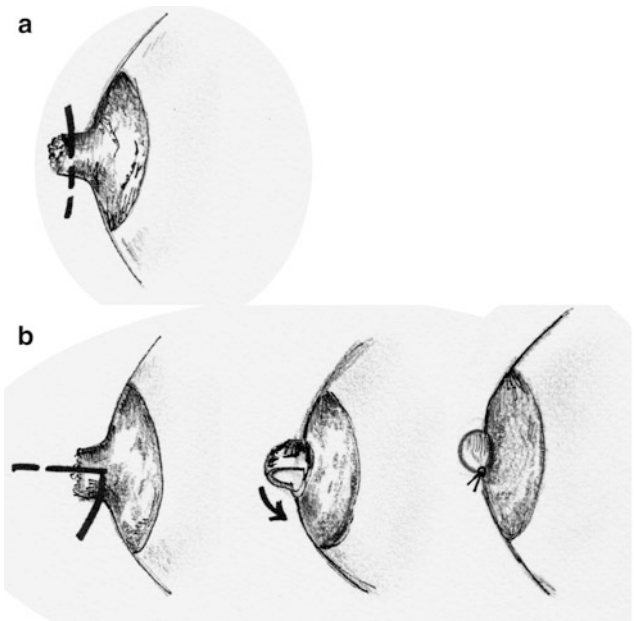

Fig. 38.3 Nipple sharing **a** decapitation, **b** vertical bipartition

performed by "decapitation" (Fig. 38.3a). The decapitation method can also be performed with "starred resection" (Fig. 38.4b). Another possible method of harvesting the nipple is "vertical bipartition", which is especially indicated if the diameter of the nipple exceeds its height. In all cases, the donor nipple is directly closed with a simple suture (Fig. 38.3b).

The perfect tissue matching with regard to color and texture between the two nipples is the main advantage of nipple grafting [10–13]. The disadvantages include the fact that any composite graft has an inherent risk of incomplete revascularization, which can lead to loss of tissue and projection. Structural distortion and lack of sensation of the nipple are also found as less frequent complications [14].

If patients are reluctant to disturb the healthy opposite nipple or if the native nipple is not large enough, other possible donor sites of composite grafts are the toe pulp and auricular tissue [15–18]. In both areas, there is a skeletal part similar to the fibrofatty nipple tissue but the color is much lighter. Even the skin graft from the labia minora was used in the past, but its use has been completely abandoned owing to the morbidity of the donor site and the very satisfactory result from the surgical reconstruction [19].

Cartilage graft is also harvested to obtain the projection of the nipple [20]. It can be positioned under a skin graft in the same surgical setting or afterward. However, the survival of the skin graft overlying cartilage cannot be secured and the ongoing skin graft contraction can gradually minimize the projection of the cartilage graft [21, 22].

38.4.2.2 The Local Flaps

More frequently, the nipple is reconstructed with local flaps. Different techniques have been described, but for all of them at least 50 % loss of the nipple projection has been observed within 1 year after surgery. For this reason, the new nipple should be planned to be larger and project more than the expected end point [23–33].

The flattening of the reconstructed nipple is due to the lack of the natural anatomical infrastructure of the normal nipple as well as the existence of centrifugal forces on the superficial surfaces on the reconstructed eminence. Projection is also influenced by local tissue characteristics, such as the thickness of the dermis and the amount of local scarring. Nipples created over previous scar have minimal loss of projection, whereas those created on an individual with a tightly expanded breast mound and a thin dermis lose the most projection.

Nipple reconstruction with local flaps depends on the local availability of soft tissue to achieve nipples of the desired size. Previous local scars (such as mastectomy and central quadrant scars) influence flap design and may interfere with flap vascularization.

The surgical techniques can be divided into two main groups: the "pull up techniques" [34–36], based on deep dermal and adipose flaps, and the "traction techniques" [37–39], based on a local skin advancement flap.

Pull-up techniques based on a central subcutaneous core require a deep dermal and adipose tissue dissection. They produce an irreducible hernia of the central core local flaps.

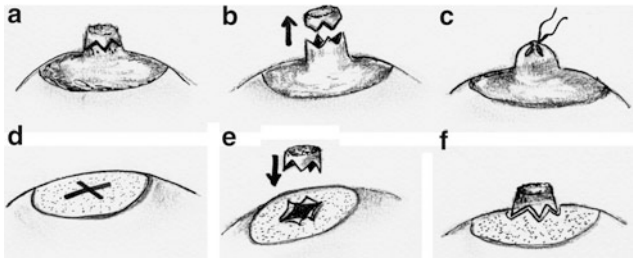

Fig. 38.4 Nipple sharing (starred resection)

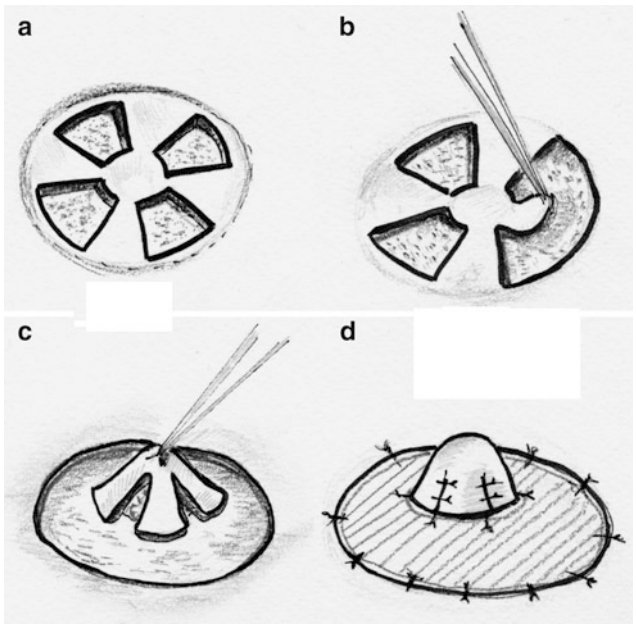

Fig. 38.5 The Quadrapod Flap

They are preferably applicable to breast reconstruction using autologous tissue. For breast mounds with a thin subcutaneous layer, as commonly associated with the implanted breast, local flaps using a central subcutaneous core can be strongly advocated. The tripod flap, the mushroom flap, the Maltese cross flap, the quadrapod flap, and the H flap also belong to "pull up techniques".

The double-opposing tabs, the Bell-flap, and the star flap belong to the "traction techniques" based on subdermal pedicled flaps.

38.4.2.3 The Quadrapod Flap

This is one of the central subcutaneous core pedicle techniques previously described by DiPirro [41] and later modified by Little [40]. After the position of the nipple and the diameter of the areola have been planned, four opposing skin flaps are dissected with preservation of the central fat core (Fig. 38.5). The radial length of the flap is according to the new nipple height projection. The dissection starts from the outer part toward the central core. The central fat core is then raised and covered by the four opposing flaps. However, the color of the new nipple does not match that of the contralateral one, so secondary tattooing is needed and the surrounding areolar area must be grafted. Despite the promising immediate result, there is still a loss of projection later.

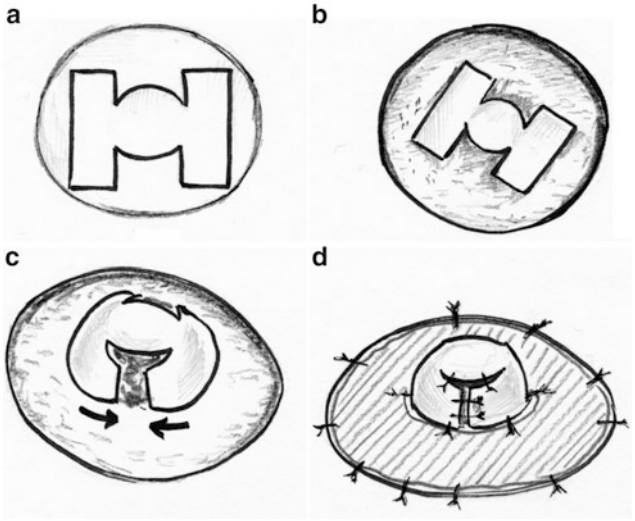

Fig. 38.6 The H flap

38.4.2.4 The H flap

This has been described by Hallock and Altobelli [42] as a cylindrical nipple reconstruction with the similar principle of a central subcutaneous core pedicle technique. The design is based on maintaining the central core projection by wrapping with counteracting cylindrical flaps. The flap is designed with diameter the same as that of the areola. The lateral rectangular shape is designed as the "H" shape (Fig. 38.6). The width of each leg is according to the designed new nipple projection and the length of each side is matched to half the circumference of the new nipple. If there is scar present in the area, the flap can be designed in a different direction. The dissection is performed by preserving subdermal vessels. However, the long-term result is still disappointing because of scar contracture and the need for secondary nipple tattooing and grafting for areola reconstruction.

38.4.2.5 The Modified Star Flap

The modified star flap belongs to second group of flaps, based on the subdermal plexus, and it is very frequently used [43]. The flap can be based superiorly, laterally, or inferiorly as local scarring dictates, although a more natural projection and appearance for the patient are obtained by basing the flap superiorly. The "wings" of the flap will determine the nipple height (Fig. 38.7). The height should

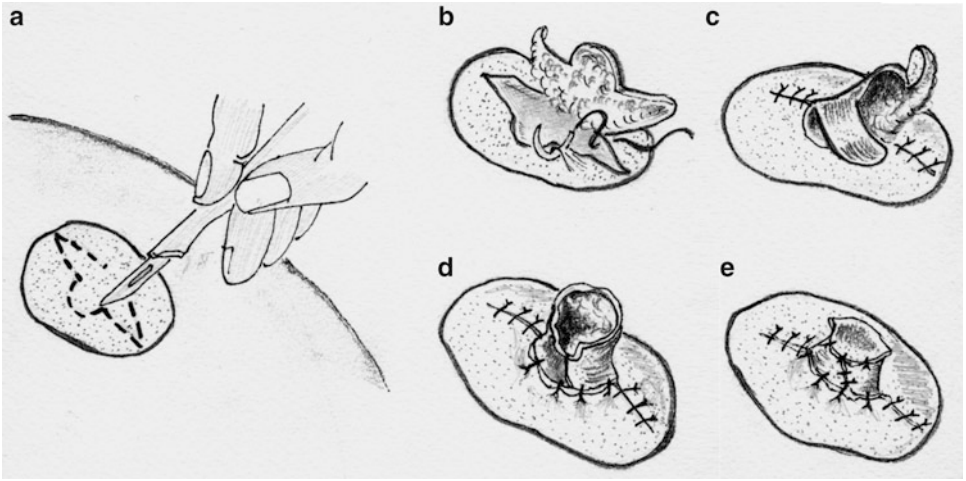

Fig. 38.7 The Modified Star Flap

be bigger than the ultimate desired height, allowing a decrease in projection over time. The nipple flap is tattooed prior to flap elevation. The wings are raised containing dermis and subcutaneous fat, getting thicker toward the base. The donor incisions are closed directly around the base of the nipple. The wings are wrapped together, one wing being placed at the base of the nipple and one partially overlapping. Afterward, the areola diameter is remarked and the areola is tattooed. The commonest problem is the variable loss of projection of the nipple over time.

38.4.2.6 The Modified Arrow Flap with Immediate Tattooing: Author's Experiences

From the previous technique of Rubino et al. [45], we agree with the principles that nipple projection and volume are obtained by increasing the amount of dermis within the flap without enclosing any excess subcutaneous fat [43–45]. The dissection of the flap can be performed effectively with the preservation of the dermal plexus. However, the necessity of skin grafting is a drawback of the original technique. Therefore, we suggest immediate tattooing simultaneously with the arrow flap procedure.

The flap can be designed in any position—superior, inferior, lateral, or medial—depending on the previous scar, if one exists. The width of the flap wing is matched to the new projection of the nipple. We recommend designing it wider because the flap will shrink in 6 months. Pretattooing is recommended before flap harvesting. Finally, additional tattooing is required to adjust the shape of the areola to that of contralateral healthy one. We experienced no increased rate of local complications by combing the two procedures.

The advantages of pretattooing are

- The reconstructed nipple has pigmentation that is more similar to that of the areola and it is not lighter than the native nipple.
- Tattooing can be performed more easily on a flat surface than on a projected nipple papule, resulting in a more uniform color.
- There is no more disadvantage from donor site harvesting.
- No further second procedure is necessary.

38.5 Conclusion and Future Trends

In conclusion, there are many options and techniques for NAC reconstruction. Each of these techniques has its own advantages and disadvantages. There is no one unique method available for every patient, but we have to individualize and discriminate for the most benefits in each patient. A meticulous surgical method should be strictly followed to achieve the maximum aesthetical outcomes. In the future, there will probably be different types of tissues and materials available for NAC reconstruction. Tissue engineering, tissue banking, and genetic tissue culture, which have already been tested in the animal laboratory, may play roles in the future of NAC reconstruction [46].

References

1. Wellisch DK, Schain WS, Noone RB, Little JW 3rd (1987) The psychological contribution of nipple addition in breast reconstruction. Plast Reconstr Surg 80(5):699–704
2. Masser MR, Di Meo L, Hobby JA (1989) Tattooing in reconstruction of the nipple and areola: a new method. Plast Reconstr Surg 84(4):677–681
3. Rees TD (1975) Reconstruction of the breast areola by intradermal tattooing and transfer. Case report. Plast Reconstr Surg 55(5): 620–621
4. Becker H (1988) Nipple-areola reconstruction using intradermal tattoo. Plast Reconstr Surg 81(3):450–453

5. Becker H (1986) The use of intradermal tattoo to enhance the final result of nipple-areola reconstruction. Plast Reconstr Surg 77(4):673–676
6. Spear SL, Convit R, Little JW 3rd (1989) Intradermal tattoo as an adjunct to nipple-areola reconstruction. Plast Reconstr Surg 83(5):907–911
7. Ward CM (1985) The uses of external nipple-areola prostheses following reconstruction of a breast mound after mastectomy. Br J Plast Surg 38(1):51–54
8. Roberts AC, Coleman DJ, Sharpe DT (1988) Custom-made nipple-areola prostheses in breast reconstruction. Br J Plast Surg 41(6):586–587
9. Hallock GG (1990) Polyurethane nipple prosthesis. Ann Plast Surg 24(1):80–85
10. Millard DR Jr (1972) Nipple and areola reconstruction by split-skin graft from the normal side. Plast Reconstr Surg 50(4):350–353
11. Bhatty MA, Berry RB (1997) Nipple-areola reconstruction by tattooing and nipple sharing. Br J Plast Surg 50(5):331–334
12. Muruci A, Dantas JJ, Noguerira LR (1978) Reconstruction of the nipple-areola complex. Plast Reconstr Surg 61(4):558–560
13. Wexler MR, Oneal RM (1973) Areolar sharing to reconstruct the absent nipple. Plast Reconstr Surg 51(2):176–178
14. Edsander-Nord A, Wickman M, Hansson P (2002) Threshold of tactile perception after nipple-sharing: a prospective study. Scand J Plast Reconstr Surg Hand Surg 36(4):216–220
15. Brent B, Bostwick J (1977) Nipple-areola reconstruction with auricular tissues. Plast Reconstr Surg 60(3):353–361
16. Rose EH (1985) Nipple reconstruction with four-lobe composite auricular graft. Ann Plast Surg 15(1):78–81
17. Klatsky SA, Manson PN (1981) Toe pulp free grafts in nipple reconstruction. Plast Reconstr Surg 68(2):245–248
18. Amarante JT, Santa-Comba A, Reis J, Malheiro E (1994) Halux pulp composite graft in nipple reconstruction. Aesthetic Plast Surg 18(3):299–300
19. Adams WM (1946) Labial transplant for correction of loss of the nipple. Plast Reconstr Surg 4(3):295–298
20. Tanabe HY, Tai Y, Kiyokawa K, Yamauchi T (1997) Nipple-areola reconstruction with a dermal-fat flap and rolled auricular cartilage. Plast Reconstr Surg 100(2):431–438
21. Yanaga H (2003) Nipple-areola reconstruction with a dermal-fat flap: technical improvement from rolled auricular cartilage to artificial bone. Plast Reconstr Surg 112(7):1863–1869
22. Cheng MH, Ho-Asjoe M, Wei FC, Chuang DC (2003) Nipple reconstruction in Asian females using banked cartilage graft and modified top hat flap. Br J Plast Surg 56(7):692–694
23. Gruber RP (1979) Nipple-areola reconstruction: a review of techniques. Clin Plast Surg 6(1):71–83
24. Chang BW, Slezak S, Goldberg NH (1992) Technical modifications for on-site nipple-areola reconstruction. Ann Plast Surg 28(3):277–280
25. Kroll SS, Reece GP, Miller MJ, Evans GR, Robb GL, Baldwin BJ et al (1997) Comparison of nipple projection with the modified double-opposing tab and star flaps. Plast Reconstr Surg 99(6): 1602–1605
26. Little JW 3rd (1984) Nipple-areola reconstruction. Clin Plast Surg 11(2):351–364
27. Eng JS (1996) Bell flap nipple reconstruction—a new wrinkle. Ann Plast Surg 36(5):485–488
28. Ramakrishnan VV, Mohan D, Villafane O, Krishna A (1997) Twin flap technique for nipple reconstruction. Ann Plast Surg 39(3): 241–244
29. Kroll SS, Hamilton S (1989) Nipple reconstruction with the double-opposing-tab flap. Plast Reconstr Surg 84(3):520–525
30. Puckett CL, Concannon MJ, Croll GH, Welsh CF (1992) Nipple reconstruction using the "inchworm" flap. Aesthetic Plast Surg 16(2):117–122
31. Shestak KC, Gabriel A, Landecker A, Peters S, Shestak A, Kim J (2002) Assessment of long-term nipple projection: a comparison of three techniques. Plast Reconstr Surg 110(3):780–786
32. Jabor MA, Shayani P, Collins DR, Jr., Karas T, Cohen BE (2002) Nipple-areola reconstruction: satisfaction and clinical determinants. Plast Reconstr Surg 110(2):457–463; discussion 64–65
33. Few JW, Marcus JR, Casas LA, Aitken ME, Redding J (1999) Long-term predictable nipple projection following reconstruction. Plast Reconstr Surg 104(5):1321–1324
34. Hartrampf CR Jr, Culbertson JH (1984) A dermal-fat flap for nipple reconstruction. Plast Reconstr Surg 73(6):982–986
35. Bosch G, Ramirez M (1984) Reconstruction of the nipple: a new technique. Plast Reconstr Surg 73(6):977–981
36. Barton FE Jr (1982) Latissimus dermal-epidermal nipple reconstruction. Plast Reconstr Surg 70(2):234–237
37. Cronin ED, Humphreys DH, Ruiz-Razura A (1988) Nipple reconstruction: the S flap. Plast Reconstr Surg 81(5):783–787
38. Weiss J, Herman O, Rosenberg L, Shafir R (1989) The S nipple-areola reconstruction. Plast Reconstr Surg 83(5):904–906
39. Lossing C, Brongo S, Holmstrom H (1998) Nipple reconstruction with a modified S-flap technique. Scand J Plast Reconstr Surg Hand Surg 32(3):275–279
40. Mandrekas AD, Zambacos GJ (1997) Modified quadrapod flap. Ann Plast Surg 38(2):195
41. DiPirro ME (1970) Reconstruction of the nipple and areola after a burn. Case report. Plast Reconstr Surg 46(3):299–300
42. Hallock GG, Altobelli JA (1993) Cylindrical nipple reconstruction using an H flap. Ann Plast Surg 30(1):23–26
43. Eskenazi L (1993) A one-stage nipple reconstruction with the "modified star" flap and immediate tattoo: a review of 100 cases. Plast Reconstr Surg 92(4):671–680
44. de Lorenzi F, Manconi A, Rietjens M, Petit JY (2007) In response to: Rubino C, Dessy LA, Posadinu A (2003) A modified technique for nipple reconstruction: the "arrow flap". Br J Plast Surg 56:247. J Plast Reconstr Aesthet Surg 60(8):971–972
45. Rubino C, Dessy LA, Posadinu A (2003) A modified technique for nipple reconstruction: the 'arrow flap'. Br J Plast Surg 56(3): 247–251
46. Cao YL, Lach E, Kim TH, Rodriguez A, Arevalo CA, Vacanti CA (1998) Tissue-engineered nipple reconstruction. Plast Reconstr Surg 102(7):2293–2298

Part VI

Breast Reconstruction in Special Populations

Immediate Breast Reconstruction in Pregnancy and Lactation

39

Cicero Urban, Cléverton Spautz, Rubens Lima, and Eduardo Schünemann Jr

39.1 Introduction

The definition of pregnancy-associated breast cancer (PABC) includes breast cancer diagnosed during pregnancy and within 1 year after pregnancy, or any time during lactation [1–3]. Although the prevalence of PABC is relatively low (one in 3,000 deliveries), it puts the medical team in a complex setting, because two individuals are involved: the mother and the unborn child. It is estimated that 3 % of all breast cancers may be diagnosed in pregnant women, and the incidence of breast cancer in pregnant women is expected to increase owing to postponement of childbearing worldwide [4, 5]. Or, putting in another way, at least 10 % of patients with breast cancer who are younger than 40 years of age will be pregnant when they are diagnosed as having breast cancer [6, 7].

Clinical examination of the breasts during pregnancy is difficult because the breasts have increased density and firmness. About 80 % of women with a palpable painless lump during pregnancy have a benign mass. Any palpable lump persisting for more than 2 weeks should be investigated further with further specific workup. Nipple discharge and the "milk rejection" sign are frequently not present [8–10]. Diagnostic delays of 2 months or longer are common in women with gestational breast cancer. Such delays may adversely impact oncologic outcome, since even a 1-month delay in diagnosis can increase the risk of nodal involvement by 1–2 % [11–14]. Most breast cancers are an infiltrating ductal carcinoma with high-grade and lymph vascular invasion. Presently around 70 % of cases are estrogen and progesterone receptor negative and have a higher expression of human epidermal growth factor receptor 2 (HER2)/neu [6, 10, 15].

The management of these young women is a challenge to all those involved in their care. In contrast to other areas of breast oncology, there are no large randomized trials to guide surgical and clinical practice. Most treatment recommendations are based on case reports and retrospective cohorts. In consequence, there is no standardized treatment of PABC. But the options should be always influenced by the need to give the optimal treatment to the mother while minimizing risks to the fetus [15–17]. Surgery is the primary therapy and mastectomy with axillary dissection is the most frequent treatment option during pregnancy, since most tumors are larger than in nonpregnant patients [18]. Therefore, breast anatomy is completely altered and no data exist about how it can affect the decisions regarding the best technique to reconstruct the breast in PABC. Consequently, some authors propose that breast reconstruction should be delayed until after delivery and after the end of oncologic treatment, when all reconstructive options are available [16]. Newer approaches such as neoadjuvant chemotherapy allow, in some cases, postponement of surgery until after delivery and use of breast conservative surgery with oncoplastic surgery in a one-step approach can avoid mastectomy in these patients [15, 19].

The purpose of this chapter is to present a model that allows immediate breast reconstruction in this complex group of patients and which compromises neither oncologic treatment nor development of the fetus.

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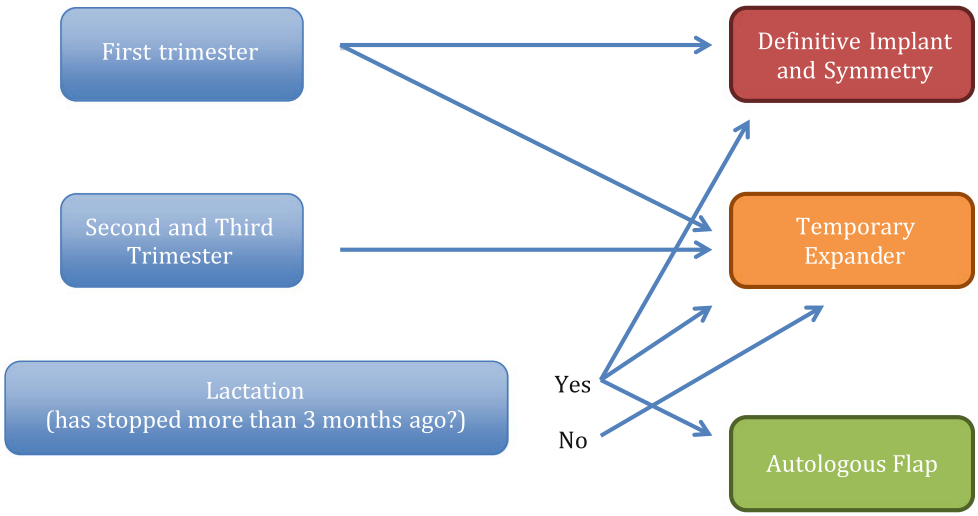

Fig. 39.1 Immediate breast reconstruction decision algorithm in pregnancy and lactation

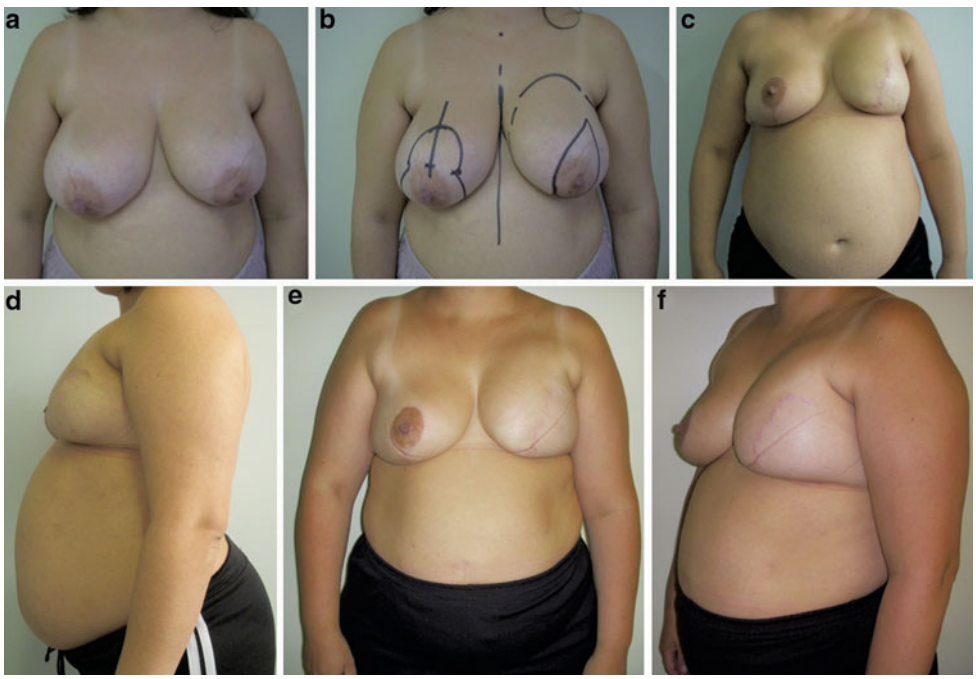

Fig. 39.2 **a**, **b** Preoperative views of a 32-year-old patient, in the eighth week of pregnancy, with diagnosis of an invasive ductal carcinoma of the *left* breast, G2, T2N1, estrogen receptor (ER)/progesterone receptor (PgR) positive, human epidermal growth factor receptor 2 (HER2) negative. **c**, **d** Eight months after left skin-sparing mastectomy, axillary dissection, immediate breast reconstruction with a form-stable implant, and contralateral breast reduction for achievement of symmetry. **e**, **f** Results 4 months after delivery

39.2 Surgical Algorithm

Most PABC patients underwent mastectomy. Breast reconstruction can be performed following a specific model designed in our breast unit since 2008, where these patients are divided into three distinct groups (Fig. 39.1):

1. *First trimester*. Immediate reconstruction in one-step surgery with breast implants and contralateral symmetrization by breast reduction or mastopexy, or in two-step surgery with temporary expanders (Fig. 39.2).
2. *Second and third-trimester*. Temporary expanders.
3. *Lactation*. Temporary expanders, autologous flaps, or breast-conserving therapy (BCT). If the lactation ceased at least 3 months earlier, it is possible to perform one-step surgery with a definitive implant and contralateral breast symmetrization (Fig. 39.3). In this situation, a breast conservative surgery approach is possible too.

39.3 Rationale

Although BCT is a good alternative in selected cases of PABC, larger tumors than those found in nonpregnant patients, associated with the fact that radiotherapy should be

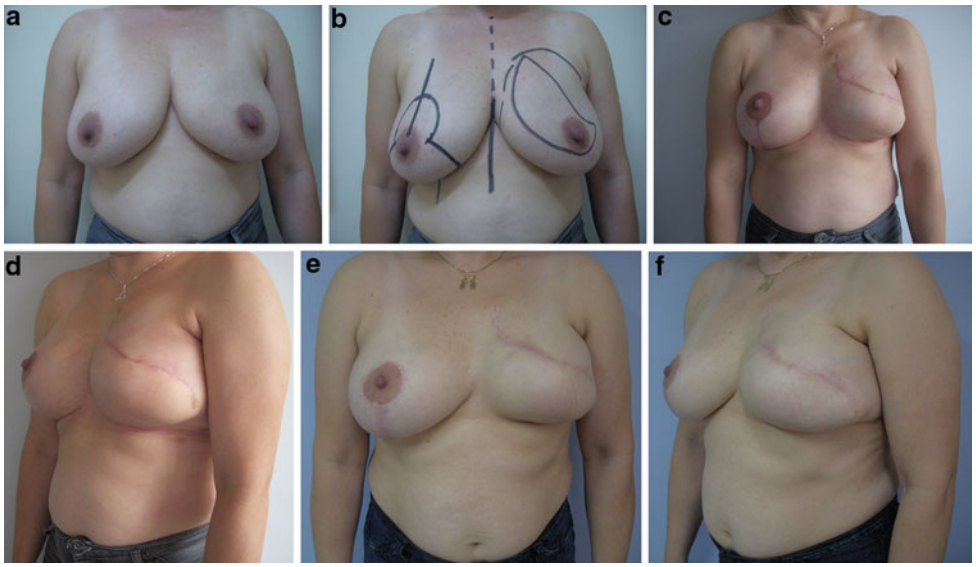

Fig. 39.3 **a**, **b** Preoperative views of a 37-year-old patient with a multicentric invasive ductal carcinoma of the *left* breast, T2N0, ER/PgR negative, HER2 negative, and lactation that ceased 3 months earlier. **c**, **d** Three months after left skin-sparing mastectomy, sentinel node biopsy, immediate breast reconstruction with a definitive form-stable implant and contralateral breast reduction for achievement of symmetry. **e**, **f** Long-term result: 2 years after surgery

avoided until after delivery, result in a low rate for this kind of surgery in this group of patients [17]. In our breast unit there were no indications for BCT, since the dominant tumors were pT2 and pT3. Therefore, sentinel node biopsy was not used in PABC until some years ago, and all patients underwent axillary dissection.

Pregnancy affects all of the body. Physiological changes particularly associated with pregnancy include increased cardiac output, decreased peripheral vascular resistance, increased blood volume, physiological dilutional anemia, increased oxygen consumption, increased renal plasma flow, increased coagulability, decreased lung capacity, supine positional hypotension, and slow gastric emptying [15, 16]. They require special care from anesthesiologists and the surgical team (Table 39.1). So there are limits to consider in the extension of surgery in pregnancy.

With regard to breast reconstruction, pregnancy affects particularly the breasts, resulting in glandular hyperplasia and hypertrophy (mean breast weight normally doubles in pregnancy), increasing ptosis, areolar enlargement, nipple hypertrophy, and increasing pigmentation of the nipple and areola. At the end, breast anatomy is completely altered (Fig. 39.4). Unfortunately no data exist about the changes in breast structure, as well as volume and shape, and how they can affect the decisions regarding the best technique to use to reconstruct the breast in PABC. For that reason, some authors propose that breast reconstruction should be delayed until after delivery, when all reconstructive options are available (especially autologous tissue flaps), and when symmetry could be easier to achieve.

Table 39.1 Physiological changes in pregnancy that can potentially affect breast reconstruction decisions and outcome

	Physiological change
Blood volume	Increases by 30–50 %
Hematocrit	30–35 % of normal
Heart rate	Increases by 10–15 bpm
Clotting factors	Increase in the levels of fibrinogen, prothrombin, and factors VII, VIII, IX, and X
White blood cells	10,000–14,000
Platelet level	Low to normal

However, nowadays, immediate breast reconstruction is widely preferred and does not have a negative influence on breast cancer survival rates or recurrences. It has innate advantages in terms of quality of life and aesthetic outcomes when compared with delayed reconstruction, especially for young women [20]. So our reconstructive approach to these patients in this series was to divide them into three different categories according to the phase of their pregnancy and body and breast modifications:

1. *First trimester*. The breasts and body are modified little by pregnancy. The result of the reconstructed breast is more predictable than in the other two phases. Immediate reconstruction can be performed in one-step surgery with breast implants and contralateral symmetrization by breast reduction or mastopexy, or in two-step surgery with temporary breast expanders (Fig. 39.2). Autologous tissue flaps, especially those involving abdominal wall

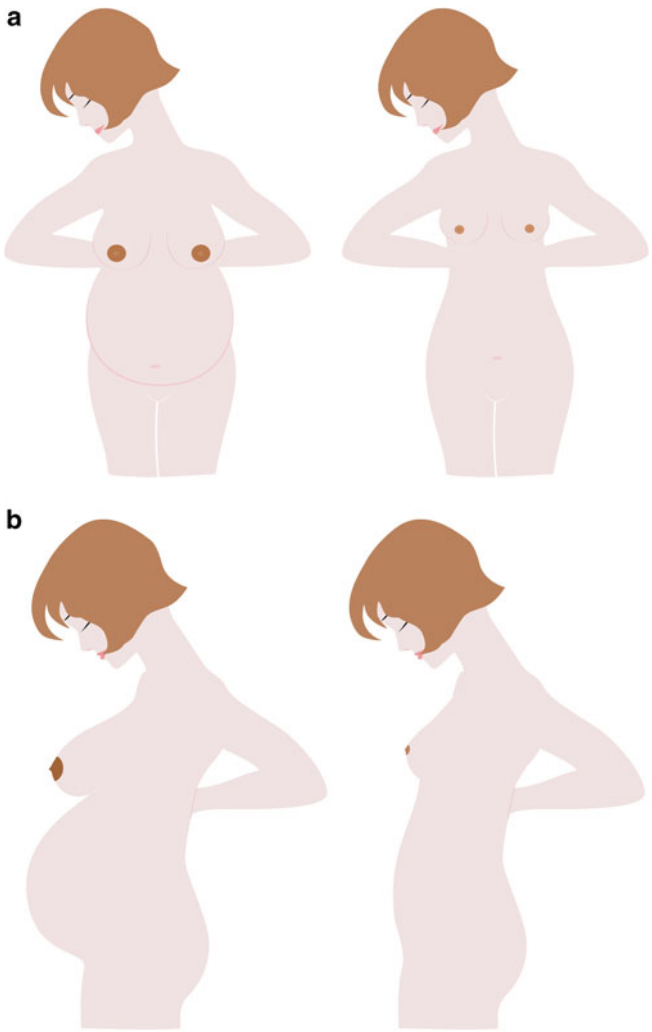

Fig. 39.4 **a, b** Aesthetic modifications in the breasts and body during pregnancy

techniques (pedicled or free transverse rectus abdominis myocutaneous flaps), are contraindicated. A latissimus dorsi flap could be indicated in well-selected cases, but it increases both the surgical time and the clinical complications. In this series there were two patients who underwent immediate breast reconstruction through one-step surgery with a definitive implant and contralateral symmetrization, resulting in a good aesthetic result. There were no significant modifications in their breasts over time.

2. *Second and third trimesters*. The breast and body modifications are more evident and the final result of the reconstructed breast is less predictable. So temporary expanders are the best choice in this group. The second surgery should be done at least 3 months after delivery (considering the impossibility of most patients to lactate owing to oncologic treatment), or 3 months after lactation, when the breast achieves its normal shape, ptosis, and volume.
3. *Lactation*. The breast modifications are more evident and the body modifications are progressively less important than before delivery. Temporary expanders are the best choice. The second surgery should be done at least 3 months after lactation has ceased, when the breasts will have achieved their definitive volume, shape, and ptosis. Autologous flaps could be indicated as primary surgery in selected cases, considering that the risks are the same as those in nonlactating and nonpregnant patients. But in making the decision, one must consider the unpredictability of breast modifications after lactation. They could have a negative influence on breast symmetry. In fact, most of the patients in our series were in this category. All of them had temporary expanders fitted with good long-term results. After the end of lactation, it was easier to achieve symmetry by changing the temporary expander for a definitive implant and by performing contralateral mammoplasty. There were no additional complications due to lactation. In cases where

Table 39.2 Comparison between pregnant and nonpregnant patients with invasive breast cancer at the Hospital Nossa Senhora das Graças Breast Unit, Curitiba, Brazil, 2004–2010

Characteristic	Non-Pregnant (n = 598)	Pregnant (n = 10)	Statistical analysis
Age (years)	56.6	33	
T2 and T3	20.1 %	90 %	$p = 0.0001$
ER/PgR+	78.7 %	30 %	$p = 0.0008$
HER2+++	22.4 %	20 %	$p = 0.456$
Axilla+	15.1 %	80 %	$p = 0.001$
Mastectomy	45.8 %	100 %	$p = 0.0002$

Modified from Urban CA et al. [22]

lactation ceased at least 3 months earlier, it is possible to perform one-step reconstructive surgery with a definitive implant (Fig. 39.3) or BCT with an oncoplastic approach.

Since PABC covers a group of patients who usually have a more aggressive disease (Table 39.1), it is expected that some of these patients will undergo postmastectomy radiotherapy and a more aggressive adjuvant therapy [21]. It is necessary to consider this in the decision-making process. Therefore, it is expected that breast reconstruction will not lead to a delay in beginning chemotherapy in this group. In a previous study performed as a retrospective and prospective analysis of consecutive PABC patients who had undergone mastectomy, axillary dissection, and immediate breast reconstruction in our breast unit from March 2004 until July 2008, from a total of 598 cases of invasive breast cancer, ten PABC cases (1.7 %) were selected (Table 39.2). These patients were younger and had more aggressive tumors than nonpregnant patients. Breast reconstructions were performed following the decision model presented here. First-trimester patients ($n = 2$) underwent immediate reconstruction in one-step surgery with breast implants and contralateral symmetrization. Second- and third-trimester patients ($n = 2$) had temporary expanders fitted. Lactating patients ($n = 5$) had temporary expanders fitted or one-step surgery with implants if lactation had ceased at least 3 months earlier ($n = 1$). No surgical complications or delay in adjuvant therapy were observed in this group of patients. Only one patient needed postoperative radiotherapy, resulting in Baker 2 capsular contracture. All patients were alive without disease and the development of the fetus was not compromised by the surgery [22]. One patient received chemotherapy from 20 weeks of pregnancy.

So, if the patient has no oncologic contraindication for immediate breast reconstruction, the key point in this model to decide on the best technique for immediate breast reconstruction is lactation. First-trimester patients and those patients in whom lactation ceased at least 3 months earlier are more predictable in terms of shape, volume and ptosis, so one-step surgery could be a good option. In cases where the effects of lactation in the breast are present, temporary expanders could be the best choice, because it is not possible to achieve symmetry owing to accentuated breast modifications. When neoadjuvant chemotherapy is necessary, the surgical treatment can be postponed until after delivery or lactation. In this case, one-step surgery with definitive breast implants or breast conservative surgery plus oncoplastic surgery is possible.

Finally, with this reconstructive approach to PABC patients, it is possible to minimize the effects of mastectomy. It is a transverse model, which considers all aspects—oncologic, obstetric, and reconstructive—with both the patient and the fetus at the center of the decision-making process.

References

1. Anderson BO, Petrek JA, Byrd DR et al (1996) Pregnancy influences breast cancer stage at diagnosis in women 30 years of age and younger. Ann Surg Oncol 3:204
2. García-Manero M, Royo MP, Espinos J, Pina L, Alcazar JL, López G (2009) Pregnancy associated breast cancer. EJSO 35:215–218
3. Gentilini O, Masullo M, Rotmennsz N, Peccatori F, Mazzarol G, Smeets A, Simsek S, De Dosso S, Veronesi P, Intra M, Zurrida S, Viale G, Goldhirsch A, Veronesi U (2005) Breast cancer diagnosed during pregnancy and lactation: biological features and treatment options. EJSO 31:232–236
4. Litton JK, Theriault RL (2010) Breast cancer and pregnancy: current concepts in diagnosis and treatment. Oncologist 15: 1238–1247
5. Martínez MCS, Simóm AR (2010) Breast cancer during pregnancy. Breast Cancer Res Treat 123:55–58
6. Navrozoglou I, Vrekoussis T, Kontostolis E, Dousias V, Zervoudis S, Stathopoulos EN, Zoras O, Paraskevaidis E (2008) Breast cancer during pregnancy: a mini-review. EJSO 34:837–843
7. Ring A (2007) Breast cancer and pregnancy. The Breast:S155–S158
8. Rovera F, Frattini F, Coglitore A, Marelli M, Rausei S, Dionigi G, Boni L, Dionigi R (2010) Breast cancer in pregnancy. Breast J 16:S22–S25
9. Sukunvanich P (2011) Review of current treatment options for pregnancy-associated breast cancer. Clin Obstet Gynecol 54:164–172

10. Halaska MJ, Pentheroudakis G, Stnard P, Stankusova H, Chod J, Robova H, Petruzelka L, Rob L, Pavlidis N (2009) Presentation, management and outcome of 32 patients with pregnancy-associated breast cancer: a matched controlled study. Breast J 15:461–467
11. Bunker ML, Peters MV (1963) Breast cancer associated with pregnancy or lactation. Am J Obstet Gynecol 85:312
12. Lethaby AE, O'Neill MA, Mason BH et al (1996) Overall survival from breast cancer in women pregnant or lactating at or after diagnosis. Auckland Breast Cancer Study Group. Int J Cancer 67:751
13. Nettleton J, Long J, Kuban D et al (1996) Breast cancer during pregnancy: quantifying the risk of treatment delay. Obstet Gynecol 87:414
14. Stensheim H, Møller B, van Dijk T, Fosså SD (2009) Cause-specific survival for women diagnosed with cancer during pregnancy or lactation: a registry-based cohort study. J Clin Oncol 27:45
15. Amant F, Deckers S, Van Calsteren K et al (2010) Breast cancer in pregnancy: recommendations of an international consensus meeting. Eur J Cancer 46(18):3158
16. Guidroz JA, Scott-conner CEH, Weigel RJ (2011) Management of pregnant women with breast cancer. J Surg Oncol 103:337–340
17. Jones AL (2006) Management of pregnancy-associated breast cancer. The Breast 15:S47–S52
18. Mondi MM, Cuenca RE, Ollila DW, Stewart JH, Levine EA (2007) Sentinel lymph node biopsy during pregnancy: initial clinical experience. Ann Surg Oncol 14:218–221
19. Hahn KM, Johnson PH, Gordon N et al (2006) Treatment of pregnant breast cancer patients and outcomes of children exposed to chemotherapy in utero. Cancer 107:1219. The Breast 15(S2): S53–S59
20. Zanetti-Dällenbach R, Tschudin S, Lapaire O, Holzgreve W, Wight E, Bitzer J (2006) Psychological management of pregnancy-related breast cancer. J Breast 2:553–559
21. Recht A, Edge SB, Solin LJ, Robinson DS, Estrabook A, Fine RE et al (2001) Postmastectomy radiotherapy: clinical practice guidelines of the American Society of Clinical Oncology. JCO 19:1539–1569
22. Urban CA, Lima R, Schunemann E Jr, Spautz C, Rabinovich I (2010) Immediate breast reconstruction in pregnancy and lactation. Revista Brasileira de Mastologia 20:115–120

Breast Reconstruction in the Elderly

40

Francesca de Lorenzi and Visnu Lohsiriwat

40.1 Introduction

Almost two-thirds of solid tumors occur in elderly patients [1]. Among them, breast cancer is largely represented, and women aged 70 years and over have the highest incidence and mortality from breast cancer of any age group.

In recent decades, breast reconstruction has been not offered to the elderly population owing to the reluctance of clinicians concerned about attendant serious comorbidities. The elderly are often considered unfit for reconstruction owing to an inaccurate estimation of operative risk. Unfortunately, no consensus exists on therapy for elderly cancer patients. Treatments are influenced by unclear standards and are usually less aggressive both for surgical and for medical options. Moreover, it has been demonstrated that many older women with breast cancer have received treatments that are not generally considered to be appropriate care [2]. Fortunately, nowadays the behavior is changing, as people are living much longer and are healthier. In addition, the survival rate for breast cancer is improving also in elderly patients, so a larger proportion of patients are living with the long-term consequences of their treatment. For these reasons, the consideration of breast reconstruction should be offered to elderly patients in order to improve their quality of life.

40.2 Definition and Characteristics of the Elderly

Conventionally, the "elderly" have been defined as those with a chronological age of 65 years or more, with those from 65 to 74 years old being referred as "early elderly" and those over 75 years as "late elderly."[3]

There are several major physiologic changes of aging that affect the central nervous system, the cardiovascular system, the respiratory system, and many other systems. When the general risk of anesthesia is quantified with the classification of the American Society of Anesthesiologists (scored from I to IV), most elderly patients fall in class II or class III. Elderly patients also have poor Karnosfsky performance status [4, 5]. The elderly should have more careful preoperative and postoperative assessment and more often probably require intensive care management to reduce the surgical risk. They are also vulnerable to the adverse effects of anesthesia because of their reduced margin of safety. Acute and chronic medical conditions, nutritional status, and level of activity needed to be taken into consideration.

40.3 Psychological Benefits and Quality of Life

In general, there is a clear psychological benefit and quality of life benefit for breast reconstruction regardless of the age group. However, there are only a few reports focusing on quality of life assessment, and most used general health questionnaires rather than specific ones [6–8]. Girotto et al. [7] reviewed 316 consecutive women older than 65 years of age (400 reconstructions) with breast cancer undergoing mastectomy with reconstruction. Their outcomes were assessed with use of a self-reported questionnaire (SF-36) addressing health-related quality of life, body image, and physical functioning. Concerning the overall quality-of-life issues after reconstruction, older patients with breast reconstruction had better outcomes than age-matched

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general population patients and previously reported mastectomy-only patients (older than 55 years). Specifically, elderly patients had better outcomes in the subscales that are strongly influenced by one's mental health. However, when compared with prior data for younger patients undergoing mastectomy and reconstruction, the older patients had worse outcomes in the areas related to physical function [7].

40.4 Oncologic Safety

Breast cancer surgery is associated with a low risk of operative morbidity and mortality when compared with more difficult and longer surgical procedures. Wherever feasible, older women with reasonable life expectancy should be treated with standard surgical procedures applicable to younger patients, including the choice of breast conservation or mastectomy where appropriate; breast reconstruction or oncoplastic procedures should be included in the options available.

Unfortunately, the review study by Kiderlen et al. [9] noted that the proportion of elderly patients who received radiotherapy after conservative treatment decreased with age in all countries. Moreover, in all countries the proportion of patients who do not receive axillary surgery increased with age. They observed large international differences in the treatment of elderly early-stage breast cancer patients, with the most surprising result being the large proportion of the elderly who did not undergo surgery at all.

Smith et al. [10] demonstrated that breast cancer outcomes have preferentially improved in women aged less than 75 years. Focused research is needed to improve outcomes in older women. However, this conclusion might be the consequence of undertreatment of the elderly resulting in poorer survival. Better screening tools and programs and more effective adjuvant chemohormonal and targeted therapy with lower toxicity are being developed and should be researched in the elderly to achieve a significant improvement in survival rate [11].

40.5 Type of Reconstruction

40.5.1 Breast Conservative Treatment

Breast conservative treatment is largely indicated for elderly patients since the favorable tumor biohistology characteristics in the elderly cohort make the local recurrence rate lower than in the general population [12, 13]. Although the large majority of quadrantectomies do not require an oncoplastic approach, in about 10–15 % of cases it is necessary to improve the cosmetic result [14–16]. In fact, wide glandular resections can induce deformities and volume and shape asymmetry between the two breasts, such as glandular defects or scar retraction as well as nipple–areola complex [17] dislocations. An oncoplastic approach may avoid these asymmetries and the difficulties of glandular reshaping after breast irradiation justify an immediate partial reconstruction. Most of the deformities can be avoided using simple tricks without any specific training in plastic surgery: optimal positioning of the scar, transposition of the nipple–areola complex to avoid dislocation, better evaluation of the symmetry. In other cases, specific knowledge of reconstructive techniques is mandatory. Schematically, there are two fundamentally different approaches: volume displacement and volume replacement procedures.

Volume displacement procedures combine resection with a variety of different breast reduction and reshaping techniques, according to the location of the tumor. Volume replacement procedures combine resection with immediate reconstruction by using local flaps, such as glandular, fasciocutaneous, and mini-muscle flaps. Glandular flaps are feasible and safe in the case of glandular and very dense breasts. In the case of a fatty breast with low radiologic density, as elderly patients usually have, a really careful evaluation is mandatory and glandular flaps are more often contraindicated since there is a very high risk of necrosis after fat undermining and mobilization. Implant replacement is indicated only in selected cases, when intraoperative exclusive irradiation is delivered [8]. In the case of fatty breasts and large resection, mammoplasty procedures should be preferred if simple closure of the lumpectomy cavity is not feasible. Surgical reshaping after quadrantectomy for wide glandular excisions (oncoplastic techniques) can be offered in elderly patients [18, 19]. Oncoplastic surgery increases the oncologic safety of breast conservative treatment as a much larger volume can be excised and wider surgical margins can be achieved [19, 20].

In the case of poor results after conservative treatment, an easy and simple technique to correct and replace the defects is fat grafting. Fat grafting is largely used also in the elderly cohort; it can be performed in a second operative procedure, after the external irradiation has been delivered, usually with the patient under local anesthesia and with minimal scarring. Several ongoing studies are in the process demonstrating the safety of lipotransfer in cancer patients [21–23].

40.5.2 Mastectomy

Many types of mastectomy can be safely offered to elderly patients, such as total mastectomy with immediate or delay reconstruction, skin-sparing mastectomy, and nipple–areola-sparing mastectomy with immediate reconstruction

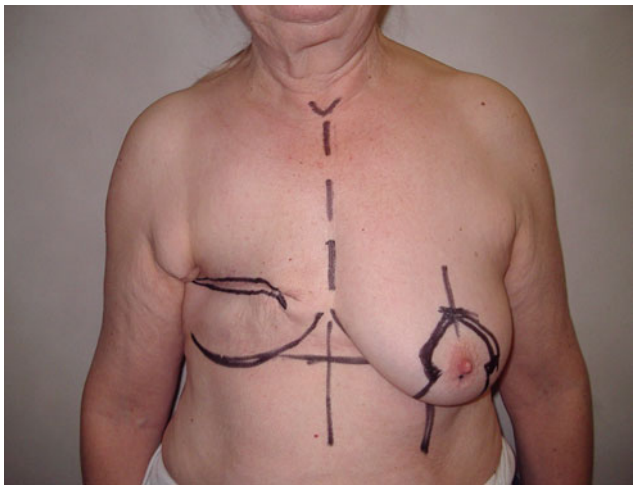

Fig. 40.1 A 73-year-old woman after right mastectomy

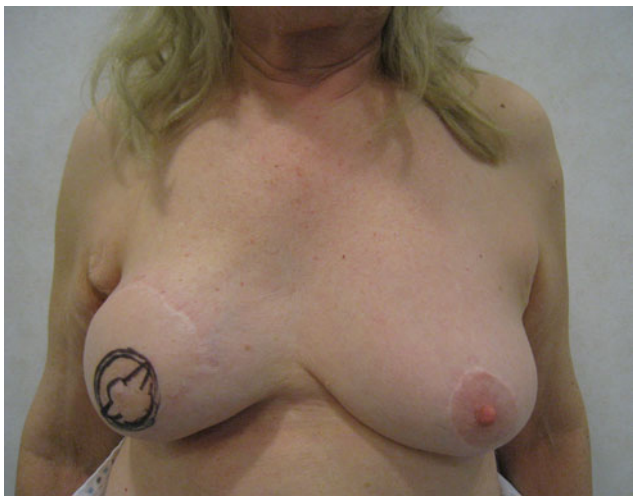

Fig. 40.2 A 73-year-old woman. Result after delayed reconstruction with a latissimus dorsi flap and planning of nipple–areola complex reconstruction

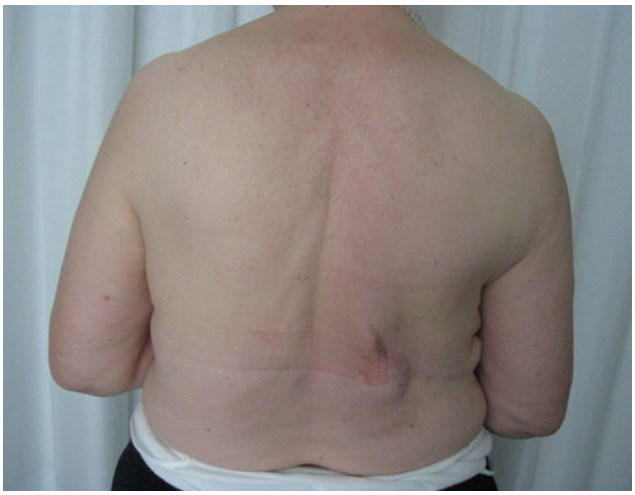

Fig. 40.3 A 73-year-old woman. Result after latissimus dorsi flap reconstruction (donor site)

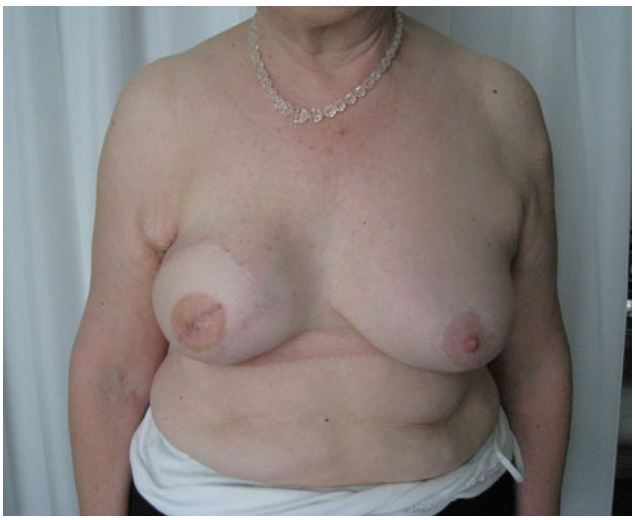

Fig. 40.4 A 73-year-old woman. Final result

[24]. Reconstruction includes implant-based and flap-based techniques (Figs. 40.1, 40.2, 40.3, 40.4).

Implant reconstruction is easy, with a short operating time, no donor site morbidity, and relatively quick recovery. Respecting and evaluation of the vascularity of the mastectomy flaps is mandatory in the immediate setting to prevent marginal flap necrosis, wound dehiscence, secondary healing, and implant exposure. Additional operations after the primary procedure are usually necessary since aesthetic outcomes deteriorate over time [18, 25, 26], but mostly these procedures can be performed with the patient under local anesthesia, including changing and removal of the implant and nipple and areola reconstruction (Figs. 40.5, 40.6).

In our experience, flap reconstructions are generally limited to those patients who have received preoperative radiotherapy, since radiation adversely affects the outcomes of implant-based reconstructions, and in those cases of wide mastectomies requiring flap repair. In the future, in the era of perforator flaps reducing donor side morbidity for strength and function, the number of elderly patients requiring this kind of reconstruction will probably increase.

Age alone should not be considered as the sole factor when selecting the type of reconstruction for patients. Nevertheless, comorbidities, the patient's condition, and concomitant factors together with the patient's opinion and tumor stage should influence the type of reconstruction. In addition, not all breast cancer patients will definitely required reconstruction. Some elderly patients who are at high risk from surgery refuse reconstructive surgery, and those with limited social lives may prefer an external prosthesis to cope with the mutilation of mastectomy.

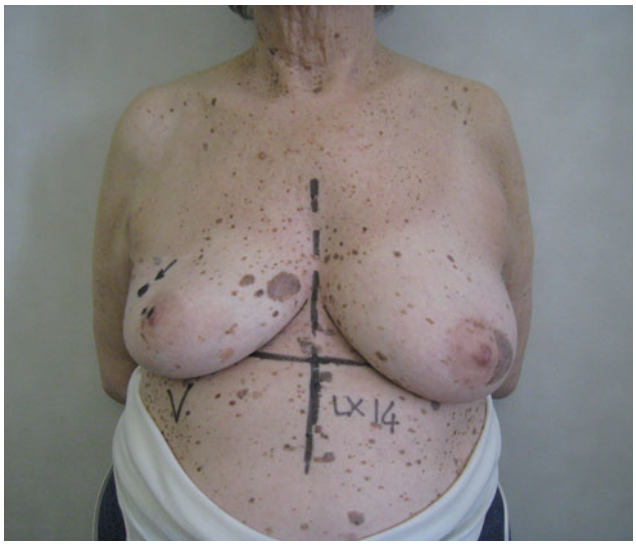

Fig. 40.5 An 86-year-old woman. Preoperative view

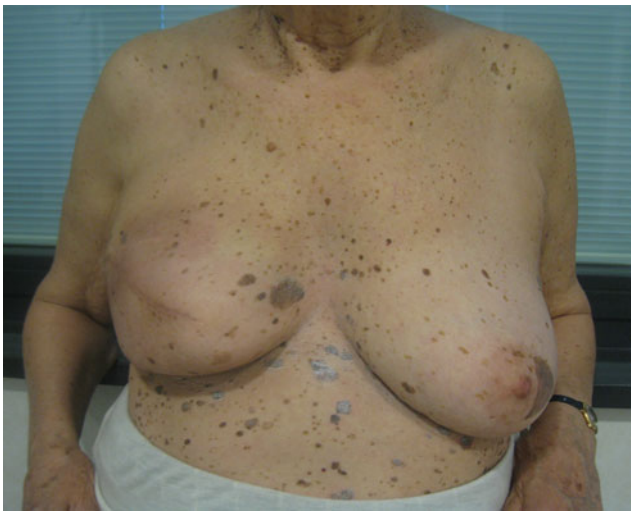

Fig. 40.6 An 86-year-old woman after skin-sparing mastectomy with immediate prosthesis reconstruction

Girotto et al. [7] reported that elderly women are less likely to complete nipple–areola complex reconstruction compared with a younger cohort. Our study demonstrated that only 15.5 % of elderly patients completed their reconstructions with the creation of the nipple–areola complex.

40.5.3 Complications

Data from the literature demonstrate that breast reconstruction is safe in elderly patients although it is well known that the risk of perioperative complications is proportionately increased because the number of comorbidities (i.e., hypertension, coronary artery disease, cerebrovascular disease, chronic lung disease, diabetes, and congestive heart failure) [27] and the relative risk of severe complications and death are significantly greater in the geriatric population than in the younger cohort. It is mandatory to address the overall status of the elderly patient when reconstructive options are being considered. Certainly, the overall heath condition, comorbidities, patient expectations and motivations, and tumor stage clearly affect the decision for reconstruction.

In our series [17], most of our elderly patients had an implant-based reconstruction with a low percentage of postoperative complications: no adverse events were observed in the postoperative period. Infection occurred in 6.34 % of patients, partial necrosis of the mastectomy flap in 5.5 %, total implant removal in 12.24 %—due to infection (5.8 %), exposure (1.9 %), or capsular contracture (4.2 %).

In contrast, Lipa et al. [8] reported a series of breast reconstructions in older women, with most of them being autologous flap reconstructions. They described a remarkably high complication rate associated with implant-based reconstructions. Fewer complications resulted from autogenous tissue reconstruction than from prosthetic reconstruction.

Howard-McNatt et al. [28] reported on 89 women older than 60 years having mastectomy and reconstruction (both implants and flaps). They concluded that age should not be a contraindication for breast reconstruction in elderly women.

40.6 Conclusion

Advanced age (in itself) is not a contraindication to breast reconstruction, and breast reconstruction can be successfully performed on well-selected patients. The safety of reconstruction together with improvements in life expectancy increases the incentive to allow older women with breast carcinoma to be reconstructed without major barriers related to age, functional status, and social support. Future cancer research should be conducted in the elderly to provide more confidence in cancer treatment and to decrease undertreatment in elderly patients.

References

1. Audisio RA, Bozzetti F, Gennari R, Jaklitsch MT, Koperna T, Longo WE et al (2004) The surgical management of elderly cancer patients: recommendations of the SIOG surgical task force. Eur J Cancer 40(7):926–938
2. Gennari R, Curigliano G, Rotmensz N, Robertson C, Colleoni M, Zurrida S et al (2004) Breast carcinoma in elderly women: features of disease presentation, choice of local and systemic treatments compared with younger postmenopasual patients. Cancer 101(6):1302–1310

3. Orimo H (2006) Reviewing the definition of elderly. Nihon Ronen Igakkai Zasshi 43(1):27–34
4. Woodfield JC, Beshay NM, Pettigrew RA, Plank LD, van Rij AM (2007) American Society of Anesthesiologists classification of physical status as a predictor of wound infection. ANZ J Surg 77(9):738–741
5. Mak PH, Campbell RC, Irwin MG (2002) physical status classification: inter-observer consistency. American Society of Anesthesiologists. Anaesth Intensive Care 30(5):633–640
6. Bowman CC, Lennox PA, Clugston PA, Courtemanche DJ (2006) Breast reconstruction in older women: should age be an exclusion criterion? Plast Reconstr Surg 118(1):16–22
7. Girotto JA, Schreiber J, Nahabedian MY (2003) Breast reconstruction in the elderly: preserving excellent quality of life. Ann Plast Surg 50(6):572–578
8. Lipa JE, Youssef AA, Kuerer HM, Robb GL, Chang DW (2003) Breast reconstruction in older women: advantages of autogenous tissue. Plast Reconstr Surg 111(3):1110–1121
9. Kiderlen M, Bastiaannet E, Walsh PM, Keating NL, Schrodi S, Engel J et al (2012) Surgical treatment of early stage breast cancer in elderly: an international comparison. Breast Cancer Res Treat 132(2):675–682
10. Smith BD, Jiang J, McLaughlin SS, Hurria A, Smith GL, Giordano SH et al (2011) Improvement in breast cancer outcomes over time: are older women missing out? J Clin Oncol 29(35):4647–4653
11. Muss HB, Busby-Whitehead J (2011) Older women with breast cancer: slow progress, great opportunity, now is the time. J Clin Oncol 29(35):4608–4610
12. Bouchardy C, Rapiti E, Fioretta G, Laissue P, Neyroud-Caspar I, Schafer P et al (2003) Undertreatment strongly decreases prognosis of breast cancer in elderly women. J Clin Oncol 21(19):3580–3587
13. Beadle BM, Woodward WA, Buchholz TA (2011) The impact of age on outcome in early-stage breast cancer. Semin Radiat Oncol 21(1):26–34
14. Rietjens M, Urban CA, Rey PC, Mazzarol G, Maisonneuve P, Garusi C et al (2007) Long-term oncological results of breast conservative treatment with oncoplastic surgery. Breast 16(4):387–395
15. Petit JY, De Lorenzi F, Rietjens M, Intra M, Martella S, Garusi C et al (2007) Technical tricks to improve the cosmetic results of breast-conserving treatment. Breast 16(1):13–16
16. Rietjens M, De Lorenzi F, Veronesi P, Intra M, Venturino M, Gatti G et al (2006) Breast conservative treatment in association with implant augmentation and intraoperative radiotherapy. J Plast Reconstr Aesthet Surg 59(5):532–535
17. Klein C, Schalla S, Schnackenburg B, Bornstedt A, Hoffmann V, Fleck E et al (2003) Improvement of image quality of non-invasive coronary artery imaging with magnetic resonance by the use of the intravascular contrast agent Clariscan (NC100150 injection) in patients with coronary artery disease. J Magn Reson Imaging 17(6):656–662
18. Clough KB, Kaufman GJ, Nos C, Buccimazza I, Sarfati IM (2010) Improving breast cancer surgery: a classification and quadrant per quadrant atlas for oncoplastic surgery. Ann Surg Oncol 17(5):1375–1391
19. Clough KB, Lewis JS, Couturaud B, Fitoussi A, Nos C, Falcou MC (2003) Oncoplastic techniques allow extensive resections for breast-conserving therapy of breast carcinomas. Ann Surg 237(1):26–34
20. Kaur N, Petit JY, Rietjens M, Maffini F, Luini A, Gatti G et al (2005) Comparative study of surgical margins in oncoplastic surgery and quadrantectomy in breast cancer. Ann Surg Oncol 12(7):539–545
21. Petit JY, Botteri E, Lohsiriwat V, Rietjens M, De Lorenzi F, Garusi C et al (2012) Locoregional recurrence risk after lipofilling in breast cancer patients. Ann Oncol 23(3):582–588
22. Petit JY, Lohsiriwat V, Clough KB, Sarfati I, Ihrai T, Rietjens M et al (2011) The oncologic outcome and immediate surgical complications of lipofilling in breast cancer patients: a multicenter study–Milan-Paris-Lyon experience of 646 lipofilling procedures. Plast Reconstr Surg 128(2):341–346
23. Lohsiriwat V, Curigliano G, Rietjens M, Goldhirsch A, Petit JY (2011) Autologous fat transplantation in patients with breast cancer: “silencing” or “fueling” cancer recurrence? Breast 20(4):351–357
24. Petit JY, Gentilini O, Rotmensz N, Rey P, Rietjens M, Garusi C et al (2008) Oncological results of immediate breast reconstruction: long term follow-up of a large series at a single institution. Breast Cancer Res Treat 112(3):545–549
25. Clough KB, O’Donoghue JM, Fitoussi AD, Vlastos G, Falcou MC (2001) Prospective evaluation of late cosmetic results following breast reconstruction: II. Tram flap reconstruction. Plast Reconstr Surg 107(7):1710–1716
26. Clough KB, O’Donoghue JM, Fitoussi AD, Nos C, Falcou MC (2001) Prospective evaluation of late cosmetic results following breast reconstruction: I. Implant reconstruction. Plast Reconstr Surg 107(7):1702–1709
27. De Lorenzi F, Rietjens M, Soresina M, Rossetto F, Bosco R, Vento AR et al (2010) Immediate breast reconstruction in the elderly: can it be considered an integral step of breast cancer treatment? The experience of the European Institute of Oncology, Milan. J Plast Reconstr Aesthet Surg 63(3):511–515
28. Howard-McNatt M, Forsberg C, Levine EA, Defranzo A, Marks M, David L (2011) Breast cancer reconstruction in the elderly. Am Surg 77(12):1640–1643

Breast Reconstruction and Postmastectomy Radiotherapy

41

Petra J. Wildgoose, Toni Zhong, and Peter G. Cordeiro

41.1 Clinical Indications for Postmastectomy Radiotherapy

Radiotherapy following mastectomy has become a fundamental component of the multimodal treatment for patients with invasive breast cancer. Findings from recent randomized control trials have demonstrated that postmastectomy radiotherapy (PMRT) provides locoregional control and improves overall survival in breast cancer patients with positive axillary nodes [1, 2]. The establishment of the oncologic benefits of PMRT prompted the American Society of Clinical Oncology (ASCO) to publish the following indications for PMRT [3]:

PMRT is "recommended" for patients with [4]

1. Locally advanced T4 cancer
2. Four or more positive axillary lymph nodes.

PMRT is "suggested" for patients with [4]

1. Operable stage III disease
2. T3 tumors with positive axillary lymph nodes.

On the one hand, PMRT is known to improve breast cancer outcomes in the above settings where patients have locoregional recurrence risks of 25–30 % [1, 2, 5]. On the other hand, the benefit of PMRT in patients with T1 and T2 tumors and with less than four positive axillary lymph nodes has not been firmly established [4, 6]. Furthermore, at currently there is insufficient evidence for modification of the ASCO guidelines on the basis os tumor-related (such as lymphovascular invasion), patient-related, or treatment-related factors [4]. To add to the complexity, recent interest in the use of neoadjuvant chemotherapy in advanced cases of breast cancer also awaits an updated approach to both the role and timing of PMRT administration [4].

41.2 Decision Algorithm for Breast Reconstruction in the Setting of PMRT

The implications of performing postmastectomy breast reconstruction (PMBR) in the setting of both previous and expected radiotherapy are both profound and controversial. Distinction between prior versus future radiotherapy must be made because the approach to PMBR will differ accordingly. In the absence of existing consensus guidelines and a large body of literature with divided views on the optimal technique and timing of breast reconstruction in patients who are expected to require PMRT [6], a clear understanding of the pros and cons of each option is critical to provide a thoughtful and individualized treatment approach.

In the setting of expander/implant reconstruction, the risks of increased postoperative complications and poor aesthetic outcomes are higher with radiotherapy regardless of the timing of radiotherapy with respect to the reconstruction (neoadjuvant vs. adjuvant) [7–9]. Although radiotherapy may yield undesired side effects in expander/implant reconstruction irrespective of the timing of radiotherapy, the timing of reconstruction (immediate vs. delayed) is a critical factor to distinguish in a patient who is expected to require PMRT. In a patient who requires a mastectomy and whose breast cancer is known to require PMRT, the option of expander/implant reconstruction may only be viable when performed as immediate breast reconstruction (IBR). If the opportunity for IBR with an expander/implant is lost before

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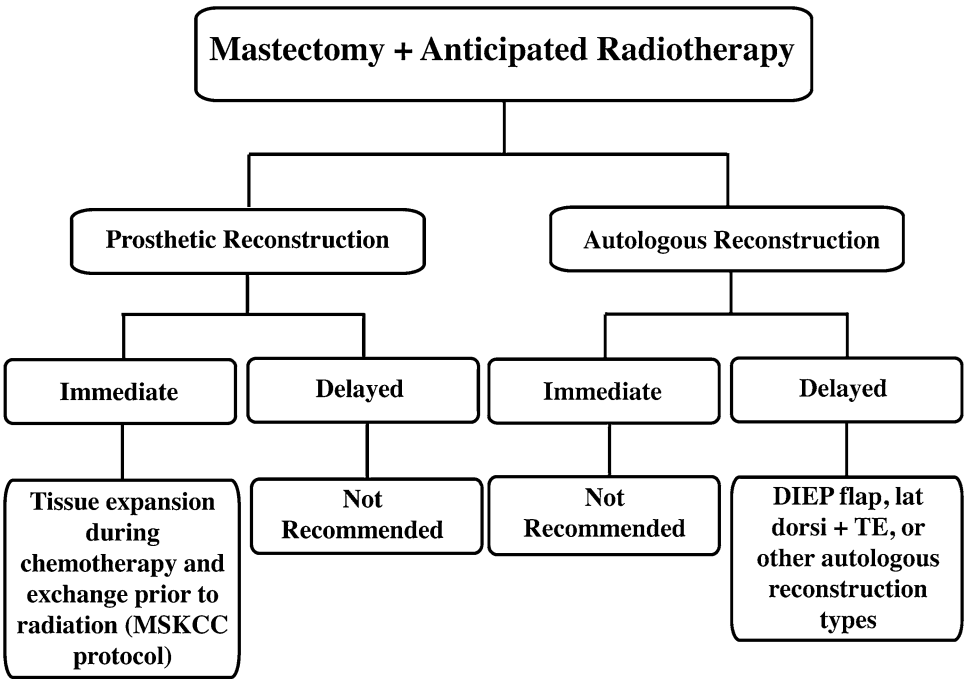

Fig. 41.1 Decision algorithm

PMRT occurs, then the option to reconstruct a delayed irradiated mastectomy defect will necessitate the use of a combination of autologous tissue and an expander/implant or autologous tissue alone [10].

In general, for a patient who prefers autologous tissue reconstruction and whose breast disease may require PMRT, the result will be more predictable if the reconstruction is performed in a delayed fashion [7, 11]. It has been shown that late complications associated with radiotherapy after an IBR with autologous tissue include fat necrosis, flap volume loss, and flap contracture [11]. Specifically, the group at M.D. Anderson Cancer Center found that at least 87.5 % of patients who received PMRT following IBR with autologous tissue experienced one or more late complications, compared with 8.6 % in the group who had prior radiotherapy and delayed breast reconstruction (DBR) with autologous tissue [11].

The timing of reconstruction and PMRT is most controversial in intermediate-stage breast cancer, where the need for PMRT is not known until after the mastectomy. As a result, the reconstructive surgeon must take into consideration the patient's personal preferences, expectations of the outcome, body habitus, and previous surgical scars before recommending the optimal method and timing of reconstruction. A possible solution for patients who are candidates for either expander/implant or autologous tissue reconstruction is the delayed–immediate technique of breast reconstruction proposed by M.D. Anderson Cancer Center [12]. This will be discussed in Sect. 41.6.

To help guide the complex decision-making process for breast cancer patients who are expected to require PMRT, we have proposed the reconstructive algorithm outlined in Fig. 41.1. The first major decision branching point depends on whether the patient desires prosthetic or autologous tissue reconstruction. The second major decision branching point depends on the importance of the timing of reconstruction to the patient's psychosocial recovery. In cases where the patient both desires and meets the requirements for expander/implant reconstruction, IBR using the Memorial Sloan-Kettering Cancer Center (MSKCC) protocol is our preferred method of reconstruction in the setting of expected PMRT. This will be explained in detail in Sect. 41.4. However, if the patient both desires and meets the requirements for autologous tissue reconstruction, then delaying reconstruction until PMRT has been completed is our recommended method of reconstruction. Finally, in patients whose primary priority is preservation of their skin envelope to optimize the cosmetic outcome, and in whom both the expander/implant and autologous tissue reconstruction are viable options, then the technique of delayed–immediate breast reconstruction would be an appropriate alternative.

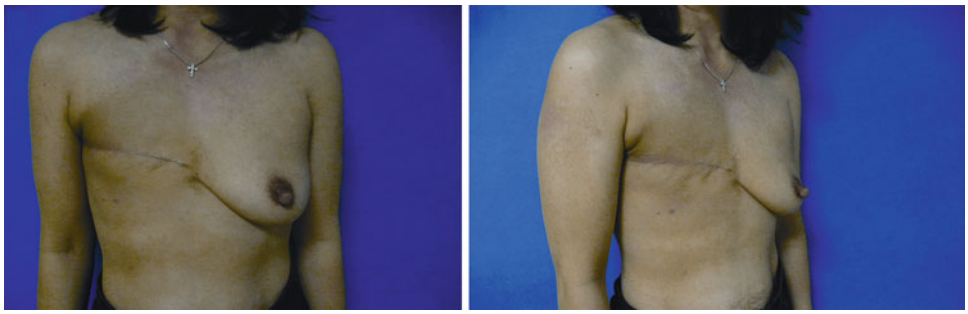

Fig. 41.2 Previous right mastectomy followed by radiotherapy

41.3 Complications Associated with PMRT

The aim of PMBR is to restore physical form and decrease the psychosocial distress associated with not having a breast. In the setting of PMRT, both prosthetic and autologous tissue reconstruction are associated with complications that can hinder these outcomes. Although some groups have found that patient satisfaction is high irrespective of complications [13], others suggest that postoperative complications contribute significantly to patient dissatisfaction following PMBR [14]. Patients contemplating PMBR in the setting of expected adjuvant radiotherapy need to be informed of the possible postradiotherapy complications associated with both types of reconstruction.

Delayed expander/implant reconstruction of a previously irradiated mastectomy defect is associated with a poor cosmetic outcome owing to contraction of the chest wall soft tissues and internal scarring (Fig. 41.2) [7]. These radiation-induced pathological processes can inhibit tissue expansion and prevent the formation of an aesthetic prosthetic breast mound with adequate ptosis [7]. As a result, some believe that immediate expander/implant breast reconstruction followed by PMRT is preferable over delayed reconstruction. Delivery of PMRT in the setting of IBR can occur either before or after exchange for a permanent implant. Regardless of the timing of delivery, PMRT has been shown to result in increased complication rates [15]. Possible complications include a poor aesthetic outcome due to dense scar formation, capsular contraction, and expander/implant extrusion (Fig. 41.3) [15]. Furthermore, in a recent study from the National Italian Cancer Center in Milan where complication rates were compared between a group of patients in whom PMRT was delivered to their permanent prosthesis ($n = 109$) and a group in whom PMRT was delivered to their tissue expanders ($n = 50$), it was found that the latter group had significantly higher rates of reconstructive failure (40 vs. 6.4 %) [10].

Similar to prosthetic reconstruction, exposure of an autologous tissue breast reconstruction to PMRT is also associated with complications that can compromise the final aesthetic outcome. These include fat necrosis, parenchymal fibrosis, tissue envelope retraction, and hypertrophic scarring of the reconstructed breast [16]. In a study that compared IBR followed by PMRT versus PMRT followed by DBR, it was found that parenchymal changes such as fat necrosis and fibrosis were significantly higher in the group that received IBR followed by PMRT [11, 16]. This group also had higher revision rates compared with patients who underwent delayed reconstruction to replace their radiation-damaged tissues [11, 16]. Therefore, in general, most authors prefer to perform delayed autologous reconstruction in the setting of expected PMRT (Fig. 41.4) [6, 17].

41.4 Prosthetic Breast Reconstruction in Patients Requiring PMRT

Prosthetic reconstruction is indicated in patients who are ineligible for autologous tissue breast reconstruction and may be preferred because it preserves tissue sensation, has a quicker postoperative recovery, and is not associated with a donor site defect. For those patients who exclusively desire prosthetic reconstruction and are known to require PMRT, the only viable solution may be to perform expander/implant reconstruction at the same time as the mastectomy. If the opportunity for IBR with an expander/implant is lost before PMRT occurs, then the option to reconstruct a delayed irradiated mastectomy defect will necessitate the use of autologous tissue.

Immediate prosthetic reconstruction in the setting of expected PMRT is feasible using the MSKCC protocol (Fig. 41.5). The MSKCC protocol is a staged approach that takes advantage of the time during adjuvant chemotherapy to fully inflate the tissue expander, and the time between the completion of adjuvant chemotherapy and start of

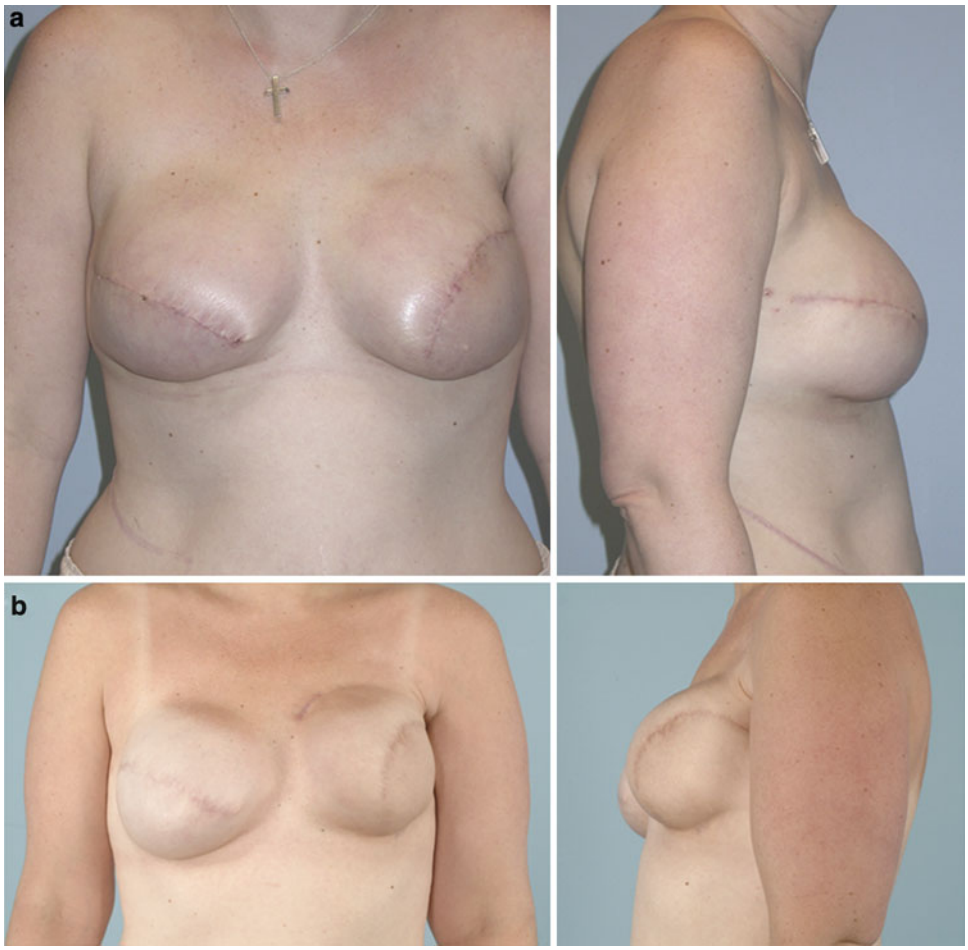

Fig. 41.3 Increased left breast capsular contracture formation following radiotherapy to the prosthetic breast mound. **a** Early postoperative result after completion of bilateral tissue expander/implant reconstruction. **b** One year after completion of radiotherapy of the left breast. Note the formation of a grade 3 capsular contracture at 1 year

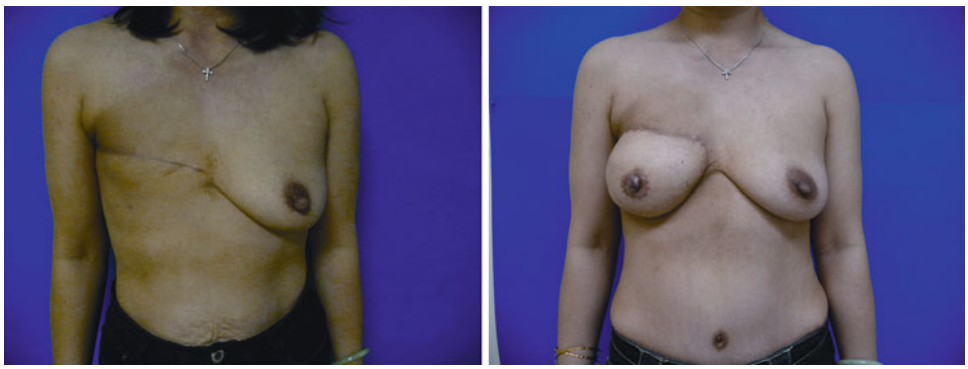

Fig. 41.4 Preoperative and postoperative results after delayed right breast reconstruction using a free deep inferior epigastric perforator flap to correct a previously irradiated mastectomy defect

radiotherapy to perform the permanent implant exchange. More specifically, at the time of the mastectomy and/or axillary lymph node dissection, a total submuscular tissue expander is placed. Approximately 2 weeks following placement, tissue expansion begins and continues during the 5 months of adjuvant chemotherapy [18]. Exchange of the tissue expander for a permanent implant occurs on average 4 weeks following the completion of chemotherapy [18]. Radiotherapy is started about 4 weeks after exchange, leaving time for the wound to heal [18]. Using this approach, McCormick et al. [18] demonstrated its oncologic safety with a 5-year locoregional control of 100 % and distant disease-free survival of 90 % in a series of 104 patients. In addition to increased survival, this approach resulted in good to excellent aesthetic results in 80 % of patients, and 72 % of patients stated that they would choose this treatment option again [19].

A new ancillary tool to prosthetic reconstruction is the use of acellular dermal matrix to provide inferolateral coverage of the expander/implant where the pectoralis major muscle is

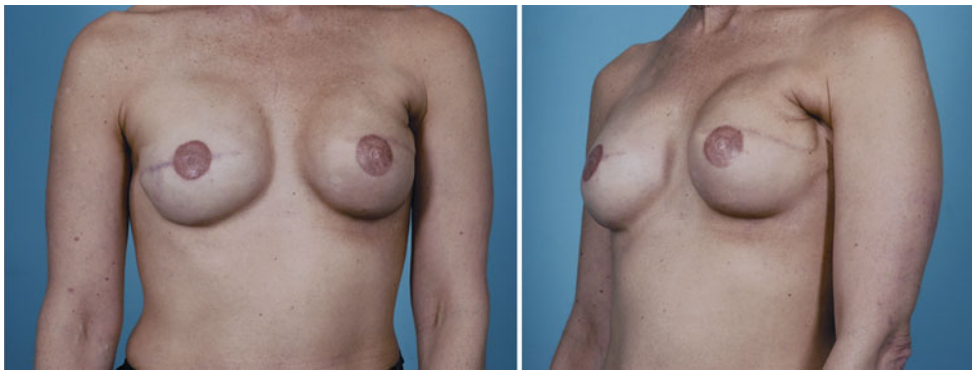

Fig. 41.5 Bilateral expander/implant reconstruction 2 years postoperatively with postexchange postmastectomy radiotherapy for the left breast (Memorial Sloan-Kettering Cancer Center algorithm). Note the grade 2 capsular contracture of the irradiated breast, with a still aesthetically pleasing result

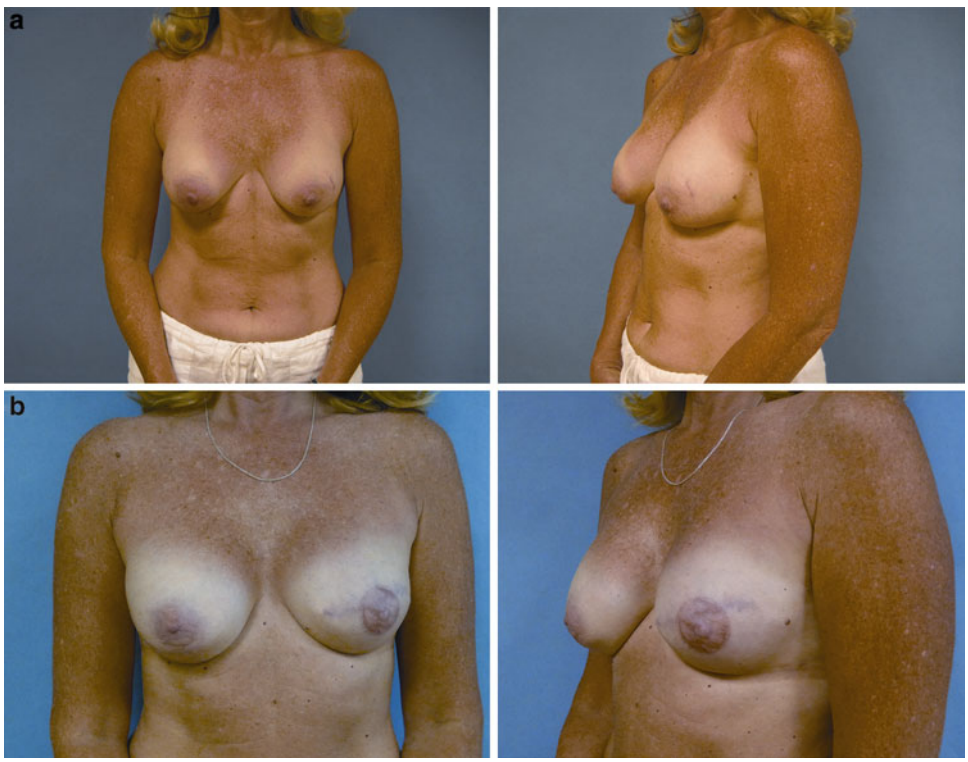

Fig. 41.6 Preoperative and postoperative results after left skin-sparing mastectomy and immediate one-stage acellular-dermal-matrix-assisted implant reconstruction. **a** Preoperative anterior and oblique views prior to skin-sparing mastectomy and reconstruction. **b** Postoperative photograph following left skin-sparing mastectomy and immediate one-stage acellular-dermal-matrix-assisted implant reconstruction and nipple/areolar reconstruction

deficient (Fig. 41.6) [20]. Purported advantages of acellular dermal matrix include the ability to bypass multiple tissue expansion processes by performing a one-stage implant reconstruction, improved postradiotherapy wound healing owing to its capacity to recellularize and revascularize tissue, decreased pain from eliminating the need to elevate the serratus anterior muscle, increased intraoperative tissue expansion volume, and improved aesthetics and ptosis [3, 20, 21]. However, the biological behavior of this dermal substitute in response to radiotherapy remains to be further elucidated [21]. Although several animal studies have shown that radiotherapy has no significant adverse effects on dermal matrix [22, 23], the small sample sizes and lack of long-term follow-up in current human studies preclude the formation of definitive conclusions [20, 24].

41.5 Autologous Tissue Breast Reconstruction in Patients Requiring PMRT

The effects of PMRT on IBR with autologous tissue remain controversial. From an oncologic perspective, it has been suggested that the effectiveness of delivery of radiotherapy to the chest wall may be impaired by the presence of an intervening autologous tissue breast mound [25]. From an

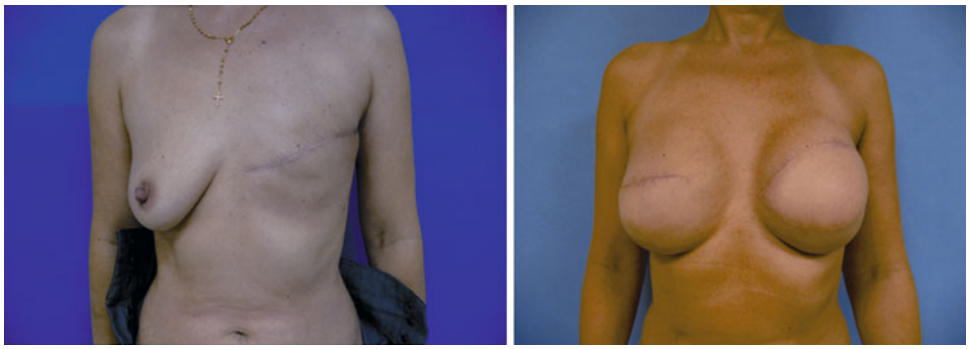

Fig. 41.7 Preoperative and postoperative photographs of patient who underwent delayed left breast reconstruction using a latissimus dorsi flap with an implant plus right mastectomy with immediate reconstruction using a tissue expander

aesthetic perspective, advantages of IBR over DBR include preservation of the inframammary fold and pliability of the native breast skin to allow a more natural appearance [17]. However, these advantages may be lost when the autologous tissue mound is subjected to PMRT owing to volume loss and tissue contraction [11]. To further confound this issue, there is conflicting evidence as to whether there is improvement in quality of life and more psychological benefit to the patient in the immediate versus the delayed reconstruction setting [13].

In the setting of expected PMRT, we prefer to perform delayed autologous tissue breast reconstruction to avoid the deleterious effects of radiation on the newly created breast mound (Fig. 41.4) [6, 17]. This is the safer option since delayed autologous reconstruction of a previously irradiated mastectomy defect generally has fewer long-term complications than irradiating an autologous mound created during IBR. The optimal time between the completion of PMRT and reconstruction is controversial; however, a minimum of 6 months is generally recommended for sufficient healing of the radiation-damaged tissue [26]. Planning for delayed reconstruction of an irradiated mastectomy defect requires an understanding of how soft tissues respond to radiotherapy and an estimate of the amount of skin that needs to be replaced. Our preferred choices of autologous tissue flaps to be used in delayed reconstruction include the pedicled or free transverse rectus abdominis myocutaneous flap, the muscle-sparing transverse rectus abdominis myocutaneous flap, and the free deep inferior epigastric perforator flap. Three technical pearls in the delayed reconstruction of an irradiated mastectomy defect include excision of the previous mastectomy scar, lengthening of the superior mastectomy flap using a relaxing "dart," and replacement of the entire lower mastectomy flap, which is generally scarred and noncompliant, with the healthy and pliable abdominal skin flap [3, 17]. With proper planning and execution, reconstruction of the breast mound with autologous tissue can result in excellent ptosis and shape, with the recreation of the inframammary fold.

In a patient who has either insufficient abdominal tissue or surgical scars that preclude the use of an abdominal skin flap, reconstruction using a latissimus dorsi myocutaneous flap in combination with an expander/implant is our second preferred method of DBR (Fig. 41.7). The adjunctive use of a latissimus dorsi flap can improve breast contour and offer protection against the adverse effects of radiation [27]. It is a well-vascularized flap that can be used to envelope the prosthesis to provide three unique advantages in an otherwise hostile irradiated milieu. First, the latissimus dorsi flap provides an extra layer of protection to lower the risk of implant extrusion; second, it likely contributes to better perfusion and healing of the overlying irradiated mastectomy skin; and lastly, it is thought to decrease the formation of capsular contracture around the prosthesis [27].

In our experience, the use of tissue from a donor site other than the abdomen, such as the transverse upper gracilis myocutaneous flap and the gluteal myocutaneous or perforator flap, is not ideal for reconstruction of a mastectomy defect. These flaps generally do not provide sufficient skin to replace the scarred inferior mastectomy skin of an irradiated breast mound to allow there to be a natural-appearing full lower pole in the reconstructed breast.

41.6 The Delayed–Immediate Technique of Breast Reconstruction

The reconstructive surgeon who provides a consultation to patients with invasive breast cancer must assume it is highly likely that the patient will require PMRT. However, the exact extent of disease and the subsequent need for PMRT can only be determined following the pathologic assessment of the permanent sections obtained during the mastectomy [6]. In a review at M.D. Anderson Cancer Center between 2002 and 2008, it was found that approximately 38 % of patients with stage 1 breast cancer required PMRT [12]. The percentage is on the rise across North America as the indications for PMRT continue to expand.

Although many centers advocate delayed reconstruction in patients who are expected to require PMRT, some argue that this practice effectively denies a select group of patients who do not in the end require PMRT both the aesthetic and the psychological benefits of IBR [6]. As a possible solution to this dilemma, M.D. Anderson Cancer Center has developed a delayed–immediate breast reconstruction approach for individuals with intermediate breast disease whose PMRT status cannot be fully determined preoperatively [12]. This group of patients has the following disease characteristics: a T2 tumor, invasive disease with widespread carcinoma in situ, multicentric disease, or one positive axillary lymph node [12].

Delayed–immediate breast reconstruction is a two-stage technique that aims to optimize both the aesthetic outcome and the delivery of radiotherapy in patients who are suitable for either autologous tissue or expander/implant reconstruction (Fig. 41.7) [12]. The first stage involves mastectomy and placement of a subpectoral tissue expander, thereby allowing the patient the benefit of a skin-sparing mastectomy for improved cosmetic outcome. The need for PMRT is then determined on the basis of final pathology results. In the event that PMRT is not indicated, the surgeon can proceed with the second stage: definitive breast reconstruction. Depending on the patient's preference, either an autologous tissue flap or a permanent implant with or without an accompanying latissimus dorsi flap can be used. Conversely, if PMRT is indicated after review of the final pathology findings, then CT planning of the radiation fields and delivery of PMRT should occur. The practice of tissue expander deflation immediately prior to CT is controversial. Deflation results in a flat chest wall to accommodate matching of the medial electron and lateral photon beam fields and optimize delivery of PMRT. Complete deflation may not be appropriate in some instances where the inferior edge of the expander can become prominent and interfere with delivery of radiation. The expander deflation process should therefore occur in consultation with a radiation oncologist. Approximately 2 weeks following PMRT, the tissue expander should be reinflated to the predeflation volume. The second definitive reconstructive stage generally occurs within 3 months from completion of PMRT and can involve either an autologous tissue flap or exchange for a permanent prosthesis [12].

Compared with the placement of a tissue expander after the completion of PMRT, the delayed–immediate approach allows the mastectomy and expander incision site to heal prior to radiotherapy to theoretically minimize the risk of expander extrusion. In both scenarios, proponents of this method advocate that the final aesthetic outcome parallels that of immediate reconstruction [12]. A critical review of this delayed–immediate approach by Kronowitz et al. [12] revealed a total complication rate of 14 % during the first stage one, 7 % during the second stage, and 17 % following PMRT and reconstruction. Overall tissue expander loss was 14 %.

41.7 The Effect of IBR on the Technical Delivery of Radiotherapy

The aim of PMRT is to deliver broad radiation coverage to the chest wall, treat the ipsilateral supraclavicular fossa and axillary apex (level III), avoid the heart, and minimize the amount of lung tissue within the therapy field [28]. Controversy exists regarding the inclusion of the ipsilateral internal mammary chain (IMC); however, randomized studies have demonstrated a survival advantage in patients who receive at least upper ipsilateral IMC radiotherapy [28]. Although the effects of PMRT on IBR have been outlined already in this chapter, the impact of IBR on the planning and technical delivery of PMRT requires additional consideration. Compared with natural breasts, reconstructed breasts tend to project more prominently on the chest wall rather draping to the side when the patient is supine [28]. The steep angulation between the breast mound and the central chest wall can impair the radiation coverage of the IMC region [28].

Despite the adverse effect that PMRT may have on the aesthetic outcome of an expander/implant reconstruction, IBR with an expander/implant is not thought to markedly impact the planning and delivery of PMRT from an oncologic perspective [29]. McCormick et al. [18] have demonstrated that reconstruction using the MSKCC algorithm does not compromise radiation delivery, evidenced by a 5-year locoregional control of 100 %. Unlike the MSKCC protocol, where the final prosthesis is irradiated, other institutions favor irradiation of the temporary tissue expander. Despite initial concerns that the presence of a metallic port in tissue expanders may scatter or even block the radiation beam, it has not been shown to significantly affect the radiation dose distribution [30].

On the other hand, autologous tissue reconstructions have been shown to negatively impact the delivery of radiotherapy [6]. Motwani et al. [25] demonstrated an alteration in radiotherapy planning in 52 % of patients who underwent autologous IBR compared with 7 % of patients who underwent mastectomy and radiotherapy without reconstruction. The steep medial and apical contours of the reconstructed breast mound and the increased distance from the chest wall to the skin surface does not allow the use of electrons in the primary radiotherapy plan because it causes excessive irradiation of the sternum and decreased irradiation of the middle of the breast mound and the IMC [25]. Tangential fields have been employed instead. However, this is at the expense of irradiating increased lung tissue and sometimes the heart [25]. Thus, PMRT in the setting of IBR using autologous tissue

challenges radiotherapy planning both in covering all regions at risk of residual disease and in protecting adjacent normal structures [25]. As a result, IBR using autologous tissue in patients undergoing mastectomy for locally advanced breast cancer should be discouraged at this time owing to the potential for impaired oncologic treatment.

41.8 Conclusion

When a breast cancer patient is confronted with the potential need for adjuvant radiotherapy following mastectomy, making a decision regarding the type and timing of breast reconstruction can be overwhelming. To help guide the complex decision-making process for patients who are also faced with time pressures, we have proposed a practical and comprehensive reconstructive algorithm as outlined in Fig. 41.1. Our first major decision branching point depends on the type of reconstruction that the patient desires: prosthetic or autologous tissue reconstruction. The second major decision branching point depends on the desired timing of reconstruction. For a patient who both desires and meets the requirements for expander/implant reconstruction, IBR using the MSKCC protocol is our preferred method of reconstruction in the setting of possible PMRT. On the other hand, if the patient's first choice is autologous tissue reconstruction, then delaying breast reconstruction until after PMRT has been completed is preferred. For a patient with early-stage or intermediate-stage disease whose top priority is to preserve the skin envelope to maximize aesthetic outcome, the technique of delayed–immediate breast reconstruction would be an appropriate alternative. We have found this treatment algorithm to be a tremendously useful guide to help patients select the most suitable method and timing of breast reconstruction in the setting of expected PMRT.

References

1. Overgaard M, Hansen PS, Overgaard J et al (1997) Postoperative radiotherapy in high-risk premenopausal women with breast cancer who receive adjuvant chemotherapy. Danish Breast Cancer Cooperative Group 82b Trial. N Engl J Med 337:949–955
2. Ragaz J, Jackson SM, Le N et al (1997) Adjuvant radiotherapy and chemotherapy in node-positive premenopausal women with breast cancer. N Engl J Med 337:956–962
3. Pomahac B, Recht A, May JW et al (2006) New trends in breast cancer management: is the era of immediate breast reconstruction changing? Ann Surg 244:282–288
4. Jagsi R, Pierce L (2009) Postmastectomy radiation therapy for patients with locally advanced breast cancer. Semin Radiat Oncol 19:236–243
5. Ragaz J, Olivotto IA, Spinelli JJ et al (2005) Locoregional radiation therapy in patients with high-risk breast cancer receiving adjuvant chemotherapy: 20-year results of the British Columbia randomized trial. J Natl Cancer Inst 97:116–126
6. Kronowitz SJ, Robb GL (2009) Radiation therapy and breast reconstruction: a critical review of the literature. Plast Reconstr Surg 124:395–408
7. Chevray PM (2008) Timing of breast reconstruction: immediate versus delayed. Cancer J 14:223–229
8. Krueger EA, Wilkins EG, Strawderman M et al (2001) Complications and patient satisfaction following expander/implant breast reconstruction with and without radiotherapy. Int J Radiat Oncol Biol Phys 49:713–721
9. McCarthy CM, Mehrara BJ, Riedel E et al (2008) Predicting complications following expander/implant breast reconstruction: an outcomes analysis based on preoperative clinical risk. Plast Reconstr Surg 121:1886–1892
10. Nava MB, Pennati AE, Lozza L et al (2011) Outcome of different timings of radiotherapy in implant-based breast reconstructions. Plast Reconstr Surg 128:353–359
11. Tran NV, Chang DW, Gupta A et al (2001) Comparison of immediate and delayed free TRAM flap breast reconstruction in patients receiving postmastectomy radiation therapy. Plast Reconstr Surg 108:78–82
12. Kronowitz SJ (2010) Delayed-immediate breast reconstruction: technical and timing considerations. Plast Reconstr Surg 125:463–474
13. Zhong T, McCarthy C, Min S et al (2012) Patient satisfaction and health-related quality of life following autologous tissue breast reconstruction: a prospective analysis of early postoperative outcomes. Cancer J 118(6):1701–1709
14. Andrades P, Fix RJ, Danilla S et al (2008) Ischemic complications in pedicle, free, and muscle sparing transverse rectus abdominis myocutaneous flaps for breast reconstruction. Ann Plast Surg 60:562–567
15. Berry T, Brooks S, Sydow N et al (2010) Complication rates of radiation on tissue expander and autologous tissue breast reconstruction. Ann Surg Oncol 17(Suppl 3):202–210
16. Albino FP, Koltz PF, Ling MN et al (2010) Irradiated autologous breast reconstructions: effects of patient factors and treatment variables. Plast Reconstr Surg 126:12–16
17. Serletti JM, Fosnot J, Nelson JA et al (2011) Breast reconstruction after breast cancer. Plast Reconstr Surg 127:124e–135e
18. McCormick B, Wright J, Cordiero P (2008) Breast reconstruction combined with radiation therapy: long-term risks and factors related to decision making. Cancer J 14:264–268
19. Cordeiro PG, Pusic AL, Disa JJ et al (2004) Irradiation after immediate tissue expander/implant breast reconstruction: outcomes, complications, aesthetic results, and satisfaction among 156 patients. Plast Reconstr Surg 113:877–881
20. Breuing KH, Colwell AS (2007) Inferolateral AlloDerm hammock for implant coverage in breast reconstruction. Ann Plast Surg 59:250–255
21. Nahabedian MY (2009) AlloDerm performance in the setting of prosthetic breast surgery, infection, and irradiation. Plast Reconstr Surg 124:1743–1753
22. Dubin MG, Feldman M, Ibrahim HZ et al (2000) Allograft dermal implant (AlloDerm) in a previously irradiated field. Laryngoscope 110:934–937
23. Ibrahim HZ, Kwiatkowski TJ, Montone KT et al (2000) Effects of external beam radiation on the allograft dermal implant. Otolaryngol Head Neck Surg 122:189–194
24. Chun YS, Verma K, Rosen H et al (2010) Implant-based breast reconstruction using acellular dermal matrix and the risk of postoperative complications. Plast Reconstr Surg 125:429–436
25. Motwani SB, Strom EA, Schechter NR et al (2006) The impact of immediate breast reconstruction on the technical delivery of postmastectomy radiotherapy. Int J Radiat Oncol Biol Phys 66:76–82

26. Momoh AO, Colakoglu S, de Blacam C et al (2012) Delayed autologous breast reconstruction after postmastectomy radiation therapy: is there an optimal time? Ann Plast Surg 69(1):14–18
27. Chang DW, Barnea Y, Robb GL (2008) Effects of an autologous flap combined with an implant for breast reconstruction: an evaluation of 1000 consecutive reconstructions of previously irradiated breasts. Plast Reconstr Surg 122:356–362
28. Schechter NR, Strom EA, Perkins GH et al (2005) Immediate breast reconstruction can impact postmastectomy irradiation. Am J Clin Oncol 28:485–494
29. Klein EE, Kuske RR (1993) Changes in photon dose distributions due to breast prostheses. Int J Radiat Oncol Biol Phys 25: 541–549
30. Moni J, Graves-Ditman M, Cederna P et al (2004) Dosimetry around metallic ports in tissue expanders in patients receiving postmastectomy radiation therapy: an ex vivo evaluation. Med Dosim 29:49–54

Immediate Breast Reconstruction in Previously Irradiated Patients

42

Cicero Urban, A. Gustavo Zucca-Matthes, Rene Vieira, and Mario Rietjens

42.1 Introduction

Radiotherapy is an essential step in breast-conserving therapy (BCT) [1]. Unfortunately, it is also a significant additional risk for any technique of reconstruction when there is a true local recurrence or a second tumor in the same breast, and the patient is eligible for mastectomy. After BCT, the use of implants is controversial because of the damaging effects of radiotherapy on soft tissues. A large risk of implant loss, high rates of wound complications, and capsular contracture when radiotherapy accompanies breast reconstruction have been reported in previous series. Today, the use of implants remains a relative contraindication when there has been previous breast irradiation.

Despite being related to a decrease in the mortality and local recurrence rates in breast cancer patients, chronic radiotherapy can cause endarteritis, which leads to a less vascularized bed. It is potentially damaging if further intervention is necessary because ischemia alters the local resistance to infection. Furthermore, the reduced lymphatic drainage, resulting from actinic lymphangitis, favors the accumulation of fluids. Finally, many patients develop a certain degree of breast fibrosis a few months after the end of radiotherapy, which impedes the expansion of the tissue with temporary or definitive expanders. Because of these factors, autologous flaps are generally indicated for previously irradiated breast cancer patients.

The purpose of this chapter is to establish an algorithm for breast reconstruction after recurrence of breast cancer in patients who have previously undergone BCT and radiotherapy.

42.2 Implants

A high percentage of capsular contractures and postoperative complications in reconstruction with implants when adjuvant radiotherapy is used have been reported. Owing to a more intensive inflammatory response, there are reports of pain, distortion, and capsular contracture in approximately 30 % of patients during long-term follow-up. There are also reports of implant displacement, implant exposure, poor aesthetic outcomes, and high rates of implant removal [2–13]. In a study done in Switzerland among 107 patients who underwent mastectomy with immediate breast reconstruction , followed for a minimum period of 2 years, 20.6 % developed capsular contracture. This rate was significantly higher for irradiated breasts (41.7 %) than for nonirradiated breasts (14.5 %) ($p = 0.01$). In another reported series of 77 patients who underwent two-stage tissue expander and implant reconstruction, 55 patients (71 %) received adjuvant radiotherapy. Eight patients with an ipsilateral recurrence had been previously irradiated at the time of the conservative treatment and the remaining ones were irradiated for the first time after placement of the expander. The complications appeared to be related to radiotherapy (14 % in the nonirradiated patients and 51 % in the irradiated ones; $p = 0.006$). Complications occurred in five of the eight previously irradiated patients (62.5 %) and in 23 of the 47 patients irradiated after reconstruction

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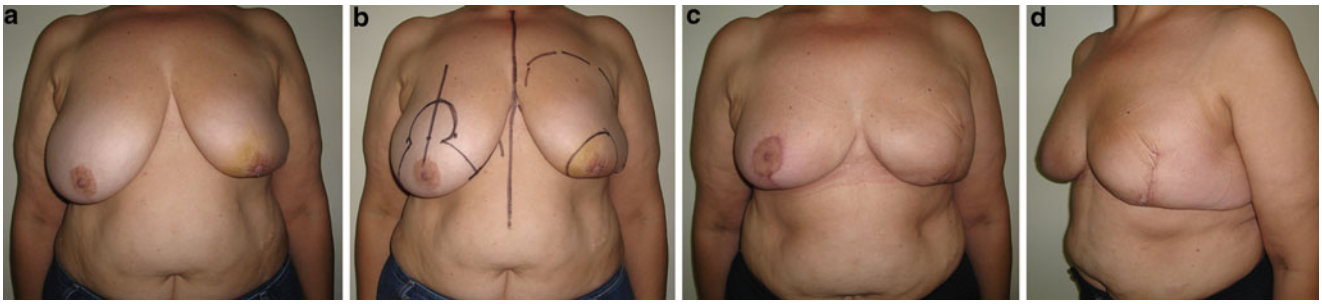

Fig. 42.1 Preoperative (**a**, **b**) and postoperative (**c**, **d**) views of a 62-year-old patient with a local recurrence after breast-conserving therapy 8 years earlier in the left breast. **c**, **d** Twelve months after one-stage breast reconstruction with an implant and contralateral breast reduction for symmetry

(49 %). All of the most serious complications (class 3) were found in patients who received radiotherapy. It was suggested by the authors that there is need for more studies regarding immediate breast reconstruction in previously irradiated patients in order to establish selection criteria before this option is undertaken [10].

For 15 years, Benacci [11] followed 57 patients who underwent salvage mastectomy for local breast cancer recurrence. Nine patients in this group underwent breast reconstruction with a tissue expander/implant, involving placement of ten prostheses. Of those three patients, six had significant complications, including inability to fully expand the tissue expander secondary to a tight overlying skin envelope in two of them (20 %), wound infection requiring implant removal in one patient (10 %), significant capsular contracture (Baker 3) in 20 % of the patients, and tissue expander extrusion in one patient. Four reconstructions required an unplanned surgical revision (expander replacement, implant exchange, and capsulectomy). In this select group of patients who underwent salvage mastectomy and afterwards two-stage surgery, 60 % of attempted reconstructions resulted in either a significant complication or unfavorable aesthetic outcomes.

More recently this paradigm—to not use implants when radiotherapy has been used or is planned—was challenged by reports of good to excellent results in breast reconstruction despite the previous use of radiotherapy or its application after reconstruction [5, 13]. However, as long as some authors describe favorable experiences of reconstruction after radiotherapy, others are still opposed to that procedure.

In a previous unpublished series from the Breast Unit of Hospital Nossa Senhora das Graças in Curitiba (Brazil), three cases were reported of one-stage breast reconstruction in patients who had previously undergone a quadrantectomy followed by radiotherapy and had local recurrence. All of them underwent skin-sparing mastectomy followed by one-stage immediate breast reconstruction with anatomic profile implants. After an average follow-up of 16 months, no evidence of capsular contracture was noticed, the aesthetic results were stable, and the patients did not have early or late complications. The authors suggest that the success in these patients could be due to the association of a selection of the patients with no breast fibrosis after radiotherapy and the use of anatomic implants smaller than the original size of the irradiated breast. Immediate breast reconstruction with implants in this well-selected group of patients needs to be tested in a large series in order to confirm these preliminary results [12] (Fig. 42.1).

42.3 Flaps

The description in 1977 of the latissimus dorsi (LD) musculocutaneous flap for breast reconstruction introduced another important option for autologous tissue reconstruction in patients after mastectomy [14]. Until the description of the transverse rectus abdominis muscle (TRAM) flap in 1982 [15], use of autologous tissue for reconstructions was closely linked with breast implants . The TRAM flap provided a relatively easy technique for acquiring ample tissue for shaping and skin coverage in most reconstructions. When a large amount of skin replacement is required, it is the preferred technique.

Complications in previously irradiated patients ranged from a mastectomy defect with minimal radiation changes to frank skin necrosis. Coverage is the primary purpose for the latter group, and the reconstructive operation becomes an aesthetic procedure in the former. For the reconstructive surgeon, there are two major areas of concern after radiotherapy:

1. The recipient bed
2. The flap's vascular pedicle

Breast reconstruction with a TRAM flap after radiotherapy is reasonable and should remain the first choice for most patients, although multivariable logistic regression analysis showed both obesity and prior radiotherapy to be associated with an increased risk of fat necrosis [16].

The bipedicled flap should be used when possible to allow there to be sufficient tissue for reconstruction after resection of the irradiated recipient site and provide improved blood supply to a vascular impoverished recipient

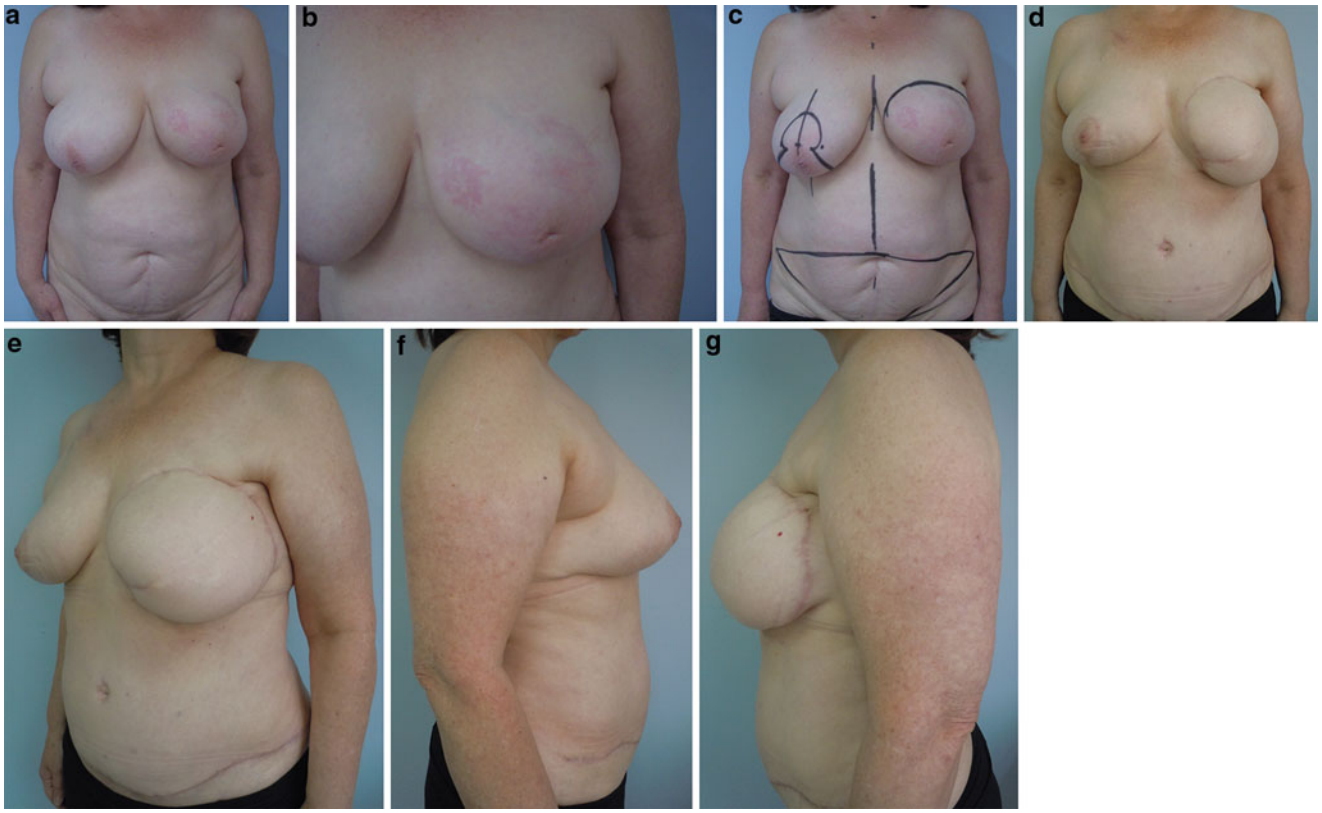

Fig. 42.2 Preoperative (**a**–**c**) and postoperative (**d**–**g**) views of a 59-year-old patient with an extensive local recurrence after breast-conserving therapy 4 years earlier in the left breast. **d**–**g** Twelve months after one-stage breast reconstruction with a bipedicled transverse rectus abdominis myocutaneous flap and contralateral breast reduction for symmetry

bed [16]. However, using a bipedicled flap in the irradiated patient does not prevent the occurrence of fat necrosis. The rate of fat necrosis suggests some compromised blood flow to the subcutaneous fat, possibly from partial obstruction of the internal mammary artery.

The largest review of irradiated patients undergoing TRAM flap reconstructions supports previous histologic studies that large vessel damage from radiation is rare and not prohibitive for using pedicles for flaps [16]. Moreover, Kroll et al. [17], using four independent observers, compared 82 patients with a history of previous chest-wall irradiation with 202 nonirradiated patients in order to determine whether prior irradiation was associated with more frequent complications. Both groups underwent LD and TRAM flap breast reconstruction. The complication rate in the irradiated group was 39 versus 25 % in the nonirradiated group ($p = 0.03$). In the irradiated group, complications were more frequent with the LD flap (63 %) than with the TRAM flap (33 %; $p = 0.063$), but this was not statistically significant.

Although only irradiated groups were evaluated, Schuster et al. [18] in a study with patient questionnaires found higher satisfaction rates with TRAM flap reconstructions than with LD flaps or implants in previously irradiated patients (Fig. 42.2).

42.4 Effects of Radiation on the Decision for Immediate Breast Reconstruction

Issues concerning breast reconstruction in patients who have had or may potentially require radiotherapy include:

- Effect of radiotherapy on soft tissues
- Timing of irradiation in the patient presenting with breast cancer
- Choice of a breast reconstruction option that will produce the optimal long-term cosmetic outcome.

The effects of radiation on wound healing are extensive and well known, although the specific causes remain a matter of speculation. Early response is characterized by dry or moist desquamation, dependent on the response of the host to the dose. The chronic phase is characterized by fibrosis, loss of elasticity, and in some circumstances a susceptibility to breakdown and ulceration [19].

An analysis of 277 consecutive LD breast reconstruction Breast reconstructions performed in 243 patients was published recently [20], with one-third of the reconstructions being immediate reconstructions. The mean age at reconstruction was 50.4 years. The mean follow-up was 47 months, and 3.6 % of patients developed Baker grade III

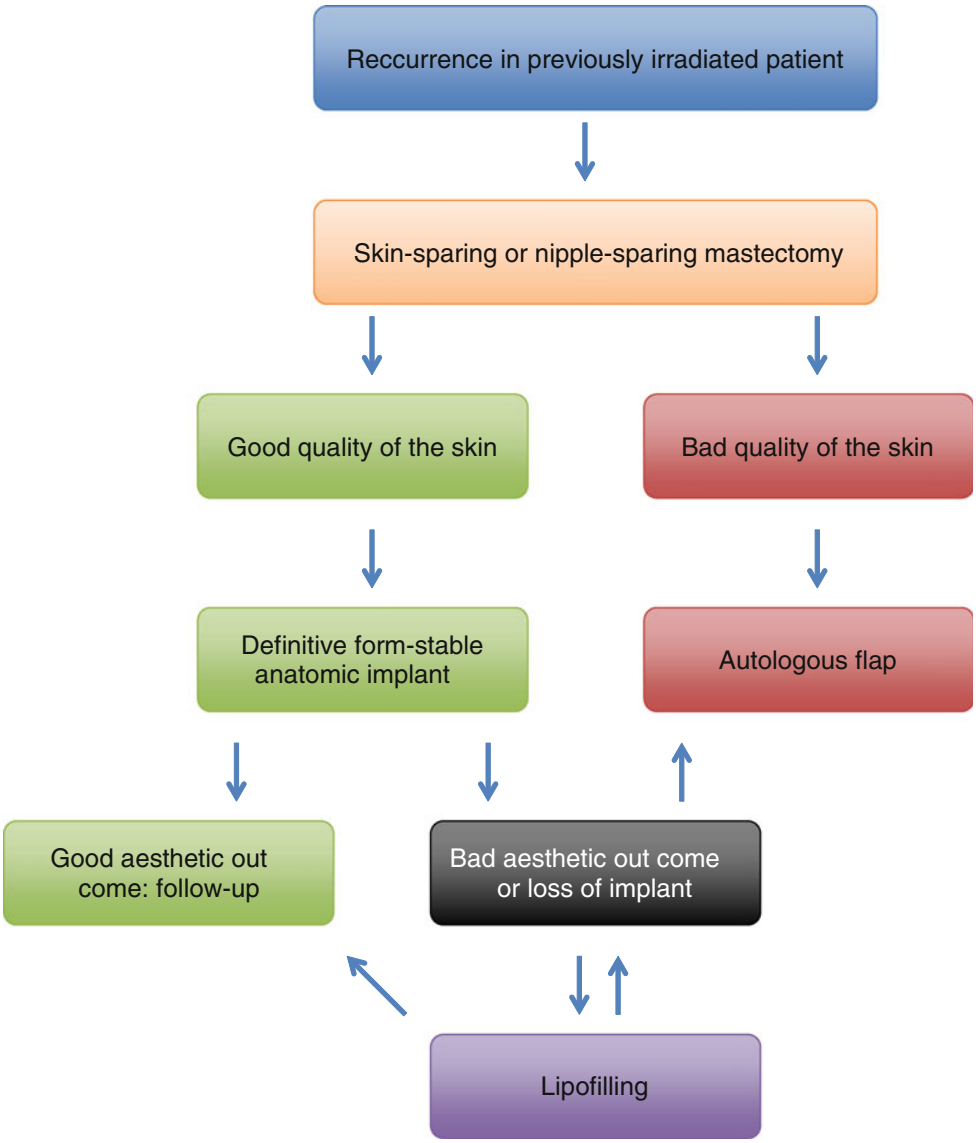

Fig. 42.3 Procedure flowchart for previously irradiated patients

capsular contracture requiring capsulotomy. Chemotherapy provided a protective effect ($p = 0.0197$) against capsular contracture formation. Previous radiotherapy had no significant influence on symptomatic capsule formation. Therefore, the conclusion was that use of textured, cohesive-gel silicone implants, combined with a standardized surgical approach, could reduce complications in the short-term and the long-term postoperative period, independent of radiotherapy.

On the other hand, Garusi et al. [21] evaluated the use of LD breast reconstruction after radiotherapy. They performed 63 LD flap with implant reconstructions between 2001 and 2007. All of them were performed in breast cancer recurrence cases after BCT and then total mastectomy. Baker grade III capsular contraction was observed in two cases (3.1 %). The rest were grade I or grade II and there were no grade IV contractures. They proposed that LD flap with implant reconstructions can be performed in irradiated breasts with a low capsular contracture rate.

The same European Institute of Oncology group [22] performed an interesting study addressing whether there is any difference in the evaluation of cosmesis according to the gender and specialization of the observer. Fifty-two photographs of patients who had undergone TRAM flap reconstruction for breast cancer were divided into three groups according to treatment (TRAM flap reconstruction alone, TRAM flap reconstruction and then radiotherapy, radiotherapy and then TRAM flap reconstruction), and were evaluated by 21 specialists, ten male and 11 female from different areas: radiotherapy, breast surgery, and plastic and reconstructive surgery. A significantly worse score was registered in the group who underwent TRAM flap reconstruction and then radiotherapy compared with the other groups.

In the last few years at the Department of Mastology and Breast Reconstruction of the Hospital de Cancer de Barretos, 45 autologous flap reconstructions were performed with or without radiotherapy. The LD flap was indicated in 29 cases, 10 % of them before radiotherapy, aiming to reshape large quandrantectomies. The comparison between the patients reconstructed before and after radiotherapy revealed unsatisfactory results in 66 % for the first group. TRAM flap reconstruction was performed in 16 patients. Poor results with flaps and implants occurred in 26.66 % of cases, the rate of capsular contracture being 52.2 % in irradiated patients versus 16 % in nonirradiated ones.

Regarding flap reconstruction, the quality of the skin at the recipient bed is important in the final decision and this must be explained to the patient. One suggestion is to avoid flap reconstruction before radiotherapy because of progressive loss of aesthetic results related to fibrosis. Complications after TRAM flap and LD flap reconstructions were more frequent in previously irradiated than in nonirradiated patients, probably because of radiation-induced damage to chest-wall skin. These differences are not enough to suggest that previous irradiation is a contraindication to breast reconstruction, but it is necessary to consider flap reconstruction as the first choice in most cases.

A recent meta-analysis selected 11 studies and a total of 1,105 patients and examined postoperative morbidity following immediate or delayed breast reconstruction combined with radiotherapy [23]. Use of autologous flaps resulted in less morbidity than implant-based reconstruction. Although the specific case of previous radiotherapy in BCT was not addressed, comparison of immediate versus delayed reconstruction with use of autologous flaps in irradiated patients after mastectomy did not produce statistically significant morbidity differences.

Cordeiro et al. [24], from Memorial Sloan-Kettering Cancer Center, in a timely article, retrospectively described their experience with immediate two-stage implant-based reconstruction in 121 patients who had previously undergone radiotherapy. They compared complications, aesthetic outcomes, and patient satisfaction with those for 1,578 patients who had undergone the same surgery but had not undergone radiotherapy. They reported a significantly higher incidence of postoperative early (29 vs. 15 %; $p \leq 0.001$) and late complications in the irradiated group and a poorer aesthetic outcome. The most frequent early complication in both groups was mastectomy flap necrosis (18 vs. 7.7 %; $p < 0.01$). However, they concluded that with careful selection of the patients, implant-based breast reconstruction is acceptable, with a slightly higher incidence of grade III and grade IV capsular contracture (10.6 vs. 6.3 %; $p = 0.2$), and despite a higher incidence of postoperative complications. Patient satisfaction did not differ between the two groups, and most of the irradiated patients had good or very good results, whereas most of the nonirradiated patients had excellent results ($p = 0.04$).

A decision flowchart used in the Breast Unit of Hospital Nossa Senhora das Graças for this group of previously irradiated patients is shown in Fig. 42.3.

42.5 Conclusions

Breast reconstruction in previously irradiated patients is a difficult challenge for the surgeon owing to the lack of specific data for the use of less aggressive techniques in these cases. Flaps remain the primary option, although for some very well selected patients, implants can achieve satisfactory results with low rates of short-term and long-term complications.

References

1. Early Breast Cancer Trialists' Collaborative Group (2005) Effects of radiotherapy and of differences in the extent of surgery for early breast cancer on local recurrence and 15-year survival: an overview of the randomized trials. Lancet 366:2087–2106
2. Thaylor CW, Horgan T, Dodwell D (2005) Oncological aspects of breast reconstruction. The Breast 14:118–130
3. Evans GR, Schusterman MA, Kroll SS et al (1995) Reconstruction and the radiated breast: is there a role for implants? Plast Reconstr Surg 96(5):1111–1115
4. Warren AG, Morris DJ, Houlihan MJ, Slavin SA (2008) Breast reconstruction in a changing breast cancer treatment paradigm. Plast Reconstr Surg 121:1116–1126
5. Perec I, Bucky LP (2008) Successful prosthetic breast reconstruction after radiation therapy. Ann Plastic Surg 60: 527–531
6. Pittet B, Montandon D, Pittet D (2005) Infection in breast implants. Lancet Infect Dis 5(2):94–106
7. Behranwala KA, Dua RS, Ross GM, Ward A, A'Hern R (2006) The influence of radiotherapy on capsule formation and aesthetic outcome after immediate breast reconstruction using biodimensional anatomical expander implants. J Plast Reconst Aesthetic Surg 59:1043–1051
8. Ascherman JA, Hanasono MM, Newman MI, Hughes DB (2006) Implant reconstruction in breast cancer patients treated with radiation therapy. Plast Reconst Surg 117:359–365
9. Benediktson K, Perbeck L (2006) Capsular contracture around saline-filled and textured subcutaneously-placed implants in irradiated and non-irradiated breast cancer patients: five years of monitoring of a prospective trial. Brit J Plast Surg 59:27–34
10. Tallet AV, Salem N, Moutardier V, Ananian P, Braud A, Zalta R, Cowen D, Houvenaeghel G (2003) Radiotherapy and immediate two-stage breast reconstruction with a tissue expander and implant: complications and esthetic results. Int J Radiation Oncol Biol Phys 57:136–142
11. Benacci JC (2002) Implant breast reconstruction in the irradiated cancer patient. Curr Surg 59:21–27
12. Urban CA, Blaszkowski DS, Lima e Silva J et al. One-stage breast reconstruction with implants in previously irradiated patients. Revista Brasileira de Mastologia (in press)

13. McCormick B, Wright J, Cordeiro P (2008) Breast reconstruction combinated with radiation therapy: long-term risks and factors related to decision making. Cancer J 14:264–268
14. Schneider WJ, Hill HL Jr, Brown RG (1977) Latissimus dorsi myocutaneous flap for breast reconstruction. Br J Plast Surg 30:277–281
15. Scheflan M, Hartrampf CR, Black PW (1982) Breast reconstruction with a transverse abdominal island flap. Plast Reconstr Surg 69:908–909
16. Williams JK, Bostwick J 3rd, Bried JT, Mackay G, Landry J, Benton J (1995) TRAM flap breast reconstruction after radiation treatment. Ann Surg 221:756–764; discussion 64–66
17. Kroll SS, Schusterman MA, Reece GP, Miller MJ, Smith B (1994) Breast reconstruction with myocutaneous flaps in previously irradiated patients. Plast Reconstr Surg 93:460–469; discussion 70–71
18. Schuster RH, Kuske RR, Young VL, Fineberg B (1992) Breast reconstruction in women treated with radiation therapy for breast cancer: cosmesis, complications, and tumor control. Plast Reconstr Surg 90:445–452; discussion 53–54
19. Schuster RH (1993) Breast reconstruction in women treated with radiation therapy for breast cancer. Plast Reconstr Surg 91:967
20. Hardwicke JT, Prinsloo DJ (2011) An analysis of 277 consecutive latissimus dorsi breast reconstructions: a focus on capsular contracture. Plast Reconstr Surg 128:63–70
21. Garusi C, Lohsiriwat V, Brenelli F et al (2011) The value of latissimus dorsi flap with implant reconstruction for total mastectomy after conservative breast cancer surgery recurrence. Breast 20:141–144
22. Leonardi MC, Garusi C, Santoro L et al (2010) Impact of medical discipline and observer gender on cosmetic outcome evaluation in breast reconstruction using transverse rectus abdominis myocutaneous (TRAM) flap and radiotherapy. J Plast Reconstr Aesthet Surg 63:2091–2097
23. Barry M, Kell MR (2011) Radiotherapy and breast reconstruction: a meta-analysis. Breast Cancer Res Treat 127:15–22
24. Cordeiro PG, Snell L, Heerdt A, McCarthy C (2012) Immediate tissue expander/implant breast reconstruction after salvage mastectomy for cancer recurrence following lumpectomy/irradiation. Plast Rec Surg 129:341–349

Breast Reconstruction After Aesthetic Surgery 43

Fabricio P. Brenelli

Breast cancer is the commonest type of cancer affecting women worldwide. It was estimated that more than 1.38 million new cases would occur in 2008, causing more than 450,000 deaths, according to the World Health Organization [1]. In November 2011, the Surveillance Epidemiology and End Results (SEER) Program of the US National Cancer Institute estimated that 230,480 women would be diagnosed with breast cancer and 39,520 women would die from the disease [2, 3].

On the other hand, breast aesthetic surgery is the most popular cosmetic intervention in the USA and probably in many other countries as well. Breast augmentation based on implant insertion heads the five commonest interventions among 318,123 procedures performed in 2010. Breast reduction is in fifth place, accounting for 138,152 procedures performed [4, 5].

Statistics suggest that one in eight women will be diagnosed with breast cancer at some time in their lives. Women who previously had breast aesthetic surgery will obviously be at risk of breast cancer. It has been estimated that 45,000 women receiving breast augmentation each year and a smaller number of women undergoing reduction mammoplasty will develop breast cancer in their lifetime.

Therefore, breast reconstruction after breast aesthetic surgery is at the forefront of discussion. It is a challenge for both the plastic and the oncoplastic breast surgeon. Nevertheless, little is known about this topic, and a good level of evidence is lacking in the literature. Knowledge has been mostly acquired from the author's experience rather than gained from prospective studies.

Breast augmentation and breast reduction procedures are categorized as aesthetic breast surgical procedures. However, these procedures are quite different in terms of breast tissue manipulation (skin and glandular parenchyma). Therefore, distinct implications for breast cancer and breast reconstructive surgery arise from both types of surgery and evaluation should be performed separately.

For this reason, this chapter has been divided into two parts: breast reconstruction after breast augmentation and breast reconstruction after reduction mammoplasty. Each technique will be evaluated and discussed separately.

43.1 Breast Reconstruction After Breast Augmentation

As previously discussed, breast augmentation is the most popular cosmetic surgery in the USA and probably in many other countries as well. The incidence of breast cancer in this population is the same as in women who did not have augmentation [6]. Breast implants are not associated with an increased risk of breast cancer. Although some studies in rodents associated the presence of foreign bodies with sarcomas, subsequent studies refuted this association. Indeed, many other studies confirmed the safety of implants regarding breast cancer. In the past, silicone-based implants were considered a risk factor for the development of breast cancer and were prohibited by US FDA regulations. The use of these implants was approved after many publications that showed theis safety in breast augmentation [7–10].

Many patients with breast cancer in previously augmented breasts will be seen at outpatient clinics. In a patient without any previous surgery, the decision as to surgical treatment should be made differently. Reconstruction can be tailored to the patient, dependent on the oncologic approach. If breast-conserving therapy is indicated, a partial reconstruction will be required. In contrast, if mastectomy is indicated, total breast reconstruction will be necessary.

43.1.1 Partial Breast Reconstruction

Breast-conserving therapy involves quadrantectomy associated with radiotherapy. Despite some publications with a

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small number of patients with good cosmetic results [11, 12], this procedure has been correlated with poor outcome in many series, resulting in pain, implant exposure, and even rupture in retained breast implants. However, Guenther et al. [13] reported that 85 % of patients undergoing quadrantectomy and radiotherapy after augmentation surgery had a good cosmetic outcome. The authors suggested that capsular contracture is less common when the implant is positioned in the submuscular space.

On the other hand, capsular contracture is a very frequent finding in this patient group according to many authors. More than half of patients required a second or third surgical correction or even mastectomy. These complications usually resulted from radiotherapy. Tumor size and location, in addition to scarce remaining glandular tissue, may have contributed to an unnatural result [6, 14–16]. Complications are shown in Figs. 43.1 and 43.2.

Breast-conserving therapy with implant removal is a less desirable option. Women having breast augmentation often have scarce breast tissue, which is actually why many undergo this procedure. In addition, the presence of an implant results in thinning of the stretched overlying breast tissue over time. One study reported that native breast tissue comprised 50 % of overall breast volume [17, 18]. Therefore, this is a suitable option only for a very small group of patients who have a considerable amount of remaining tissue. In these cases, mammoplasty techniques should be used as a T Wise pattern or vertical scar technique (Lejour's technique).

Patients who are candidates for partial breast irradiation, especially those who are candidates for intraoperative radiotherapy could benefit from lumpectomy and implant maintenance [19]. Despite the paucity of evidence, this could be a good option for resection alone and local glandular flap partial reconstruction (Fig. 43.3). Figure 43.4 shows a flowchart for decision-making regarding augmented breast surgery and oncologic surgery.

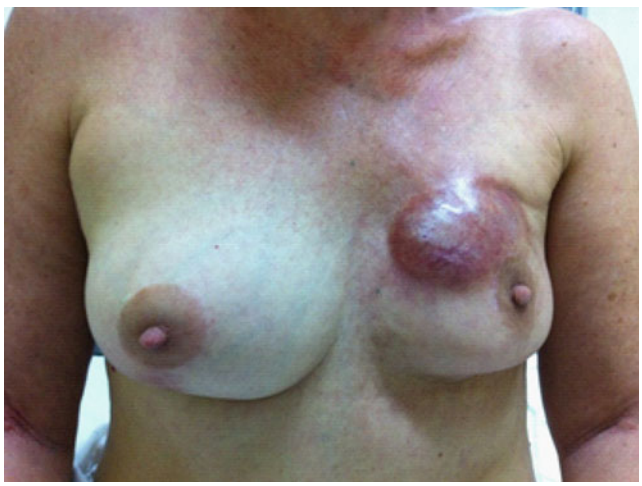

Fig. 43.1 Capsular contracture and skin alteration after an augmented breast treated with lumpectomy and radiotherapy

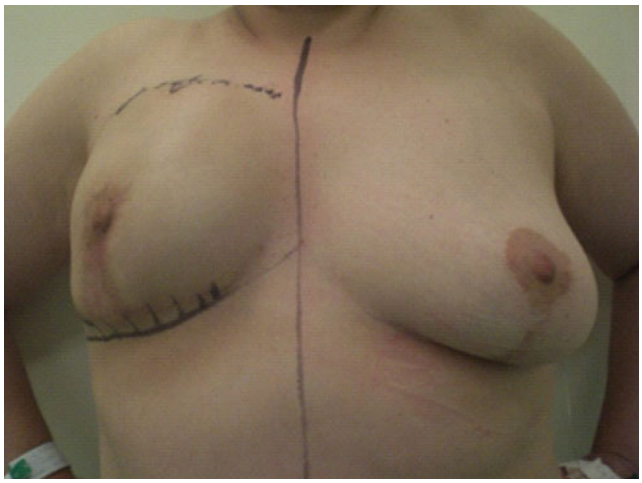

Fig. 43.2 Capsular contracture and asymmetry after mammoplasty with an implant and radiotherapy

43.1.2 Total Breast Reconstruction

As previously discussed, mastectomy and immediate reconstruction seems to be the best treatment for breast cancer patients with preexisting breast augmentation [20–22]. Decisions on the type of reconstruction should be made according to local conditions following mastectomy. If a large amount of skin needs to be removed, reconstruction with autologous tissue is more suitable, e.g., a transverse rectus abdominis myocutaneous flap or deep inferior epigastric perforator flap. A latissimus dorsi flap with an implant is also a good option for these cases. An extended latissimus dorsi flap without an implant would probably not be a good option, since patients usually hope for a reconstructed breast that is the same size as before. With use of this technique, it is difficult to achieve the desired result. The choice of technique can be challenging, because many patients with augmentation surgery are thin and the donor site can be insufficient.

In contrast, if native skin can be preserved, a skin-sparing mastectomy (SSM) or nipple-sparing mastectomy (NSM) is performed. Reconstruction can easily be performed with a single-stage implant (implant or definitive breast expander) or a two-stage implant (tissue expander plus implant exchange). When implant-based reconstruction is chosen, it is critically important to evaluate both the quality of the skin and muscles (pectoralis major muscle and serratus muscle). As shown in previous chapters, adequate implant reconstruction is performed with a good muscular pocket that partially or completely covers the implant. In a partially covered implant where the skin is compromised

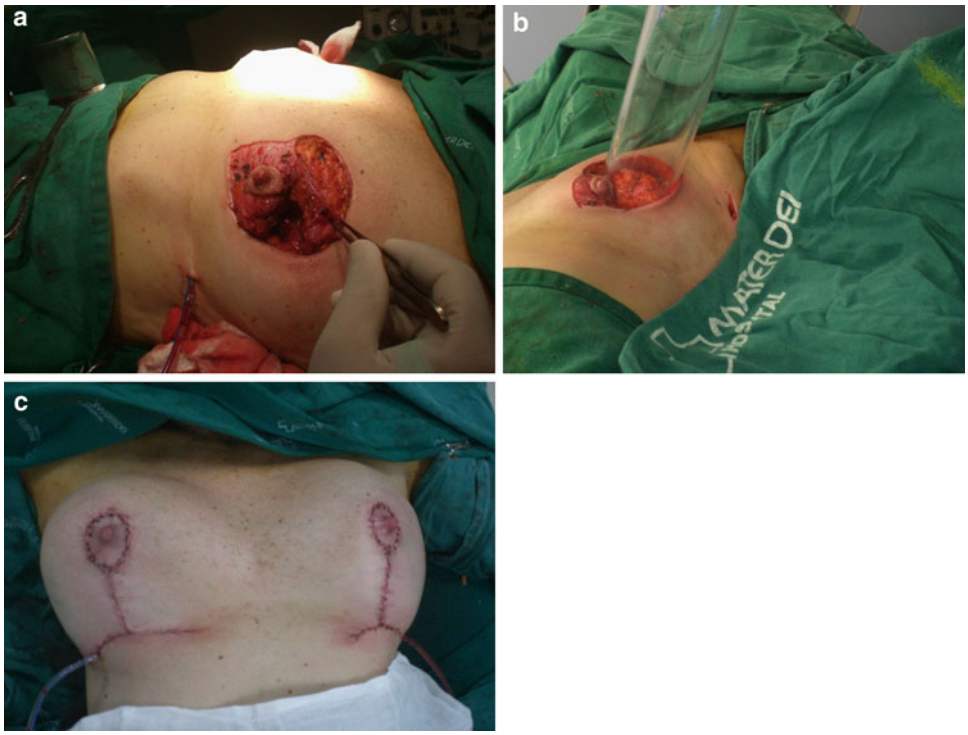

Fig. 43.3 **a** Lumpectomy after implant removal and inferior pedicle mammoplasty. **b** Intraoperative radiotherapy at the tumor bed **c** Final result after lumpectomy and implant reinsertion (new implant)

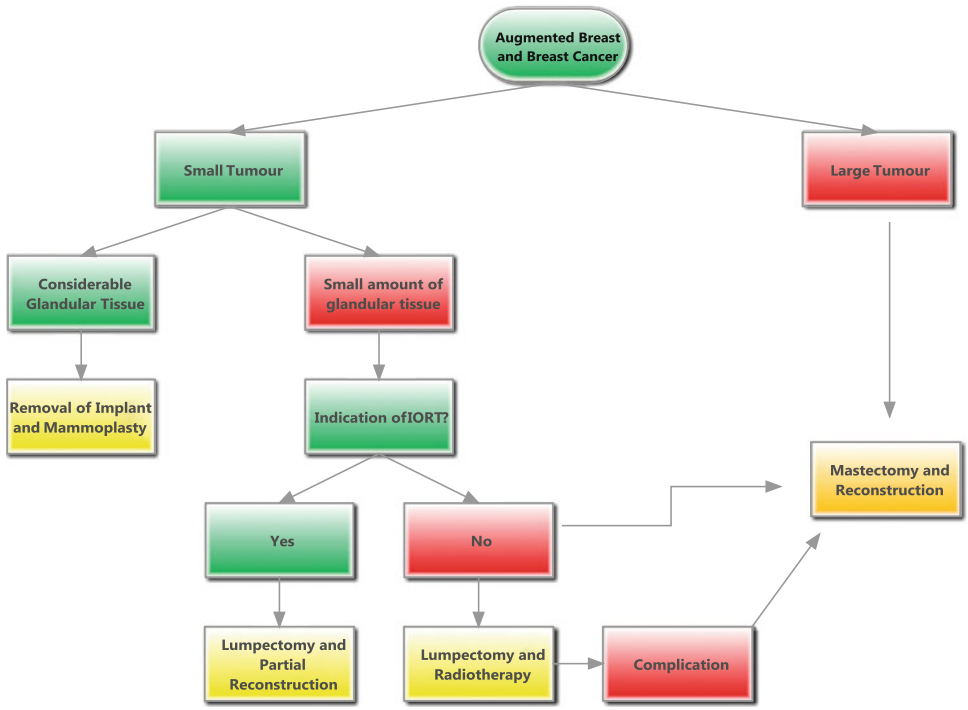

Fig. 43.4 Flowchart for the surgical decision for an augmented breast and lumpectomy. *IORT* intraoperative radiotherapy

(vascular suffering, infection, necrosis), the implant can be exposed and should be removed.

Definitive implant reconstruction is desirable in patients in whom a minimal amount of skin needs to be removed. The reason is that it is a faster technique with no donor site complications [23, 24]. In a previously augmented breast, skin coverage is rarely a problem and good cosmetic results can be achieved.

The need for adjuvant radiotherapy may play an important role in the decision for reconstruction. Although

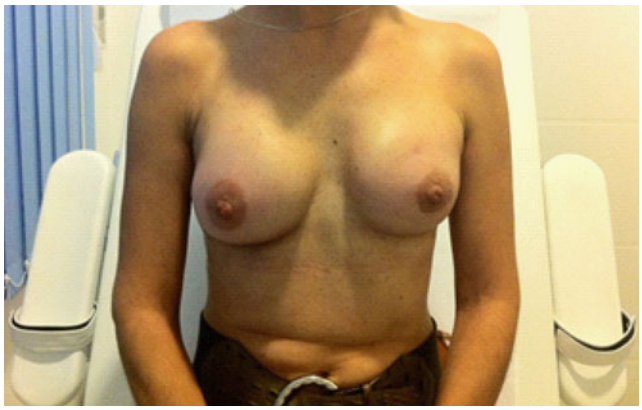

Fig. 43.5 Left breast capsular contracture after mastectomy and implant reconstruction in a breast-augmented patient followed by radiotherapy

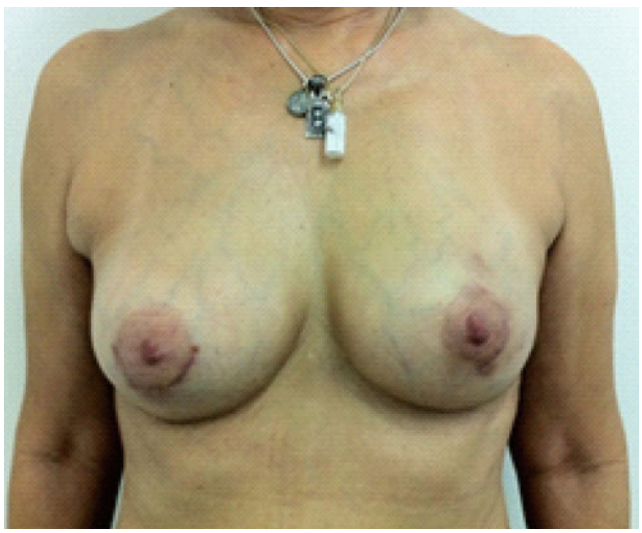

Fig. 43.6 Left breast implant-based reconstruction after left nipple-sparing mastectomy (NSM) in an augmented patient with radiotherapy

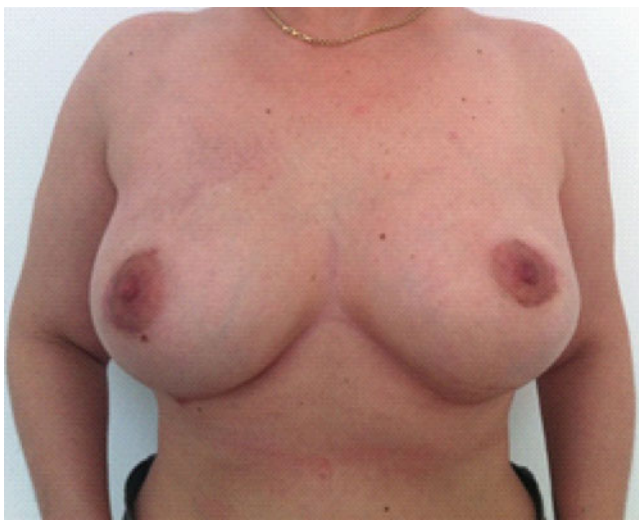

Fig. 43.7 Bilateral implant-based breast reconstruction after bilateral NSM in an augmented patient with no radiotherapy

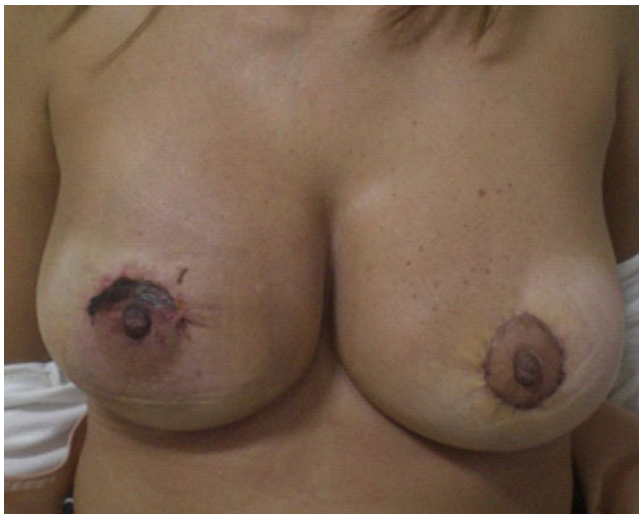

Fig. 43.8 Periareolar mastectomy and reconstruction in previously augmented patient with partial necrosis of the nipple–areola complex (NAC)

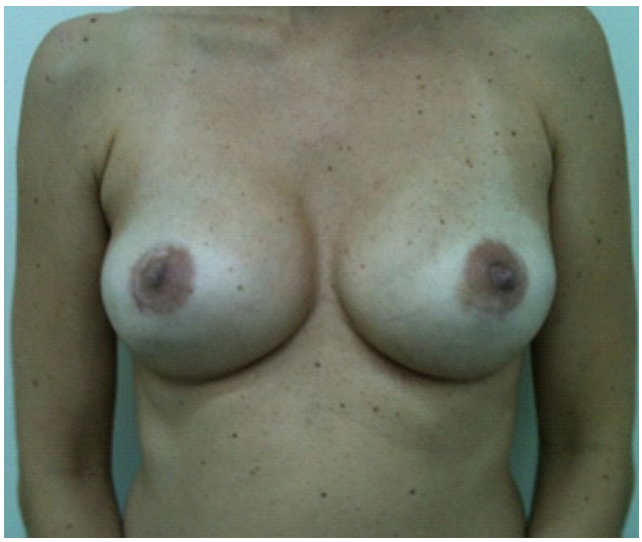

Fig. 43.9 Periareolar bilateral mastectomy and reconstruction in a previously augmented patient with no complications

some authors strongly contraindicate reconstruction because of a high complication rate (up to 70–90 %) [25], good results have been achieved by many other authors, showing patient satisfaction of up to 80 % [26]. Indeed, we recommend implant reconstruction whenever feasible, even in a scenario of adjuvant radiotherapy. If complication happens afurther autologous reconstruction can alwaysbe performed. Figures 43.5, 43.6 and 43.7 show the results of breast reconstruction with and without radiotherapy.

Tumor location and skin incision is of major importance to surgical outcome. Skin or nipple–areola complex (NAC) necrosis can translate into reconstruction failure if there is exposure of the implant. There is no study addressing the

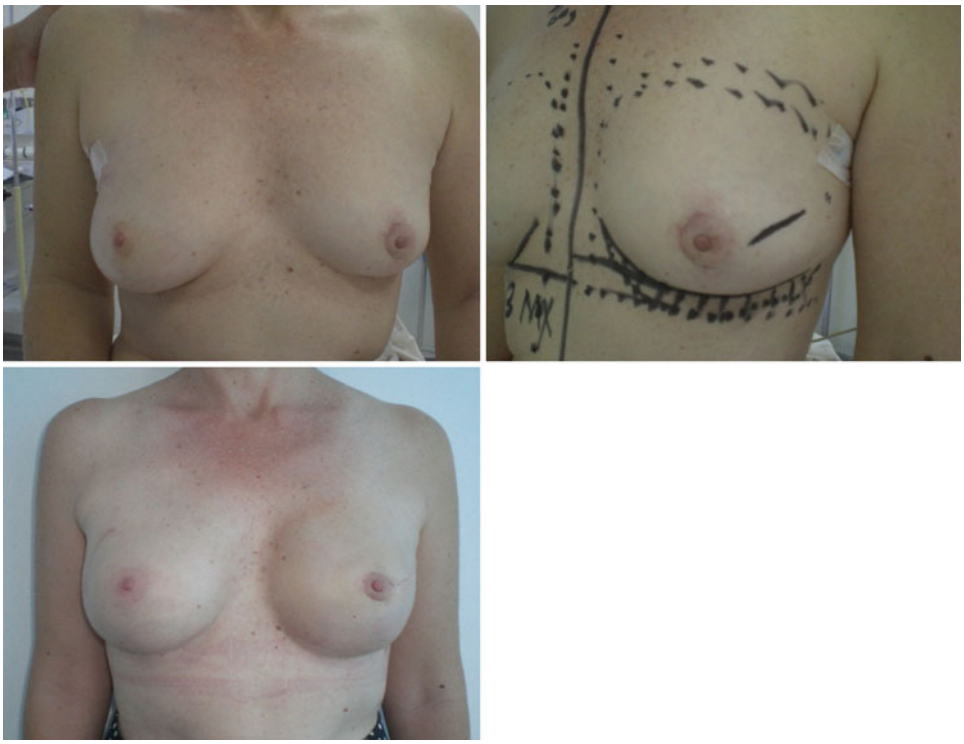

Fig. 43.10 Patient with periareolar breast augmentation and capsular contracture in the preoperative period, and postoperatively after left breast mastectomy and reconstruction using a radial scar and right breast implant exchange

use of a preexisting augmentation mammoplasty incision to perform mastectomy. When choosing an incision, the surgeon must consider the oncologic outcome and preexisting scarring which can translate into abnormality of the skin and NAC irrigation. Figures 43.8 and 43.9 show a periareolar approach in which a preexisting scar from breast augmentation is used.

Preexisting breast surgery is a well-known factor related to postoperative complications. Skin incisions for augmentation mammoplasty are periareolar (complete or partial) in the inframammary fold or in the axillary line when it is not associated with mastopexy (vertical or inverted-T pattern). SSM is performed with removal of the NAC, so the incision must be made in the central portion of the breast. However, when NSM is indicated, the incision can be made in any part of the breast (periareolar, inframammary fold, etc.). Therefore, the surgeon can attempt to use the preexisting scar to perform NSM.

To predict the surgical outcome relative to surgical access for mastectomy and reconstruction, an analogy was made between studies evaluating NSM incisions according to outcome. Wijayanayagam et al. [27] showed that a radial incision and an inframammary fold incision (in small breasts) are good options with a low risk of NAC or skin necrosis. Algaithy et al. [28] showed a low risk of necrosis with a superolateral radial incision and a high risk of complications with a circumareolar and periareolar incision. Figure 43.10 shows a radial approach to mastectomy and reconstruction in a patient with periareolar breast augmentation.

Therefore, a complete periareolar incision or a large circumareolar incision should be discouraged. Inframammary fold incisions should be performed in selected cases and only in patients with small breasts. A periareolar 180° incision can be performed, although the risk of wound dehiscence and skin necrosis is higher owing to direct skin traction during surgery. Table 43.1 shows the risk of skin and NAC necrosis according to the location of the incision and breast size.

Another issue that should be discussed is whether the implant should be exchanged during surgery or whether the old implant should be maintained. Many authors consider that implant exchange is mandatory when the implant is located in the subglandular space because it must be removed for adequate patient treatment. Other considerations that are clearly in favor of implant exchange are implant rupture, capsular contracture, infection, and poor cosmetic result [20, 21]. Few publications have advocated the possibility of maintaining a preexisting implant in the case of a new-generation implant located in the submuscular space [29]. Actually, this should be an exception rather than the rule, applied only to strictly selected cases.

Table 43.1 Risk of skin and nipple–areola complex necrosis according to the skin incision pattern in mastectomy and breast volume, based on published data [27, 28]

Incision	Large breast	Medium-sized/small breast
Complete periareolar	High risk	High risk
Periareolar 180°	Moderate risk	Moderate risk
Circumareolar	High risk	High risk
Radial	Low risk	Low risk
Inframammary fold	High risk	Low risk

Figure 43.11 shows a flowchart of decisions on augmented breast and total breast reconstruction.

43.2 Breast Reconstruction After Breast Reduction Mammoplasty

As previously discussed, breast reduction mammoplasty is the fifth commonest cosmetic intervention in the USA. A considerable number of patients undergoing this procedure will develop breast cancer at some time in their lives. The procedure per se reduces the risk of breast cancer. Some studies have shown up to 50 % reduction in breast cancer risk [30].

Considering the high prevalence of breast reduction surgery, a likely scenario encountered by the oncoplastic surgeon is breast cancer in a glandular parenchyma subject to many changes and skin scarring that may lead to vascular pattern abnormality. Despite the lack of specific studies concerning these abnormalities, it is a well-documented fact that previous mammoplasty is associated with minor and major postoperative complications, e.g., wound breakdown, fat and glandular necrosis, skin necrosis, and loss of the NAC [31, 32]. Although mammoplasty is a widely accepted procedure, it is associated with up to 42–50 % of complications in some series. Major complications include skin and NAC necrosis, leading to a reoperation rate ranging from 5 to 15 % [32].

Therefore, patients with preexisting mammoplasty and breast cancer undergoing large resections or mastectomy for cancer who require reconstructive surgery should be particularly and conscientiously evaluated. Counseling should be offered to these patients regarding the commonest postoperative complications.

43.2.1 Partial Breast Reconstruction

Partial breast reconstruction can be performed with local glandular remodeling or major remodeling, including dermal–glandular flaps with mammoplasty techniques. In the first situation, a low complication rate is found, unless large undermining has occurred and fatty tissue has more likely suffered necrosis (Fig. 43.12). Therefore, fatty breasts should be treated with minor undermining for the correction of defects, especially in patients with previous breast reduction.

If a large resection is required or the tumor is located in a quadrant where the aesthetic outcome can be unnatural, i.e., the internal or inferior quadrants, then a mammoplasty technique will be necessary. Studies with substantial evidence correlating preexisting mammoplasty with oncoplastic surgery are lacking. However, it is known that consecutive breast surgery may lead to an increased risk of complications. Therefore, we used data from studies evaluating risk factors for mammoplasty to estimate the risk of complications in partial breast reconstruction. Table 43.2 shows the risk factors for mammoplasty. In these patients, preexisting breast reduction per se raises the complication risk. Cumulative risk factors increase the rate of these complications.

When a mammoplasty or mastopexy technique is chosen to correct the breast defect, it is crucially important to know which technique was used previously. Despite the lack of evidence, we strongly discourage the use of patterns of mammoplasty in oncoplastic reconstruction different from those used in the previous surgical procedures, i.e., use of an inferior pedicle after a superior pedicle mammoplasty. Although the vascular autonomization phenomenon occurs, NAC vascularization may be compromised when a different pedicle pattern (inferior pedicle after a superior pedicle) is used. Necrosis is a proclaimed complication that affects aesthetic and oncologic outcome. Delayed healing can postpone adjuvant therapy. Figure 43.13 shows a satisfying result after mammoplasty and partial reconstruction with a new mammoplasty. Figure 43.14 shows a patient who underwent three mammoplasties for aesthetic reasons and a bad outcome with NAC necrosis after mammoplasty for cancer.

A good medical history and discussion with the patient are critically important for prediction of the outcome. A surgeon is obliged to choose the most suitable technique for oncoplastic surgery. If a high complication risk is expected

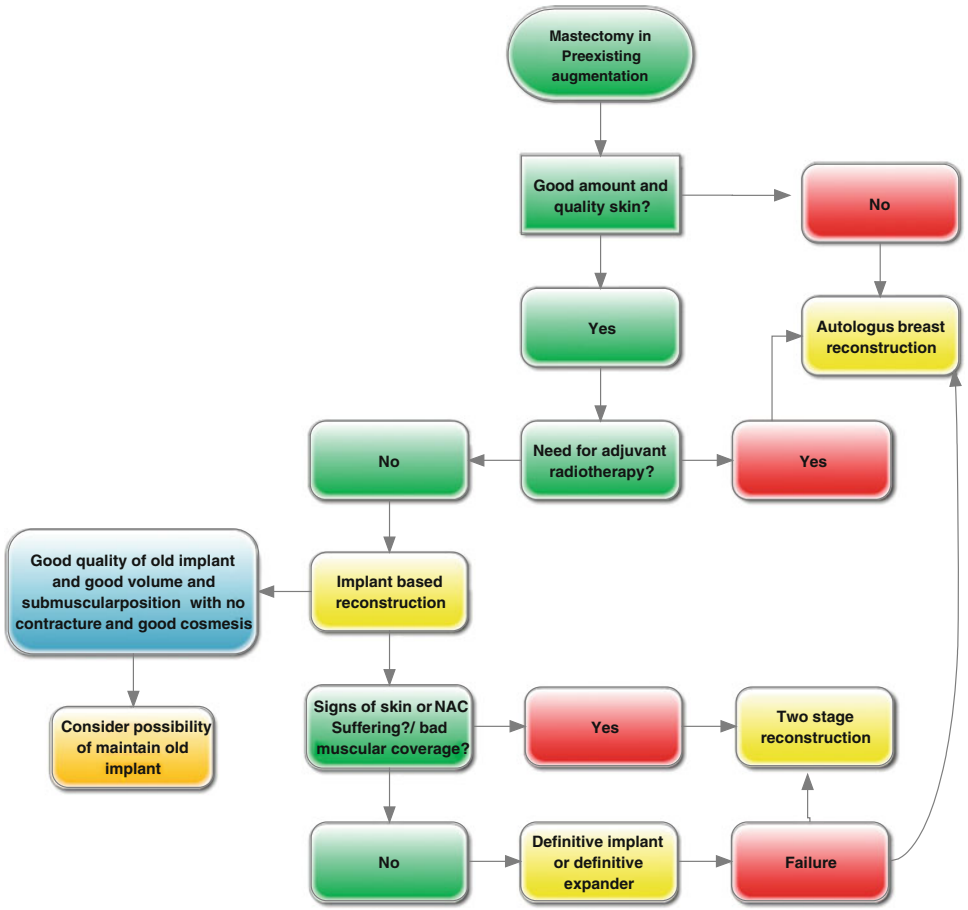

Fig. 43.11 Flowchart of indications for breast reconstruction after mastectomy in augmented patients

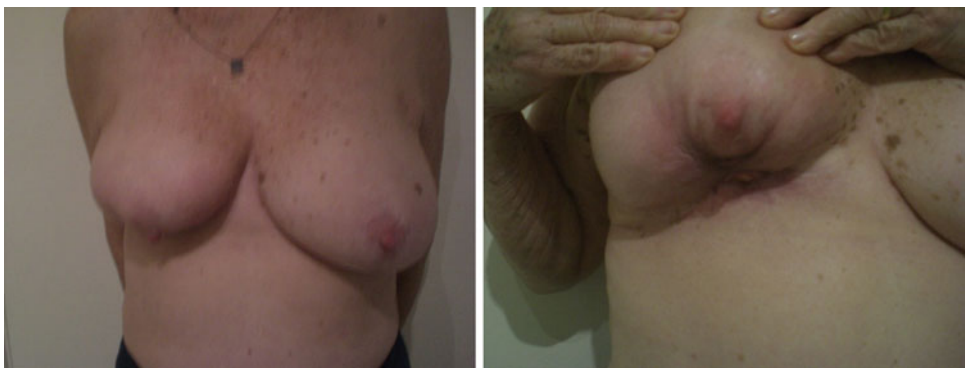

Fig. 43.12 Fat necrosis of the breast after extensive glandular undermining in oncoplastic partial reconstruction in a patient with previous mammoplasty and tumor in the inferolateral quadrant

Table 43.2 Risk factors for complications after mammoplasty

Risk factor	Risk of complication
Previous surgery	Medium/high
Heavy smoker	High
Obesity (BMI > 35)	High
Large resections (>1,000 g)	High
Diabetes (uncontrolled)	High
Age (>50years)	Low/medium

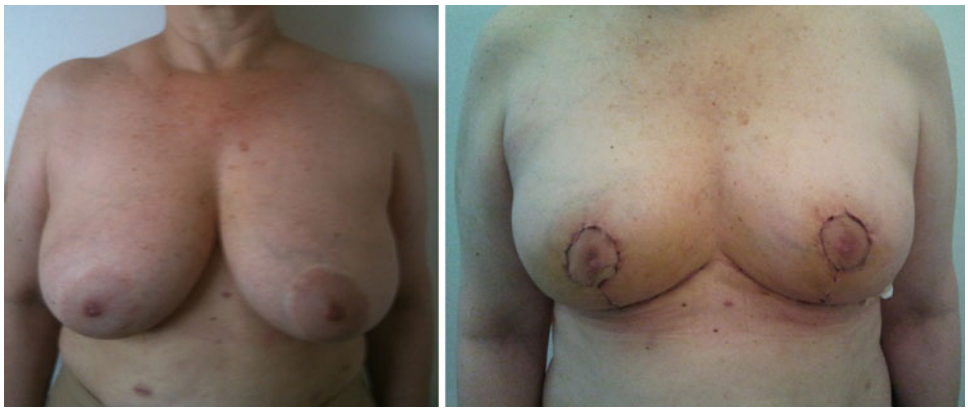

Fig. 43.13 Oncoplastic mammoplasty (superior pedicle breast reduction with excision of the tumor in the lower quadrant and SNB) in a patient with previous mammoplasty

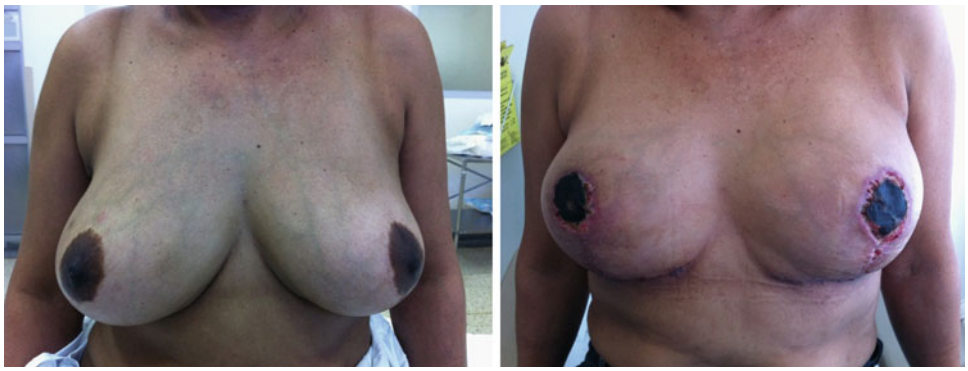

Fig. 43.14 Bilateral NAC necrosis after oncoplastic mammoplasty for a tumor located in the upper quadrant of the left breast. The patient had undergone three mammoplasties before this procedure

(Table 43.2) and the lesion is located in the quadrant where the NAC vascular pedicle was previously based, or if the previous technique is unknown, minor surgery should be performed or another technique should be used. A free NAC graft or even mastectomy with reconstruction should be considered in these cases. Figure 43.15 shows the decision steps in partial breast reconstruction after mammoplasty.

43.3 Total Breast Reconstruction

The principles of total breast reconstruction in patients with previous reduction mammoplasty are quite similar to those of total reconstruction after augmentation mammoplasty described in this chapter.

However, the choice of the mastectomy reconstruction technique should be based on particularities of previous reduction mammoplasty. As already discussed, previous scars can lead to a higher risk of complications, especially in NSM and reconstruction [23, 25, 28]. Therefore, NSM and SSM may pose a higher risk of post-operative complications for these patients owing to larger and multiple skin scars caused by reduction mammoplasty.

Despite the paucity of evidence, we recommend obtaining a very good medical history andconsider NSM or SSM in low-risk patients (Table 43.2). The incision must preferably be made in a preexisting scar, e.g., a periareolar scar, a periareolar scar extended to a vertical scar, or a horizontal scar in the inframammary fold. The risks of complications according to the scar position are listed in Table 43.1 and can be used for preoperative risk analysis.

The reconstruction technique will once again depend on the choice of the patient, the amount of viable skin available, and preservation of the pectoralis major muscle and anterior serratus muscle. In addition, adjuvant treatment can also influence the decision about the technique. If radiotherapy is indicated, delayed reconstruction or autologous reconstruction can be indicated instead of an implant-based reconstruction (definitive or temporary implants).

A good alternative for this patient group is skin-reducing mastectomy with anatomic implant reconstruction, initially described by Nava et al. [33]. Since many patients undergoing reduction mammoplasty still have large breasts after surgery with ptosis frequently recurring over time, this technique reduces excess skin and corrects ptosis.

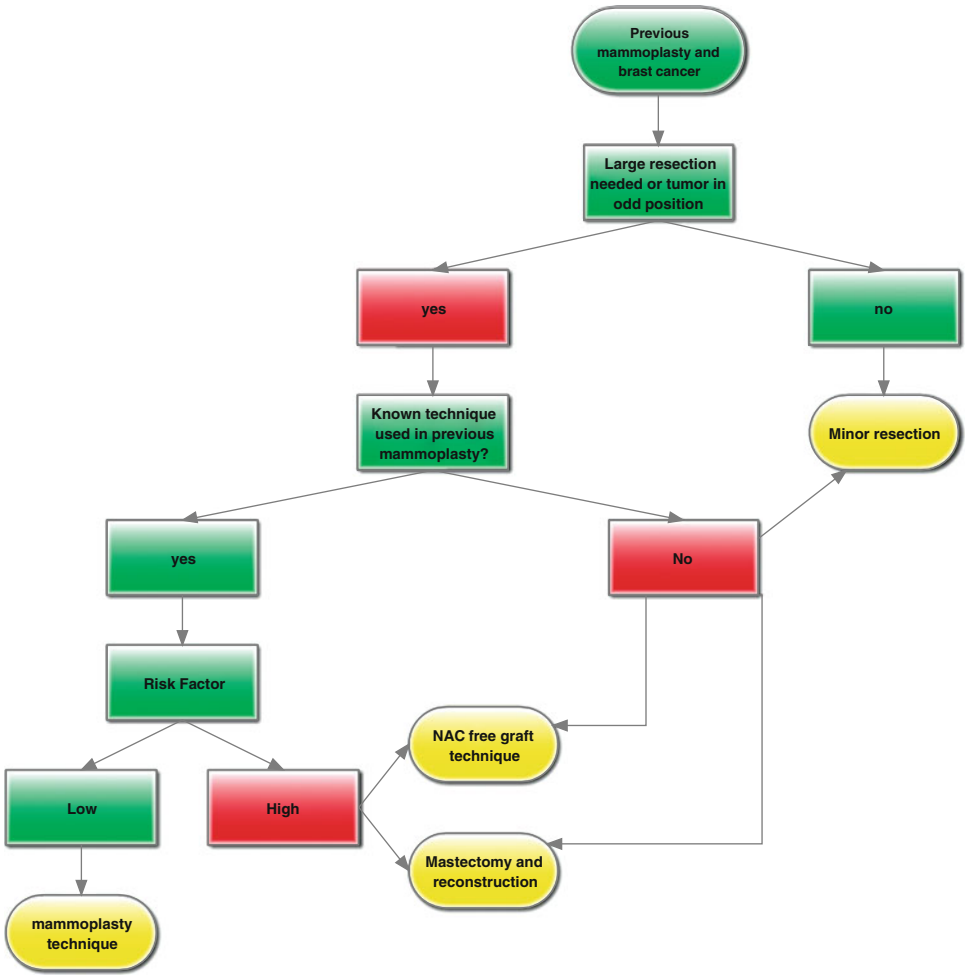

Fig. 43.15 Flowchart for the surgical decision about partial breast reconstruction in patients with previous mammoplasty

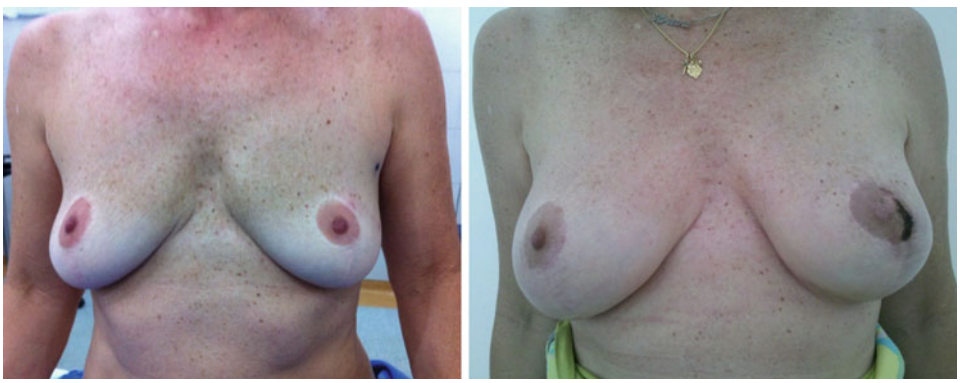

Fig. 43.16 Left NSM and reconstruction with an implant using a periareolar incision from a previous reduction mammoplasty. Note the partial areolar necrosis

Therefore, it is possible to use a definitive anatomic implant. With this technique, previous mammoplasty scar is removed since a Wise skin pattern resection is used. NAC's preservation in this group can be very risky due to necrosis. Discussion with the patient must be made before the procedure, and SSM maybe preferable.

Figures 43.16 and 43.17 show breast reconstruction with an implant after mammoplasty using a preexisting mammoplasty scar with and without a compromised areola. Figures 43.18 and 43.19 show a skin-reducing mastectomy after reduction mammoplasty with good results and one with postoperative complications.

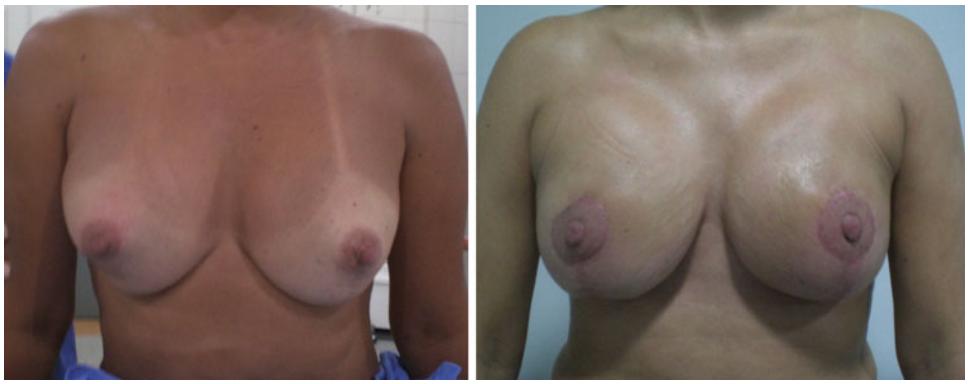

Fig. 43.17 Bilateral NSM and reconstruction using the preexisting reduction mammoplasty incision. The patient had a history of breast reduction and posterior implant insertion

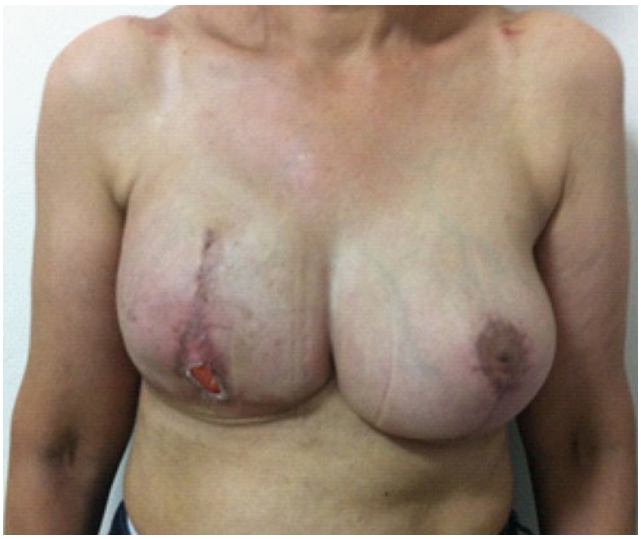

Fig. 43.19 Right skin-reducing mastectomy and implant reconstruction in patient with a previous mammoplasty with skin necrosis

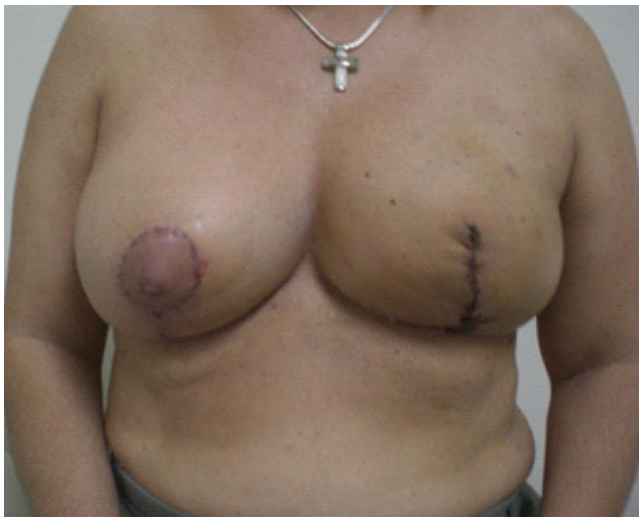

Fig. 43.18 Left skin-reducing mastectomy and implant reconstruction in a patient with a previous mammoplasty

43.4 Conclusion

Breast aesthetic surgery is the most popular plastic surgery performed in the USA and probably in many other countries as well. As the technique becomes easier and technology is used to spread knowledge, more skilled surgeons can offer this treatment to patients. With cost reduction, an increasing number of women will be able to afford the procedure.

Breast, plastic, and oncoplastic surgeons will increasingly evaluate patients with breast implants or breast reduction and cancer. As previously discussed, this type of patient is different from a regular patient and deserves closer attention. In addition to optimal oncologic control, these patients expect good cosmetic results from the oncologic and reconstructive surgical team. Surgeons and patients must discuss indications, outcome, and complications thoroughly.

Patients should gain informed knowledge about surgical options and how to cope with good and bad results.

References

1. GLOBOCAN 2008 (IARC) Section of cancer information (25/2/2012)
2. Howlader N, Noone AM, Krapcho M, Neyman N, Aminou R, Waldron W, Altekruse SF, Kosary CL, Ruhl J, Tatalovich Z, Cho H, Mariotto A, Eisner MP, Lewis DR, Chen HS, Feuer EJ, Cronin KA, Edwards BK (eds) SEER cancer statistics review, 1975–2008. National Cancer Institute, Bethesda
3. Bethesda, MD, http://seer.cancer.gov/csr/1975_2008/. Based on Novemb 2010 SEER data submission, posted to the SEER web site, 2011
4. American Society of Plastic Surgeons: 2006 Reconstructive surgery procedures. http://www.plasticsurgery.org. 28 Febr 2008
5. American Society for Aesthetic Plastic Surgery. http://www.surgery.org. 2010 Cosmetic surgery national statistics, 25 Febr 2012
6. Handel N (2007) The effect of silicone implants on the diagnosis, prognosis, and treatment of breast cancer. Plast Reconstr Surg 120(7 Suppl 1):81S–93S
7. Hoshaw SJ et al (2001) Breast implants and cancer: causation, delayed detection and survival. Plast Reconstr Surg 107:1393

8. Deapen MD et al (1986) The relationship between breast cancer and augmentation mammoplasty: an epidemiologic study. Plast Reconstr Surg 77:361
9. Deapen D et al (2000) Breast cancer stage at diagnosis and survival among patients with prior breast implant. Plast Reconstr Surg 105:535
10. Muzaffar AR, Rohrich RJ (2001) The silicone gel-filled breast implant controversy: an update. Plast Reconstr Surg 109:742
11. Bosworth JL, Chossein NA (1984) Limited surgery, radiotherapy in the treatment of localized breast cancer: an overview. Surg Clin N Am 64:1115–1123
12. Gray RJ, Forstner-Barthell AW, Pockaj BA, Schild SE, Halyard MY (2004) Breast-conserving therapy and sentinel lymph node biopsy are feasible in cancer patients with previous implant breast augmentation. Am J Surg 188:122–125
13. Guenther JM, Tokita KM (1994) Giuliano AE Breast-conserving surgery and radiation after augmentation mammoplasty. Cancer 73(10):2613–2618
14. Evans GR, Schusterman MA, Kroll SS et al (1995) Reconstruction and the radiated breast: is there a role for implants? Plast Reconstr Surg 96:1111–1115; discussion 1116–1118
15. Spear SL, Onyewu C (2000) Staged breast reconstruction with saline-filled implants in the irradiated breast: recent trends and therapeutic implications. Plast Reconstr Surg 105:930–942
16. Vandeweyer E, Deraemaecker R (2000) Radiation therapy after immediate breast reconstruction with implants. Plast Reconstr Surg 106:56–58; discussion 59–60
17. Karanas YL, Leong DS, Da Lio A et al (2003) Surgical treatment of breast cancer in previously augmented patients. Plast Reconstr Surg 111:1078–1083; discussion 1084–1086
18. Tang SSK, Gui GPH (2011) A review of the oncologic and surgical management of breast cancer in the augmented breast: diagnostic, surgical and surveillance challenges. Ann Surg Oncol 18:2173–2181
19. Rietjens M, De Lorenzi F, Veronesi P, Intra M, Venturino M, Gatti G, Petit JY (2006) Breast conservative treatment in association with implant augmentation and intraoperative radiotherapy. J Plast Reconstr Aesthet Surg 59(5):532–535
20. Spear SL, Slack C, Howard MA (2001) Postmastectomy reconstruction of the previously augmented breast: diagnosis, staging, methodology, and outcome. Plast Reconstr Surg 107:1167–1176
21. Carlson GW, Moore B, Thornton JF et al (2001) Breast cancer after augmentation mammoplasty: treatment by skin-sparing mastectomy and immediate reconstruction. Plast Reconstr Surg 107:687–692
22. Colwell AS, Damjanovic B, Zahedi B, Medford-Davis L, Hertl C, Austen WG Jr (2011) Retrospective review of 331 consecutive immediate single-stage implant reconstructions with acellular dermal matrix: indications, complications, trends, and costs. Plast Reconstr Surg 128(6):1170–1178
23. Petit JY, Veronesi U, Orecchia R, Rey P, Martella S, Didier F, Viale G, Veronesi P, Luini A, Galimberti V, Bedolis R, Rietjens M, Garusi C, De Lorenzi F, Bosco R, Manconi A, Ivaldi GB, Youssef O (2009) Nipple sparing mastectomy with nipple areola intraoperative radiotherapy: one thousand and one cases of a five-year experience at the European Institute of Oncology of Milan (EIO). Breast Cancer Res Treat 117(2):333–338
24. Garcia-Etienne CA, Cody Iii HS 3rd, Disa JJ, Cordeiro P, Sacchini V (2009) Nipple-sparing mastectomy: initial experience at the Memorial Sloan-Kettering Cancer Center and a comprehensive review of literature. Breast J 15(4):440–449
25. Pomahac B, Recht A, May JW, Hergrueter CA, Slavin SA (2006) New trends in breast cancer management: is the era of immediate breast reconstruction changing? Ann Surg 244(2):282–288. Erratum in: Ann Surg 245(3):table of contents
26. Cordeiro PG (2008) Breast reconstruction after surgery for breast cancer. N Engl J Med 359(15):1590–1601
27. Wijayanayagam A, Kumar AS, Foster RD, Esserman LJ (2008) Optimizing the total skin-sparing mastectomy. Arch Surg 143(1):38–45
28. Algaithy ZK, Petit JY, Lohsiriwat V, Maisonneuve P, Rey PC, Baros N, Lai H, Mulas P, Barbalho DM, Veronesi P, Rietjens M (2012) Nipple sparing mastectomy: can we predict the factors predisposing to necrosis? Eur J Surg Oncol 38(2):125–129
29. Robbins CM, Long JN, Fix RJ, de la Torre JI, Vasconez LO (2008) Mastectomy with breast reconstruction in previously augmented patients: indications for implant removal. Ann Plast Surg 61(5):500–505
30. Muir TM, Tresham J, Fritschi L, Wylie E (2010) Screening for breast cancer post reduction mammoplasty. Clin Radiol 65(3):198–205
31. Shermak MA, Chang D, Buretta K, Mithani S, Mallalieu J, Manahan M (2011) Increasing age impairs outcomes in breast reduction surgery. Plast Reconstr Surg 128(6):1182–1187
32. Henry SL, Crawford JL, Puckett CL (2009) Risk factors and complications in reduction mammaplasty: novel associations and preoperative assessment. Plast Reconstr Surg 124(4):1040–1046
33. Nava MB, Cortinovis U, Ottolenghi J, Riggio E, Pennati A, Catanuto G, Greco M, Rovere GQ (2006) Skin-reducing mastectomy. Plast Reconstr Surg 118(3):603–610; discussion 611–613

Thoracic Wall Reconstruction in Local Recurrences and Advanced Cases

44

Lorenzo Spaggiari, Francesco Petrella, and Piergiorgio Solli

44.1 Introduction

The incidence of local recurrences after mastectomy and breast-conserving therapy ranges between 5 and 40 % depending on risk factors and primary therapy [1]. No standard therapy for local recurrences has been defined, and the current recommendation is to excise the visible tumor with subsequent radiotherapy, although in many cases irradiation or chemotherapy is the primary or only therapy [2].

Local recurrences are often misjudged as the first indication of a systemic dissemination of the disease and a curative approach is therefore abandoned [3]. Although some patients with chest wall recurrence have evidence of metastatic growth, reports have demonstrated long-term survival [2]; moreover, these patients often have disabling symptoms such as pain, bleeding, ulceration, malodorous secretion, and infection [4]. Although palliation rather than prolongation of survival is usually the main aim of chest wall resection, whether complete resection of local recurrence offers a palliative or curative approach or major prolongation of survival continues to be unclear [2, 4].

Most locoregional recurrences occur as isolated chest wall disease, and only a small proportion occur with concurrent systemic disease or following distant metastasis [5–7]. Chest wall recurrence is commoner in patients who had a mastectomy as the initial treatment for breast cancer. In this situation, locoregional recurrences are likely to penetrate the chest wall, growing around ribs and the sternum because of the previous loss of tissue. Considering that some tumors show a limited tendency for lymphatic or hematogenous spread, they may extend locally prior to becoming metastatic [5]. We argue that although the primary goal of chest wall resection is to achieve local control of the tumor, potentially leading to long-term palliation, another result may be cure in a small subset of patients with isolated chest wall recurrence of breast cancer [8, 9].

44.2 Oncologic Aspects

The overall 5-year survival after a full-thickness chest wall resection for breast cancer recurrence ranges from 18 to 45 % in older series [10–13] and recently it has been reported to be up to 71 % [14]. It has been demonstrated that patients in whom chest wall recurrence develops are a heterogeneous population [14]; hence, differences in outcome could be explained by failure to identify prognostic factors that accurately predict the breast pathological subtype, treatment response, and ultimately survival. Recently, Santillan et al. [5] demonstrated that the strongest and most independent predictor of survival is the triple-negative phenotype—estrogen receptor negative, progesterone receptor negative, human epidermal growth factor receptor 2 (HER2)/neu expression negative—in the recurrent breast tumor (Table 44.1).

In a correctly selected group of patients undergoing chest wall resection after local recurrence of breast cancer, the primary goal is to regain local control regardless of the extent of disease. Some of these patients, in fact, will present with painful, infected, ulcerated, or fungating lesions that cause a great distress to the patients [5]. Treatment with radiotherapy, systemic therapy, and surgery, alone or in combination, can help to achieve local control [15, 16].

The reported overall operative mortality rate after chest wall resection for breast cancer recurrence is fairly low, ranging from 0 % in most of the recent series [3–5] up to 2.0 % [17]; however, a higher mortality rate, ranging form 3.5 to 4.5 %, has been reported [9], and a 30-day mortality rate of 7 % has occasionally been reported [18]. In contrast, the postoperative complication rate is not negligible. Minor

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Table 44.1 Literature review

Authors	Years	Number of patients	Five-year survival (%)	Country
Miyauchi et al. [12]	1992	23	48	Japan
Dahlstrøm et al. [20]	1993	98	56	Denmark
Mora et al. [21]	1996	69	72	USA
Faneyte et al. [8]	1997	44	45	Netherlands
Downey et al. [3]	2000	38	18	USA
Henderson et al. [22]	2001	61	24	Australia
Moran et al. [23]	2002	53	55	USA
Friedel et al. [17]	2005	51	41	Germany
Veronesi et al. [4]	2007	15	19	Italy
Friedel et al. [2]	2008	63	46	Germany
Santillan et al. [5]	2008	28	18	USA

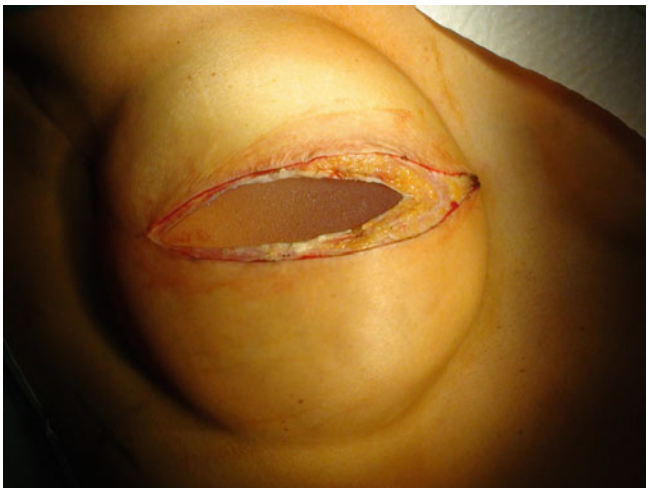

Fig. 44.1 The previously implanted breast prosthesis is removed

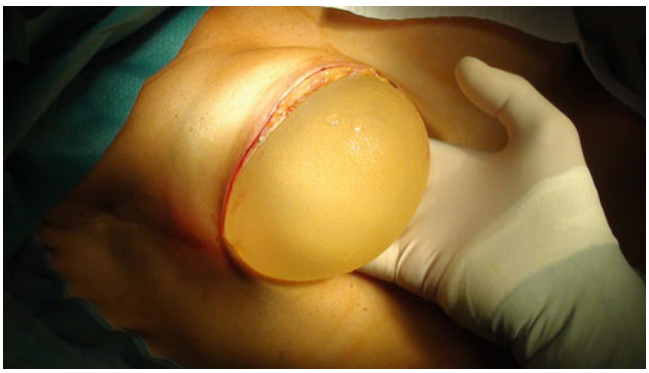

Fig. 44.2 The previously implanted breast prosthesis is removed

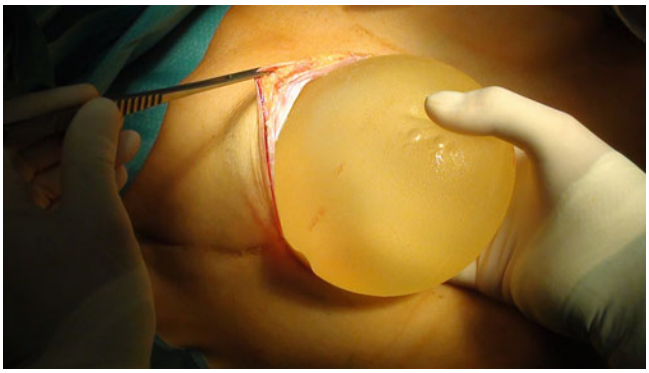

Fig. 44.3 The previously implanted breast prosthesis is removed

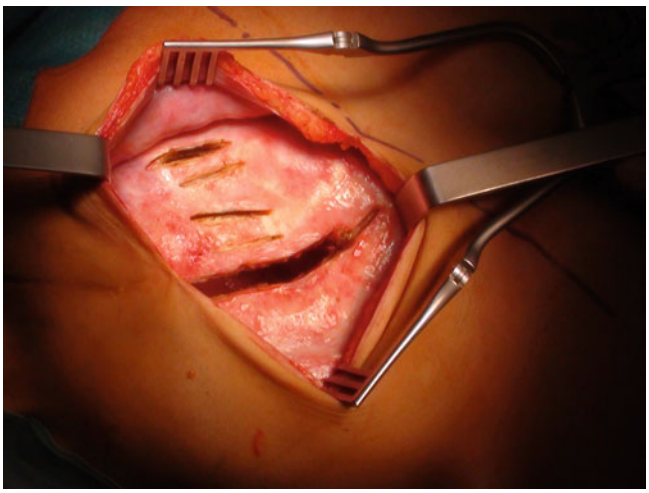

Fig. 44.4 Chest wall is exposed and every single involved rib is prepared by *scollaperiostio*

postoperative morbidity includes edge necrosis of the myocutaneous flap requiring surgical excision with the patient under local or general anesthesia, and pleural effusion requiring pleural drainage. Reported major complications are prosthesis infection, chest wall hematoma (requiring a re-do operation), massive atelectasis (requiring toilette bronchoscopy), and postoperative empyema. Morbidity has been reported to be 20–50 % in various studies, with a rate of reintervention ranging from 17 to 22 % [2].

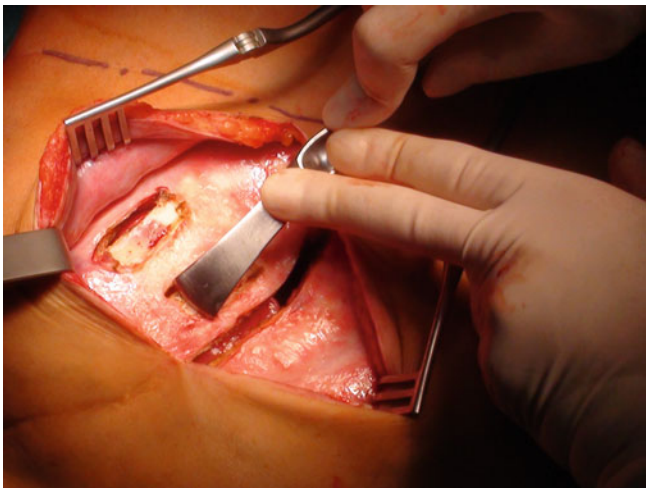

Fig. 44.5 Chest wall is exposed and every single involved rib is prepared by *scollaperiostio*

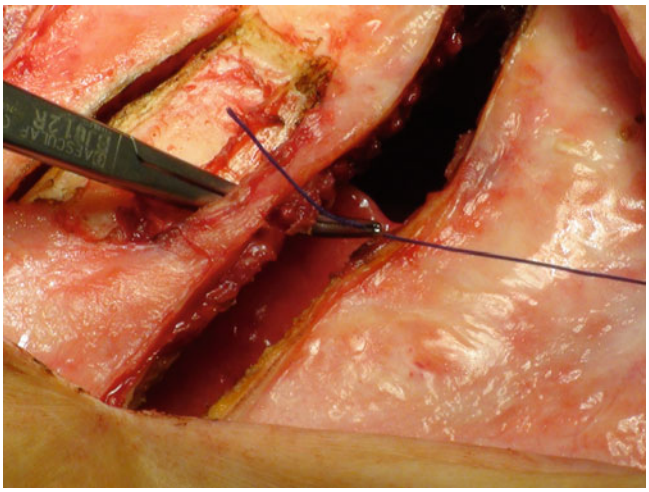

Fig. 44.7 Intercostal vein and artery are dissected and ligated to allow a safe rib resection by *costotomo*

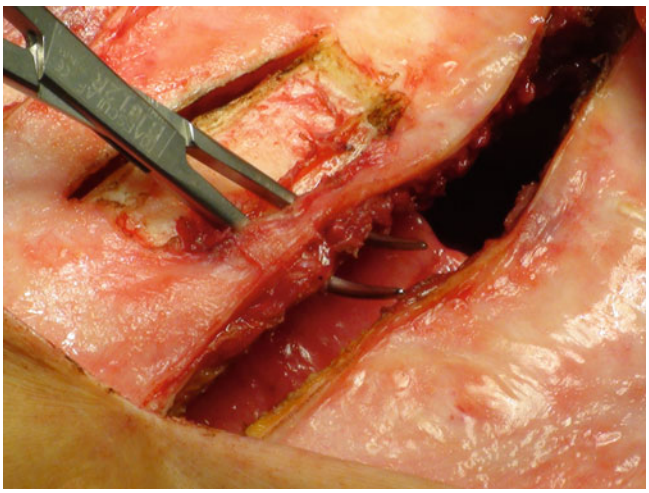

Fig. 44.6 Intercostal vein and artery are dissected and ligated to allow a safe rib resection by *costotomo*

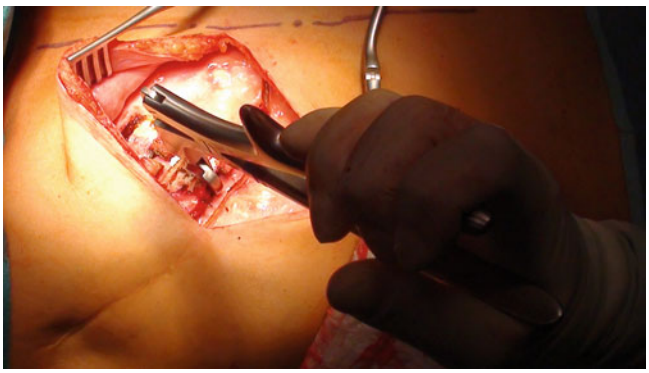

Fig. 44.8 Intercostal vein and artery are dissected and ligated to allow a safe rib resection by *costotomo*

On the basis of the existing literature, we may argue that complete resection with free margins is recommended as the first choice for treatment in recurrent breast cancer. In fact, local recurrence has to be regraded as a repeated episode of a disease with an increased risk of subsequent metastases and not vice versa. The curve of metastatic incidence might be flattened or reduced markedly by a radical resection with sufficient safety margins [2].

Risk factors affecting long-term survival are a diameter of the local recurrence greater than 1.5 cm, disease-free interval of less than 2 years, skin incision, initial tumor stage, and positive lymph nodes [19]. Age at the time of primary resection has been described as a prognostic factor, although different cutoff and prognostic values have been reported. Faneyte et al. [8] observed that patients who were younger than 35 years at

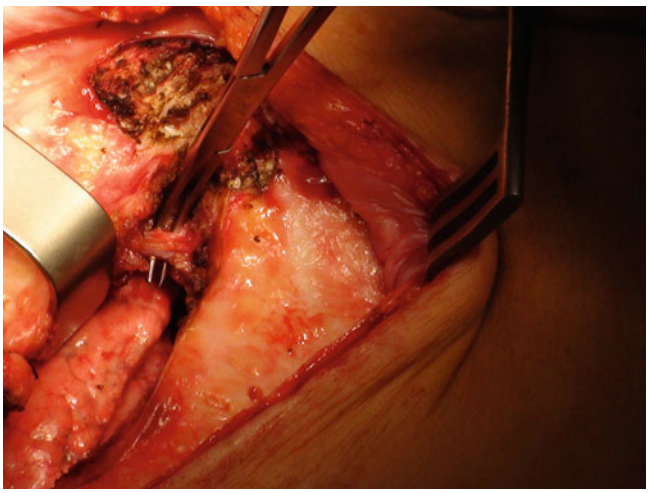

Fig. 44.9 Mammary vein and artery of the involved hemisternum are dissected, isolated and then ligated

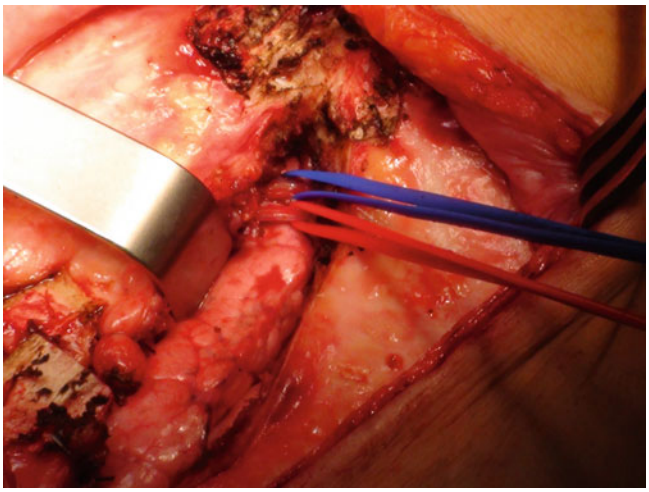

Fig. 44.10 Mammary vein and artery of the involved hemisternum are dissected, isolated and then ligated

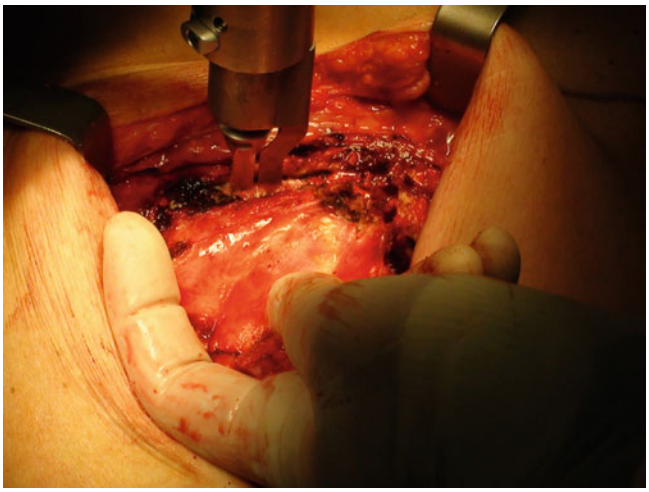

Fig. 44.12 The sternum is then transected, both horizontally and vertically by sternotomy

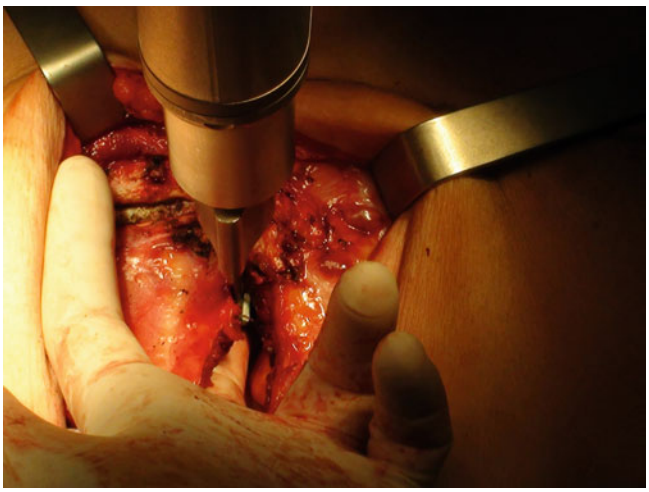

Fig. 44.11 The sternum is then transected, both horizontally and vertically by sternotomy

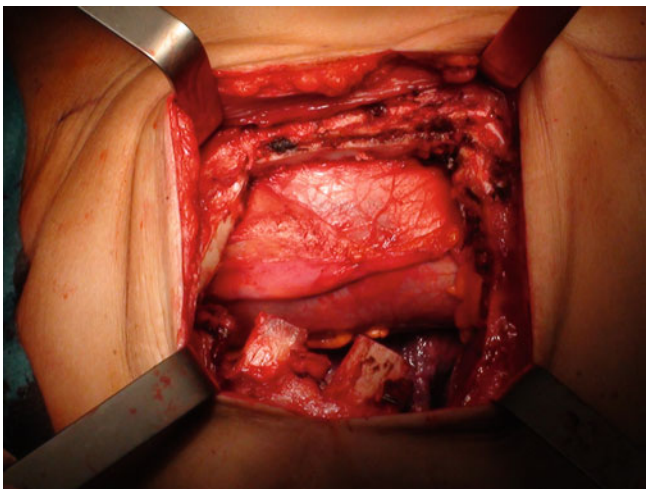

Fig. 44.13 Chest wall resection is then completed, exposing intrathoracic structures; interrupted mutliple non adsorbable stitches are roundly placed for subsequent fixing of the prosthesis

the time of primary therapy had significantly lower survival rates after the resection of a chest wall recurrence. In contrast, Friedel et al. [2] observed that the distinction between younger and older patients was determined to be 45 years, with an improved long-term survival for the younger group, who had better prognosis with surgical therapy for the local recurrence than older patients. Whether this is actually due to the therapeutic procedure or the generally decreased life expectancy of older patients has not been clarified yet.

44.3 Technical Aspects

The previously implanted breast prosthesis is removed (Figs. 44.1, 44.2, 44.3). The chest wall is exposed and every involved rib is prepared with a periosteal elevator (Figs. 44.4, 44.5). The intercostal vein and artery are dissected and ligated to allow a safe rib resection with a rib cutter (Figs. 44.6, 44.7, 44.8). The mammary vein and artery of the involved hemisternum are dissected, isolated, and then ligated (Figs. 44.9, 44.10). The sternum is then transected, both horizontally and vertically, with a sternal saw (Figs. 44.11, 44.12). The chest wall resection is then completed, exposing intrathoracic structures. Interrupted multiple nonabsorbable stitches are roundly placed for subsequent fixing of the prosthesis (Figs. 44.13, 44.14). A polypropylene prosthesis is prepared with resinous material according to the extent of parietal defect following chest wall resection (Fig. 44.15). The prosthesis is then implanted and fixed to adjacent healthy bones of the chest wall (Fig. 44.16). The latissimus dorsi muscle flap is then

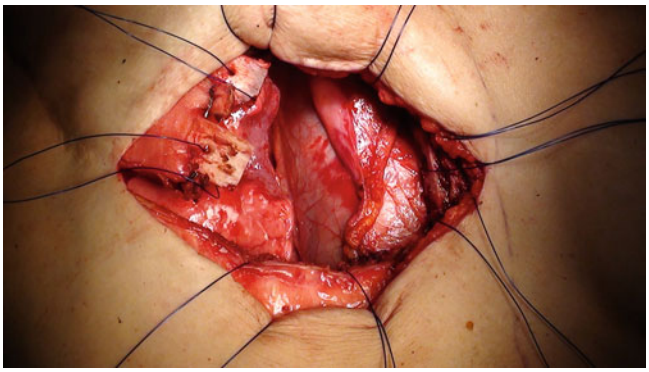

Fig. 44.14 Chest wall resection is then completed, exposing intrathoracic structures; interrupted mutliple non adsorbable stitches are roundly placed for subsequent fixing of the prosthesis

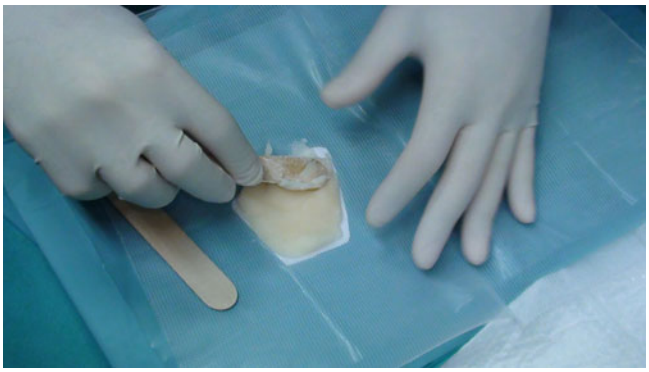

Fig. 44.15 Polypropylene prosthesis is prepared with resinous material, according to the extent ofparietal defect following chest wall resection

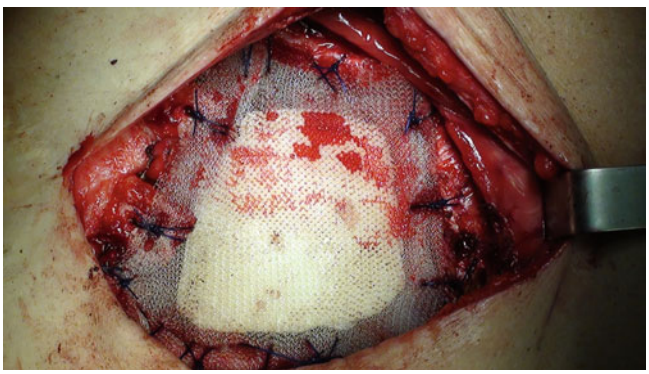

Fig. 44.16 Prosthesis is then implanted and fixed to adjacent healthy bones of the chest wall

prepared, with a cutaneous island, and then rotated to cover the prosthesis and to close the anterior tissue defect (Figs. 44.17, 44.18).

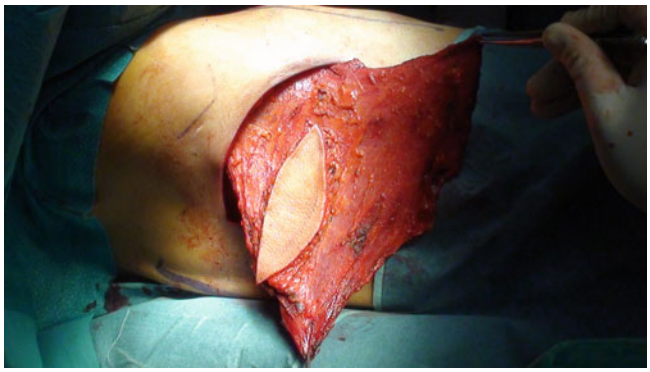

Fig. 44.17 Latissimus dorsi muscle flap is then prepared, with cutaneous island, and then rotated to cover the prosthesis and to close anterior tissue defect

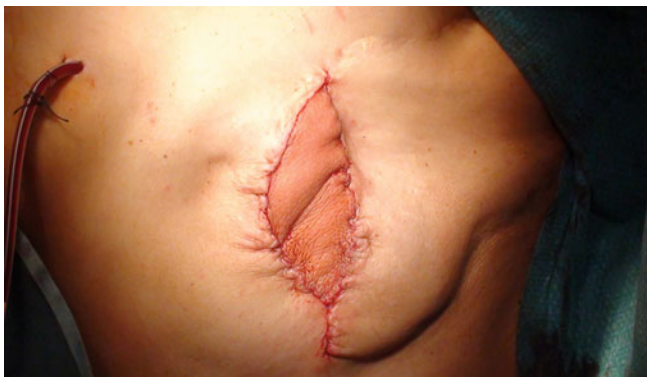

Fig. 44.18 Latissimus dorsi muscle flap is then prepared, with cutaneous island, and then rotated to cover the prosthesis and to close anterior tissue defect

44.4 Conclusion

Full-thickness resection of the chest wall can be done with acceptable morbidity and mortality, offering significant palliation in patients with locally recurrent disease. Palliative surgical resection may be taken into consideration even in the case of multiple nodules, skin ulceration, and distant metastatic disease, providing good aesthetic results along with palliation of symptoms.

In locally recurrent breast cancer, complete chest wall resection may offer radical control of the disease if it is performed with sufficient tumor-free safety margins (2–5 cm). In fact, it may offer a cure for a significant proportion of patients with isolated chest wall recurrence.

Patients with a long disease-free interval form their initial treatment and a slow clinical course may be ideal candidates for surgical treatments. Moreover, because the triple-negative phenotype is not amenable to any form of

therapy, palliation with chest wall resection may represent the only hope that can be offered.

To facilitate surgical therapy and to cover large chest wall defects, cooperation between thoracic and plastic surgeons plays a basic role.

References

1. Bedwinek J (1994) Natural history and management of isolated loco-regional recurrence following mastectomy. Semin Radiat Oncol 4:260–269
2. Friedel G, Kuipers T, Dippon J, Al-Kammash F, Walles T, Kyrisss T, Veit S, Greulich M, Steger V (2008) Full-thickness resection with myocutaneous flap reconstruction for locally recurrent breast cancer. Ann Thorac Surg 85:1894–1900
3. Downey RJ, Risch V, Hsu FI, Leon L, Venkatraman E, Linehan D, Bains M, van Zee K, Korst R, Ginsberg R (2000) Chest wall resection for locally recurrent breast cancer: is it worthwhile? J Thorac Cardiovasc Surg 119(3):420–428
4. Veronesi G, Scanagatta P, Goldhirsch A, Rietjens M, Colleoni M, Pelosi G, Spaggiari L (2007) Results of chest wall resection for recurrent or locally advanced breast malignancies. The Breast 16:297–302
5. Santillan AA, Kiluk JV, Cox JM, Meade TL, Allred N, Ramos D, King J, Cox C (2008) Outcomes of locoregional recurrence after surgical chest wall resection and reconstruction for breast cancer. Ann Surg Oncol 15(5):1322–1329
6. Clemons M, Danson S, Hamilton T, Goss P (2001) Locoregionally recurrent breast cancer: incidence, risk factors and survival. Cancer Treat Rev 27(2):67–82
7. Taghian A, Jeong JH, Mamounas E, Anderson S, Bryant J, Deutsch M, Wolmark N (2004) Patterns of locoregional failure in patients with operable breast cancer treated by mastectomy and adjuvant chemotherapy with or without tamoxifen and without radiotherapy: results from five national surgical adjuvant breast and bowel project randomized clinical trials. J Clin Oncol 22(21):4247–4254
8. Faneyte IF, Rutgers EJ, Zoetmulder FA (1997) Chest wall resection in the treatment of locally recurrent breast carcinoma: indications and outcome for 44 patients. Cancer 80:886–891
9. Pameijer CR, Smith D, McCahill LE, Bimston DN, Wagman LD, Ellenhorn JD (2005) Full-thickness chest wall resection for recurrent breast carcinoma: an institutional review and meta-analysis. Am Surg 71(9):711–715
10. Snyder AF, Farrow GM, Masson JK, Payne WS (1968) Chest wall resection for locally recurrent breast cancer. Arch Surg 97: 246–253
11. Shah JP, Urban JA (1975) Full thickness chest wall resection for recurrent breast carcinoma involving the bony chest wall. Cancer 35:567–573
12. Miyauchi K, Koyama H, Noguchi S, Inaji H, Yamamoto H, Kodama K, Iwanaga T (1992) Surgical treatment for chest wall recurrence of breast cancer. Eur J Cancer 28:1059–1062
13. Toi M, Tanaka S, Bando M, Hayashi K, Tominaga T (1997) Outcome of surgical resection for chest wall recurrence in breast cancer patients. J Surg Oncol 64(1):23–26
14. Chagpar A, Meric-Bernstam F, Hunt KK, Ross MI, Cristofanilli M, Singletary SE, Buchholz TA, Ames FC, Marcy S, Babiera GV, Feig BW, Hortobagyi GN, Kuerer HM (2003) Chest wall recurrence after mastectomy does not always portend a dismal outcome. Ann Surg Oncol 10(6):628–634
15. Schuck A, Konemann S, Matthees B, Rube CE, Reinartz G, Hesselmann S, Micke O, Schafer U, Willich N (2002) Radiotherapy in the treatment of locoregional relapses of breast cancer. Br J Radiol 75(896):663–669
16. Waeber M, Castiglione-Gertsch M, Dietrich D, Thürlimann B, Goldhirsch A, Brunner KW (2003) Swiss Group for Clinical Cancer Research (SAKK). Adjuvant therapy after excision and radiation of isolated postmastectomy locoregional breast cancer recurrence: definitive results of a phase III randomized trial (SAKK 23/82) comparing tamoxifen with observation. Ann Oncol 14(8):1215–1221
17. Friedel G, Kuipers T, Engel C, Schopf C, Veit S, Zoller J, Kyriss T, Greulich M, Toomes H (2005) Full-thickness chest wall resection for locally recurrent breast cancer. GMS Thorac Surg Sci 2:Doc01. http://www.egms.de/en/journals/tss/2005-2/tss000006.shtml
18. Mansour KA, Thourani VH, Losken A, Reeves JG, Miller JI Jr, Carlson GW, Jones GE (2002) Chest wall resection and reconstruction: a 25-year experience. Ann Thorac Surg 73: 1720–1725
19. Fortin A, Larochelle M, Laverdiere J, Lavertu S, Tremblay D (1999) Local failure is responsible for the decrease in survival for patients with breast cancer treated with conservative surgery and postoperative radiotherapy. J Clin Oncol 17:101–109
20. Dahlstrøm KK, Andersson AP, Andersen M, Krag C (1993) Wide local excision of recurrentbreast cancer in the thoracic wall. Cancer 72(3):774–777
21. Mora EM, Singletary SE, Buzdar AU, Johnston DA (1996) Aggressive therapy for locoregionalrecurrence after mastectomy in stage II and III breast cancer patients. Ann Surg Oncol 3(2):162–168
22. Henderson MA, Burt JD, Jenner D, Crookes P, Bennett RC (2001) Radical surgery with omental flap foruncontrolled locally recurrent breast cancer. ANZ J Surg 71(11):675–679
23. Moran MS, Haffty BG (2002) Local-regional breast cancer recurrence: prognostic groups based onpatterns of failure. Breast J 8(2):81–87

Part VII

Other Special Considerations

Systemic Impact of Breast Reconstruction

45

Giuseppe Curigliano, Janaina Brollo, and Maximiliano Cassilha Kneubil

45.1 Introduction

Surgery is still the main curative therapeutic modality for breast cancer. Breast reconstruction following mastectomy or lumpectomy has been a part of cancer treatment and has been widely studied in the last few decades. To the best of our knowledge, systemic effects of breast reconstruction may have a relationship with tumor biology. The features, extent, and duration of surgery can influence levels of release systemic proangiogenic cytokines [1–4].

Angiogenesis plays a key role in both wound healing and the ability of a cancer to survive and grow. Investigations into the angiogenic response may help guide surgical approaches [1] Normal wound repair generates an angiogenic response to deliver nutrients and inflammatory cells to injured tissue. The angiogenic response facilitates the removal of debris and is central to the development of a granulation tissue framework for wound closure [2]. The mediators of wound angiogenesis include soluble factors such as vascular endothelial growth factor (VEGF), tumor necrosis factor (TNF), transforming growth factor (TGF)-β, basic fibroblast growth factor (bFGF), and platelet-derived growth factor, which have been identified in several wound models [3]. Angiogenic agonists (e.g., VEGF) and antagonists (e.g. thrombospondin-1) have been described at various times during repair [4–6], suggesting that the neoangiogenic stimulus may be a balance of factors changing to favor either vessel growth or vessel regression [7]. Previous studies have shown that surgical wound fluid collected within a few hours of an operation is potently angiogenic. The levels of bFGF have been shown to peak immediately after surgery and then fall by the second postoperative day [8]. This immediate release has been suggested to function to initiate wound angiogenesis. In later wounds, VEGF is the predominant angiogenic mediator [4]. An upregulation of VEGF production in wound repair has been demonstrated in keratinocytes in skin wounds in rat, guinea pig, and mouse models [9]. The TGF family is involved in several steps of wound healing: monocyte chemoattraction, formation of granulation tissue and fibroblast stimulation, neovascularization, wound contraction, and extracellular-matrix reorganization.

The response of the body to a cancer is not a unique mechanism but has many parallels with inflammation and wound healing. It has been suggested that the inflammatory cells and cytokines found in tumors are more likely to contribute to tumor growth, progression, and immunosuppression than they are to mount an effective host antitumor response [10]. If genetic damage is the "match that lights the fire" of cancer, some types of inflammation may provide the "fuel that feeds the flames." Moreover, cancer susceptibility and severity may be associated with functional polymorphisms of inflammatory cytokine genes, and deletion or inhibition of inflammatory cytokine genes inhibits development of experimental cancer. Work on the production of proangiogenic cytokines in early human wound fluid has been done using drain fluid from patients undergoing cancer surgery [4, 8]. These studies are based on the premise that wound fluid is generally representative of the growth environment of the wound.

It is important to study if the features, extent, type, and duration of surgery can affect systemic perioperative levels of angiogenic cytokines in patients with breast cancer. A better understanding of the time interval during which the sequelae of events in wound healing occur may be the basis for defining new therapeutic strategies that can interfere with tumor outgrowth sparing wound healing processes. After surgical resection of a tumor, the microenvironment of the wound site differs from that of normal tissue in

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several ways. Hypoxia, fibroblast activation, and various growth factors released after wounding make the wounded site different from nonwounded tissue. Patients undergoing major oncological resections might develop cytokine production dysregulation and subsequent postsurgical immunosuppression, especially when the operation is of long duration. Another point of discussion related to the use of "autologous fat transplantation" in breast reconstruction is the numerous observations of adipocyte, preadipocyte, and progenitor cells as potential actors in breast cancer tumorigenesis [11]. In this chapter, we will review the links between breast reconstruction and systemic effects and we will discuss the potential implications of these links for breast cancer recurrence.

45.2 Proangiogenic Cytokines

Tumor growth is angiogenesis-dependent. Perioperative levels of endogenous stimulators (bFGF, VEGF, cathepsin, copper, interleukins 1, 6, and 8), inhibitors (plasminogen activator inhibitor 1, tissue inhibitor of metalloprotease, zinc, interleukins 10 and 12), and modulators of angiogenesis (TGF-β, TNF-α) may indicate the switch to the angiogenic phenotype of neoplasia that depends on a net balance between positive and negative angiogenic factors released by the tumor. In particular, there is an alteration in the circulating levels of acute-phase reactants that are believed to play an important role in the perioperative period, at the time of enhanced release of malignant cells into the circulation, with risk of metastasis induction. Endothelial growth factors have a cell mitogen effect and act as regulator of vascular permeability. Several retrospective studies reported that VEGF is significantly associated with relapse-free survival, overall survival, or both. Patients with early-stage breast cancer who have tumors with elevated levels of VEGF, TGF-β, or bFGF have a higher likelihood of recurrence than patients with low-angiogenic tumors, even if they are treated with conventional adjuvant therapy [1]. The preoperative levels of VEGF, bFGF, and TGF-β described in our study are similar to those previously reported [12–14]. Other studies reported a correlation between clinical pathological features of disease and preoperative levels of angiogenic factors [15].

To better understand the mechanism of wound angiogenesis and its significance in tumor biology and surgical intervention, we specifically evaluated the temporal profile of serum VEGF, bFGF, and TGF-β in breast cancer patients who underwent minimal, moderate, or extended surgery [16]. Blood samples were collected prospectively from 84 consecutive premenopausal and postmenopausal patients who had presented with primary or recurred operable (T1–T4) node-negative/positive (N0–N2) breast cancer. Forty-three patients (52 %) underwent minimal surgery (quadrantectomy), 18 patients (22 %) underwent moderate surgery (mastectomy without reconstruction), and 21 patients (26 %) underwent extended surgery [mastectomy followed by reconstruction with a transversus rectus abdominis myocutaneous (TRAM) flap]. The preoperative median values ($n = 82$) of serum VEGF, bFGF, and TGF-β levels were 84.50 pg/ml (range 14.97–573.66 pg/ml), 10.21 pg/ml (range 0.44–74.70 pg/ml), and 21.45 pg/ml (range 6.34–135.94 pg/ml), respectively, for each type of surgery. In our study, no relationship was observed between age, stage, biological features, and levels of preoperative angiogenic factors. Median values of VEGF, bFGF and TGF-β usually have a drop out at 24–48 h after surgery. The reduction of TGF-β levels from before the operation to after the operation was statistically significant. Kong et al. [17] showed that plasma TGF-β levels were elevated preoperatively in 81 % of patients. The mean plasma TGF-β level in breast cancer patients normalized after surgery (19.3 ± 3.2 vs. 5.5 ± 1.0 ng/ml, $p < 0.001$) in most subjects; the levels were persistent if lymph node metastases or overt residual tumor was present. No data have been reported on bFGF in correlation to the timing or extent of surgery in patients with breast cancer. An overall 23 % reduction after surgery has been described for VEGF. In a previous report [18], a significant change in serum VEGF levels with time compared with preoperative values was described, with an initial drop over the first 3 days; thereafter, the levels recovered. In that study, an analysis of the local wound response showed that VEGF levels in the wound environment were much higher than the serum equivalent from as early as the first postoperative day. They then peaked on the second day and remained at a higher level for several days thereafter. This observation fits well with wound vascular mechanisms in animal models. An acute wound response could act as a "molecular trap" for angiogenic factors and the reduction of serum levels of VEGF, TGF-β, and bFGF in our patients could be a result of this "trapping."

Another explanation for the reduction of angiogenic factors, especially for VEGF, could be the drop in platelet counts after surgical injury. Since platelets are the main source of serum VEGF, it is reasonable to suppose that their trapping in wound healing could explain the drop in VEGF levels after surgery. The surgical wound itself is a unique extravascular compartment with increased vascular permeability and a high surface area to volume ratio. If reabsorption occurs freely from the surgical wound site, changes in local VEGF concentrations should be reflected in the circulation, i.e., serum levels. Subsequent increase of the levels of VEGF (specifically in patients who underwent TRAM flap surgery) should be related to massive local wound production of VEGF. TRAM flap surgery creates a wound with a larger surface area than a wide local excision. This effect may mark an interaction between residual

tumor-derived local inhibitors, resulting in an initially depressed normal stromal angiogenic response that recovers over time. This would be in keeping with the evidence that tumor cells secrete factors that provide negative-"feedback" regulation and serve to suppress vascular growth, restraining the growth of secondary tumors or metastases [19–21]. Surgical clearance of cancer involves regional extirpation, and residual tissues may still be under the influence of tumor-derived inhibitors delaying the normal angiogenic wound response. The mechanism underlying these observations requires additional investigation and may relate to the half-life of angiogenic stimulators compared with inhibitors, to a local effect on the stroma when the angiogenic drive from the tumor is removed, or because of impaired influx of blood and platelet release at the time of injury. This muted response in cancer patients may represent an opportunity to complete surgical treatment while minimizing stimulation of metastatic disease, a biological argument in favor of immediate reconstruction after, for example, breast cancer surgery.

Experimental evidence suggests that a growth-factor-rich environment permits the survival of cancer cells left in an area of cancer extirpation or in the circulation [19–21]. However, as wounds age, the surgical site becomes less favorable to tumor implantation, and when healing is complete, injected tumor cells do not localize to the surgical site [20]. Thus, local recurrence found in conjunction with widespread metastatic disease is likely to have been established by perioperative seeding rather than as a late phenomenon. Furthermore, a growth-factor-stimulated microenvironment affects growth of established residual tumor foci in vivo and of cell lines in vitro [22]. Antiangiogenic therapy is currently undergoing clinical trials, and in the future, perioperative systemic therapy or local therapy may include use of such therapy. However, our findings indicate that very high local concentrations may need to be antagonized. Quantification of this in vivo biological response should facilitate the design of wound healing experiments to more closely represent the response to surgical stress.

Drainage systems may offer an opportunity to manipulate the early wound environment and reduce local cancer recurrence rates in the future. A better understanding of the time interval during which the sequelae of events in wound healing occur may be the basis for defining new therapeutic strategies that can interfere with tumor outgrowth sparing wound healing processes.

45.3 Adipocytes and Progenitor Cells

Lipotransfer can be considered a technical revolution in plastic surgery and is widely performed in esthetic surgery. Recently, lipofilling has been indicated in breast reconstruction and deformity correction after breast conservative treatment. However, there is lack of understanding concerning the interactions between the potential tumor beds and the lipoaspirate grafts. Current literature underlines the efficacy of the technique as well as its safety. Nevertheless, many experimental studies provide data on the endocrine, paracrine, and autocrine activities of the transplanted fat tissues. Adipocyte, preadipocyte, and progenitor cell secretions can stimulate angiogenesis and cell growth. The "tumor–stroma interaction" can potentially induce reappearance of cancer by "fueling" dormant breast cancer cells in the tumor bed. There is lack of translational research that proves this concern from a clinical aspect. No study on the effects of lipotransfer on human cancer breast cells in vivo is available. Most published studies focus on the technique, complications, fat graft survival, and cosmetic results. Several studies have focused on breast cancer patient safety. They mainly deal with the risk of microcalcifications observed on the mammogram in the follow-up. No data are available on the risk of recurrence due to the endocrine, paracrine, and autocrine fat activity. In 2007, the French Society of Plastic Surgery (SOFCPRE) addressed the question of cancer safety for the lipofilling technique in breast cancer patients. The society sent a recommendation to French plastic surgeons to postpone lipofilling in the breast with or without breast cancer history unless it is performed under a prospective controlled protocol. One year later, the American Society of Plastic Surgeons (ASPS) assembled eight important American plastic surgeons in the ASPS Fat Graft Task Force to assess the indications, the safety, and the efficacy of autologous fat grafting [23]. Five major end points were identified:

1. What are the current and potential applications of fat grafting?
2. What risks and complications are associated with fat grafting?
3. How does the technique affect the outcomes of fat grafting?
4. What risk factors need to be considered for patient selection?
5. What advancements in bench research/molecular biology should potentially impact current or future methods of fat grafting?

The task force also stated that "based on a limited number of studies with few cases, no interference with breast cancer detection has been observed; however, more studies are needed." Despite the fact that postlumpectomy and postmastectomy are clearly included in the indications for fat graft, the task force did not discuss the issues of adipocyte–stroma interaction, and the risk of development of local recurrences.

Subcutaneous or peritoneal cotransplantation of murine mammary carcinoma cells into adipose-tissue-rich regions can lead to tumor growth and metastasis [24]. This is the

main interesting concept of a local effect acting via a paracrine, autocrine, or "tumor–stroma interaction" pathway that can also happen in lipofilling procedures applied to the breast. We have evidence that both stimulatory and inhibitory effects can be observed in experimental research. Some studies tried to validate a single type of cell or a type of adipokine which may be responsible for some particular stages of breast cancer cell line development. However, most of those studies are from fundamental research and in vitro study and are somewhat difficult to link to the clinical model. Indirect data that support the safety of fat transfer are based on reconstruction using an autologous flap technique such as the TRAM flap or the deep inferior epigastric perforator flap. Despite the large amount of fat tissue transferred with the flap, no increased risk of cancer recurrence has been reported in the literature. However both techniques should be distinguished. An autologous flap is made of a complex tissue with its own vascular system; the composition or ratio of the fat tissue in the flap is not altered. The composition of lipotransfer fat is altered from the original donor site ratio. After conservative treatment, the fat tissue is injected through the glandular tissue. Such injection of adipocytes is able to produce adipokines and several secretions which can potentially induce the reappearance cancer by "fueling" dormant breast cancer cells in the tumor bed through the tumor–stroma interaction. We cannot conclude that the flap transfer does not have any tumor–stroma interaction. No study has provided reliable comparative oncological outcomes between flap reconstruction and lipotransfer in breast cancer patients. Clinical series providing oncological data on lipotransfer in breast cancer patients are still limited.

Illouz and Sterodimas [25] reviewed a personal series of 820 patients with lipofilling. Only 381 patients were cancer patients; other indications were for congenital breast asymmetry and cosmetic augmentation without history of cancer. However, they could not draw a conclusion on oncological safety because lack of oncological data and follow-up for almost half of the patients. Rietjens et al. [26] reported one of the biggest series focusing on lipotransfer in breast cancer treatment and reconstruction. They followed 158 patients and found that the postoperative complication rates were very low and there was little alteration in follow-up mammograms. Although they found only one recurrence in 18 months, they concluded that the potential risk of local "dormant" tumor cells being stimulated to induce a local recurrence is still unclear. A study based on cancer evolution by Rigotti et al. [27] compared the number of locoregional recurrences for the same group of patients before and after lipofilling. Such a method should be criticized, because the risk of locoregional recurrence decreases with time and cannot be considered as equivalent in the prelipofilling and the postlipofilling period. The authors excluded 104 breast conservative treatment patients from the whole study population which breast conservative treatment patients could be the group at greatest risk of locoregional recurrence. Without translational research, this report concluded that autologous lipoaspirate transplant combines striking regenerative properties with no or marginal effects on the probability of postmastectomy locoregional recurrence of breast cancer . There is increasing evidence that the stroma is important for driving tumor growth. When performing a fat transfer procedure, we should consider the potential adipokine downstream effects on breast cancer tumorigenesis. Adipokines can potentially increase the interaction between the tumor and stromal cells rather than conferring self-sufficiency to the tumor. Adipocytes, preadipocytes, and adipokines can promote or inhibit breast cancer cell tumorigenesis through autocrine and paracrine mechanisms enhancing tumor–stroma interactions. These data question the safety of fat grafting in reconstructive surgery of the breast. Since November 2007, the French Society of Plastic Surgery has recommended not using adipose tissue in breast surgery until its harmlessness has been proved. The authors also underline that the autologous fat grafting to the breast is not a simple procedure and should be performed only by well-trained and skilled surgeons. Major complications can be observed when this procedure is performed by untrained and untutored physicians, and the role of education in the lipofilling technique is of paramount importance.

We cannot state that a lipofilling procedure is dangerous or should not be done in patients with breast cancer , since available data are balanced regarding suppressive or promoting effects of fat transfer on breast cancer progression. Therefore, we should promote translational research to evaluate the role of fat grafting in the development of breast tumor, to evaluate if fat grafting may induce cancer recurrence (especially after radiotherapy), and to evaluate whether cancer induction or recurrence depends on angiogenesis mediated by cytokines produced by the lipofilling. Clinical studies based on an accurate follow-up of patients with breast cancer who underwent lipotransfer are required to definitively address all relevant questions. A prospective clinical registry including high-volume multicenter collaborative data is warranted.

45.4 Conclusion

The alteration in the circulating levels of proangiogenic cytokines may play an important role in the perioperative period, at the time of enhanced release of malignant cells into the circulation, with risk of metastasis induction. However, a high local concentration of growth factor may need to be antagonized. A better understanding of the time interval during which the sequelae of events in wound

healing occur may be the basis for defining new therapeutic strategies that can interfere with tumor outgrowth sparing wound healing processes.

Moreover, there is increasing evidence that adipocyte, preadipocyte, and progenitor cells can promote breast cancer cell tumorigenesis. Clinical studies with a control group based on accurate follow-up are required to confirm the safety of lipotransfer in breast cancer patients.

References

1. Reid SE, Kaufman MW, Murthy S, Scanlon EF (1997) Perioperative stimulation of residual cancer cells promotes local and distant recurrence of breast cancer. J Am Coll Surg 185:290–306
2. Battegay EJ (1995) Angiogenesis: mechanistic insights, neovascular diseases, and therapeutic prospects. J Mol Med 73:333–346
3. Orredson SU, Knighton DR, Scheuenstuhl H, Hunt TK (1983) A quantitative in vitro study of fibroblast and endothelial cell migration in response to serum and wound fluid. J Surg Res 35: 249–258
4. Nissen NN, Polverini PJ, Koch AE, Volin MV, Gamelli RL, DiPietro LA (1998) Vascular endothelial growth factor mediates angiogenic activity during the proliferative phase of wound healing. Am J Pathol 152:1445–1452
5. Reed MJ, Puolakkainen P, Lane TF, Dickerson D, Bornstein P, Sage EH (1993) Differential expression of SPARC and thrombospondin-1 in wound repair: immunolocalization and in situ hybridization. J Histochem Cytochem 41:1467–1477
6. Di Pietro LA, Nissen NN, Gamelli RL, Koch AE, Pyle JM, Polverini PJ () Thrombospondin 1 synthesis and function in wound repair. Am J Pathol 148:1851–1860
7. Martin P (1997) Wound healing–aiming for perfect skin regeneration. Science (Washington, DC) 276:75–81
8. Nissen NN, Polverini PJ, Gamelli RL, DiPietro LA (1996) Basic fibroblast growth factor mediates angiogenic activity in early surgical wounds. Surgery (St. Louis) 119:457–465
9. Brown LF, Yeo KT, Berse B, Yeo TK, Senger DR, Dvorak HF, van de WL (1992) Expression of vascular permeability factor (vascular endothelial growth factor) by epidermal keratinocytes during wound healing. J Exp Med 176:1375–1379
10. Balkwill F, Mantovani A (2001) Inflammation and cancer: back to Virchow? The Lancet 357:539–545
11. Lohsiriwat V, Curigliano G, Rietjens M et al (2011) Autologous fat transplantation in patients with breast cancer: ''silencing'' or ''fueling'' cancer recurrence? The Breast 20(4):351–357
12. Heer K, Kumar H, Read JR, Fox JN, Monson JRT, Kerin MJ (2001) Serum vascular endothelial growth factor in breast cancer. Its relation with cancer type and estrogen receptor status. Clin Cancer Res 7:3491–3494
13. Sliutz G, Tempfer C, Obermair A, Dadak C, Kainz C (1995) Serum evaluation of basic FGF in breast cancer patients. Anticancer Res 15(6B):2675–2677
14. Kong FM, Anscher MS, Murase T, Abbott BD, Iglehart JD, Jirtle RL (1995) Elevated plasma transforming growth factor-beta 1 levels in breast cancer patients decrease after surgical removal of the tumor. Ann Surg 222(2):155–162
15. Sancak B, Coskun U, Gunel N, Onuk E, Cihan A, Karamercan A, Yildirim Y, Ozkan S (2004) No association between serum levels of insulin-like growth factor-I, vascular endothelial growth factor, prolactin and clinicopathological characteristics of breast carcinoma after surgery. Intern Med J 34(6):310–315
16. Curigliano G, Petit JY, Bertolini F, Colleoni M, Peruzzotti G, de Braud F, Gandini S, Giraldo A, Martella S, Orlando L, Munzone E, Pietri E, Luini A, Goldhirsch A (2005) Systemic effects of surgery: quantitative analysis of circulating basic fibroblast growth factor (bFGF), vascular endothelial growth factor (VEGF) and transforming growth factor beta (TGF-b) in patients with breast cancer who underwent limited or extended surgery. Breast Cancer Res Treat 93:35–40
17. Kong FM, Anscher MS, Murase T, Abbott BD, Iglehart JD, Jirtle RL (1995) Elevated plasma transforming growth factor-beta 1 levels in breast cancer patients decrease after surgical removal of the tumor. Ann Surg 222(2):155–162
18. Hormbrey E, Han C, Roberts A, McGrouther DA, Harris AL (2003) The relationship of human wound vascular endothelial growth factor (VEGF) after breast cancer surgery to circulating VEGF and angiogenesis. Clin Cancer Res 9:4332–4339
19. Simpson-Herren L, Sanford AH, Holmquist JP (1976) Effects of surgery on the cell kinetics of residual tumor. Cancer Treat Rep 60:1749–1760
20. Fisher B, Gunduz N, Coyle J, Rudock C, Saffer E (1989) Presence of a growth-stimulating factor in serum following primary tumor removal in mice. Cancer Res 49:1996–2001
21. Blitstein-Willinger E (1991) The role of growth factors in wound healing. Skin Pharmacol 4:175–182
22. Davies DE, Farmer S, White J, Senior PV, Warnes SL, Alexander P (1994) Contribution of host-derived growth factors to in vivo growth of a transplantable murine mammary carcinoma. Br J Cancer 70: 263–269
23. Gutowski KA, Baker SB, Coleman SR, Khoobehi K, Lorenz HP, Massey MF et al (2009) Current applications and safety of autologous fat grafts: a report of the ASPS Fat Graft Task Force. Plast Reconstr Surg 124(1):272–280
24. Elliott BE, Tam SP, Dexter D, Chen ZQ (1992) Capacity of adipose tissue to promote growth and metastasis of a murine mammary carcinoma: effect of estrogen and progesterone. Int J Cancer 51:416–424
25. Illouz YG, Sterodimas A (2009) Autologous fat transplantation to the breast: a personal technique with 25 years of experience. Aesthetic Plast Surg 33(5):706–715
26. Rietjens M, De Lorenzi F, Rossetto F, Brenelli F, Manconi A, Martella S et al (2011) Safety of fat grafting in secondary breast reconstruction after cancer. J Plast Reconstr Aesthet Surg 64(4): 477–483
27. Rigotti G, Marchi A, Stringhini P, Baroni G, Galiè M, Molino AM et al (2010) Determining the oncological risk of autologous lipoaspirate grafting for postmastectomy breast reconstruction. Aesth Plast Surg 34:475

Psychological Aspects of Breast Reconstruction 46

Barbara Rabinowitz

46.1 Background

Understanding the psychological aspects of breast reconstruction really begins with seeking understanding of the psychological impact of a breast cancer diagnosis and the ensuing treatments and therapies. Much research has focused on reactions to surgery and to adjunct therapy, rather than to the reaction women have to the diagnosis alone [1], although clearly breast cancer specialists have borne witness to the person-dependent range of emotions that can surface as women face the breast cancer diagnosis. Women's reactions can be said to fall along a continuum from what may appear as equanimity (e.g., their proceeding through life "as normal" during the period of decision making and awaiting treatment) to feeling completely undone emotionally and in some instances almost unable to move forward with life's general tasks and the decisions regarding treatment choices.

Early understanding of the emotional impact of a breast cancer diagnosis can be found in a rather unique 1952 article by Renneker and Cutler [2]. These physicians wrote with great early understanding of the multiple ways that this diagnosis and ensuing treatment could impact women. With mastectomy the only surgical option for women at that time, they spoke in depth regarding the range of emotions women may experience, which included anxiety, depression, and feelings of shame and fear. Although treatment options have greatly broadened during the decades since that seminal article, women continue to report a great range of emotional sequelae to hearing the diagnosis and to the treatments that include loneliness, distress over cognitive deficits they may perceive, sleeplessness, and cancer-related fatigue. Ahead of their time, Renneker and Cutler focused also on the importance of physicians caring for women with breast cancer to consult with specialists from the psychological domain to aid cancer specialists in offering patients comprehensive care not just of the breast, but of the whole woman as she seeks to recover from her treatments and to reclaim all of her life.

Research in the subsequent decades has shown that women experience problems living with uncertainty, with changes in communication patterns with friends and family, and in confusion about what to tell their children [3]. As cancer does not exert its negative psychosocial aura over the woman alone, impact on the family has been studied, with findings noting that family distress, including mood swings, anxiety, and depression, is found with some frequency [4]. A more recent report of companion studies has shown evidence that a patient's perceptions of her partner's positive involvement with her after diagnosis has a salutary impact on three domains of recovery (marital satisfaction, emotional distress, and psychosexual adjustment) [5]. Ganz et al. [6, 7], well known for research furthering understanding of the psychosocial impact of a breast cancer diagnosis and ensuing treatments, have shown that there are frequent deficits that women experience in how they regard themselves, in health related quality of life , and in their sexual lives. It has become evident that the skilled practitioners working to aid the woman with breast cancer must become sensitive to the potential for a negative impact of the breast cancer experience on any one of many domains of quality of life and must be responsible for referring women to psychosocial specialists to aid women in their quest for comprehensive recovery (Fig. 46.1).

46.2 Breast Reconstruction

The plastic and reconstructive surgeon may meet the woman with breast cancer early in her experience (particularly if immediate reconstruction is a consideration) or may not, unfortunately, meet her until she has completed her initial ablative surgery and adjunct therapies. Clearly, the opinion of

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Fig. 46.1 Psychological research tree

the author is that an early meeting (prior to a surgical decision being made) with a plastic and reconstructive specialist leaves the woman best placed to be a true partner in the informed decision making process, as well as best placed to have her psychosocial issues addressed and supported by the full range of specialists with whom she will work over her time of breast cancer treatment and recovery.

Women who are in a clinical position to be a partner in the choice between breast-conserving surgery, mastectomy alone, or mastectomy with either immediate or delayed reconstruction have much to consider. Breast centers, in which each woman is seen by a variety of specialists before choices are finalized, can be a real aid to a woman moving through her decision making process as there is the expectation that many members of the breast center team will review the best options for the woman and that breast reconstruction will receive a "fair hearing" early in the decision making process. This can be so both in breast centers where practitioners are located in one setting and in colloquially named "breast centers without walls" in which a group of breast cancer specialists work in separate private practices, but who come together at multidisciplinary treatment planning meetings. Even in settings without a designated breast center, solid collegial and collaborative relationships between breast cancer surgeons and their plastic and reconstructive surgery colleagues can help secure the inclusion of the reconstruction option early on.

Research regarding the benefits and limitations of breast reconstruction has been less prolific than research seeking to understand women's emotional and psychological reactions to breast cancer, to breast cancer surgery, and to the impact of psychosocial interventions that can mitigate the emotional burdens women frequently endure. Nevertheless, there is a body of literature that aids in understanding the psychological issues related to the breast reconstruction experience and in helping to inform plastic and reconstructive surgeons regarding how to enhance the positive effect of their role as women seek to make the best decision for themselves.

Seeking to understand the "psychosocial and psychopathological" outcome for women with breast reconstruction, Rubino et al. [8] studied women with mastectomy alone, women with breast reconstruction, and healthy women and, interestingly, found no difference in social, sexual, relationship, and quality-of-life issues at 1 year between the group with breast reconstruction and healthy women. Although anxiety was not different between the women with mastectomy alone and the women with breast reconstruction, importantly, depression in the reconstruction group was less than for those women who had mastectomy alone. Evaluating satisfaction as a worthy emotional end point, one prospective study of women who underwent delayed reconstruction found that preoperative expectations were met in 90 % of the patients, with a hearty majority stating their satisfaction with the outcome [9]. Negative to psychological peace after reconstruction for some women is the experience of "decision regret." While seeking to understand the effect of information satisfaction and personal variables on regret, one study found that most women in the study reported no decision regret but that for those who did experience mild to moderate or strong regret it was associated with low satisfaction with preparatory information [10]. The value of meeting and speaking with

the reconstructive specialist before surgery was clearly reinforced in the findings.

Emphasizing that there are psychological/psychosocial benefits for breast reconstruction, Hasen et al. [11] noted in an evaluation of the overall role of plastic surgery as a component of comprehensive care of cancer patients that "the most convincing data for improved psychosocial well being through plastic surgery is in the setting of breast reconstruction after mastectomy." Yet the evidence in the research literature is mixed. Evidence for the value of breast reconstruction can be seen in a study comparing women with breast reconstruction with women with breast conservation which found no difference between the two groups in overall psychosocial adjustment to illness, body image, or satisfaction with relationships or sexual life [12]. However, some studies have shown no difference in psychosocial parameters between women with and women without reconstruction following mastectomy. Seeking to broaden the comparison, many authors have sought psychological comparison between those with breast conservation, those with mastectomy alone, and those with mastectomy with reconstruction [13–16]. Two studies comparing the three groups found that the groups did not differ significantly in the psychosocial domains measured [13, 14]. The general capacity for women, irrespective of the surgical option, to adjust and return to a good quality of life was further supported by the prospective study of Parker et al. [15] in which those three groups showed differences in adjustment and adaptation at different time points along the study's trajectory, with no significant differences in psychosocial adjustment by the study's end. Likewise, Collins et al. [16] found there were differences between groups at different points along the trajectory of the study, with women with breast reconstruction faring less well on body image than those women having breast-conserving surgery at "time 2." However, by the end of the study (2 years) there were no significant differences in body image for the different surgery types between any of the groups. Although it is good news that a statistically significant number of women, independent of which surgery they choose, will return to a good psychosocial state within a reasonable period after surgery, none of this research seems to show that breast reconstruction offers a better return to psychological health than mastectomy alone. If left without further studies, one could postulate that women who do not feel the need for reconstruction are in some measure emotionally prepared to live without a breast, whereas those women who choose breast reconstruction know the need they feel for this enhancement and would do less well psychologically were it not available to them. In clinical practice, this author has certainly experienced those distinctions. One study does lend credence to this theory as the researchers sought to isolate the psychological outcome for those with and without good cosmetic outcomes and did find a significant correlation between good cosmetic scores and good psychological adjustment [14]. Also of note is one recent study evaluating patient satisfaction and health-related quality of life specifically for those women whose breast reconstruction was conducted as autologous tissue reconstruction [17]. Using the newly available BREAST-Q research tool and validating the results with the findings of two other frequently used tools (Hospital Anxiety and Depression Scale and Impact of Event Scale), the authors found that these women enjoyed significantly higher scores on measures of psychosocial well-being, satisfaction with the breast, and sexual well-being as early as 3 weeks after surgery compared with their baselines on these measures.

46.3 Immediate Versus Delayed Reconstruction

Relatively few investigators have sought to understand the possible psychological distinctions for women with immediate reconstruction versus those with delayed reconstruction. An early study by Wellisch et al. [18] found women with immediate breast reconstruction less often reporting "high distress" in recalling their mastectomy surgery (25 %) than those women with delayed reconstruction (60 %). Another early and small study found that those with immediate reconstruction experienced significant advantages that included a sense of freedom with attire as well as improved self-image as compared with women with delayed reconstruction [19]. Adding to these salutary findings on behalf of immediate breast reconstruction, a retrospective analysis of the psychological advantages of immediate reconstruction found that anxiety and depression were lower and body image, self-esteem, feeling sexually attractive, and satisfaction were higher for the immediate reconstruction group than for their delayed reconstruction counterparts [20]. Analyzing subjects from the Michigan Breast Reconstruction Outcomes Study, Roth et al. [21] identified that women awaiting their mastectomy with immediate reconstruction showed "higher prevalence of psychosocial and functional morbidity" (e.g., depressed emotional well-being and increased anxiety) compared with the women awaiting reconstruction for a previous mastectomy. It is important not to assume, however, that immediate reconstruction is a poor choice with regard to emotional outcome, but rather to await further studies in which those with immediate reconstruction could be assessed again at a time further distant from their receiving a diagnosis of breast cancer to assess whether their time for emotional adjustment to the cancer diagnosis would compensate for this reported finding. The authors noted that those awaiting surgery for a previous mastectomy had likely

been through the adjustment to their breast cancer diagnosis, whereas those awaiting immediate reconstruction concurrent to their mastectomy were likely dealing with "the apprehension and fears related to a recent diagnosis of breast cancer." Lending credibility to this theory are two other studies, one prior to the above-mentioned study and one later, following women from this same database that found that women with immediate reconstruction showed significant improvement on all of the psychosocial outcome subscales (the later study evaluating them further from their time of diagnosis) other than on body image (having come from intact breasts to surgically produced breasts), and that women with delayed reconstruction showed improvement only on the subscale for body image (having come from having no breast tissue to now having surgically produced breasts), but not on the other psychosocial measures (already having had time to adjust to psychosocial issues before their breast reconstruction) [22, 23]. The analysis by Wilkens et al. [22] and the later analysis by Atisha et al. [23] also showed little to no difference in psychosocial well-being for the different types of reconstruction procedure.

46.4 Prophylactic Mastectomy

In addition to women for whom breast reconstruction is a follow-up to cancer-related mastectomy of the breast(s) scheduled for reconstruction are those women whose breast reconstruction follows a contralateral prophylactic mastectomy and those at "high risk" who chose a bilateral prophylactic mastectomy. Although the circumstances driving the need for reconstruction are different, there is an interesting body of literature to inform our understanding of the psychological issues for women with reconstruction after either contralateral or bilateral prophylactic mastectomy. McGaughey [24], in an integrative review of 13 studies evaluating the impact of prophylactic mastectomies on women's body image and sexuality, found that up to half of the women experienced a negative impact on body image and sexuality. Unfortunately, many studies found likewise. Payne et al. [25] following women who had registered in the Memorial Sloan-Kettering Cancer Center National Prophylactic Mastectomy Registry found women reporting negative impact on body image and sexual function as well. Following in that tradition, a smaller and more recent study with a 93 % response rate found 75 % of the women after bilateral prophylactic mastectomy reporting that enjoyment of sex was negatively impacted [26]. Evaluating the experience of women with contralateral prophylactic mastectomy, Boughey et al. [27] found that the women in their study who had had contralateral prophylactic mastectomy on average 20 years earlier frequently noted a negative impact on sense of femininity, body appearance, and sexual relationships. Further validation of the impact on sexuality comes from a more recent prospective study evaluating the impact of bilateral prophylactic mastectomy on body image, sexuality, emotional reactions, and quality of life for "high-risk" women. Brandberg et al. [28] analyzed responses from women preoperatively, at 6 months postoperatively, and at 1 year postoperatively. Sexual pleasure decreased significantly from assessment preoperatively to assessment at 1 year postoperatively, although, interestingly, the frequency of sexual activity remained stable through all assessment points. Although the latter might seem counterintuitive in the face of the former, it is beyond the scope of this chapter to theorize, and I only note that this prospective work supports the findings of previous retrospective studies that these women do experience a negative impact on their sexuality. This frequently reported negative impact on sexuality is not difficult to understand given the change in body image and the loss of this part of a woman's anatomy that is often pivotal to a woman's experience of sexual pleasure.

One of the major drivers of the decision for bilateral prophylactic mastectomy is an anticipated decrease in anxiety [29]. Happily, this was born out in the prospective study of Brandberg et al. [28], with women reporting decreased anxiety over time. This was further supported by the findings in an early study that offered bilateral prophylactic mastectomy to 143 women considered to be high risk of breast cancer. [30] Assessing preoperatively and then following both the "accepters" and "decliners" for 18 months postoperatively, on psychological and sexual domains, the study found that the 79 acceptors showed decreased psychological morbidity over time, whereas no such changes were observed for the "decliners." In contrast to other studies cited herein, this study found no changes over time in sexual comfort or sexual pleasure for either group. It is noteworthy that those who accepted and received prophylactic mastectomies as well as those who declined them and kept both breasts intact were both able to continue to enjoy sexual comfort and sexual pleasure, with no significant differences between the groups.

46.5 Regrets Versus Satisfaction with Prophylactic Mastectomy

Boughey et al. [27] reported on long-term satisfaction for women who had undergone contralateral prophylactic mastectomy. In spite of the also reported adverse impact on body image, sense of sexuality, and sexual relationships found in this study, most of the women both at an average of 10 years and also at an average of 20 years after contralateral prophylactic mastectomy reported satisfaction with their decision to have contralateral prophylactic

mastectomy. Reporting on women who had had bilateral prophylactic mastectomy, Gahm et al. [26] reported that feelings of regret were almost nonexistent. Likewise, with a mixed contralateral prophylactic mastectomy and bilateral prophylactic mastectomy group, only 21 of the 370 women who had registered in the Memorial Sloan-Kettering Cancer Center National Prophylactic Mastectomy Registry reported regrets about their decision to have a prophylactic mastectomy [25]. It is illuminating that although there were relatively few women reporting regrets in the registry, those regrets covered a somewhat broad range. Psychological distress and the distress over the unavailability of psychological and rehabilitation support were the commonest regrets noted. Among other regrets noted were those regarding cosmesis, surgical complications, residual pain, and lack of education about the procedure. It seems that better preparing women for the potential sequelae might mitigate the impact of some of these outcomes.

46.6 The Plastic Surgeon as Communicator and Educator

The range of decisions with which women are faced as they contemplate breast reconstruction have become ever more complex. Beyond the basic decision to have or not have reconstruction there are decisions about timing (immediate vs. delayed), the reconstruction method in the face of the clinical options available to that particular woman, and personal preferences. The plastic surgeon's role in the education of these patients is deep and broad. It is essential that the plastic surgeon provides each woman with a great deal of information regarding the types of reconstruction options open to her while also being sensitive to listening to her preferences, ascertaining her goals and being tuned into concerns. Lee et al. [31] afforded women in their study an opportunity to comment on what drove their decision for reconstruction, their experience with reconstruction, and how they felt about their decision. Overall, they found that women who felt they had been well prepared and understood what the recovery process would entail seemed most satisfied with their decision. However, women in this study strongly advised that women in future be well informed on all matters of recovery beyond the basic issues of the difficulty of the operation, the length of the surgery, the risks, and the potential problems with flaps. They felt they were far less well informed on matters such as the impact of any possible loss of muscle strength, potential numbness and tingling, potential amount of scarring and of umbilical asymmetry, and potential hernia and advised through their study responses that surgeons cover these matters routinely as well. Although the women in this study expressed satisfaction with their decision to proceed with reconstruction, many expressed the need for more information. Following the analysis of the data generated by the study, Lee et al. suggest that plastic surgeons routinely ask their patents to state their concerns and encourage plastic surgeons to specifically ask patients for their preferences for the reconstruction method, as many women in the study stated that their choice was based solely on what their plastic surgeon recommended, without voicing their own preferences. They encourage a frank discussion on such issues patients may have concerning how they will look both in clothes and out of clothes and whether both are equally important so surgeons are better positioned to ascertain if they will be able meet their patients' expectations.

It would appear that plastic surgeons must be good educators not only for their patients but also for their physician colleagues so that women are referred for a discussion of breast reconstruction options before their ablative surgery. Ananian et al. [32] identified that the women in their study who chose reconstruction more frequently recognized the importance of discussing this decision with a surgeon than those choosing mastectomy alone. Alderman et al. [33] found that of the women in their study who had not had breast reconstruction following mastectomy, only just over 59 % of them felt that they were adequately informed of the breast reconstruction options. Lantz et al. [34], seeking to understand the impact of the ability to be involved in this decision, found that increased involvement played a significant role in satisfaction and avoidance of decision regret . In another study, likewise seeking to understand decision regret, the authors identified that for the almost 50 % of their sample who experienced some level of decision regret that it was associated with low satisfaction with "preparatory information" [10]. In addition to the women who were having their breast reconstruction as a follow-up to their breast cancer surgery, it appears that women having their reconstruction as a part of their prophylactic mastectomy process have shown a need for robust information and education as well. A study by Rolnick et al. [35] specifically asked women what they wish they had known before making their decision. Two-thirds of the women reported wishing that they had had more information, with most of the comments regarding insufficient information related to the longevity of implants, the look and feel of the implants, and possible complications (e.g., pain, numbing, and scarring). Women specifically noted that they wished they had known about the rate of implant failure and the possibility of the need for replacement in a shorter than anticipated timeframe. Although it may seem that women might have anticipated the loss of breast sensation, a number of women voiced that they were not prepared for this loss. It would seem that the imperative for robust discussions offering in-depth information has been established. Although the American Society of Plastic

Surgeons has published a well-written booklet for women considering breast reconstruction (*Choices*), it seems clear that it will take meaningful discussions between the surgeon and the woman contemplating reconstructive surgery to ensure that women's informational and educational needs have been met.

46.7 Summary

Research to date seeking to further our understanding of the psychosocial issues related to breast reconstruction has been evaluated to beg for increasing scientific rigor [36]. Winters et al. [36] noted there are inherent limitations in the large group of research studies they reviewed. It appears that there may have been some missed opportunities in the way the research questions were asked, in the timing of the queries (prospective vs. retrospective), and in the design and in the power of the research they evaluated. To date, we may be missing some of the important and enlightening nuances.

Nevertheless, we have learned from prevailing studies, and from clinical practice, that breast reconstruction is an option that meets the needs of and enhances the quality of life of a subgroup of women facing mastectomy. We do not know definitively for which women breast reconstruction feels more necessary to their recovery than others, in part because it is clear that some women are not offered this option or are not offered any information in this domain. It part perhaps owing to methodological issues such as those raised by Winters et al. [36], it has been difficult to perceive the positive psychosocial impact of breast reconstruction between women who have this surgery compared with women with mastectomy alone and compared with women with breast conservation surgery. Yet, we can learn something about the positive psychological impact of breast reconstruction from the distinctions of the experience of women with immediate breast reconstruction versus delayed reconstruction. Therein we see a group of women who are all self-identified as desirous of breast reconstruction. Women with immediate breast reconstruction have reported better body image, self-image, self-esteem, and feelings of attractiveness than women who must wait. In addition, women in the immediate reconstruction groups report less anxiety and depression.

As current research shows, independent of the surgery type, it may take up to 2 years or more for women who have been diagnosed with breast cancer and have had treatment for breast cancer to reclaim their previous level of psychosocial comfort. We in the psychosocial/psychological community must partner with our surgery and plastic surgery colleagues, and ask they seek us out as well, so that together we avail our patients of psychosocial support throughout the trajectory of their breast cancer experience.

References

1. Drageset S, Lindstrom TC, Underlid K (2010) Coping with breast cancer between diagnosis and surgery. J Adv Nurs 66:149–158
2. Renneker R, Cutler M (1952) Psychological problems of adjustment to cancer of the breast. JAMA 148:833–838
3. Vess JD, Moreland JR, Schwebel AI et al (1988) Psychosocial needs of cancer patients: learning from patients and their spouses. J Psychosoc Oncol 6:31–51
4. Northouse LL (1995) The impact of cancer in women on the family. Cancer Pract 3:134–142
5. Wimberly SR, Carver CS, Laurenceau JP et al (2005) Perceived partner reactions to diagnosis and treatment of breast cancer: impact on psychosocial and psychosexual adjustment. J Consult Clin Psychol 73:300–311
6. Ganz PA, Rowland JH, Desmond K et al (1998) Life after breast cancer: understanding women's health- related quality of life and sexual functioning. J Clin Oncol 16:501–514
7. Ganz PA, Guadagnoli E, Landrum MB et al (2003) Breast cancer in older women: quality of life and psychosocial adjustment in the 15 months after treatment. J Clin Oncol 21:4027–4033
8. Rubino C, Figus A, Lorettu L et al (2007) Post-mastectomy reconstruction: a comparative analysis on psychosocial and psychopathological outcomes. J Plast Reconstr Aesthet Surg 60:509–518
9. Tykka E, Asko-Seljavaara S, Hietanen H (2002) Patient satisfaction with delayed breast reconstruction: a prospective study. Ann Plast Surg 49:258–263
10. Sheehan J, Sherman KA, Lam T et al (2007) Association of information satisfaction, psychological distress and monitoring coping style with post-decision regret following breast reconstruction. Psychooncology 16:342–351
11. Hasen KV, Few JW, Fine NA (2002) Plastic surgery: a component in the comprehensive care of cancer patients. Oncology 16:1685–1698
12. Schover LR, Yetman RJ, Tuason LJ et al (1995) Partial mastectomy and breast reconstruction: a comparison of their effects on psychosocial adjustment, body image, and sexuality. Cancer 75:54–64
13. Rowland JH, Desmond KA, Meyerowitz BE et al (2000) Role of breast reconstructive surgery in physical and emotional outcomes among breast cancer survivors. J Natl Cancer Inst 92:1422–1429
14. Nicholson RM, Leinster S, Sassoon EM (2007) A comparison of the cosmetic and psychological outcome of breast reconstruction, breast conserving surgery and mastectomy without reconstruction. Breast 16:396–410
15. Parker PA, Youssef A, Walker S et al (2007) Short-term and long-term psychosocial adjustment and quality of life in women undergoing different surgical procedures for breast cancer. Ann Surg Oncol 14:3078–3089
16. Collins KK, Liu Y, Schootman M et al (2011) Effects of breast cancer surgery and surgical side effects on body image over time. Breast Cancer Res Treat 126:167–176
17. Zhong T, McCarthy C, Min S et al (2011) Patient satisfaction and health-related quality of life after autologous tissue breast reconstruction. Cancer. doi:10.1002/cncr.26417
18. Wellisch DK, Schain WS, Noone RB et al (1985) Psychosocial correlates of immediate versus delayed reconstruction of the breast. Plast Reconstr Surg 76:713–718

19. Dean C, Chetty U, Forrest AP (1983) Effects of immediate breast reconstruction on psychosocial morbidity after mastectomy. Lancet 1:459–462
20. Al-Ghazal SK, Sully L, Fallowfield L et al (2000) The psychological impact of immediate rather than delayed breast reconstruction. Eur J Surg Oncol 26:17–19
21. Roth RS, Lowery JC, Davis J et al (2005) Quality of life and affective distress in women seeking immediate versus delayed breast reconstruction after mastectomy for breast cancer. Plast Reconstr Surg 116:993–1002
22. Wilkens EG, Cederna PS, Lowery JC et al (2000) Prospective analysis of psychosocial outcomes in breast reconstruction: one-year postoperative results from the Michigan Breast Reconstruction Outcome Study. Plast Reconstr Surg 106:1014–1025
23. Atisha D, Alderman AK, Lowery JC et al (2008) Prospective analysis of long-term psychosocial outcomes in breast reconstruction: two-year postoperative results from the Michigan Breast Reconstruction Outcomes Study. Ann Surg 247:1019–1028
24. McGaughey A (2006) Body image after bilateral prophylactic mastectomy: an integrative literature review. J Midwifery Women's Health 51:45–49
25. Payne DK, Biggs C, Tran TN et al (2000) Women's regrets after bilateral prophylactic mastectomy. Ann Surg Oncol 7:150–154
26. Gahm J, Wickman M, Brandberg Y (2010) Bilateral prophylactic mastectomy in women with inherited risk of breast cancer: prevalence of pain and discomfort, impact on sexuality, quality of life and feelings of regret two years after surgery. Breast 19:462–469
27. Boughey J, Hoskin T, Hartmann L et al (2011) Contralateral prophylactic mastectomy: consistency of satisfaction and psychosocial consequences over time. Abstract no. 1693 American Society of Breast Surgeons
28. Brandberg Y, Sandelin K, Erikson S et al (2008) Psychological reaction, quality of life, and body image after bilateral prophylactic mastectomy in women at high risk for breast cancer: a prospective one-year follow-up study. JCO 26:3943–3949
29. Tan MB, Bleiker EM, Menke-Pluymers MB et al (2009) Standard psychological consultations and follow-up for women at increased risk of hereditary breast cancer considering prophylactic mastectomy. Hered Cancer Clin Pract. doi:10.1186/1897-4287-7-6
30. Hatcher MB, Fallowfield L, A'Hern R (2001) The psychosocial impact of bilateral prophylactic mastectomy: prospective study using questionnaires and semi-structured interviews. BMJ 322:76
31. Lee CN, Hultman CS, Sepucha K (2010) What are patients' goals and concerns about reconstruction after mastectomy? Ann Plast Surg 64:567–569
32. Ananian P, Houvenaeghel G, Protiere C et al (2004) Determinants of patients' choice of reconstruction with mastectomy for primary breast cancer. Ann Surg Oncol 11:762–771
33. Alderman AK, Hawley ST, Morrow M et al (2011) Receipt of delayed breast reconstruction after mastectomy: do women revisit the decision? Ann Surg Oncol 18:1748–1756
34. Lantz PM, Janz NK, Fagerlin A et al (2005) Satisfaction with surgery outcomes and the decision process in a population-based sample of women with breast cancer. Health Serv Res 40:745–767
35. Rolnick SJ, Altschuler A, Nekhlyudov L et al (2007) What women wish they knew before prophylactic mastectomy. Cancer Nurs 30:285–291
36. Winters ZE, Benson JR, Pusic AL (2010) A systematic review of the clinical evidence to guide treatment recommendations in breast reconstruction based on patient-reported outcome measures and health-related quality of life. Ann Surg 252:929–942

Aesthetics and Quality of Life After Breast Reconstruction

47

Gabriela dos Santos and Cicero Urban

47.1 Introduction

There are many gaps concerning satisfaction and quality of life of patients undergoing breast cancer treatment. Some authors report high levels of satisfaction with their outcomes, although the findings are limited by the use of different methods and small series [1]. Patient satisfaction is the result of the care and attention given as well as some subjective opinions. The levels of satisfaction also depend on other factors, such as social–economic factors, clinical conditions, and the treatment as a whole, including adjuvant therapy, preservation of the nipple and areola complex (NAC), and contralateral symmetrization [1].

The development of oncoplastic surgery is one of the greatest achievements for the treatment of breast cancer, where better aesthetic outcomes, less psychological damage, and better quality of life are expected. By use of reductive mammaplasty techniques, large areas can be resected for the treatment of large tumors, preserving the breast and keeping the symmetry with the contralateral breast, therefore resulting in satisfactory oncological and aesthetic results.

Subcutaneous mastectomy, preserving or not preserving the NAC and preserving the inframammary crease, is also an excellent option, as it can produce aesthetic outcomes that are better than those achieved with partial resections for some specific cases. When radical mastectomy is indicated, it is important to consider the following procedures: immediate reconstruction with a myocutaneous flap from the abdominal wall (transverse rectus abdominis myocutaneous flap, TRAM flap) or from the latissimus dorsi, or even implants, all of which help improve the physical and psychological well-being of the patient, having a positive impact on quality of life.

The aim of this chapter is to analyze the criteria for aesthetic and quality-of-life evaluation after breast reconstruction.

47.2 Aesthetic and Oncological Results

Randomized trials have shown that conservative breast surgery achieves the same oncological results as for mastectomy in small tumors [2, 3]. Rietjens et al. [4] demonstrated a rate of around 8 % of exiguous margins or compromised ones in patients with T1–T2 tumors undergoing conservative surgery with oncoplastic techniques, a lower percentage compared with the 10 % for patients with T1 tumors from the NSABP B-06 study. Therefore, by using oncoplastic techniques, we can achieve wide margins, which means better control of local recurrence.

A satisfactory oncological result is the most important aim of conservative surgery. Indications for conservative surgery have been reviewed and have included patients with large tumors, who would undergo mastectomy in the past. Nowadays, such patients can undergo conservative procedures using concomitant plastic remodeling techniques and contralateral symmetrization.

Immediate breast reconstruction after mastectomy, preserving or not preserving the NAC, using implants or myocutaneous flaps, associated with surgery of the contralateral breast contributes to better outcomes and patient satisfaction as to her body image, preserving the woman's self-esteem.

Among other things, the aesthetic outcome depends on the size and shape of the breasts, tumor location, and the experience of the person who performs the evaluation. The existing scales do not cover all of these individualized aspects or the patient's opinion (Table 47.1).

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Table 47.1 Examples of methods for the evaluation of aesthetic results

Methods	Parameters used	Scores	Conclusion
Harris scale [5, 32]	Fibrosis, breast retractions, changes in the skin and the matchline effect	0 = none 1 = slight 2 = moderate 3 = severe	Excellent, good, fair, or poor
Breast Cancer Conservative Treatment. cosmetic results (BCCT.core) [8, 9]	Asymmetry, skin color change, and scar visibility		Excellent, good, fair, or poor
Breast Analyzing Tool (BAT) [7, 9]	Asymmetry		Good, fair, or poor
Garbay et al. [13]	Volume and shape of breasts, symmetry, position of the sulcus, and scar	Ranging from 0 (worst result) to 10 (best result)	
Calabrese et al. [14]	Shape, volume, and symmetry	Ranging from 1 (worst result) to 3 (best result)	8–9 = excellent 6–7 = good 4–5 = fair 3 or below = poor

In 1979, Harris et al. [5] evaluated the aesthetic outcomes considering fibrosis, breast retractions, changes in the skin, and the matchline effect. The scoring system was as follows: score 0 for none, 1 for slight, 2 for moderate, and 3 for severe. In addition, other classifications were also used: scar unapparent (0), scar apparent (1), and major tissue loss (2). As a whole, the aesthetic results were classified as 1 for excellent (treated breast nearly identical to untreated breast), 2 for good (treated breast slightly different from untreated breast), 3 for fair (treated breast clearly identical to untreated breast but not seriously distorted), and 4 for poor (treated breast seriously distorted).

Two objective methods were described to assess aesthetic results in breast conservative surgery, Breast Cancer Conservative Treatment. Cosmetic results (BCCT.core) [6] and the Breast Analyzing Tool (BAT) [7]. Both methods evaluate photographic records of the patients. BCCT.core analyzes parameters related to asymmetry, color change, and scar, whereas BAT focuses only on asymmetry.

The BCCT.core program automatically evaluates several indices used for the aesthetic evaluation of breast cancer conservative treatment (asymmetry, skin color change, and scar visibility). BCCT.core then uses artificial intelligence techniques to translate these measures into an overall objective classification of aesthetic results reported to the user as excellent, good, fair, or poor [8, 9]. A former analysis showed that the BCCT.core aesthetic status agreed fairly with the patient perspective, measured by the Breast Conservative Treatment Outcome Scale (BCTOS) aesthetic status [10–12].

The BAT program uses well-defined landmarks (jugulomamillary distance and distances from the nipples to the edge of the breast) and calculates the difference between left and right breasts. This difference in length is multiplied by the difference in surface area and is noted as a percent difference and as a difference factor. The values obtained can be converted to a simplified three-point Harris scale (good, fair, poor) [7, 9].

The BCTOS aesthetic status, constructed by Stanton et al. [12], contains 22 items. It was designed to assess women's subjective evaluation of both the aesthetic and the functional outcome after breast cancer treatment. Patients are instructed to rate each item of the BCTOS questionnaire on a four-point scale evaluating the differences between the treated and the untreated breast (1 for no difference to 4 for large difference). The English version produced a coherent factor structure on 18 items and three internally consistent scales, which are defined as functional status (e.g., shoulder and arm movement, stiffness or pain), cosmetic status (e.g., breast size and texture, breast shape, scar tissue), and breast-specific pain (e.g., breast pain, breast tenderness, and sensitivity) [12].The value of the score of each scale is the mean of the ratings over all the items belonging to this scale [11].

Another method described to evaluate the aesthetic results and modified by Garbay et al. [13], considers the volume and shape of the breast, symmetry, the position of the inframammary crease, and scars (Table 47.2). This instrument seems to be the most complete one from the objective point of view for the evaluation of aesthetic results by experts.

Another scale reported in the literature, developed by Calabrese et al. [14], uses a scoring system that ranges from 1 to 3, and the values of parameters that can be easily identified and quantified by the researcher: shape, volume, and symmetry of the operated on breasts (Table 47.3). A sum of the scores of the three parameters between 8 and 9 was considered excellent, between 6 and 7 was good, between 4 and 5 was fair, and 3 or below was poor. This scoring was reduced by one point every time the following elements were identified: visible scar, NAC badly placed, and visible cutaneous effects from radiotherapy.

Table 47.2 Scale modified by Garbay et al. [13]

Subscale	Category 0	Category 1	Category 2
Volume of breast	Marked discrepancy relative to contralateral side	Mild discrepancy relative to contralateral side	Symmetrical volume
Shape of breast	Marked contour deformity or shape asymmetry	Mild contour deformity or shape asymmetry	Natural or symmetrical contour
Placement of breast	Marked displacement	Mild displacement	Symmetrical and aesthetic placement
Inframammary fold	Poorly defined/not identified	Defined, but with asymmetry	Defined and symmetrical
Breast scars	Poor (hypertrophy, contracture)	Fair (wide scars, poor color match, but without hypertrophy, contracture)	Good (thin scars, good color match)

Table 47.3 Scale for evaluation of aesthetic results

Parameters	Score
Shape	1 2 3
Volume	1 2 3
Symmetry	1 2 3
Rough and visible scar	−1
NAC badly placed	−1
Cutaneous effects from radiotherapy	−1

From Calabrese et al. [14]
NAC nipple and areola complex

Cano et al. [15] recently published a study evaluating results using BREAST-Q with only 66 % adherence, which makes it questionable because the ideal rate would be above 75 % [16]. BREAST-Q, a patient-reported outcome instrument, was developed with strict adherence to recommended international guidelines to address the lack of instruments for breast surgery patients [17]. There are currently four modules (breast reduction, augmentation, reconstruction, and mastectomy without reconstruction), each of which includes a core of independent scales assessing six domains (satisfaction with breasts, satisfaction with overall outcome, psychosocial well-being, sexual well-being, physical well-being, and satisfaction with care). For each item, the use of response categories scored with successive integer scores (e.g., 1 for very dissatisfied to 4 for very satisfied) implies a continuum of increasing satisfaction, from less (very dissatisfied) to more (very satisfied).

47.3 Quality of Life

In 1947, the World Health Organization defined quality of life for the first time as "a state of complete physical, mental and social well-being, not merely the absence of disease or infirmity."

Quality of life is the result of a combination of subjective factors, such as the overall level of satisfaction of an individual with his/her own life, and objective factors, such as material well-being, good family relations, promptness to undergo cancer treatment, and reliability on the medical care; to sum up, various items that provide one with peace, reliability, confidence, and well-being. Quality of life needs to cover all human needs, concerning their physical, psychological, social, and spiritual aspects.

Quality of life must be considered throughout all phases of the treatment of a cancer patient. In fact, all symptoms and problems intrinsically related to cancer and its treatment may affect the patient, and they include limitations in daily activities and toxicity resulting from chemotherapy. Many patients still experience changes concerning their jobs, social relations, physical capability, and role within the family.

As a whole, the findings demonstrate that physicians tend to underestimate functioning incapability, the severity of symptoms, psychological afflictions, and psychiatric morbidity among their patients [18, 19]. So, the use of questionnaires that evaluate quality of life has been a way to discover the functioning, psychological, and social needs of patients.

In the past decade, the psychosocial impact of cancer has become a central aspect concerning both the care of patients and the research on this disease. Much research focuses on specific aspects of quality of life that were formerly neglected, such as body image and sexuality [20, 21]. However, there are still few data taking into consideration the period of the end of the primary treatment and extended life [21]. Some researches suggest that problems involving sexuality are usual [20, 22–24], but there is also a decline in the quality of life, body image, humor, and family relations [24, 25].

Several instruments have been used to evaluate quality of life, but we have noticed that they are general questionnaires that do not assess the specific changes realized and experienced by patients undergoing breast cancer treatment (Table 47.4). We have realized that there are changes concerning the self-esteem, sexuality, and femininity that are not properly and satisfactorily assessed in the questionnaires already described and validated. These general instruments aim to evaluate, in a global way, important aspects related to quality of life (physical, social,

Table 47.4 Examples of instruments for the evaluation of quality of life

Instruments	
SF-36 [33, 35]	Consisting of 11 questions, in a total of 36 items, divided into 8 components: functioning capacity (10 items), physical aspects (4 items), pain (2 items), general health condition (5 items), vitality (4 items), emotional aspects (3 items), mental health (5 items), social aspects (two items) and a question that compares the current health condition with that 1 year before
WHOQOL-100 [27]	Comprising 24 facets scored in six domains: physical health, psychological health, levels of independence, social relationships, environment, and spirituality, religion, and personal belief
EORTC QLQ-C30 [28]	The domains of the functional scale include overall quality of life, physical functioning, role/performance, cognitive functioning, emotional functioning, and social functioning. The three domains of the symptom scale are fatigue, pain, and nausea/vomit. The six simple items are dyspnea, insomnia, loss of appetite, constipation, diarrhea, and financial problems
EORTC QLQ BR-23 [28]	Consisting of 23 questions, incorporated into multi-items to measure side effects of chemotherapy, symptoms related to the arm and the breast, body image, and sexuality. There are simple items to evaluate sexual satisfaction, disturbance due to hair loss, and future perspectives
EORTC Trial 10801 [36]	10 questions related to body image, fear of recurrence, satisfaction concerning the treatment, and the aesthetic results
FACT-B [29]	Includes physical, social, emotional, and functional subscales plus the Breast Cancer Subscale
Rosenberg Self-Esteem Scale [37, 38]	10 questions, with four options for each answer: strongly agree, agree, disagree, or strongly disagree.
State–Trait Anxiety Inventory (STAI) [35]	20-item scale for measuring state anxiety and trait anxiety
Center for Epidemiologic Studies Depression Scale (CES-D) [35]	20-item self-report scale designed to measure the presence and degree of depressive symptoms
RAND 36-Item Health Survey version 1.0 [34, 39]	Divided into 8 dimensions: physical functioning, bodily pain, role limitations due to physical health problems, role limitations due to personal or emotional problems, general mental health, social functioning, vitality (energy/fatigue), and general health perceptions. In addition, it includes a single item providing an indication of perceived changes in health

psychological, spiritual), for instance, the Medical Outcomes Study 36—Item Short Form Health Survey (SF-36) [26], the World Health Organization Quality of Life (WHOQOL) [27], the European Organization for Research and Treatment of Cancer Breast Cancer-Specific Quality of Life Questionnaire (EORTC QLQ-BR23) [28], and Functional Assessment of Cancer Therapy—Breast (FACT-B) [29], and during the climacteric the most relevant ones are the Menopause Specific Quality of Life Questionnaire (MENQOL) [30], the Menopause Rating Scale (MRS) [31], and the Women's Health Questionnaire (WHQ) [32]. These questionnaires have proven reliable.

SF-36 is a multidimensional questionnaire that consists of 11 questions, with a total number of 36 items, divided into eight components: functioning capacity (ten items), physical aspects (four items), pain (two items), overall health condition (five items), vitality (four items), emotional aspects (three items), mental health (five items), social aspects (two items) and a question that compares the current health condition with that of 1 year before. Each component corresponds to a value that ranges from zero to 100, for which zero represents the worst and 100 the best health condition [33, 34]. Nevertheless, this questionnaire has some limitations, such as not including questions concerning sexuality.

WHOQOL-100 is an instrument that covers 24 facets, assessed by 96 questions, and one general health and overall quality of life facet. Each facet is measured with four items with a five-point Likert scale. Twenty-four facets were initially scored in six domains of overall quality of life: physical health, psychological health, levels of independence, social relationships, environment, and spirituality, religion, and personal beliefs [27]. Nowadays, it is well accepted to convert these 24 facets into four domains as described by the WHOQOL group [33]. High facet scores indicate good quality of life, except for the facets pain and discomfort, negative feelings, and dependence on medication or treatments, which are negatively framed. The timeframe of reference is the previous 2 weeks. The reliability and validity [33] are adequate, and the sensitivity of the instrument is high [35].

EORTC QLQ-C30 and BR-23 is a questionnaire translated and validated in 81 languages and it is used in over 3,000 studies all over the world. QLQ-C30 3.0 is the most recent version and it must be used in all new studies. It consists of 30 questions that define five functioning scales, three symptom scales, an overall quality of life item, and six simple items. The scales comprise a single question. EORTC QLQ-C30 is supplemented by specific disease modules, for instance, breast (QLQ BR-23), lung, head, and

Table 47.5 EORTC Trial 10801: quality of life questionnaire [36]

	All of the time	Most of the time	Some of the time	Little of the time	None of the time
1. I feel self-conscious about my appearance	1	2	3	4	5
2. I am bothered by thoughts about the recurrence of cancer	1	2	3	4	5
3. I feel ashamed of my body	1	2	3	4	5
4. I believe that the difficulties with my illness are over	1	2	3	4	5
5. I feel self-conscious about being seen nude by husband/partner	1	2	3	4	5
6. I don't feel like myself	1	2	3	4	5
7. I feel uneasy about my future health	1	2	3	4	5
8. I don't feel as if my body belongs to me	1	2	3	4	5
9. If I should have to be treated again, I should like to have the same therapy	1 certainly 2 probably 3 probably not 4 certainly not				
10. The treated breast resembles the other one	1 very much 2 quite a bit 3 a little 4 not at all				

neck, esophageal, ovary, gastric, and cervical cancer and multiple myeloma. The domains of the functioning scale are overall quality of life (items 29 and 30), physical functioning (items 1–5), role/performance (items 6 and 7), cognitive functioning (items 20 and 25), emotional functioning (items 21–24), and social functioning (items 26 and 27). The three domains of the symptom scale are fatigue (items 10, 12, and 18), pain (items 9 and 19), and nausea/vomit (items 14 and 15). The six simple items are dyspnea (item 8), insomnia (item 11), loss of appetite (item 13), constipation (item 16), diarrhea (item 17) and financial difficulty (item 28). Module BR-23 consists of 23 questions incorporated in multi-item scales to measure side effects from chemotherapy (items 31–34 and 36–38), symptoms related to the arms (items 47–49) and the breast (items 50–53), body image (item 39–42), and sexuality (items 44 and 45). There are simple items to evaluate sexual satisfaction (item 46), disturbance due to hair loss (item 35), and future perspectives (item 43) [28].

EORTC Trial 10801 is a study that evaluated the quality of life of 278 patients, 127 undergoing radical modified mastectomy and 151 undergoing conservative surgery, using a questionnaire with ten questions concerning body image, fear of recurrence, and satisfaction with both the treatment and the aesthetic results [36]. Although this questionnaire has not been validated yet, it seems to be the most adequate to evaluate the satisfaction level of patients undergoing breast cancer treatment (Table 47.5).

FACT-B is designed for self-administration by patients with breast disease, and has been widely used since 1997. FACT-B consists of FACT-General (FACT-G) plus the Breast Cancer Subscale, which complements the general scale with items specific to quality of life in breast cancer. FACT-G includes physical, social, emotional, and functional subscales. Subjects are required to choose the most suitable answer according to each item of each subscale: ''not at all,'' ''a little bit,'' ''somewhat,'' ''quite a bit,'' and ''very much.'' All subscale items are summed to a total, which is the subscale score. All subscales are scored so that a higher score is correlated with a more favorable quality of life, i.e., the higher the score, the better the quality of life [29].

In the past few decades, some scales have been used to measure the patient's level of satisfaction, such as the Rosenberg Self-Esteem Scale, which is widely accepted among the international scientific community [37, 38], through which the patient evaluates herself. The scale is composed of ten questions, with four options for each answer: strongly agree, agree, disagree, or strongly disagree. The scale produces a score that ranges from 0 (best possible self-esteem) to 30 (worst possible self-esteem) [38] (Table 47.6).

Other scales are also reported in the literature are the State Trait–Anxiety Inventory (STAI) and the Center for Epidemiologic Studies Depression Scale (CES-D).

STAI consists of two 20-item scales for measuring state anxiety and trait anxiety [35]. This scale assesses how people feel at a particular moment in time and has a four-point rating scale ranging from 1 (not at all/almost never) to 4 (very much so/almost always).

CES-D is a 20-item self-report scale designed to measure the presence and degree of depressive symptoms over the past week. The rating scale ranges from 1 (seldom or never) to 4

Table 47.6 Rosenberg Self-Esteem Scale [37, 38]

On the whole, I am satisfied with myself
At times I think I am no good at all
I feel that I have a number of good qualities
I am able to do things as well as most other people
I feel I do not have much to be proud of
I certainly feel useless at times
I feel that I'm a person of worth, at least on an equal plane with others
I wish I could have more respect for myself
All in all, I'm inclined to feel that I am a failure
I take a positive attitude toward myself
Choices of answer
Strongly agree
Agree
Disagree
Strongly disagree

The scale produces a score that ranges from 0 (best possible self-esteem) to 30 (worst possible self-esteem)

[(almost) always]. Scores can range from 0 to 60; scores above 16 are suggestive of depressive symptoms [35].

The RAND 36-Item Health Survey version 1.0 is practically identical to SF-36 [34] and evaluates health in eight dimensions: physical functioning, bodily pain, role limitations due to physical health problems, role limitations due to personal or emotional problems, general mental health, social functioning, vitality (energy/fatigue), and general health perceptions. In addition, it includes a single item providing an indication of perceived changes in health. The rationale for these dimensions is that the health concepts are most frequently included in widely used health surveys. The items used to measure the scores per dimension were adapted from instruments that have been used for 20–40 years or longer [34]. Subscale scores are represented on a scale from 0 to 100. A high score indicates a good health status. The timeframe for evaluation of functioning is the previous 4 weeks. RAND-36 has good reliability and validity [39].

47.4 Future Perspectives

To date, the selection of the most valid method to evaluate aesthetic outcome remains challenging.

Future prospective studies should be performed in women submitted to oncoplastic surgery and breast conservative surgery as well as to mastectomy with or without reconstruction to permit comparison of different techniques of breast reconstruction, including TRAM flap, latissimus dorsi flap, free flaps, and breast implant reconstruction [40].

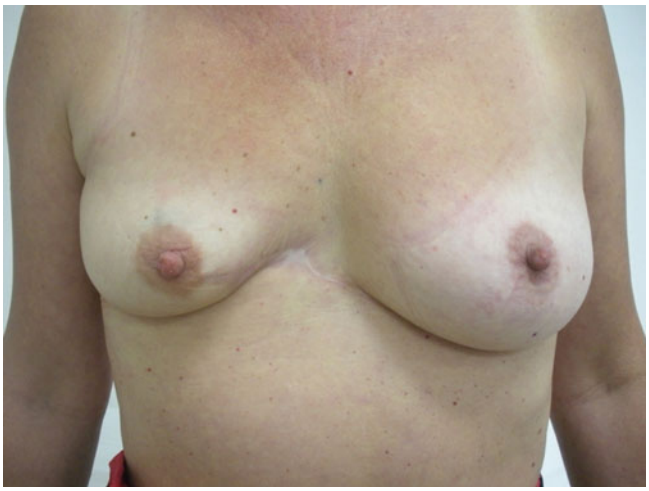

Fig. 47.1 Case 1

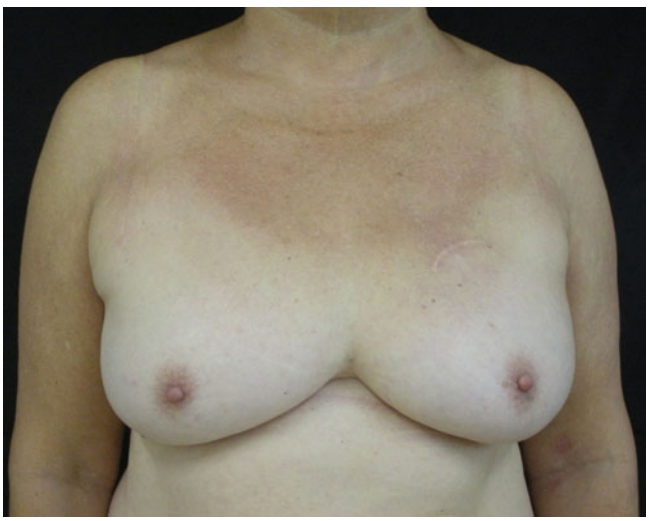

Fig. 47.2 Case 2

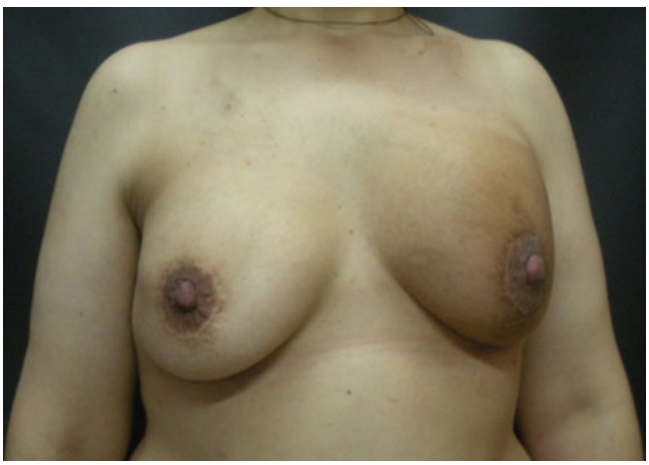

Fig. 47.3 Case 3

Table 47.7 Case 1: scale modified by Garbay et al. [13]

Subscale	Category 0	Category 1	Category 2	Example
Volume of breast	Marked discrepancy relative to contralateral side	Mild discrepancy relative to contralateral side	Symmetrical volume	0
Shape of breast	Marked contour deformity or shape asymmetry	Mild contour deformity or shape asymmetry	Natural or symmetrical contour	0
Placement of breast	Marked displacement	Mild displacement	Symmetrical and aesthetic placement	0
Inframammary fold	Poorly defined/not identified	Defined, but with asymmetry	Defined and symmetrical	1
Breast scars	Poor (hypertrophy, contracture)	Fair (wide scars, poor color match, but without hypertrophy, contracture)	Good (thin scars, good color match)	1
Total score				2
Conclusion				Poor

Table 47.8 Case 1: Calabrese scale [14]

Parameters	Score			Example
Shape	1	2	3	1
Volume	1	2	3	1
Symmetry	1	2	3	1
Rough and visible scar	−1			−1
NAC badly placed	−1			0
Cutaneous effects from radiotherapy	−1			0
Total score				2
Conclusion				Poor

Table 47.9 Case 2: scale modified by Garbay et al. [13]

Subscale	Category 0	Category 1	Category 2	Example
Volume of breast	Marked discrepancy relative to contralateral side	Mild discrepancy relative to contralateral side	Symmetrical volume	2
Shape of breast	Marked contour deformity or shape asymmetry	Mild contour deformity or shape asymmetry	Natural or symmetrical contour	2
Placement of breast	Marked displacement	Mild displacement	Symmetrical and aesthetic placement	2
Inframammary fold	Poorly defined/not identified	Defined, but with asymmetry	Defined and symmetrical	2
Breast scars	Poor (hypertrophy, contracture)	Fair (wide scars, poor color match, but without hypertrophy, contracture)	Good (thin scars, good color match)	1
Total score				9
Conclusion				Excellent

The models described for the evaluation of aesthetic results do not take into consideration the shape of the breasts and the location of the tumor, which are determining factors for the final result. Morbidity, postoperative limitations, and scars in the reconstructions with a TRAM flap, for instance, are not evaluated as well, and they are determining factors for the quality of life of these patients. Another important aspect that must be highlighted is the importance of the patient's perception of her own body image and satisfaction.

There is a need to systematically and objectively evaluate the aesthetic outcome of different surgical and radiotherapy techniques. Therefore, we need to further develop valid approaches to define third-party objective consensus

Table 47.10 Case 2: Calabrese scale [14]

Parameters	Score			Example
Shape	1	2	3	1
Volume	1	2	3	1
Symmetry	1	2	3	1
Rough and visible scar	−1			−1
NAC badly placed	−1			0
Cutaneous effects from radiotherapy	−1			0
Total score				9
Conclusion				Excellent

Table 47.11 Case 3: scale modified by Garbay et al. [13]

Subscale	Category 0	Category 1	Category 2	Example
Volume of breast	Marked discrepancy relative to contralateral side	Mild discrepancy relative to contralateral side	Symmetrical volume	1
Shape of breast	Marked contour deformity or shape asymmetry	Mild contour deformity or shape asymmetry	Natural or symmetrical contour	1
Placement of breast	Marked displacement	Mild displacement	Symmetrical and aesthetic placement	1
Inframammary fold	Poorly defined/not identified	Defined, but with asymmetry	Defined and symmetrical	1
Breast scars	Poor (hypertrophy, contracture)	Fair (wide scars, poor color match, but without hypertrophy, contracture)	Good (thin scars, good color match)	1
Total score				5
Conclusion				Fair

Table 47.12 Case 3: Calabrese scale [14]

Parameters	Score			Example
Shape	1	2	3	1
Volume	1	2	3	1
Symmetry	1	2	3	1
Rough and visible scar	−1			−1
NAC badly placed	−1			0
Cutaneous effects from radiotherapy	−1			0
Total score				2
Conclusion				Poor

on aesthetic outcome and to promote real objective assessment on this basis [10].

47.5 Clinical Cases

The aesthetic results were evaluated for three cases (Figs. 47.1, 47.2, 47.3) using two models: the scale modified by Garbay et al. [13] (Tables 47.7, 47.9, and 47.11 for cases 1, 2, and 3, respectively) and the Calabrese scale (Tables 47.8, 47.10, and 47.12 for cases 1, 2, and 3, respectively).

In case 3, there was a difference in the results using the two instruments, which draws our attention to the difference between the methods and the need for a wider and more uniform scale.

References

1. Guyomard V, Leinster S, Wilkinson M (2007) Systematic review of studies of patients' satisfaction with breast reconstruction after mastectomy. Breast 16(6):547–567

2. Veronesi U, Cascinelli N, Mariani L et al (2003) Twenty-year follow-up of a randomized study comparing breast-conserving surgery with radical mastectomy for early breast cancer. N Engl J Med 347:1227–1232
3. Fisher B, Anderson S, Bryant J et al (2003) Twenty-year follow-up of a randomized trial comparing total mastectomy, lumpectomy, and lumpectomy plus irradiation for the treatment of invasive breast cancer. N Engl J Med 347:1233–1241
4. Rietjens M, Urban CA, Rey PC, Mazzarol G, Maisonneuve P, Garusi C, Intra M, Yamaguchi S, Kaur N, De Lorenzi F, Matthes AG, Zurrida S, Petit JY (2007) Long-term oncological results of breast conservative treatment with oncoplastic surgery. Breast 16(4):387–395
5. Harris JR, Levene MB, Svensson G, Hellman S (1979) Analysis of cosmetic results following primary radiation therapy for stages I and II carcinoma of the breast. Int J Radiat Oncol Biol Phys 5:257–261
6. Cardoso MJ, Cardoso J, Amaral N, Azevedo I, Barreau L, Bernardo M, Christie D, Costa S, Fitzal F, Fougo JL, Johansen J, Macmillan D, Mano MP, Regolo L, Rosa J, Teixeira L, Vrieling C (2007) Turning subjective into objective: the BCCT.core software for evaluation of cosmetic results in breast cancer conservative treatment. Breast 16(5):456–461
7. Fitzal F, Krois W, Trischler H, Wutzel L, Riedl O, Kühbelböck U, Wintersteiner B, Cardoso MJ, Dubsky P, Gnant M, Jakesz R, Wild T (2007) The use of a breast symmetry index for objective evaluation of breast cosmesis. Breast 16(4):429–435
8. Cardoso JS, Cardoso MJ (2007) Towards an intelligent medical system for the aesthetic evaluation of breast cancer conservative treatment. Artif Intell Med 40(2):115–126
9. Cardoso MJ, Cardoso JS, Wild T, Krois W, Fitzal F (2009) Comparing two objective methods for the aesthetic evaluation of breast cancer conservative treatment. Breast Cancer Res Treat 116(1):149–152
10. Heil J, Carolus A, Dahlkamp J, Golatta M, Domschke C, Schuetz F, Blumenstein M, Rauch G, Sohn C (2012) Objective assessment of aesthetic outcome after breast conserving therapy: subjective third party panel rating and objective BCCT.core software evaluation. Breast 21(1):61–65
11. Heil J, Holl S, Golatta M, Rauch G, Rom J, Marme F et al (2010) Aesthetic and functional results after breast conserving surgery as correlates of quality of life measured by a German version of the Breast Cancer Treatment Outcome Scale (BCTOS). Breast 19:470–474
12. Stanton AL, Krishnan L, Collins CA (2001) Form or function? Part 1. Subjective cosmetic and functional correlates of quality of life in women treated with breast-conserving surgical procedures and radiotherapy. Cancer 91:2273–2281
13. Garbay JR, Rietjens M, Petit JY (1992) Esthetic results of breast reconstruction after amputation for cancer. 323 cases. J Gynecol Obstet Biol Reprod (Paris) 21(4):405–412
14. Calabrese C et al (2001) Immediate reconstruction with mammaplasty in conservative breast cancer treatment: long-term cosmetic results. Osp Ital Chir Rome 7(1–2):38–46
15. Cano SJ, Klassen AF, Scott AM, Cordeiro PG, Pusic AL (2012) The BREAST-Q: further validation in independent clinical samples. Plast recontr surg 129(2):293–302
16. Pusic AL, Klassen AF, Scott AM, Klok JA, Cordeiro PG, Cano SJ (2009) Development of a new patient-reported outcome measure for breast surgery: the BREAST-Q. Plast Reconstr Surg 124(2):345–353
17. Pusic A, Chen C, Cano S et al (2007) Measuring quality of life in cosmetic and reconstructive breast surgery: a systematic review of patient-reported outcomes instruments. Plast Reconstr Surg 120:823–837
18. Conde DM et al (2005) Quality of life in Brazilian breast cancer survivors age 45–65 years: associated factors. Breast J 11(6): 125–132
19. Casso D, Buist D, Taplin S (2008) Quality of life of 5–10 years breast cancer survivors diagnosed between age 40 and 49. Eur Jour of Oncol Nurs 12:53–57
20. Sheppard LA, Ely S (2008) Breast cancer and sexuality. Breast J 14(2):176–181
21. Hormes JM, Lytle LA, Gross CR, Ahmed RL, Troxel AB, Schmitz KH (2008) The body image and relationships scale: development and validation of a measure of body image in female breast cancer survivors. J Clin Oncol 26(8):1269–1274
22. Beckjord E, Campas BE (2007) Sexual quality of life in women 19 with newly diagnosed breast cancer. J Psychosoc Oncol 25(2): 19–36
23. Broeckel JA, Thors CL, Jacobsen PB, Small M, Cox CE (2002) Sexual functioning in long-term breast cancer survivors treated with adjuvant chemotherapy. Breast Cancer Res Treat 75(3): 241–248
24. Spagnola S, Zabora J, Brintzenhofeszoc K, Hooker C, Cohen G, Baker F (2003) The satisfaction with life domains scale for breast cancer (SLDS-BC). Breast J 9(6):463–471
25. Ganz PA, Kwan L, Stanton AL, Krupnick JL, Rowland JH, Meyerowitz BE et al (2004) Quality of life at the end of primary treatment of breast cancer: first results from the moving beyond cancer randomized trial. J Natl Cancer Inst 96(5):376–387
26. Ciconelli RM, Ferraz MB, Santos W et al (1999) Brazilian-Portuguese version of the SF-36. A reliable and valid quality of life outcome measure. Rev Bras Reumatol 39:143–150
27. WHOQOL Group (1998) The World Health Organization Quality of Life Assessment (WHOQOL): development and general psychometric properties. Soc Sci Med 46:1569–1585
28. Sprangers MA, Groenvold M, Arraras JI, Franklin J, te Velde A, Muller M et al (1996) The European Organization for Research and Treatment of Cancer breast cancer-specific quality-of-life questionnaire module: first results from a three-country field study. J Clin Oncol 14(10):2756–2768
29. He ZY, Tong Q, Wu SG, Li FY, Lin HX, Guan XX (2011) A comparison of quality of life of early breast cancer patients treated with accelerated partial breast irradiation versus whole breast irradiation in China. Breast Cancer Res Treat 133(2):545–552
30. Hilditch JR, Lewis J, Peter A, van Maris B, Ross A, Franssen E et al (1996) A menopause-specific quality of life questionnaire: development and psychometric properties. Maturitas 24(3): 161–175
31. Hauser GA, Huber IC, Keller PJ, Lauritzen C, Schneider HP (1994) Evaluation of climacteric symptoms (Menopause Rating Scale). Zentralbl Gynakol 116(1):16–23
32. Hunter M (1992) The Women's Health Questionnaire: a measure of mid-aged women's perceptions of their emotional and physical health. Psychol Health 7(1):45–54
33. Power M, Harper A, Bullinger M (1999) The World Health Organization WHOQOL-100: tests of the universality of quality of life in 15 different cultural groups worldwide. Health Psychol 18:495–505
34. Ware JE Jr, Sherboune CD (1992) 36-item short-form health survey (SF-36). I: Conceptual framework and item selection. Med Care 30:473–483
35. Den Oudsten BL, Van Heck GL, Van der Steeg AF, Roukema JA, De Vries J (2009) The WHOQOL-100 has good psychometric properties in breast cancer patients. J Clin Epidemiol 62(2): 195–205
36. Curran D, van Dongen JP, Aaronson NK, Kiebert G, Fentiman IS, Mignolet F, Bartelink H (1998) Quality of life of early-stage breast cancer patients treated with radical mastectomy or breast-

conserving procedures: results of EORTC Trial 10801. Eur J Cancer 34(3):307–314
37. Dini GM et al (2004) Translation into Portuguese, cultural adaptation and validation of the Rosenberg Self-Esteem Scale. Rev Soc Bras Cir Plast 19:47–52
38. Veiga DF, Veiga-Filho J, Ribeiro LM, Archangelo I Jr, Balbino PF, Caetano LV, Novo NF, Ferreira LM (2010) Quality-of-life and self-esteem outcomes after oncoplastic breast-conserving surgery. Plast Reconstr Surg 125(3):811–817
39. Van Der Steeg AF, De Vries J, Roukema JA (2008) The value of quality of life and health status measurements in the evaluation of the well-being of breast cancer survivors. Eur J Surg Oncol 34(11):1225–1230
40. Freitas-Silva R, Conde DM, de Freitas-Júnior R, Martinez EZ (2010) Comparison of quality of life, satisfaction with surgery and shoulder-arm morbidity in breast cancer survivors submitted to breast-conserving therapy or mastectomy followed by immediate breast reconstruction. Clinics (Sao Paulo) 65(8):781–787

Oncoplastic and Reconstructive Surgery: Qualifications, Limits, and Mentoring

48

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48.1 Introduction

There has been major progress in breast cancer surgery over the past few decades. Conceptually, it must now be performed with special attention to cosmetic results and the quality of life of the patients. Disfiguring and mutilating surgical procedures can no longer be biologically and oncologically justified for most patients under screening programs. In this way, oncoplastic surgery is a necessary evolution and a final refinement of breast cancer surgery. It combines oncologic and plastic surgery techniques in order to improve the final aesthetic outcomes. It includes appropriate oncologic surgery, immediate reconstruction using the full range of all available plastic surgery techniques, and immediate correction of contralateral breast symmetry, whenever indicated [1–10].

The original concept of oncoplastic surgery and the philosophy of work is already consolidated since there are no significant changes in basilar oncologic principles. Local control in terms of margins and surgical care is the same as in breast-conserving treatment and mastectomy. This advance is now the standard practice in many centers in different countries [1–7].

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Three important facts are considered as the main reasons for a change in the system of breast surgery training. The first one is that most breast cancer patients do not receive any kind of breast reconstruction. The classic model "breast surgeon–plastic surgeon working together in all cases" works very well but is clearly not sufficient to cover all of the new breast cancer cases. The second one is that immediate breast reconstruction with volume displacement and replacement techniques has better oncologic results in breast-conserving surgery in terms of margins, lower index of re-excisions, better local control of disease, and positive results regarding radiotherapy planning, particularly for the group of patients with gigantomastias. Although there have been few studies in oncoplastic surgery (most of them are series of cases or retrospective cohorts of patients), it is clear that the combination of plastic surgery techniques and breast-conserving surgery do not compromise clear excision margins nor the long-term oncologic results. Moreover, immediate breast reconstruction has better aesthetic outcomes than delayed breast reconstruction after conservative surgery and mastectomies. The third one, and perhaps the most important of them, is the cultural and psychological representation of the breast in postmodern society. Patients with pronounced asymmetry after breast cancer surgery are more likely to feel significantly stigmatized. They have more fear of death, increased psychosocial problems due to loss of their femininity, more depressive symptoms, and, consequently, more harm to their quality of life independent of their chances of cure [6, 8, 10].

So, this new arrangement is perfectly well justified. Fellowships need to expand the current curriculum in order to create a new specialist surgeon who performs all kinds of reconstructions—the so-called oncoplastic surgeon. Of course, a single surgeon with both oncologic and reconstructive backgrounds requires special training in cross-specialty techniques to undertake all these procedures to the highest standard and with new responsibilities and new medicolegal implications. The aim of this chapter is to address the qualifications and limits in oncoplastic surgery training and practice.

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48.2 Who is the Oncoplastic Surgeon?

The new generation of breast surgeons should be oncoplastic surgeons. In other words, oncoplastic surgeons are the specialist breast surgeons. Although there is controversy in some countries as to whether breast surgeons or plastic surgeons should perform breast reconstruction, the breast is an aesthetic–functional organ, and surgeons who perform breast surgery should also consider the aesthetic and functional outcomes in all their procedures on the breast. Even those breast surgeons who work together with plastic surgeons can perform high-quality surgery if they have broader skills in techniques related to plastic surgery of the breast. On the other hand, plastic surgeons who have deeper knowledge of all oncologic aspects of breast surgery work better with integration in breast teams. Moreover, there is no longer a clear limit between the aesthetic and the oncologic aspects in breast oncologic surgery.

It is necessary to develop international standards for training and a special qualification for oncoplastic surgery. Fellows eligible for acceptance into a comprehensive breast cancer training program for oncoplastic surgery can be specialists from gynecology, general surgery, and plastic and reconstructive surgery. The real aim of this new model is to expand high-quality breast reconstruction in order for it to be available to most breast cancer patients.

48.3 Breast Training Competences in Oncoplastic Surgery

An oncoplastic surgery fellowship training curriculum must be multidisciplinary and include knowledge from various breast cancer correlated disciplines, such as molecular biology and genetics, anatomy and physiology, epidemiology, bioethics and legal medicine, medical photography, radiology, pathology, radiotherapy, and clinical oncology. This knowledge is the basis for breast cancer surgery decisions.

Regarding specifically oncoplastic surgery , there are three major topics to be covered in the training of oncoplastic surgeons: developing specific surgical skills, ethics, and openings for research opportunities.

48.3.1 Developing Skills

Oncoplastic surgeons should be well trained and competent in all aspects of breast oncology and oncologic surgery of the breast, have broad understanding of breast defects and all their reconstructive requirements, have competence in almost all breast reconstructive techniques, and be proficient in prevention and care of all of the potential complications [6].

There is no formal training of breast surgeons in breast reconstruction techniques, and training differs over the world. Competence in performing these surgical procedures needs to be graduated in a specific classification in order to standardize training programs. The classification proposed here is based on different levels of competence:

- *Level I*. Monolateral and displacement techniques: aesthetic skin incisions, deepithelization of the areola margins, glandular mobilization and reshaping techniques, purse-string sutures for central quadrant reconstruction
- *Level II*. Bilateral and replacement techniques: breast reduction (inferior and superior pedicles, and round-block techniques), mastopexy, Grisotti flap, nipple and areola reconstruction
- *Level III*. Expander/Implant techniques: immediate breast reconstruction with temporary expanders or implants, and contralateral symmetrization
- *Level IV*. Autologous flap techniques: pedicled or free flaps, or a combination of techniques

Since most breast cancer patients need level I–III techniques, it is highly recommended that the basic surgical training of oncoplastic surgeons be in these competences. Specific competence in plastic surgery techniques of the breast is not required at level I, since general surgeons, working only on the compromised breast, do most of these procedures now. Level II requires specific competence in reduction mammoplasty techniques in order to repair major partial defects after breast-conserving surgery, and to achieve better symmetry of the contralateral breast whenever necessary. Level III requires competence in indications, surgical techniques, and management of complications with breast implants. A high standard of knowledge of different qualities of implants is necessary in order to individually select which patient is better served with which implant.

If surgeons are well trained in immediate breast reconstruction with expander/implants, in superior and inferior pedicle breast reductions, and in round-block techniques, they will be able to solve more than 90 % of their cases. So, level IV competence (with flaps) will require advanced surgical training.

The real point to consider is how to set the limits for this new discipline, which is translational among different specialties. The challenge is to train surgeons to be competent in all these techniques in order to achieve high-quality breast surgery for most breast cancer patients, reducing the differences between different centers. Surgeons must be able to recognize their own limits using this classification.

Since there is increasing demand for training in oncoplastic surgery techniques, and breast surgeons have different backgrounds and work in different scenarios, it is

difficult to establish a minimal number of cases per surgeon. Evidence-based training in oncoplastic surgery is more complex to implement than it was before the introduction of sentinel node biopsy. Here the numbers of techniques involved are numerous, and many of them are not part of regular training in general surgery.

The training of the new generation of breast surgeons must include at least the first three levels of competence in the curriculum in order to solve most breast cancer cases. At least 20 cases per technique per surgeon under supervision in accredited breast units and/or in cadavers is recommended as a learning curve.

48.3.2 Ethics

The demands and expectations of patients tend to be higher with oncoplastic surgery. Although delay in the diagnosis of breast cancer remains the commonest reason why breast specialists are sued for malpractice in the USA, there is a potential for increasing issues in oncoplastic surgery. The appearance of the breast is becoming a critical component in breast cancer treatment for patients. It is expected that medicolegal analysis will change with these advances. The essential and central element is the duty of the breast surgeon to obtain a good aesthetic outcome without compromising oncologic control. Basically, the oncologic scenario is easy to document and analyze individually in a medicolegal scenario as it is standardized now: mastectomy versus conservative indications, local control with clear margins, and right adjuvant and neoadjuvant treatment indications. The reconstructive part of oncoplastic surgery is the new and real great difference in the medicolegal analysis. It is clear that oncoplastic surgery is not like aesthetic surgery in terms of outcomes and judgments. It is both an oncologic and a reconstructive procedure, not a purely aesthetic breast surgery. It has all the oncologic limits in its background and the aim is not only aesthetics. All the limitations must be included in the informed consent in order to avoid errors of interpretation and communication between the surgeon and the patient. Of course, the integration of plastic surgery techniques with oncologic breast surgery will potentially improve aesthetic outcomes, but it will add new responsibilities for the surgeon too. Regular protocols and respect of levels of individual competences and limits may avoid both additional risks to the patients and increasing liability.

48.3.3 Research

There are many research opportunities to be explored in oncoplastic surgery, such as how improve oncoplastic surgery training, how to decrease re-excision rates, how to decrease complication rates, how to decrease recurrence rates, how to optimize operating room time, how to optimize aesthetic outcomes, how to reduce costs of treatment, and analysis of the aesthetic and psychological benefits of the techniques.

48.4 Surgical Mentoring

Mentoring, according to Rombeau et al. [11], is the provision of personal and professional guidance, usually to younger surgeons. Education and growth in surgery is highly dependent on this old process, maybe more than in other disciplines in medicine. The complete concept of mentoring, according to these authors, has three basic characteristics related to the mentor's personality and ability to teach and evaluate the technical skills of a trainee: experience, trust, and commitment. Recent changes in breast surgery with the advent of oncoplastic techniques in the past two decades are bringing different methods of mentoring and require new strategies in teaching and setting limits for the mentee.

Leaders in oncoplastic surgery have an important role, and are an important part of the future of breast surgery. There is worldwide interest in the career benefits of breast surgery with these new opportunities in oncoplastic surgery. There are also challenges that are completely different from the traditional surgical mentoring process. There is no standard and no consensus between breast surgery societies and plastic surgery societies all over the world on how to establish training programs, and concurrently there are an emerging number of surgeons who are now interested in learning these techniques [12] So, it is time to revisit our pedagogical way of teaching and a lack of formal guidelines in mentoring oncoplastic surgeons.

There are three generations of oncoplastic surgeons. The first were the pioneers who began to do these surgical procedures between 1980 and 1990, most coming from Europe after the consolidation of breast-conserving treatment. The next were young breast surgeons who trained with the pioneers or went to progressive plastic surgery departments to obtain specific training in plastic and reconstructive techniques. The third generation is the new breast surgeons who are now receiving this background in their regular training as a specialty, as in Brazil, or as a subspecialty in plastic surgery or in general surgery, as in the UK. Between the second and third generations, however, there is an important gap.

This group in the gap is surgeons who perform most breast cancer surgical procedures all over the world and have had no specific training in oncoplastic techniques or are not able to offer breast reconstruction to most of their patients because of difficulties or unavailability of plastic

surgeons to work with them. Many of these surgeons are now looking for training opportunities in short or intensive courses in order to learn techniques that can help them with their patients. They are not young residents or fellows, but are already specialized surgeons, with different degrees of experience and technical skills in breast surgery. How do we provide practical guidance for mentors of oncoplastic surgeons to guide these colleagues? What is the philosophy behind oncoplastic surgery and its implications for mentoring? What are the limitations for these different courses? How do we set the limits? These are the unsolved, although fundamental, questions for breast surgery in the next few years.

The basic question is what oncoplastic surgery is and what the philosophy behind it is According to Werner Audretsch, the German surgeon who originally coined the term, oncoplastic surgery is tumor-specific immediate breast reconstruction [13]. So, it is not considered a new specialty. It is a gray zone between plastic surgery and breast surgery, a common area of interest for both specialties. It does not make sense anymore to discuss who should do oncoplastic surgery (and consequently who should not do it), because even plastic surgeons who have training in all reconstructive techniques should now have experience in all breast cancer treatments and their consequences in order to decide on the best approach for each individual patient. They cannot think only in terms of aesthetics anymore. At the same time, breast surgeons have an oncologic background, but usually do not have training or experience in plastic and reconstructive techniques. However, they should not be limited only to oncologic outcomes. This fragmented approach leads to negative consequences in an organ that is aesthetic and functional and to negative consequences for the patient's quality of life. Most breast cancer patients are currently not undergoing breast reconstruction, even in developed countries. In contrast, oncoplastic surgery is a translational way of doing breast surgery, by one surgeon, or by a team. Breast reconstruction should be integral to breast cancer treatment for most patients, not an option [2, 3, 6, 8, 12–14].

Considering that oncoplastic surgery is a group of techniques for breast cancer treatment concerned with oncologic and aesthetic outcomes, and that there are many differences in breast surgery training worldwide, our focus should be on how to achieve individualized skills in different techniques. In countries such as Brazil, breast surgery (which is coined "mastology") is a specialty, so naturally the Brazilian Society of Mastology is now including oncoplastic surgery in residency training programs, and mentors are adapting themselves to this new reality. In the UK, oncoplastic surgery is a subspecialty and belongs to plastic surgery and general surgery, and in the USA, breast surgery is part of a general surgery background [2, 3, 8, 12, 13]. All of these different approaches have particular challenges for training surgeons.

We should establish a universal mentoring culture for oncoplastic surgery . In previous eras, a single mentor characterized mentoring of young surgeons. Multiple mentors have become the dominant surgical model for most surgical specialties in a world of limited time [11]. In oncoplastic techniques, it is quite different. We are mentoring residents, fellows, and specialized surgeons of different ages and levels of experience. Particularly, surgeons who perform breast surgical procedures should be skilled in oncologic techniques and principles, mammoplasty techniques (basically superior and inferior pedicles and round block), implants, and flaps. Some countries offer more facilities for training directly with patients in the operating room, others with cadaver laboratories. There is no universal pattern for mentoring oncoplastic surgeons as there is in other specialties. A single oncoplastic surgeon could be more effective as a mentor than a team in some situations, although in others a team would be more appropriate.

Do short courses solve the problem? Of course they do not. But they are important because they help surgeons to learn some techniques, refine other ones, and increase their interest in learning oncoplastic surgery in order to improve their practice. However, they does not provide a complete oncoplastic surgery background because mentoring is necessary. Oncoplastic surgery is more than learning in an operating room or in a cadaver laboratory. It is well-planned surgery, and in order to properly learn the techniques, it is necessary for preoperative evaluation to be taught during the breast marking and the decision making process. After the operation, we should deal with specific complications (and how to solve them), which are different from lumpectomy, mastectomy, axillary dissection, or sentinel node biopsy complications. But how should we mentor oncoplastic surgeons, and for how long? This depends on the previous surgical background of the mentee, and it is difficult to establish a standard norm. Oncoplastic surgery is more subjective than other surgical disciplines or regular residency training. The learning curve should be individualized for each technique and for each surgeon, not for oncoplastic surgery in general, because it is not a new specialty, but a surgical refinement of conservative and radical approaches in breast cancer surgery. Mentors should identify technical limits and establish the borders for their mentees using a model of levels of competence. Objective variables of technical skills should be based on competency-based training.

48.5 Conclusions

It is necessary to ensure the safe introduction of oncoplastic surgery into surgical practice. Surgeons have two important aims to address in this new reality: to perform good local control of disease and to focus on the quality of life of all breast cancer patients. The quality of life is a matter of breast surgery decisions at the moment of breast cancer diagnosis. So the curriculum in breast surgery must expand the limits and the responsibilities in order to better change the reality of breast cancer patients. There is an exciting future for mentoring oncoplastic surgeons. Instruments for performance assessment will be Internet-based, simulating real cases, with virtual reality and telementoring. Finally, oncoplastic surgery is completely reshaping breast cancer surgery. But the way that this is accomplished will depend on how mentors help the present and future generations of surgeons bridge the gap. Overall, mentoring must be individualized, ethically founded, and committed to present and future patients, to mentees, and to new potential areas for research.

References

1. Clough KB, Lewis JS, Fitoussi A, Faulcoult MC (2003) Oncoplastic techniques allow extensive resections for breast-conserving therapy of breast carcinomas. Ann Surg 237:26–34
2. Skillman JM, Humzah MD (2003) The future of breast surgery: a new subspecialty of breast surgeons? The Breast 12: 161–163
3. Rainsbury RM, Brown JP (2001) Specialization in breast surgery: options of UK higher surgical trainees. Ann R Coll Surg Engl 83(Suppl):298–301
4. Kaur N, Petit JY, Rietjens M et al (2005) Comparative study of surgical margins in oncoplastic surgery and quadrantectomy in breast cancer. Ann Surg Oncol 12:1–7
5. Rietjens M, Urban CA, Rey PC et al (2007) Long-term oncological results of breast conservative treatment with oncoplastic surgery. Breast 16:387–395
6. Urban CA (2008) New classification for oncoplastic procedures in breast surgery. The Breast 17:321–322
7. Munhoz AM, Aldrighi CM, Ferreira MC (2007) Paradigms in oncoplastic breast surgery: a careful assessment of the oncological need and esthetic objective. Breast J 13:326–327
8. Losken A, Nahabedian M (2009) Oncoplastic breast surgery: past, present, and future in the United States. Plast Reconstr Surg 124:969–972
9. Losken A, Hamdi M (2009) Partial breast reconstruction: current perspectives. Plast Reconstr Surg 124:722–736
10. Waljee JF, Hu ES, Ubel PA et al (2008) Effect of esthetic outcome after breast-conserving surgery on psychosocial functioning and quality of life. J Clin Oncol 26:3331–3337
11. Rombeau J, Goldberg A, Loveland-Jones C (2010) Surgical mentoring: building tomorrow's leaders. Springer, New York
12. Urban CA (2010) Oncoplastic in US: a Brazilian perspective in an American problem. Plast Reconst Surg 125:1839–1841
13. Audretsch WP, Rezai M, Kolotas C, Zamboglou N, Schnabel T, Bejar H (1998) Tumor specific immediate reconstruction in breast cancer patients. Persp Plast Surg 11:71–100
14. Clough KB, Kroll SS, Audretsch W (1999) An approach to the repair of partial mastectomy defects. Plast Reconst Surg 104: 409–420

Bioethics and Medicolegal Aspects in Breast Cancer Reconstruction

49

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49.1 Introduction

The integration of bioethics in reconstructive breast cancer surgery is essential, because few diseases represent such complexity from the scientific, psychological, therapeutic, ethical, and social points of view as breast cancer. Surgeons who are dedicated to this delicate field of work face daily situations that demand great sensitivity and deep bioethical and medicolegal analysis.

Bioethics is one of the most dynamic emerging fields of philosophy applied to professional praxis and research in biotechnology and in medical practice. Although bioethics was born in the USA in 1970, in Brazil and in Latin America it appeared only in the mid-1980s, and is considered now as late bioethics within the global scenario. Yet, it has been assuming increasing importance among the main specialized medical societies and medical associations. That is because of its relationship with both individual and professional dilemmas that affect health professionals, legislators, and citizens. This chapter considers the most relevant bioethical issues and medicolegal aspects concerning breast cancer treatment, with a special focus on breast reconstruction.

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49.2 Current Concept

The concept that has come the closest to the ideal that bioethics proposes was elaborated by Reich in 1995 in his *Encyclopedia of Bioethics*: "A systematic study of the moral dimensions—including moral visions, decisions, conduct, and policies—of the life sciences and health care, employing a variety of ethical methodologies in an interdisciplinary setting" [1].

Bioethics must be considered a tool for medical decision-making, although being interdisciplinary is its most important characteristic. This is what makes it different from classical medical ethics, which is traditionally marked by an almost exclusive emphasis on the physician–patient relationship. This deontological approach has proven to not be enough to encompass the emerging situations that have arisen in the past few decades [2]. Thus, the domains of medical ethics and today's deontology interact with bioethics for the resolution of conflicts in research, public health, and internal medicine.

49.3 Bioethics and Research in Breast Cancer

Breast cancer is one of the most currently researched diseases involving human subjects. The ethical regulations that govern such research were developed from events that raised great concern among the academic community because of history, such as the research performed by Nazi physicians and by the American postwar physicians, especially those in the study of Tuskegee, in the state of Alabama [1, 3].

One of the main bioethical elements found in the regulations for research involving humans is the expectation that the knowledge and advances produced will ideally lead to the well-being of all humanity. Therefore, a moral principle in research with humans is respect for human dignity. Two components must be highlighted here. The first one is the choice of subjects for research, aiming to provide the subjects

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themselves and other groups with benefits, and also for the advance of science. The second one is the use of morally acceptable means to reach the same ends. The key point in moral objections to research is using another human as a means to legitimate ends. It is unacceptable to treat people as a means or an object. Such an attitude harms the dignity that is innate to humans, as it also downgrades the medical professionals, researchers, and humanity as a whole [3–5].

Risks in research must be interpreted from the bioethical principle of no harm, that is, the duty of forecasting or avoiding harm to the subjects involved in research. They must not be involved in unnecessary risks. Research with humans must be beneficial to society as a whole, but also to the subjects themselves. That means that all patients with breast cancer involved in research need to benefit as well [3–5]. Umberto Veronesi stated that "*si cura meglio dove si fà ricerca*," which means "we can treat patients better where we can perform research." It is necessary that this principle be respected and advocated by members of the institutional review board and also by the sponsors involved and by the researchers themselves.

The ethical approach to this research needs to center on the patient with cancer. Sometimes the expectations, interests, and hopes of the patient in research are not proportional to the real benefits. In order for their free and clear consent to be established in its full potential, the transmission of information must be technically adequate, individualized, and in clear language. Therefore, a positive and collaborative relationship between the researcher and the research subject is established. Considering patients with breast cancer, it is important to highlight the vulnerability existing among patients diagnosed with a serious, chronic, and potentially mutilating disease. These patients demand special attention as to free and clear consent in order to respect their autonomy.

Research in breast surgery that involves patients either directly or indirectly (e.g., those researches who use health records or test results) must follow the principles specified in international recommendations such as the Helsinki Declaration, the Norms for Good Clinical Practice, and the Human Rights Declaration. Research protocols must go through the approval of an institutional review board, in agreement with each country's standards. Research involving areas such as genetics, human reproduction, and research with new drugs with the cooperation of industry need special attention in order to protect patients, and prevent them from being the subject of exploitation in research that involves significant conflict of interest, especially in developing countries and vulnerable populations [5]. Particularly, in breast reconstruction research, patients should be respected in regard to their privacy, with special care taken with photographs.

49.4 Breast Cancer and Public Health Care

The remarkable American bioethicist Daniel Callahan has severely criticized the ways of Western medicine. He argues that one of Western medicine's main problems is setting unlimited horizons for its range of work. This lack of limits and the uncontrolled expansion (even disregarding the health–disease relationship) end up resulting in an increase of medical care costs that does not always corresponds to an improvement in most people's health. Therefore, the use of sophisticated resources with high costs and benefits that are not always proportional to such costs has turned modern medicine into an impossible project to accomplish [6].

One examples concerns the USA, a country that spends over two trillion dollars on health, which corresponds almost to the amount spent by all other countries together, or the Chinese economy [7, 8]; yet, over 46 million Americans are not covered by the health system. Suffice to say that one of the key points of Barak Obama's past presidential campaign was health reform in the USA. This is something that will become even more difficult to complete in a period of global economic crisis.

Breast cancer, as a health problem all over the world, may have important consequences if erroneous decisions in health policies are made. In Brazil, breast cancer is the main cause of death from cancer among females. The use of only 2–3 % of gross domestic product on health (in the USA, more than 15 % is used) results in an ethical dilemma of considerable proportions within the public health system, which is known by all Brazilian health professionals. The public health system in Brazil is a Universalist one, and it is similar to most European models (guaranteed by article 196 of the Brazilian Federal Constitution of 1988—"health is the right of all people and the duty of the state…."). However, as happens in many European countries, the state cannot limit its costs, so it risks becoming bankrupt. That is why in the specific case of breast cancer, mammographic screening and timely access to updated treatments are inadequate given the distribution of existing resources. So the Universalist model does not manage to reach everybody equally. The unequal conditions in diagnosing and treating breast cancer in the Brazilian environment have not been properly studied yet. The damage in terms of life expectancy and years of work lost are noticeable and may increase in the coming years.

The aim of health policies on cancer in developed countries is focused on prevention and early diagnosis. The mammographic screening test and the routine clinical examination may reduce mortality caused by breast cancer by 25–30 % among women over 50 years of age. Such measures aim to find small tumors, which implies treatments will have more effective results and at lower costs. An example of how

this can work is ductal carcinoma in situ, which is the sort of breast tumor with the highest incidence in developed countries. Over 90 % of cases are not palpable, and diagnosis is only possible through mammography. There is no need for chemotherapy or sentinel node biopsy or for axillary dissection. The rate of cure is approximately 100 %, and for most of patients with breast preservation techniques.

Considering that the number of years wasted with breast cancer is second only to cardiovascular diseases, the economic and social importance of breast cancer are evident. The reduction in breast cancer mortality, first noticed in the USA then in Sweden and England, and now reaching most countries of the European Union, is a result of investments in detection and access of most of the population to better diagnostic and therapeutic modalities. It is clear that early diagnosis not only benefits women in terms of survival and less mutilating surgical procedures, but also reduces treatment costs and keeps an important portion of society with breast cancer economically active.

On the other hand, in developing countries in reproductive age groups, breast cancer is considered a substantial problem with importance similar to that of major global priorities such as maternal mortality [8, 9]. Advanced tumors demand therapeutic resources at higher costs. Results in terms of disease-free survival, however, are less satisfactory than at the early breast cancer stages. Local recurrences and distant metastasis require the use of chemotherapy schemes, hormone therapy, radiotherapy, and monoclonal antibodies of growing complexity in relation to those applied to more precocious tumors. Besides, they diminish the labor capacity of these patients and require longer rehabilitation periods. A patient with metastatic breast cancer currently undergoing the recommended treatment will cost the state and health insurance companies more than the transplant of organs and a few mammography and ultrasonography devices.

In developing countries, an increase in both the incidence of cases and the mortality caused by this disease is expected [8, 9]. Therefore, it is imperative that the population has access to early diagnosis and proper treatment at the right time. These are some of the challenges in breast cancer that public health systems all over the world have to face. In this situation, bioethics may work as an element of facilitation in the formation of governmental decisions, following the example of other countries such as the USA and Italy, which have national committees of bioethics involved in public health matters.

49.5 Genetics and Breast Cancer

Although a positive family history is reported in between 15 and 20 % of women with breast cancer, congenital breast cancer occurs only in 5–6 % of all cases [10], and mutations of genes *BRCA1* or *BRCA2* are found in most of these cases [11]. Today genetic tests to identify such mutations are commercially available. The frequency of these mutations is rare; however, they occur in approximately 0.1 % of the population in general [12]. The prevalence of BRCA mutations is higher among Ashkenazi Jewish women, reaching 2 % [13]. These genes are considered tumor-suppression genes, and they work on repairing DNA. When there is a mutation, this function is not performed properly, which allows a tumor to form. Transmission is autosomal dominant, but penetration is incomplete; therefore, genetic mutation points to a higher susceptibility of developing breast cancer, but that does not occur in all cases. It is estimated that a person with a mutation of gene *BRCA1* or *BRCA2* has a risk of developing breast cancer of around 50–87 % throughout life, and a risk of developing ovary cancer of between 15 and 44 % [14, 15].

Genetic advice and a genetic test should be proposed when (a) the patient has a personal or family history that points to a genetic condition susceptible to cancer, (b) the genetic test may be adequately interpreted, and (c) the test results contribute to the diagnosis or influence the clinical or surgical treatment of patients or their families with risk of congenital cancer. It is recommended that the genetic test be performed only together with genetic advice before and after the test, which must include a discussion of the possible risks and benefits of early detection of cancer and the modalities for prevention [16].

It is critical to interpret the results adequately. There are three types of results:

1. *Positive result* The mutation with deleterious effects in *BRCA1* or *BRCA2* was found, and it puts the person at risk by increasing the risk of development of breast cancer and ovarian cancer.
2. *Negative result* A mutation is known in the family, but the person tested does not carry such a mutation.
3. *Inconclusive or undetermined result* No mutation is identified in the person tested and there is no case of mutation known in the family, or otherwise, a mutation was found in the test but its meaning is unknown.

The decision to undergo the diagnostic test must be made exclusively by the patients. They must be aware of their decision to either accept or refuse the genetic test. In the pretest advice session, all of the important and necessary information must be given to the patient. This must cover the advantages and limitations of the test, the possible types of results, and the measures to minimize risk that can be taken. Informed consent is, therefore, a mandatory prerequisite for any type of genetic test. The principle of autonomy is the basis of informed consent, and it is essential for preserving the individual's freedom and her right to make choices [17].

When an inherited breast cancer syndrome is suspected in a family, the first person that has to be tested is the relative with the disease. If the test identifies the mutation, a genetic test for this specific mutation can be performed in the other family members. Each relative has a 50 % chance of being a mutation carrier [18].

If the genetic test is positive for a mutation, one of the most effective methods that can be considered to reduce the breast cancer risk is prophylactic surgery. Prophylactic surgery includes prophylactic bilateral mastectomy and/or prophylactic bilateral salpingo-oophorectomy. If the patient does not want to undergo prophylactic surgery, chemoprevention (tamoxifen) and surveillance (clinical breast examination, self breast examination, mammography, and magnetic resonance imaging) can be considered [18].

Although there are no randomized prospective trials that evaluated the efficacy of prophylactic bilateral mastectomy, and not many studies have considered this issue, the literature shows that bilateral prophylactic mastectomy reduces the risk of breast cancer by approximately 90 % in *BRCA1*/*BRCA2* mutation carriers and high-risk breast cancer patients [19–23]. Even though the accomplishment of a prospective randomized trial would be the best way to evaluate the efficacy of prophylactic surgery, it probably would be not possible because not many patients would accept being randomized for prophylactic surgery or no treatment.

In terms of surgery, there are four kinds of prophylactic mastectomy: total mastectomy, skin-sparing total mastectomy, nipple-sparing mastectomy, and areola-sparing mastectomy. The lack of prospective randomized studies comparing these different techniques makes it more difficult to establish which one is the ideal approach. Total mastectomy initially appears to be the safest procedure because it removes the breast tissue, skin, and nipple–areola complex; on the other hand the aesthetic outcome is poor. Skin-sparing mastectomy emerged as an alternative to total mastectomy, with better aesthetic outcome because it preserves the skin, and when it is associated with a reconstruction procedure, it can achieve a better outcome. Recently, subcutaneous mastectomy (nipple-sparing mastectomy) has appeared as a surgical variation that consists in preservation of the skin and the nipple–areola complex, ensuring an even better aesthetic result, with a more natural appearance of the breast. There is a serious concern with this technique, however, because a greater amount of tissue is preserved along with the nipple–areola complex and this could be associated with a higher incidence of cancer. Although this fear came from pathology studies that showed the presence of cancer cells in the nipple ducts, there are insufficient data to support this argument, and some studies have already demonstrated good results with this technique [18, 24]. Finally, areola-sparing mastectomy consists in the preservation of the skin and the areola, and the removal of the breast and the nipple. There are insufficient data with this kind of surgery in terms of aesthetic–functional outcomes and/or long-term oncologic results.

Respect of the privacy of the patient's genetic information demands that the result of the test not be revealed to anyone without the consent of the individual tested. When family mutations are identified, individuals should be strongly encouraged to share the results with other family members who are also at risk, especially when risk reduction measures can be taken [25]. However, some people may not feel like revealing genetic information to other members of the family. The physician may face an ethical dilemma if the patient refuses to reveal genetic information to relatives who are at risk. In such situations, the subject of confidentiality conflicts with the ethical principle of preventing damage to others [26]. Most authors do not support the revealing of family genetic information without the patient's consent, unless the possibility of serious damage exists and is very high [25, 27].

Another important aspect to be considered is genetic discrimination. This refers to less favorable or adverse treatment that an individual without traces or symptoms of the disease gets on the basis of the genetic or genotypic characteristics [25]. The affected individual may experience discrimination from insurance companies and job agencies. The fear of discrimination is one of the most commonly identified reasons among women who are not willing to take a BRCA genetic test [28–30]. Considering that, preserving the confidentiality of the individual's genetic information is very important.

Finally, the psychosocial influences that the result of the genetic test will have on the life of the patient must be considered. Knowing that a genetic mutation is present and the consequences of the personal risk of breast cancer may affect a person in various ways. Women with positive test results might experience a wide variety of emotions, such as anxiety, depression, fear, and anger. Women who have already had breast cancer may feel disturbed when learning that they have the risk of developing other types of cancer. Also, individuals might have a feeling of guilt, despite the existence of a possible mutation. Carriers of a BRCA mutation may experience "transmission sense of guilt" because they can transfer an increased genetic risk of cancer to their children, whereas noncarriers may experience the "survivor's sense of guilt" for being among the members of the family who did not inherit the mutation. Therefore, proper psychological preparation of the patient before performing the genetic test is important.

49.6 Clinical Bioethics

Clinical case study: 37 year-old, white, homemaker, Catholic, diagnosed with breast cancer, T2N0, estrogen receptor/progesterone receptor positive and human epidermal growth factor receptor 2 (HER2) negative. She is in the seventh week of

pregnancy and wants to have an immediate breast reconstruction. The breast surgeon was asked to give an opinion on the case.

Regardful medical virtues such as integrity, compassion, and altruism are determinant for the exercise of medicine [31]. Albert Jonsen [2] created a practical method to aid in the resolution of complex clinical cases, like the one presented above. It is based on four fundamental points: medical indications, patients' preferences, quality of life, and contextual aspects. A favorable point of this method is that it allows a shared bioethical sense that is easy to understand.

49.6.1 Medical Indications

It is the relationship between pathophysiology and therapeutic/diagnostic interventions that is indicated to solve the case properly. This refers to the application of medical and scientific knowledge. Whenever possible (and when such conditions are available), decisions must be based on clear scientific evidence. In breast oncology, around 60–80 % of all decisions can use data from evidence-based medicine, in contrast with general medicine, in which a little more than 15 % of the clinical decisions are based on consistent scientific evidence, and around 40 % are based solely on professional expertise. Important points to be considered and those with bioethical implications are:

- What is the patient's health problem?
- Is it a severe or a chronic problem? A critical one? An emergency? Is it reversible?
- What are the targets of the treatment?
- What are the probabilities of success?
- What are the perspectives of failure of the treatment?
- To sum up, how can the patient benefit from the treatment in question?

49.6.2 Patients' Preferences

In all medical treatments, patients' preferences, based on their own values and perceptions as to the benefits and risks, are ethically relevant. The following points must be clarified before making a decision:

- Did the patient express preferences concerning the treatment?
- Was the patient correctly informed about the risks, benefits, and consent?
- Is the patient mentally capable and legally competent?
- If the patient is incapable, who is the legally responsible individual?
- To sum up, is the patient's autonomy being respected?

49.6.3 Quality of Life

Besides preserving the life of the patient, another major target of medical intervention is to reestablish, keep, and improve the quality of life. What is the expectation with and without the treatment for the patient to return to a normal life? The questions that must be clarified are:

- What problems may impede the evaluation of the patient's quality of life?
- What physical, mental, and social limitations will the patient have after the treatment?
- Is the present or future condition of the patient considered undesirable?
- What are the plans to offer the patient some comfort or palliation?

49.6.4 Contextual Aspects

The care of patients is influenced either positively or negatively by the family and by a variety of contexts, such as personal, emotional, psychological, religious, financial, educational, legal, institutional, scientific, and social contexts. The questions that must be clarified are:

- Are there family problems that may influence therapeutic decisions?
- Are there any financial problems?
- Are there any medical or nursing problems?
- Are there any religious or cultural problems involved?
- What about the allocation of resources?
- Is there any reason for breaking confidentiality?
- And how about legal matters?
- Is there any research/teaching involved?
- Is there any conflict of interest?

Some important points emerge from this type of methodology. One of the most important of them is that no bioethical analysis of clinical problems should be performed without a deep scientific knowledge and clinical experience of the matter. A lack of knowledge invalidates any conclusion a posteriori. The second one is that a bioethical background is fundamental to the specialist's decision.

By applying Albert Jonsen's method to help the breast surgeon find an answer to the clinical dilemma, one can find:

1. *Medical indications* This refers to a 37-year-old patient with a breast neoplasia in the seventh week of pregnancy who is asking to maintain the pregnancy (in some countries it is not allowed to perform an abortion unless the patient is at risk of dying), and wants a breast reconstruction. The patient is not a good candidate for neoadjuvant chemotherapy owing to the risk of malformation. Since the patient is not in an urgent situation, there is no need to make an immediate decision—the

decision can be discussed with the bioethical committee, the patient, and the family. Breast reconstruction in this case can be done with less aggressive techniques such as expander/implants without compromising the pregnancy or oncologic treatment.

2. *Patient's preferences* The patient requested a breast reconstruction and to maintain the pregnancy. She is legally competent.
3. *Quality of life* The quality of life without reconstruction is expected to be worse. The patient has a chance to return to a normal life and the absence of the breast will damage to her quality of life in the near future.
4. *Contextual aspects* There are medicolegal implications for abortion in Brazil and the patient would not terminate the pregnancy because she was influenced by her Catholic background [32]. Breast reconstruction in this case, once abortion is well documented in the medical records and properly authorized by the patient, is ethically acceptable in such a case.

Albert Jonsen's method improves knowledge about conflicts, protects patients' autonomy, and integrates medical decisions. On the other hand, although it examines these situations and organizes them systematically, it does not solve conflicts in all cases. Conflicts may occur within each of the points mentioned. Decision making is sometimes so complex that it is necessary to resort to technical support from a consultancy professional with bioethical competence in the resolution of problems or, preferentially, a bioethical committee.

49.7 Medicolegal Aspects in Breast Cancer Reconstruction

According to the American Society of Plastic Surgeons in 2010, 93,083 breast reconstruction procedures were performed; 74 % of these used either saline (20 %) or silicone (54 %) implants. Another 19.5 % were accomplished using various flaps, including a transverse rectus abdominis myocutaneous flap, a latissimus dorsi flap, and a deep inferior epigastric perforator flap. Further, 22 % of the implants were ultimately removed. According to Mark Gorney from The Doctors' Company [33, 34], 31 % of claims against plastic surgeons involve elective breast operations. Of these, 55 % are related to scarring or tissue loss/necrosis and 45 % are related to augmentation or reconstruction of the breast with expanders and subsequent implants [34]. As oncoplastic surgery done by breast surgeons is a relatively new concept in the USA, further evaluation in this area is not available but there will soon be careful examination. This rest of section will outline several areas that both plastic and oncoplastic breast surgeons need to address to limit their liability. These include patient selection and expectations, communication, informed consent, documentation, and event management.

49.7.1 Patient Selection and Expectations

It is important to realize that patients who present for purely aesthetic breast procedures are very different in their expectations from those who need reconstruction as part of their breast cancer treatment. The former will want a result that is better than their baseline in terms of aesthetics and symmetry. These patients will not ordinarily present with a breast cancer diagnosis and may be unrealistic in their expectations. The ability of the surgeon to perform to these expectations is fundamental. The cancer patient will undergo a destructive procedure to cure the cancer and the final result is not usually expected to be as good as the original breast. Reconstructive surgeons should be well suited to this task with appropriate training. Although the expectations are somewhat lower, a near-normal breast with symmetry should be accomplished. This, of course, is made harder by the removal of breast tissue, chemotherapy, and radiotherapy. These patients may also return some time after their initial care for further aesthetic–functional adjustments and surgery. The surgeon should be able to handle this as well. Surgeons should learn to identify these patients when they present to serve them in the most appropriate manner.

When dealing with a patient's expectations, a careful history is very important to ascertain the patient's motives and desires. This requires good patient contact, empathy, attention, and questioning. It may also be useful to talk with significant others such as the spouse or family members to further determine the results desired.

Not only are patient factors important in planning surgery, but the surgeon's comfort level with the patient, experience, and training are also variables to consider before operating. The patient must have reasonable expectations regarding what is possible, and the surgeon must be confident that he or she can deliver the desired result. If the surgeon is not confident, then not operating or referring the patient to someone more qualified is certainly a good option.

49.7.2 Communication

Honest and timely communication is of utmost importance in any physician–patient encounter. Being on time in the office or giving the patient a cell phone number or e-mail address is powerful communication. Eye contact, body language, and choice of vocabulary also come together to send a message to the patient and her family, either good or bad. The ability to communicate and establish a relationship will significantly add to the credibility of the surgeon. The acronym HEAL [35] has been very useful in establishing and continuing relationships

with patients and their families especially in times of poor outcomes. "H" is for "hear." Hear what your patients and families are trying to say. "E" is "emotions." Address the patient's and the family's emotions. "A" is for "ask and answer." Ask patients and their families to tell you what they already know and answer what they want to know. Finally, "L" is for "loyalty." Foster already existing loyalty and rebuild that portion that may have been lost. Most medical malpractice cases are caused by no or misunderstood information and the patient's or the family's need to learn the facts of the care given [35, 36]. The surgeon must learn to be a good communicator and, thus, educator of his patients. This education informs the patient of the disease process, prognosis, treatments, and alternatives and explains possible negative outcomes. This begins with the first handshake and never ends.

49.7.3 Informed Consent

The process of informed consent is the foundation of the physician–patient relationship. Through this interaction the patient comes to understand her diagnosis, the options for management, the potential outcomes and risks of each option, and what can be expected as an ultimate result. From this information, the patient can choose a course of action by including her own preferences and desires. Informed consent is not a simple form the patient signs but a process that begins with the first consultation and continues with each encounter. It involves the previously mentioned areas of patient selection, communication, and management of expectations. It is the surgeon's best friend in malpractice litigation. It is one of the first areas of examination by the plaintiff's attorneys and, if it absent or weak, it is almost always included in complaints.

In documenting informed consent, one usually requires a preprinted form (Fig. 49.1), but, in addition, hospital or office notes should reflect the thought process the surgeon and patient have taken in support of the final written consent. These notes should include the patient's thoughts, expectations, and specific refusal of offered options. A specific summary statement should be included in the notes (e.g., "I have talked with the patient at length regarding her diagnosis, proposed procedure, potential risks, possible benefits, and alternative modes of therapy. Risks discussed included but were not limited to _____. She understands the procedure, accepts the risks, and wishes us to proceed. We will do so soon."). Risks should be listed, but the list is not meant to be all inclusive. The most commonest potential risks of oncoplastic surgery are as follows:

- Death
- Myocardial infarction
- Stroke
- Deep venous thrombosis
- Pneumonia
- Infection
- Bleeding
- Prolonged drainage
- Partial or total necrosis of skin or flaps
- Seroma
- Hematoma
- Multiple surgical procedures/reoperation
- Loss of implant or expander
- Nonsymmetry of breasts
- Expectations not met
- Recurrence of cancer
- Prolonged care/wound care
- Necrosis of nipple–areola complex
- Loss of sensation of nipple–areola complex
- Chronic pain
- Keloids/scars
- Discoloration
- Need for drainage/aspiration
- Lymphedema
- Pain, swelling, numbness, disability, dysfunction of arms
- Nerve or blood vessel damage
- Hernia
- Pneumothorax
- Fat necrosis
- Implant contracture, immediate or delayed
- Rejection of implant at any time
- Rupture of expander or implant.

A good informed consent process will not only protect the surgeon but will also enhance the relationship with the patient.

49.7.4 Documentation

Documentation is the cornerstone of any malpractice defense. Good documentation may convince a plaintiff's attorney not to pursue a case. In addition, it is certainly valuable when reviewing a patient's care and outcomes as well as making treatment plans. Documentation includes many aspects of the medical record. The hospital medical record should be completed in a timely manner, including the history, physical examination results, consents, operation notes, and discharge summary. The office records should include all interactions and contact with the patient, such as telephone calls, literature given to the patient, notes of office visits, consents, correspondence, and photographs (preoperative and postoperative). The office notes should include the history, physical examination results, diagnostic results, diagnosis, treatment plans, referrals, alternatives, risks, and the patient's desires and expectations. Of course, no record should be altered after being signed off as this greatly weakens the credibility of the medical record. Late entries are allowed if they are indentified as such. The records should also be legible.

CONSENT FOR SURGERY

1. I,..... according to my own will, hereby authorize doctor CICERO URBAN and all the other members of his team of professionals related to my medical assistance to perform the surgery herein described..... ...., as well as the medical treatments and follow-up care derived from it.
2. I certify that this surgery I now consent has been fully explained to me by doctor CICERO URBAN and his team both in person and through printed information material, therefore I understand that:

   A permanent **SCAR** will form as a result of the surgery, but all the necessary measures will be taken in order to minimize its effects and visibility.

   There might be a **SWELL** in the operated site, which may remain for weeks and even, though rarely, for a few months.

   SPOTS or **DEPIGMENTATION OR DISCOLOURATION AREAS** may also appear in the operated site for some time. In very rare cases they can remain permanently.

   Occasionally, **LIQUIDS** (blood or secretion or fluids) may accumulate in the operated site, so there is the need for draining, aspiration or surgical repair. This is more frequent after axillary dissection.

   There may be **LOSS OF SENSITIVITY AND/OR MOBILITY** in the operated site for an indefinite period of time, which varies from patient to patient. It occurs more frequently after axillary dissection.

   There may be **LOSS OF BIOLOGICAL VITALITY** in the operated site, caused by blood vascularisation reduction, which may result in alterations of the skin and, in more rare cases, necrosis, which demands repair through another operation or even operations.

   There may be **POSTOPERATIVE PAIN**, in either higher or lower levels of intensity, for an indefinite period of time, which varies from patient to patient.

   Every surgery may demand better **FINISHING** or small complementary surgeries performed to achieve better results.

   Considering that I have been informed of all the above:

3. **I assume** that throughout the surgical procedure there may be unexpected situations that had not previously been identified and, as a result, **ADDITIONAL PROCEDURES OR**

Fig. 49.1 Informed consent model for oncoplastic and reconstructive surgery from the Breast Unit of Hospital Nossa Senhora das Graças, Curitiba, Brazil

49.7.5 Event Management

Despite the surgeon's best efforts, poor outcomes do occur. Patients and their families are often very disappointed with these results. They have trusted the surgeon to meet their expectations and when that does not occur, trust is shaken and the surgeon is likely to be second-guessed. It is at this point that the relationship with the patient may be lost. The surgeon must continue to communicate. It is necessary to give a full and honest explanation to the patient and the patient's family. Sincere and empathic apologies may also help to ease the disappointment. In this regard, many lawsuits are filed simply because of lack of explanation [37]. These patients and their families may not have been

DIFFERENT ONES from those that had been arranged may be needed. Bearing that in mind, I allow the team to perform procedures that match such new situations.

4. **I assume** that Doctor XXXXXXXXX and his team will solely use all the necessary technical and scientific means at their disposal to achieve the results that are so desired, nevertheless such results are not guaranteed. Medicine is not an exact science, and consequently **GUARANTEES OF GOOD RESULTS CANNOT BE OFFERED.**

5. **I assume** that **TOBACCO SMOKING**, the use of **DRUGS** and **ALCOHOL**, though they are not able to prevent the surgery from being performed, are risk factors that can produce surgical-medical complications.

6. **I allow** the recording (photos, sound and/or filming) of the surgical procedures to be made because I understand that such registering is a legal-medical demand and a source of study and scientific information.

7. **I accept** that considering breast implants, the possibility of hardening may occur, as well as shape alterations, local pain and loss of sensitivity, and implant rupture, which derive from the use of silicon (or other kind of implants), and reactions of my body to it. This effect might imply that new surgeries be performed.

8. **I am aware** that I may experience limitations to perform everyday activities for an indefinite period of time.

I have had the opportunity to **CLARIFY ALL OF MY DOUBTS** concerning the surgery that I am voluntarily about to undergo, reason why **I ALLOW Doctor CICERO URBAN and his team** to perform all the necessary procedures.

Location:

Date: _____

Doctor's signature: _____

ID:_____

Witnesses:

1._____

ID:_____

2._____

ID:_____

Fig. 49.1 continued

personally approached by their surgeon or may feel something may be being "covered up". Many plaintiffs file complaints to find out the truth.

In addition, some progressive malpractice insurers wish to be notified of adverse events when they happen to help guide the surgeon in recovering the patient's trust. This interaction is important as the surgeon and his or her ego are most vulnerable at this time. The initial impulse is to avoid the situation, and that is precisely the wrong approach[38–40]. Advice from an event manager can prove to be quite helpful in avoiding litigation. Many feel that this transparency is full of potential problems but, in fact, this approach can actually decrease the frequency of lawsuits, increase credibility, and maintain the physician–patient relationship.

49.8 Conclusions and Perspectives

Bioethics has been walking together with the development of biotechnology and with its dilemmas, which go far beyond the technical–scientific debate. Within reconstructive breast cancer surgery specifically, there is the need for introducing bioethics and medicolegal aspects into the educational programs for specialists. It is true that technological development has improved the possibilities for the diagnosis and treatment of breast cancer, but the individual experience of those who deal with this malady daily is not the only object of scientific calculation. In addition to scientific competence, physicians must have the humility to recognize their role and their limits: taking care above curing. This is the most important virtue to be cultivated by the breast surgeon with the aid of bioethics, reducing claims and improving the breast cancer patient's survival and quality of life.

References

1. Callahan D (2004) Bioethics. In: Post SG (ed) Encyclopedia of bioethics. Thomson & Gale, New York, pp 278–287
2. Jonsen AR SM, Winslade WJ (2010) Clinical ethics, 7th edn. McGraw Hill, New York
3. Beecher HK (1966) Ethics and clinical research. N Engl J Med 274(24):1354–1360
4. Emanuel EJ, Wendler D, Grady C (2000) What makes clinical research ethical? JAMA 283(20):2701–2711
5. Emanuel EJ, Currie XE, Herman A. Undue inducement in clinical research in developing countries: is it a worry? Lancet 366(9482):336–340
6. Callahan D (1999) False hopes: overcoming the obstacles to a sustainable, affordable Medicine. Rutgers University Press, New Brunswick
7. Dalen JE (2000) Health care in America: the good, the bad, and the ugly. Arch Intern Med 160(17):2573–2576
8. Herzlinger R (2007) Who killed health care? America's $2 trillion medical problems and the consumer-driven cure. McGraw Hill, New York
9. Forouzanfar MH, Foreman KJ, Delossantos AM, Lozano R, Lopez AD, Murray CJ et al (2011) Breast and cervical cancer in 187 countries between 1980 and 2010: a systematic analysis. Lancet 378(9801):1461–1484
10. Malone KE, Daling JR, Thompson JD, O'Brien CA, Francisco LV, Ostrander EA (1998) BRCA1 mutations and breast cancer in the general population: analyses in women before age 35 years and in women before age 45 years with first-degree family history. JAMA 279(12):922–929
11. Couch FJ, DeShano ML, Blackwood MA, Calzone K, Stopfer J, Campeau L et al (1997) BRCA1 mutations in women attending clinics that evaluate the risk of breast cancer. N Engl J Med 336(20):1409–1415
12. Newman B, Austin MA, Lee M, King MC (1988) Inheritance of human breast cancer: evidence for autosomal dominant transmission in high-risk families. Proc Natl Acad Sci U S A 85(9):3044–3048
13. Struewing JP, Hartge P, Wacholder S, Baker SM, Berlin M, McAdams M et al (1997) The risk of cancer associated with specific mutations of BRCA1 and BRCA2 among Ashkenazi Jews. N Engl J Med 336(20):1401–1408
14. Thull DL, Vogel VG (2004) Recognition and management of hereditary breast cancer syndromes. Oncologist 9(1):13–24
15. Wooster R, Weber BL (2003) Breast and ovarian cancer. N Engl J Med 348(23):2339–2347
16. American Society of Clinical Oncology policy statement update: genetic testing for cancer susceptibility. J Clin Oncol 21(12):2397–2406 (2003)
17. Lowrey KM (2004) Legal and ethical issues in cancer genetics nursing. Semin Oncol Nurs 20(3):203–208
18. Guillem JG, Wood WC, Moley JF, Berchuck A, Karlan BY, Mutch DG et al (2006) ASCO/SSO review of current role of risk-reducing surgery in common hereditary cancer syndromes. J Clin Oncol 24(28):4642–4660
19. Hartmann LC, Schaid DJ, Woods JE, Crotty TP, Myers JL, Arnold PG et al (1999) Efficacy of bilateral prophylactic mastectomy in women with a family history of breast cancer. N Engl J Med 340(2):77–84
20. Rebbeck TR, Friebel T, Lynch HT, Neuhausen SL, van 't Veer L, Garber JE et al (2004) Bilateral prophylactic mastectomy reduces breast cancer risk in BRCA1 and BRCA2 mutation carriers: the PROSE Study Group. J Clin Oncol 22(6):1055–1062
21. Hartmann LC, Sellers TA, Schaid DJ, Frank TS, Soderberg CL, Sitta DL et al (2001) Efficacy of bilateral prophylactic mastectomy in BRCA1 and BRCA2 gene mutation carriers. J Natl Cancer Inst 93(21):1633–1637
22. Heemskerk-Gerritsen BA, Brekelmans CT, Menke-Pluymers MB, van Geel AN, Tilanus-Linthorst MM, Bartels CC et al (2007) Prophylactic mastectomy in BRCA1/2 mutation carriers and women at risk of hereditary breast cancer: long-term experiences at the Rotterdam Family Cancer Clinic. Ann Surg Oncol 14(12): 3335–3344
23. Meijers-Heijboer H, van Geel B, van Putten WL, Henzen-Logmans SC, Seynaeve C, Menke-Pluymers MB et al (2001) Breast cancer after prophylactic bilateral mastectomy in women with a BRCA1 or BRCA2 mutation. N Engl J Med 345(3):159–164
24. Sacchini V, Pinotti JA, Barros AC, Luini A, Pluchinotta A, Pinotti M et al (2006) Nipple-sparing mastectomy for breast cancer and risk reduction: oncologic or technical problem? J Am Coll Surg 203(5):704–714
25. Harris M, Winship I, Spriggs M (2005) Controversies and ethical issues in cancer-genetics clinics. Lancet Oncol 6(5):301–310
26. Ensenauer RE, Michels VV, Reinke SS (2005) Genetic testing: practical, ethical, and counseling considerations. Mayo Clin Proc 80(1):63–73
27. Clayton EW (2003) Ethical, legal, and social implications of genomic medicine. N Engl J Med 349(6):562–569
28. Armstrong K, Calzone K, Stopfer J, Fitzgerald G, Coyne J, Weber B (2000) Factors associated with decisions about clinical BRCA1/2 testing. Cancer Epidemiol Biomarkers Prev 9(11):1251–1254
29. Armstrong K, Weber B, FitzGerald G, Hershey JC, Pauly MV, Lemaire J et al (2003) Life insurance and breast cancer risk assessment: adverse selection, genetic testing decisions, and discrimination. Am J Med Genet A 120A(3):359–364
30. Peterson EA, Milliron KJ, Lewis KE, Goold SD, Merajver SD (2002) Health insurance and discrimination concerns and BRCA1/ 2 testing in a clinic population. Cancer Epidemiol Biomarkers Prev 11(1):79–87
31. Horton R (2005) Medicine: the prosperity of virtue. Lancet 366(9502):1985–1987
32. Post SG, Puchalski CM, Larson DB (2000) Physicians and patient spirituality: professional boundaries, competency, and ethics. Ann Intern Med 132(7):578–583
33. Gorney M (1999) The wheel of misfortune. Genesis of malpractice claims. Clin Plast Surg 26(1):15–19, v
34. Gorney M (2001) Preventing litigation in breast augmentation. Clin Plast Surg 28(3):607–615

35. Saxton JW KP, Baker L, Reifsteck S (2006) Communication strategies to help patients H.E.A.L. HCPro, Marblehead
36. Saxton J. The satisfied patient: a guide to preventing claims by providing excellent customer service, 2nd edn. HCPro; 2007
37. Wojcieszak D SJ, Finkelstein MF (2010) Sorry works! Disclosure, apology, and relationships prevent medical malpractice claims, 2nd edn. Authorhouse, Bloomington
38. Banja J (2005) Medical errors and medical narcissism. Jones and Bartlett, Sudbury
39. Gorney M, Martello J (1999) The genesis of plastic surgeon claims: a review of recurring problems. Clin Plast Surg 26(1): 123–131, ix
40. Shestak K (2006) Reoperative plastic surgery of the breast. Lippincott Williams & Wilkins, Philadelphia

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