Oncoplastic Breast Surgery Techniques for the General Surgeon

V. Suzanne Klimberg
Tibor Kovacs
Isabel T. Rubio
Editors

Springer

Oncoplastic Breast Surgery Techniques for the General Surgeon

V. Suzanne Klimberg
Tibor Kovacs • Isabel T. Rubio
Editors

Oncoplastic Breast Surgery Techniques for the General Surgeon

Springer

Editors
V. Suzanne Klimberg
University of Texas Medical Branch
Galveston, TX
USA

MD Anderson Cancer Center
Houston, TX
USA

Tibor Kovacs
Breast Surgery, Guy's and St. Thomas' Hospital
King's College London Guy's and St. Thomas' Hospital
London
UK

Isabel T. Rubio
Clinica Universidad de Navarra
Universidad de Navarra
Madrid
Spain

ISBN 978-3-030-40195-5 ISBN 978-3-030-40196-2 (eBook)
https://doi.org/10.1007/978-3-030-40196-2

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

To our family, friends, colleagues, and mentors with appreciation for their generous support of our careers which has allowed the development of this book. Most of all to our patients who have been our constant and faithful partners as we struggle to improve their outcomes from breast disease.

Preface

This book covers an up-to-date review of advances in the management strategies for patients with breast cancer and their comorbidities. The goal of this book is to increase the competencies and performance of healthcare professionals involved in treating this patient population, which will ultimately improve the aesthetic outcomes, quality of life, and overall survival of patients with breast disease and breast cancer. Oncoplastic breast surgery represents a "third pathway" between standard breast conservation and mastectomy. It allows wide excisions and removal of large portions of the breast without compromising the natural shape of the breast. It combines plastic surgery techniques for immediate breast reshaping with techniques of oncological resectional surgery. Surgical breast deformities are avoidable and unnecessary with preoperatively planned oncoplastic procedures.

Oncoplastic breast surgery combines tumor removal with breast reconstruction techniques. Oncoplasty became standard of care for breast conservation surgery and can lead to improving aesthetic outcomes of breast cancer surgery, without compromising oncological outcomes. Its goal is to avoid the breast distortion that accompanies breast cancer surgery and tumor removal. This type of surgery allows for immediate remodeling techniques to rebuild breast shape as breast tissue is being removed. Oncoplastic procedures may include breast lift, breast reduction, utilization of the skin and tissue flaps, and nipple skin-sparing techniques, all of which are covered in this book and performed or optimized by the general surgeon.

Advanced oncoplastic reconstruction should allow for coordinated efforts between the general surgeon and the plastic surgeon to include planned imaging in a multidisciplinary fashion. This book will help the general surgeon to provide improved oncologic as well as aesthetic results for patients.

Galveston, TX, USA — V. Suzanne Klimberg
London, UK — Tibor Kovacs
Madrid, Spain — Isabel T. Rubio

Acknowledgments

We, the editors of the inaugural edition *Oncoplastic Techniques for the General Surgeon* are indebted to each contributor for their invaluable time and efforts taken from their already busy academic and clinical practices to provide us with intraoperative photos and depictions of their oncoplastic techniques used in the breast. The authors have detailed not only best practices for conventional procedures but new and evolving techniques that are not found in the usual textbooks and atlases. We are very appreciative of the efforts of the contributors to detail the step-by-step instruction and that of the artists and illustrators at *Springer Nature* in developing precise illustrations. Collectively, this collection of work is usable from the medical students and general surgeons seeking to improve results in private practice to professors learning and teaching new breast surgery techniques.

We would also like to thank the staff members of Springer Nature, Richard Hruska, Executive Editor, and Lillie Gaurano, Assistant Editor, both in Medicine & Life Science, Books, who have made the publication of this *inaugural* oncoplastic book possible. In particular, we would like to thank Prakash Jagannathan, Project Coordinator for Development/Production, for his helpful day-to-day editorial exchanges with the contributing authors, artists, and editors, ensuring quality, accuracy, and coordination in the development of this book.

We and our authors are grateful to the multiple residents, fellows, students, and participating colleagues and patients who have supported our efforts with their insightful contributions, questions, and support in the treatment of breast disease that has been the basis for this book.

Contents

Contributors

Vanessa Amoroso, MD Department of Breast Surgery, Our Lady of Grace Hospital and Little Prince Medical School, Curitiba, Paraná, Brazil

Gabrielle Aubry, MD Department of Surgery, Institut Curie, Paris, France

Yoav Barnea, MD Tel Aviv University Medical School, Tel Aviv-Yafo, Israel

Department of Plastic and Reconstructive Surgery, 'Sourasky' Tel Aviv Medical Center, Tel Aviv-Yafo, Israel

Department of Breast Surgery "Assuta" Medical Center, Tel Aviv-Yafo, Israel

Peres Academic Center, Rehovot, Israel

Peter A. Barry, FRACS, MPhil Breast Unit, Royal Marsden NHS Foundation Trust, London, UK

Jean-Philippe Binder, MD Department of Surgery, Institut Curie, Paris, France

Kirby I. Bland, MD, FACS UAB Hospitals and Clinics, Birmingham, AL, USA

University of Alabama in Birmingham, School of Medicine, Birmingham, AL, USA

UAB O'Neal Comprehensive Cancer Center, Birmingham, AL, USA

Apolline Bout-Roumazeilles, MD Department of Surgery, Institut Curie, Paris, France

Gwendolyn Bryant-Smith, MD Breast Imaging, University of Arkansas for Medical Sciences, Little Rock, AR, USA

Esther Jennifer Campbell, MD Department of Surgery, University Hospital Crosshouse, Crosshouse, Kilmarnock, UK

Giuseppe Catanuto, MD Group for Reconstructive and Therapeutic Advancements, G.RE.T.A, Milan, Naples, Catania, Italy

Multidisciplinary Breast Unit, Azienda Ospedaliera Cannizzaro, Catania, Italy

Department of Clinical Medicine and Surgery, University of Naples "Federico II", Naples, Italy

Benoit Couturaud, MD Department of Surgery, Institut Curie, Paris, France

Stergios E. Douvetzemis, MD Breast Surgery, Guy's and St Thomas' NHS Foundation Trust, London, UK

King's College, London, UK

Department of Anatomy and Surgical Anatomy, Medical School, University of Athens, Athens, Greece

Rosa Di Micco, MD Breast Unit, San Raffaele University and Research Hospital, Milan, Italy

Department of Clinical Medicine and Surgery, University of Naples Federico II, Naples, Italy

James M. Economides, MD Private Practice, Arlington, VA, USA

Private Practice, Washington, DC, USA

Jean-Guillaume Feron, MD Department of Surgery, Institut Curie, Paris, France

Florian Fitzal, MBA, FEBS University Clinic for Surgery, Comprehensive Cancer Center Vienna, Medizinische Universität Wien 21A, Wien, Austria

Jennifer S. Gass, MD, FACS Women and Infants' Hospital, Providence, RI, USA

Alpert Medical School, Brown University, Providence, RI, USA

Abby Geletzke, MD University of Pittsburgh Medical Center, Pinnacle, Lancaster, PA, USA

Oreste Davide Gentilini, MD Breast Unit, San Raffaele University and Research Hospital, Milan, Italy

Shadi Ghali, MD, FRCS (Plast) University College London, University of London, The Royal Free Hospital Foundation Trust, London, UK

Michael Golatta, MD University Hospital Heidelberg, Department of Obstetrics and Gynecology, Heidelberg, Germany

Stephen R. Grobmyer, MD, FACS Cleveland Clinic Abu Dhabi, Abu Dhabi, UAE

Hisham Hamed, MD Department of Breast Surgery, Guy's & St. Thomas NHS Foundation Trust, London, UK

King's College, London, UK

Martin Haug, MD Breast Center, University Hospital Basel, Basel, Switzerland

Joerg Heil, MD University Hospital Heidelberg, Department of Obstetrics and Gynecology, Heidelberg, Germany

André Hennigs, MD University Hospital Heidelberg, Department of Obstetrics and Gynecology, Heidelberg, Germany

Ronda S. Henry-Tillman, MD, FACS Department of Surgery, University of Arkansas for Medical Sciences and the Winthrop P. Rockefeller Institute, Little Rock, AR, USA

Dennis Ricky Holmes, MD Department of Surgery, John Wayne Cancer Institute, Santa Monica, CA, USA

Erik Hoy, MD, MBA Division of Plastic Surgery, Women and Infants' Hospital, Providence, RI, USA

Sadia Khan, DO, FACS Hoag Memorial Hospital Presbyterian, Newport Beach, CA, USA

Department of Surgery, Keck School of Medicine, University of Southern California, Los Angeles, CA, USA

V. Suzanne Klimberg, MD, PhD University of Texas Medical Branch, Galveston, TX, USA

MD Anderson Cancer Center, Houston, TX, USA

Michael Knauer, MD, PhD, FEBS Breast Center Eastern Switzerland, St. Gallen, Switzerland

Ashutosh Kothari, MD Department of Breast Surgery, Guy's & St. Thomas NHS Foundation Trust, London, UK

King's College, London, UK

Tibor Kovacs, MD, PhD Breast Surgery, Guy's & St. Thomas NHS Foundation Trust, London, UK

King's College, London, UK

Flávia Kuroda, MD Department of Breast Surgery, Our Lady of Grace Hospital, Curitiba, Paraná, Brazil

Christian Kurzeder, MD Breast Center, University Hospital Basel, Basel, Switzerland

Enora Laas, MD Department of Surgery, Institut Curie, Paris, France

Julie Labrosse, MD Department of Surgery, Institut Curie, Paris, France

Zoltán Mátrai, MD, PhD, med habil, FEBS Department of Breast and Sarcoma Surgery, National Institute of Oncology, Budapest, Hungary

Elise Mecham, MD University of Texas MD Anderson Cancer Center of Houston, Houston, TX, USA

Elizabeth Morrow, MD Department of Academic Surgery, University of Glasgow, Glasgow, UK

Maurizio Bruno Nava, MD School of Plastic Surgery, University of Milan, Milan, Italy

Group for Reconstructive and Therapeutic Advancements, G.RE.T.A, Milan, Naples, Catania, Italy

Daniela Ochoa, MD, FACS Department of Surgery, University of Arkansas for Medical Sciences and the Winthrop P. Rockefeller Institute, Little Rock, AR, USA

Pooja Padmanabhan, MRCSEd, DNB (Gen. Surg.), FEBSQ Breast Unit, Royal Marsden NHS Foundation Trust, London, UK

Moshe Papa, FACS, FICS Tel Aviv University Medical School, Tel Aviv-Yafo, Israel

Department of Breast Surgery "Assuta" Medical Center, Tel Aviv-Yafo, Israel

Julie Park, MD Utah Surgical Associates, Provo, UT, USA

Linda Phillips, MD, FACS Utah Surgical Associates, Provo, UT, USA

Troy A. Pittman, MD Private Practice, Washington, DC, USA

Fabien Reyal, MD, PhD Department of Surgery, Institut Curie, Paris, France

Translational Research Department, RT2Lab Team, Institut Curie, Paris, France

Heather Richardson, MD Bedford Breast Center, Beverly Hills, CA, USA

Fabian Riedel, MD University Hospital Heidelberg, Department of Obstetrics and Gynecology, Heidelberg, Germany

Nicola Rocco, MD Group for Reconstructive and Therapeutic Advancements, G.RE.T.A, Milan, Naples, Catania, Italy

Department of Clinical Medicine and Surgery, University of Naples "Federico II", Naples, Italy

Multidisciplinary Breast Unit, Azienda Ospedaliera Cannizzaro, Catania, Italy

Laszlo Romics, MD Department of Surgery, New Victoria Hospital, Glasgow, UK

Department of Academic Surgery, University of Glasgow, Glasgow, UK

Léa Rossi, MD Department of Surgery, Institut Curie, Paris, France

Isabel T. Rubio, MD, PhD Clinica Universidad de Navarra, Universidad de Navarra, Madrid, Spain

Anne Sabaila, MD Department of Surgery, Institut Curie, Paris, France

Neil S. Sachanandani, MD, FACS Beaumont Plastic and Reconstructive Surgery, Department of Surgery, Beaumont Health System, Royal Oak, MI, USA

Giuseppe Sanese, MD PhD School on Medical-Surgical Applied Sciences-Plastic Regenerative research area, "Tor Vergata" University of Rome; Federated Specialization School on Plastic, Reconstructive and Aesthetic Surgery, "Sapienza", University of Rome and "Tor Vergata" University of Rome, School of Medicine, Rome, Italy

Benjamin Sarfati, MD Service de Chirurgie Plastique et Reconstructrice, Gustave Roussy, Villejuif, France

Nirav B. Savalia, MD Hoag Memorial Hospital Presbyterian, Newport Beach, CA, USA

Department of Surgery, Keck School of Medicine, University of Southern California, Los Angeles, CA, USA

Peter Schrenk, MD Kepler University Clinic Surgery, Linz, Austria

Melvin J. Silverstein, MD, FACS Hoag Memorial Hospital Presbyterian, Newport Beach, CA, USA

Department of Surgery, Keck School of Medicine, University of Southern California, Los Angeles, CA, USA

Benny K. Tan, MD Department of Plastic and Reconstructive Surgery, Johns Hopkins, Baltimore, MD, USA

Paul Thiruchelvam, BSc, MD, PhD, FRCS Imperial College Healthcare, London, UK

Imperial College, London, London, UK

Cicero Urban, MD, PhD Department of Breast Surgery, Our Lady of Grace Hospital, Positivo University Medical School, Curitiba, Paraná, Brazil

Stephanie A. Valente, DO, FACS Lerner College of Medicine, Cleveland Clinic, Cleveland, OH, USA

Walter P. Weber, MD University Hospital Basel and University of Basel, Basel, Switzerland

Eva Weiler-Mithoff, MD Canniesburn Plastic Surgical Unit, Glasgow Royal Infirmary, Glasgow, UK

Shawna C. Willey, MD, FACS Peterson Chair of Breast Cancer Research, Inova Schar Cancer Institute, Inova Fairfax Hospital, Fairfax, VA, USA

James C. Yuen, MD, FACS Division of Plastic Surgery, University of Arkansas for Medical Sciences, Little Rock, AR, USA

Gustavo Zucca-Matthes, MD, PhD Head of Breast and Reconstruction Surgery Department, Breast Unit Barretos – Barretos Cancer Hospital, Barretos, SP, Brazil

1 Concept, Principles and Indication of Oncoplastic Breast Surgery: Fashion or Necessity

Stergios E. Douvetzemis and Tibor Kovacs

Introduction

The breast is an aesthetic and functional organ and a symbol of motherhood, femininity, and sexuality, which typifies the central focus of a woman's anatomy. For those reasons, breast surgery should take into account its importance to each woman's identity [1].

It is undeniable that Halsted's radical mastectomy has altered breast cancer prognosis. On the other hand, there is no doubt that both surgeons and their patients struggled to accept this method as the best possible solution, because of the profound physical and psychological impact on women who decide to undergo this presumed "life-saving" surgery. Growing consciousness of screening made the diagnosis of smaller cancers possible and this altered the entire surgical approach [2].

Breast-conserving surgery (BCS) combined with radiotherapy (RT) has become the gold standard for the majority of women presenting with primary breast cancer over the last 20 years [3].

A number of prospective randomized trials have compared BCS with mastectomy, showing a survival rate that is unrelated to the type of surgery performed [4–7] and also showed that the risk of local recurrence (LR) following BCT is significantly increased when surgical margins are involved [8–10].

S. E. Douvetzemis
Breast Surgery, Guy's and St Thomas' NHS Foundation Trust, London, UK

King's College, London, UK

Department of Anatomy and Surgical Anatomy, Medical School, University of Athens, Athens, Greece

T. Kovacs (✉)
Breast Surgery, Guy's and St Thomas' NHS Foundation Trust, London, UK

King's College, London, UK

V. S. Klimberg et al. (eds.), *Oncoplastic Breast Surgery Techniques for the General Surgeon*, https://doi.org/10.1007/978-3-030-40196-2_1

On the other hand, trials including patients with clear margins [11–16] did not show significant differences between BCS and mastectomy regarding local control.

The risk of LR is related to several factors, including positive margins, tumor grade, extent of in situ component, lymphovascular invasion, and age [17].

In any case, the wider the margin of clearance, the less the risk of incomplete excision and thus potentially of LR, but the greater the amount of tissue excised, the higher the risk of visible deformity leading to an unacceptable cosmetic result [18].

This clash of interests is even more evident when attempting BCS in patients with smaller breast–tumor ratios [19].

Shape deformity leading to an inferior cosmetic outcome is due to the amount of breast tissue excised, the size of the breast (tumor to breast size ratio), whether or not skin is resected with the tumor, the location of the tumor in the breast, orientation of surgical incisions, and postoperative RT [20, 21].

Compromised cosmetic outcome is more often occurring when the tumor is located centrally, medially, or inferiorly into the breast [22, 23].

Residual deformities noticed after BCS and RT can either be seen immediately after surgery or develop over time and might be: glandular tissue deficiency, skin retraction or indent, nipple-areola complex (NAC) malposition, change of inframammary fold (IMF) position, and loss of natural ptosis. Cosmetic failure is more common than generally appreciated, affecting up to half of the patients undergoing BCS [24–27] (Fig. 1.1).

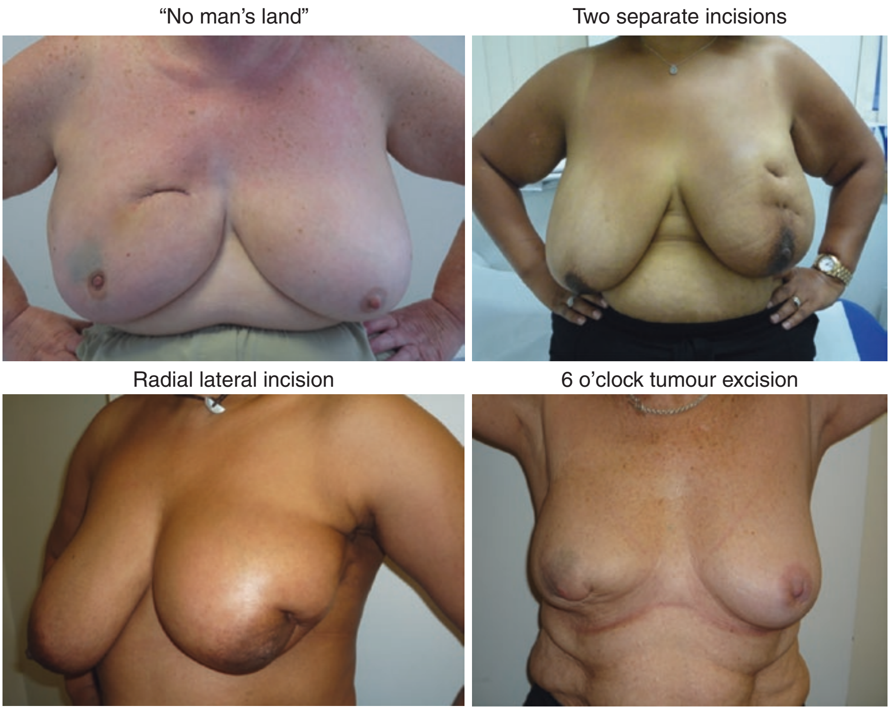


Fig. 1.1 Deformities noticed after BCS and RT

Here comes the role of oncoplastic breast surgery, which allows women who may otherwise have an unacceptable cosmetic result, to avoid the above-mentioned deformities. Oncoplastic breast surgery refers to resection of the tumor with adequately free margins to achieve locoregional control (either partial or total mastectomy) and reconstruction of the defect using plastic surgical techniques, to improve the cosmetic result, immediate and late reconstruction after mastectomy, contralateral breast symmetrization, and reconstruction of the NAC, when needed.

Oncoplastic breast-conserving surgery (OBCS) allows women who may otherwise have mastectomy and immediate reconstruction the choice to conserve their breast and to avoid deformity and consists of various techniques [28].

A study that compared OBCS with mastectomy and immediate breast reconstruction, taking into consideration body image scale (BIS) scores of psychosocial function- and patient-reported outcome measures for breast appearance and return to function, showed that results significantly favored OBCS. It is interesting that case-matched women with larger breasts treated by OBCS reported better BIS scores and self-rated breast appearance than mastectomy and immediate reconstruction, whereas no significant difference was observed for smaller breasts. BIS and appearance favored OBCS, regardless of whether radiotherapy would have been avoided if treated by mastectomy and immediate reconstruction [29].

At this point a question arises. Which is the ideal breast conservation surgery? Is it conventional BCS or OBCS? Is there always a need for OBCS? Are complex oncoplastic procedures bringing the supposed benefit (less re-excisions, better aesthetics, better patient satisfaction)? The answer is that we don't really know. OBCS with adjuvant RT is an emerging area of clinical investigation, and future studies might benefit from adopting a more consistent and standardized reporting of data, for patients undergoing OBCS [28].

There is a lack of randomized controlled trials and well-designed, prospective multicenter studies comparing OBCS to conventional BCS, following a predefined algorithm. However, a large body of observational evidence consistently indicates that OBCS is oncologically safe [30].

A systematic review was done to establish the completeness of reporting of key patient, tumor, treatment, and outcomes information in the randomized-controlled trials (RCTs) of standard BCS considered to be the "gold-standard," and to compare this with the reporting of the same key criteria for all published studies for OBCS. It is interesting that there is no RCT for OBCS. 16 RCT of BCS (n = 11,767 pts) were reviewed, together with 53 OBCS studies (n = 3236 pts). In BCS, a mean 64% of key criteria is routinely reported, compared to OBCS, where a mean of 54% of key criteria is reported. It is obvious that there is much room for improvement in reporting key criteria and also in quality of information recorded. This publication proposed some standards to give future studies of BCS a framework for reporting key information and outcomes [31] (Table 1.1).

1. Number of patients included
2. Patient age
3. Breast age
4. Resection weight

Table 1.1 Framework for reporting key information and outcomes regarding BCS

Key reporting and additional important criteria	
Key reporting criteria	
Demographic and tumor data	Number of patients included Patient age Tumor size Tumor type Estrogen receptor status Tumor focality Tumor grade Nodal status
Surgical data	Minimum clear excision margin Number of incomplete excisions Study definition of a microscopic clear margin Number of procedures converted to mastectomy
Follow-up data	Mean follow-up Number of local and distant recurrences Mortality rate
Adjuvant therapy data	Whole breast radiotherapy delivery and dose Boost radiotherapy delivery and dose Marking of tumor bed and method used Other adjuvant treatments given
Additional important criteria	
Surgical data	Breast size Resection weight Resultant breast size after radiotherapy
Follow-up data	Radiological follow-up Need for any procedure to exclude recurrence Cosmetic outcomes Secondary revisions

5. Tumor size (mean, range)
6. Tumor type
7. Presence of lymphovascular invasion
8. Tumor grade
9. Estrogen receptor status
10. HER2 positivity
11. Regional lymph node involvement
12. Study definition of clear pathological margins
13. Width of closest margin (mean, range)
14. Incomplete excision rate
15. Rate of conversion to mastectomy
16. Whole breast radiotherapy given
17. Neoadjuvant chemotherapy given
18. Other adjuvant treatment given
19. Tumor bed boost radiotherapy
20. Tumor bed marking (and method)

21. Resultant breast size after radiotherapy
22. Duration of follow-up (mean, range)
23. Radiological follow-up
24. Local recurrence rate
25. Distant recurrence rate
26. Breast cancer-related mortality rate
27. Need for any procedure to exclude recurrences
28. Cosmetic outcome (preferably including patient-reported outcomes)
29. Secondary revisions

Indications

Role of Oncoplastic Surgery

Until now, surgical options have been limited to BCS or mastectomy. BCS has focused attention on new oncoplastic techniques that can avoid unacceptable cosmetic results.

The aim was to improve long-term cosmetic outcomes following breast conservation and radiotherapy, facilitating conservation surgery where significant relative volume needs to be excised or where the location of the tumor is adverse. The interrelationship between breast–tumor ratio, volume loss, cosmetic outcome, and margins of clearance is complex [32].

OBCS avoids the need for mastectomy in selected patients and can influence the outcome of BCS in three respects:

- Oncoplastic techniques allow removal of larger tumors, without risking major local deformity.
- The use of oncoplastic techniques can extend the indication of BCS to include patients when more than 20% of breast volume needs to be excised, without compromising the adequacy of resection or the cosmetic outcome.
- OBCS can be used after previous BCS and radiotherapy to correct unacceptable deformity [33].

As previously mentioned, current trend is to reduce over-surgery for invasive breast cancer. The aim is for high-quality breast conservation where possible, with reduced re-excision rates. This is facilitated with the use of oncoplastic techniques and with the use of primary systemic therapy, as a surgical tool, to minimize the excised breast volume.

Multidisciplinary approach of each case is essential to allow multimodality treatment, which facilitates safe and less radical surgery. Cautious use of new technologies to assess disease extent, such as Breast MRI and margin "probes" is essential. Another issue that needs to be mentioned is the need to stop performing bilateral mastectomy for unilateral disease, when there is no oncological benefit from that [34].

Indications for OBCS

1. Patients with primary breast cancer, scheduled for BCS, when a poor cosmetic result is expected if standard BCS is used.
   - Unfavorable tumor volume to breast volume ratio is an indication for OBCS. Resection of more than 20% of breast volume is likely to result in asymmetry and poor cosmetic outcomes [21] with patient satisfaction rates of over 90% if only 5% or less of breast volume was excised, compared to 25%, when 20% of breast volume is excised [35].

     OBCS in these cases permits BCS for large lesions for which a standard excision would be either impossible or lead to major deformity.
   - Unfavorable tumor location is if the tumor is in the medial, superomedial, inferior, central, or inferior parts of the breast. Excision of tumors located in the upper inner quadrant may lead to scaring in the cleavage area and indentation, if there is less breast parenchymal volume. Excision of tumors from these areas may also result in nipple malposition due to scar retraction. Resection of inferiorly sited tumors may also cause a bird's beak deformity. Centrally located tumors may require nipple sacrifice [32].
   - Multifocal or multicentric disease. There is emerging evidence that breast conservation in multifocal (MF) disease is oncologically safe [36] but may result in a slightly inferior outcomes. The use of OBCS is also emerging in the treatment of multicentric disease, where BCS was considered to be a contraindication, until recently. However, evidence supporting the oncological safety of this approach is still weak, although a number of case series show acceptable oncological outcomes [37, 38].
   - Extensive DCIS or invasive lobular carcinoma and partial or poor responses to neoadjuvant chemotherapy are other possible indications for OBCS.
   - Macromastia. OBCS may be seen as an opportunity for simultaneous bilateral breast reduction, which may have considerable appeal in their quality of life. They can obtain oncologically safe and cosmetically excellent outcomes with therapeutic reduction mammoplasty. The tumor may be excised en bloc with the reduction tissue, provided that margin marking and orientation is meticulously done. Rates of LR with this technique are acceptable [39–41]. However, there is a lack of randomized controlled trials.
2. OBCS has a role following standard BCS:
   - Patients who need re-excision for involved margins and where a simple re-excision may end up in a shape deformity [42].

     In these cases, the use of OBCS is the means to avoid total mastectomy and achieve an acceptable aesthetic result.
   - Patients with free margins but who seek correction of defects for cosmetic reasons, following BCS. It is important to remember that BCS followed by radiotherapy is associated with increased morbidity due to radiation and inferior long-term cosmesis.

3. Patients scheduled for mastectomy:

Patients with primary breast cancer scheduled for total mastectomy, who seek immediate breast reconstruction with implants or autologous flaps.

Contraindications for OBCS

There are oncological and cosmetic contraindications for OBCS. When breast conservation is unlikely to result in an acceptable cosmetic outcome, due to unfavorable tumor to breast size ratio or when tumor-free margins cannot be obtained, even with the use of OBCS techniques, then breast conservation is not recommended. In these cases, there is a clear indication either for upfront mastectomy and immediate or delayed reconstruction or for primary systemic treatment, with a view to BCS, based on the tumor biology and response [32]. Even in the cases where neoadjuvant chemotherapy (NACT) is given, if there is no response or if progression is noted, breast preservation cannot be considered as a safe possibility, if a patient was not eligible for BCS initially.

In the past, multifocal and multicentric breast cancer were not considered appropriate to be treated with BCS. Now this contraindication does not exist anymore, provided that clear margins can be achieved. BCS in multifocal disease is oncologically safe [43], but with slightly inferior outcome compared with BCS for unifocal disease and with a higher 10-year LR rate (0.6% vs. 6.1%, $p < 0.001$) [36] but with little or no impact on survival [44].

Evidence, however, for BCS for multicentric cancers is still relatively weak. Usually multicentric invasive lobular disease is not ideal for an oncoplastic procedure due to the higher risk of margin involvement and to the poorer response to neoadjuvant chemotherapy.

Nevertheless, patients with recurrent cancer following BCS and whole breast or chest wall RT are at high risk for complications, due to the previous RT [32]. Moreover, patients with inflammatory breast cancer are not candidates for BCS.

Finally, patients with specific comorbidities, such as diabetes, heavy smoking, obesity, and concomitant physical and psychological illness are not ideal candidates for OBCS. Those patients have to be aware that they are in increased risk of complications.

Contraindications for Immediate Reconstruction, Following Mastectomy

Contraindications for immediate reconstruction, following mastectomy are: inflammatory breast carcinoma, locally advanced disease, or when significant comorbidities exist, such as diabetes, heavy smoking, obesity, and concomitant physical and psychological illness.

Limitations of OBCS

Limitations of OBCS depend on patient characteristics, tumor size, and increased operative time.

Patient considerations including breast size and comorbidities are important. Although level I procedures can be applied to the vast majority of patients, level II techniques are not helpful for women with small breast size. For these patients with small breasts who require excision of greater than 20% of the breast volume, implant based or autologous flap reconstruction should be considered.

Comorbidities that increase the risk of tissue necrosis, such as history of smoking, diabetes, and obesity, must also be taken into serious consideration during surgical planning.

Tumor characteristics, such as size and location in the breast, have to be considered while forming the appropriate surgical plan. Tumors in unfavorable locations in the breast have few volume redistribution solutions.

Finally, additional operation time is required for advanced level II OBCS. This may be a disadvantage; however, this can be balanced by the rest of the factors.

Preoperative Evaluation and Planning

The principles of OBCS within the multidisciplinary framework for preoperative assessment of patients can be summarized as follows:

- Primary diagnosis and evaluation of the extent of disease prior to surgical intervention
- Patient's psychosocial needs and expectations
- Evaluation of need for primary systemic treatment
- Precise surgical planning to include resection and reconstruction options
- En bloc tumor resection and intra-operative margin assessment if possible
- Marking of tumor bed margins for adjuvant radiation and follow-up
- Evaluation of need for sentinel lymph node biopsy (SLNB) or axillary node clearance (ANC)
- Evaluation of need for adjuvant treatment (type and timing) [2]

The success of OBS depends on meticulous preoperative planning and on the choice of the appropriate technique. There are several factors that play a crucial role in this planning.

Tumor Size

The size of the tumor is analogical to the predicted defect if BCS is performed. The first and most important decision to make, when planning breast surgery, is whether a patient is eligible for BCS or needs a mastectomy. This is determined by the tumor size in relation to the breast size [45].

Some tumor parameters are associated with a higher risk for involved surgical margins, and a larger resection volume is likely to be necessary, in cases of large tumors, palpable tumors, or presence of DCIS.

For that reason, accurate preoperative breast imaging is important and breast MRI may be helpful to evaluate tumor size, to identify possible satellite lesions, to exclude multicentricity and multifocality, and to plan the access to the tumor. On the other hand, it is well known that breast MRI may lead to unnecessary investigations for incidentally detected lesions [46].

Neoadjuvant chemotherapy (NACT) has an increasingly important role in the treatment of breast cancer and has several advantages over traditional adjuvant chemotherapy. NACT may help decrease tumor size and is being used for conversion of some cases to BCS, where a mastectomy was initially necessary. Interestingly, however, BCS rates have not significantly increased, despite the increase in the use of NACT. Surgical overtreatment of breast cancer still happens, despite the fact that neoadjuvant and adjuvant therapies have remarkably improved outcomes and responses. Data are making more clear the role of BCS in patients who respond to NACT [47]. Despite higher complete pathologic response (pCR) rates due to more efficient drugs leading to better outcomes, there is still a high rate of mastectomy, in fact even higher than decades past when therapies were less robust. This apparent paradox might be explained by both surgeon and patient variables, such as the difficulty to determine radiologically the extent of residual disease post-NACT. Moreover, surgeons haven't yet overcome their perception for risk of recurrence. In several cases, surgical plan is wrongly based on prechemo imaging, which eliminates some of the advantages of NACT. What is more, it cannot be ignored that a significant number of patients opts for mastectomy, even though they might be eligible for BCS and regardless the fact that there is no survival benefit from mastectomy after NACT.

Except from down-staging breast disease, NACT also has the advantage of early administration of systemic treatment, and it also allows tailoring of further treatment using information about response to NACT.

It is evident that there is no consensus on the surgical management of either the breast or axilla in patients following NACT. Thus, the importance of multidisciplinary approach, communication, and cooperation between the medical and surgical teams is crucial in the NACT setting [47].

Tumor Location

The location of the tumor in the breast determines the technique used for OBCS. This will be analyzed in further details in a following chapter.

Operative Access

Access to the tumor and the axilla is something that has to be accurately planned preoperatively. Direct access to the tumor is preferable, as it makes resection more straightforward. The possibility of performing axillary surgery from the same incision is ideal, as it reduces the number of scars and pain. Finally, it is advisable, when planning an incision for BCS, to keep in mind the possible need of a mastectomy, in case of involved margins. For that reason, before performing the initial incision, its location should be carefully planned, keeping in mind that a re-operation might eventually be necessary.

Re-excision

In the case of involved margins, re-excision is necessary. This can be either excision of the involved margins or a mastectomy, depending on the residual breast size [48].

If a re-excision of margins is decided, this might be more technically demanding, after level II OBCS, and is better if it is performed by the surgeon who did the initial procedure, as after volume displacement tumor bed may be in a different position than expected.

Radiotherapy

BCS followed by radiotherapy is associated with increased morbidity due to radiation and inferior long-term cosmesis. RT following OBCS is not straightforward, because of the parenchymal rearrangement that is routinely involved in oncoplastic techniques. The targeted tissue can be relocated, thus posing a challenge to localize the tumor bed for breast radiotherapy boost [28, 32].

Following OBCS marking of the pectoral muscle as well as the superior, inferior, medial, and lateral tissue around the tumor cavity with clips is necessary, before it is shifted to the final location. These clips allow more accurate radiotherapy planning.

Immediate reconstruction after mastectomy, when postoperative radiation is considered, is due to a higher risk for complications and inferior cosmetic results [49]. However, evidence support that this is feasible and safe.

Shifting of the Original Tumor Bed After OBCS

OBCS may lead to local recurrences in areas within the breast that are different from the original tumor, because of volume displacement. Knowledge of the oncoplastic surgical procedure performed, together with the original and the new location of the tumor site, is important.

Frozen Section

Intraoperative evaluation of the resection margins with frozen section is preferable in patients with invasive breast cancer. This allows immediate re-excision in case of close or involved margins. Frozen sections are not helpful in patients with DCIS, since information provided about margin status is not reliable. In patients with no palpable tumors, assessment of its excision is crucial, whether it is by intraoperative specimen X-rays or other techniques.

Specimen Marking

As in BCS, specimen orientation is crucial and inadequate marking consists malpractice. OBCS specimens are more likely to be complex, including large, multifocal, or multicentric tumors, a known area of impalpable DCIS, cases post neoadjuvant chemotherapy, where only a marker clip may indicate the original primary location. The pathologist must be made aware of these. Any intraoperative cavity shaves must be similarly marked [32].

Accurate marking ensures that only the involved margin needs to be re-excised and not re-excision of the whole cavity. Despite the importance of specimen marking and orientation, there is no universally accepted specimen marking system. The most common protocol seems to be the method with different length or number of sutures and clips on three of the six margins [50, 51].

It is interesting that the presence of the skin or muscle on the specimen does not contribute to better orientation [52].

Cavity Marking

Knowing the exact position of the tumor bed has always been important for the radiation oncologists for the planning of boost radiotherapy, although there are no data to support that accurate tumor bed delineation leads to less LR. There are data, however, that this may improve cosmesis [53].

The most widely accepted and efficient cavity marking method is the placement of metallic surgical clips to the tumor bed, for each margin of the cavity [33] straight after resection and before volume displacement [54].

The Contralateral Breast

Patients can undergo bilateral single-staged surgery to achieve breast symmetry in one operation. This requires more accurate preoperative planning with the contralateral breast made slightly smaller and the nipple placed higher than that on the breast cancer site. A delayed symmetrization procedure (6–12 months after primary surgery) has the advantage that there is no possibility of any further re-excisions and the radiated breast has reached its final position.

Preoperative Consultation

The approach to OBCS includes careful patient selection. It is important to make the patient aware that although OBCS procedures may save the need for mastectomy and can provide greater satisfaction with a better cosmetic outcome, outcomes do vary. Candidates for OBCS should be informed that they will end up possibly with longer and multiple scars. The position of incisions should be described in advance. The patient should also be aware of the possible asymmetry that will follow OBCS and that a contralateral symmetrization could be performed either simultaneously or preferably as a second-stage procedure, 6–9 months, following radiotherapy. Finally, they should be aware that mastectomy might eventually not be avoided, if clear margins cannot be obtained after multiple re-excisions.

Marking and Positioning of the Patient

All oncoplastic procedures begin with preoperative marking of the patient standing. All appropriate arrangements should have been made, before the skin incision, so that patient can be moved from the supine to the upright position during the operation. Both arms need be extended, especially if any axillary surgery is planned.

Surgical Technique

Choice of Oncoplastic Technique

Reshaping of the breast is required after any tumor excision in order to recreate a normal breast shape in one operative procedure. In most cases, this can be achieved with a simple unilateral approach following lumpectomy, with small parenchymal rotations, mobilizing glandular flaps to close the defect. More complex breast reduction techniques, repositioning the nipple-areola complex (NAC) and local skin rotation flaps, might be necessary in other instances. In the second case, bilateral approach incorporating a contralateral symmetrization is unavoidable, in order to perform a wide excision with no asymmetry and deformity [55].

There are two categories of techniques to reconstruct the defect, following excision of parenchyma: volume displacement and volume replacement techniques.

1. *Volume displacement techniques:* Local breast parenchymal dermoglandular flaps are transpositioned to fill the defect of the resection site. These can be further subdivided in two categories of techniques, using either simple advancement (level I OBCS techniques) or more complex pedicles (level II OBCS techniques), which can also be termed therapeutic mammoplasty techniques [56–58].
2. *Volume replacement techniques:* Importing volume from elsewhere to replace the amount of tissue resected. Distant autologous flaps, such as muscle or dermofascial flaps, or heterologous material, such as silicone prostheses (fixed volume implants or expanders) or fat grafting (Lipomodelling), are used to substitute for tissue loss [32].

Classification of volume displacement OBCS techniques is based upon the level of surgical difficulty.

Level I techniques should be able to be performed by all breast surgeons. A level I approach includes skin and glandular undermining, including the NAC and NAC mobilization.

Level II techniques encompass more complex procedures that involve skin excision and glandular mobilization to allow major volume resection. Those techniques are inspired by breast reduction mammoplasty and require oncoplastic training.

If less than 20% of the breast volume is excised, then a level II approach is not usually necessary. In that case, a level I procedure is usually adequate. When 20–50% of breast volume is to be excised or the cancer is in an unfavorable location, then a level II procedure is ideal. Large-volume excisions usually require concurrent skin excision.

As a general rule, it is much easier to prevent than to correct a deformity that has developed. A major advantage of OBCS is eliminating secondary reconstruction by preventing major breast deformities [59]. Especially the results of postoperative repair of BCS defects in irradiated tissue are poor, regardless of the surgical procedure [60, 61].

Volume displacement techniques require less extensive surgery, avoid donor-site problems, and have quicker recovery. On the other hand, volume replacement techniques can reconstruct the breast, achieving symmetry and excellent cosmesis, usually without the need for contralateral surgery.

The choice of technique depends on a number of factors, such as the extent of resection, position of the tumor, timing of surgery, experience of the surgeon, patient's comorbidities, general condition, and last but not least expectations of the patient. The last one must be taken into serious consideration. Patient's expectations and not surgeon's will is the main factor that should guide the decision for the most appropriate technique.

OBCS can be also divided into four categories: Conventional tumorectomy, oncoplastic mastopexy, oncoplastic tumorectomy, and oncoplastic reduction mammoplasty. An indication algorithm based on the size and shape of the breast as well as the size and location of the tumor suggests a selection of suitable tailored flaps and pedicles based on tumor location and vascular supply of the breast. This helpful algorithm tailors every operation to the individual patient, in a standardized manner [62] (Fig. 1.2).

Ultrasound-Guided BCS

Ultrasound (USS)-guided BCS has shown advantages for the localization of non-palpable tumors. A randomized control trial, COBALT, showed significant reduction in margin involvement (3.1% vs. 13%) and significantly reduced specimen volumes (38 cc vs. 53 cc) for the USS-guided cohort, compared to the palpation-guided cohort. No loco-regional recurrence was noted within 41 months, and in both cohorts the overall survival rate was 94–97%, with no difference between the two groups.

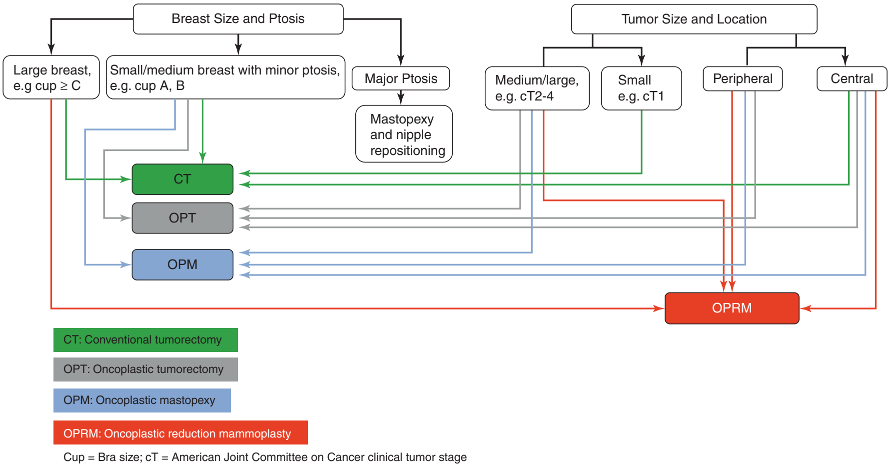


Fig. 1.2 Indication algorithm for conventional BCS and OBCS

Better overall cosmetic outcomes were noticed for the USS-guided cohort (poor outcomes 11% vs. 21%), with poor outcomes being almost twice more often in the palpation group. Significant difference was noted in patient satisfaction in favor of the USS-guided cohort at 3 years postoperatively. This trial also showed that resection of more than 40 cc of breast volume had a 2.65 odds of worse cosmetic outcomes.

The outcomes of this trial were that USS-guided BCS could help reduce excision volume and improve cosmetic outcome and that complex (level II) OBCS should be reserved where higher excision volume/breast volume ration is expected as an option to avoid mastectomy [63].

Timing of Procedures

Immediate reconstruction at the time of mastectomy is associated with clear surgical [64], financial [65, 66], and psychological [67] benefits, and similar benefits are seen in patients undergoing immediate breast-sparing reconstruction after partial mastectomy. Thus, it can be easily explained why OBCS is becoming increasingly popular.

For the above reasons, reconstruction of the partial or total mastectomy defect should ideally be performed immediately after the tumor resection, in order to prevent deformity rather than to correct it later. Immediate reconstruction is associated with fewer technical problems and complications, than delayed. On the other hand, reconstruction may be compromised by previous or future radiotherapy.

Deformities Following Breast-Conserving Therapy

Until recently, little attention has been paid to the cosmetic outcome of BCS, as most patients are relieved just not to lose their breast. What is more, many surgeons are unfamiliar with OBCS techniques, recommending delayed reconstruction, following recovery from radiotherapy. Although this is possible, reconstruction of the breast after surgery and radiotherapy is technically challenging, with cosmetic results that are often inferior.

Surgical approach of patients that already had BCS is challenging. Clough et al. [68, 69] published a simple classification, which divides the patients to three groups, as a guide for choosing the optimal reconstructive technique and as a predictor of the final cosmetic result after surgery [21, 70].

- Type I deformities: Patients following BCS with a good cosmetic outcome, but with asymmetry between the two breasts.
- Type II deformities: Patients have a deformity of the treated breast. This deformity can be corrected with OBCS, with the irradiated breast tissue being spared.
- Type III deformities: Patients have a major distortion of the treated breast, or diffuse painful fibrosis, so severe, that only a mastectomy and reconstruction with either implants or autologous flaps can be considered [68].

Oncoplastic Considerations

Oncoplastic breast surgeons should always choose the simplest procedure that will maintain or improve the aesthetics. Three factors are significant for the identification of patients who would benefit from OBCS. When considered together, they provide a sound basis for determining when and what type of OBCS to perform. These are:

- Excision volume
- Tumor location [71]
- Glandular density
- Volume

The first and most important determining element is volume that will be excised. This is the most predictive factor for cosmetic surgical outcome, thus deformity. Once 10–20% of the breast volume is excised, there is a clear risk of deformity [72].

Excision volume compared to the total breast volume has to be estimated preoperatively, since tumor size is known from preoperative imaging. The average specimen from BCS should weigh between 20 g and 40 g, and as a general rule 80 g of breast tissue is the maximum weight that can be removed from a medium-sized breast without resulting in deformity. Of course this largely depends on the size of

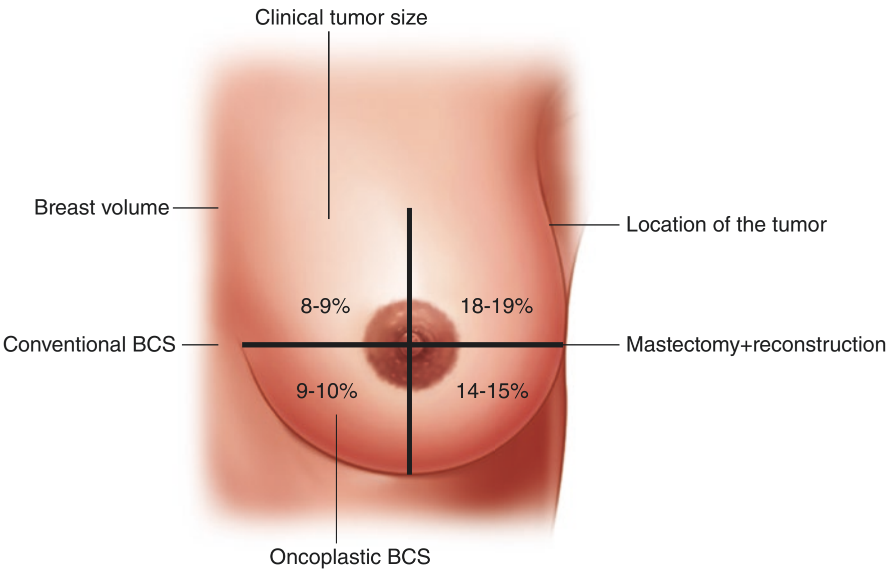


Fig. 1.3 Maximum tolerable volume loss per breast quadrant

the breast, as excision of even 20 g of breast tissue might cause an unacceptable deformity to a very small breast.

OBCS allows for significantly greater excision volumes while preserving the natural breast shape. Reshaping of the breast is based upon rearrangement of the breast parenchyma to correct volume loss. This can be achieved through either the displacement of breast tissue flaps into excision defects or volume replacement [71].

A publication from D. Pukancsik et al. gives a guidance regarding the maximum tolerable volume loss, per breast quadrant [73] (Fig. 1.3).

- Tumor location

High-risk zones in the breast are centrally located tumors and tumors in the lower pole and the upper inner quadrant. Excision of masses from these areas is more likely to be followed by deformity after BCS.

On the other hand, tumors located in the upper outer quadrant of the breast are more suitable for larger volume excisions, with the use of OBCS.

- Glandular density

Breast density estimates the amount of fat in the breast and determines the possibility to safely perform extensive breast undermining and reshaping. Glandular density can be evaluated both clinically and radiologically. Although clinical examination provides reliable information, mammographic evaluation is more accurate and certainly is a more reproducible approach. Breast density can be classified into four categories based on the Breast Imaging Reporting and Data System (BI-RADS).

- Fatty
- Scattered fibroglandular
- Heterogeneously dense
- Extremely dense breast tissue [74]

Denser breast tissue (BI-RADS 3/4) can be mobilized easily, without risk of fat necrosis, compared to a less dense breast with a more fatty component (BI-RADS 1/2). Thus, procedures that require extensive skin undermining are not ideal for a patient with a predominantly fatty breast. In these cases, some level II OBCS techniques, which require less skin undermining, compared to Level I techniques, can be considered as a safer alternative. As a general rule, level I OBCS includes undermining the breast from both the skin and pectoralis fascia, so they are less appropriate for less dense breasts with a more fatty component. These techniques are best performed on women with dense breasts, especially if significant parenchymal mobilization is used [32].

Thus, breast density is a predictor of long-term cosmetic outcomes. Volumetric breast density (VBD) and percentage of breast volume excised (PBVE) can be calculated with image analysis software. Breasts with a VBD that is more than15% (more fatty breasts) and PBVE that is less than10% are considered not only to predict better cosmetic outcome after BCS alone, but also to be an indication for immediate breast reconstruction. PBVE is more responsible for early-stage cosmetic outcome, while VBD is associated with later-stage cosmetic outcomes. Low breast density was associated with loss of adipose tissue volume, thus increased fibroglandular tissue volume and fibrosis after BCS [75].

Volume Replacement Techniques

Several different approaches to volume replacement have been developed. Volume replacement should always be considered when adequate local tumor excision is expected to lead to an unacceptable degree of local deformity. Resection of more than 20% of breast volume, particularly from central, medial, or inferior locations, increases the possibility of a significant local deformity [21]. In these patients, volume replacement can extend the role of BCS and avoid mastectomy when resecting up to 70% of the breast. It is particularly suitable for patients who wish to avoid volume loss and contralateral symmetrization surgery. It is also suitable for patients who wish a delayed reconstruction and is the method of choice for correcting severe postradiotherapy deformity. In the possibility when a mastectomy will be necessary, volume replacement is also the technique of choice. Patients must be consented for the possibility of complications that may result in prolonged convalescence.

Immediate or delayed lipofilling is a relatively new volume replacement technique that improves cosmetic outcomes. Especially following a wide local excision in patients with small breasts, where excision of even a small cancer is predicted to produce a poor cosmetic outcome.

Volume Displacement Techniques

Level I OBCS

What made level I OBCS techniques so popular is the ability of the majority of surgeons to adopt them into their surgical practice.

In level I OBCS, skin incision is followed by undermining of the skin and/or NAC. OBCS is not minimally invasive surgery. The concepts of oncoplastic surgery are not based on minimizing incision length. Short incision lengths limit mobilization of the gland, which is a key component in achieving a natural breast shape and do not allow creation of adequate glandular flaps to fill excision defects.

Incisions that follow Kraissl's lines minimize scarring [76]. Then excision of cancer follows (from subcutaneous fat, usually down to pectoralis fascia), surrounded by healthy breast tissue. A specimen X-ray to demonstrate complete radiological excision is always necessary, and at this stage further cavity shaves are resected, if necessary. The next step is re-approximation of breast parenchyma to close the glandular defect. In BCS, breast tissue is either re-approximated or left open allowing for seroma formation. However, seroma formation does not always result in predictable long-term cosmetic results, and the excision cavity contracts due to fibrosis, creating a noticeable defect. For this reason, redistribution of the remaining breast volume is advisable. Finally, if NAC repositioning is required (in cases where NAC displaces toward the site of excision and is no longer positioned in the center of the breast mound), a crescent de-epithelialization surrounding the areola is performed. Avoiding NAC displacement is a key element for both level I and II OBCS. The level of NAC sensitivity is reduced by extensive mobilization [77]. Caution must always be taken, not to compromise NAC's vascular supply. This, however, is not compromised by careful de-epithelialization [78].

Level II OBCS

Level II techniques are generally preferred when volume excisions between 20% and 50% are required. They allow large volume resection without cosmetic deformity and can be based on modifications of the superior or inferior pedicle and round-block therapeutic mammoplasty techniques. There is a wide range of level II OBCS techniques that can be adapted and modified to deal with tumors in any quadrant or to avoid a preexisting scar [32].

For many of these techniques, the nipple is repositioned with the use of a pedicle, which may arise inferiorly or superiorly usually, or even a combination of several pedicles. Vascular supply of several pedicles has been described by O'Dey et al. [78].

Atlas Principles

The concept of the oncoplastic atlas is based primarily on tumor location. OBCS has evolved to allow resection of breast lesions located almost anywhere in the breast [79].

Level II OBCS will generally result in a smaller breast that is placed higher on the chest wall, compared to the contralateral breast. Either immediate or delayed symmetrization can be performed, depending on patient's will. In a series of 175 women having OBCS, a contralateral breast reduction was performed in 25% of patients (19% immediate and 6% delayed). A higher rate of contralateral surgery was performed in patients who had an inverted-T mammoplasty (50% vs. 14% with other techniques; $P < 0.001$) [80].

There are multiple "atlases" of techniques for tumors located in different breast quadrants [35], and surgeons should be familiar with a range of methods and also have the efficiency and ability to modify them when necessary.

There is a profound need to developing a universally accepted OBCS classification and quadrant-by-quadrant atlas, which will improve communication between oncoplastic surgeons and patients.

The diagrams below are representative examples for the more appropriate OBCS technique according to tumor location. It is noticeable that an extremely heterogeneous group of therapeutic mammoplasties is available, with different complication rates and long-term outcomes [81, 82] (Figs. 1.4, 1.5, and 1.6).

Surgical Complications and Solutions

We know that mammoplasty techniques for cosmetic breast reduction have acceptable complication rates. Early complications include scarring, asymmetry, seroma, hematoma, bleeding, wound infection, skin or nipple necrosis, and delayed healing. Late complications may involve fat necrosis, loss of nipple sensitivity, and NAC necrosis [83]. Extensive data are not available on complication rates specifically for OBCS, however.

Volume displacement techniques may be complicated by necrosis of the dermoglandular flaps, and routinely contralateral surgery is required to restore symmetry. On the other hand, volume replacement techniques require additional theater time and may be complicated by donor-site morbidity, skin flap or nipple necrosis, flap loss, implant loss, capsular contracture, and longer convalescence. Glandular necrosis is the most challenging complication. Patient selection and careful surgical technique will avoid this. Areas of fat necrosis can become infected and cause wound dehiscence resulting in postoperative treatment delay. If fat necrosis occurs, multiple sessions of lipomodelling can result in good long-term results.

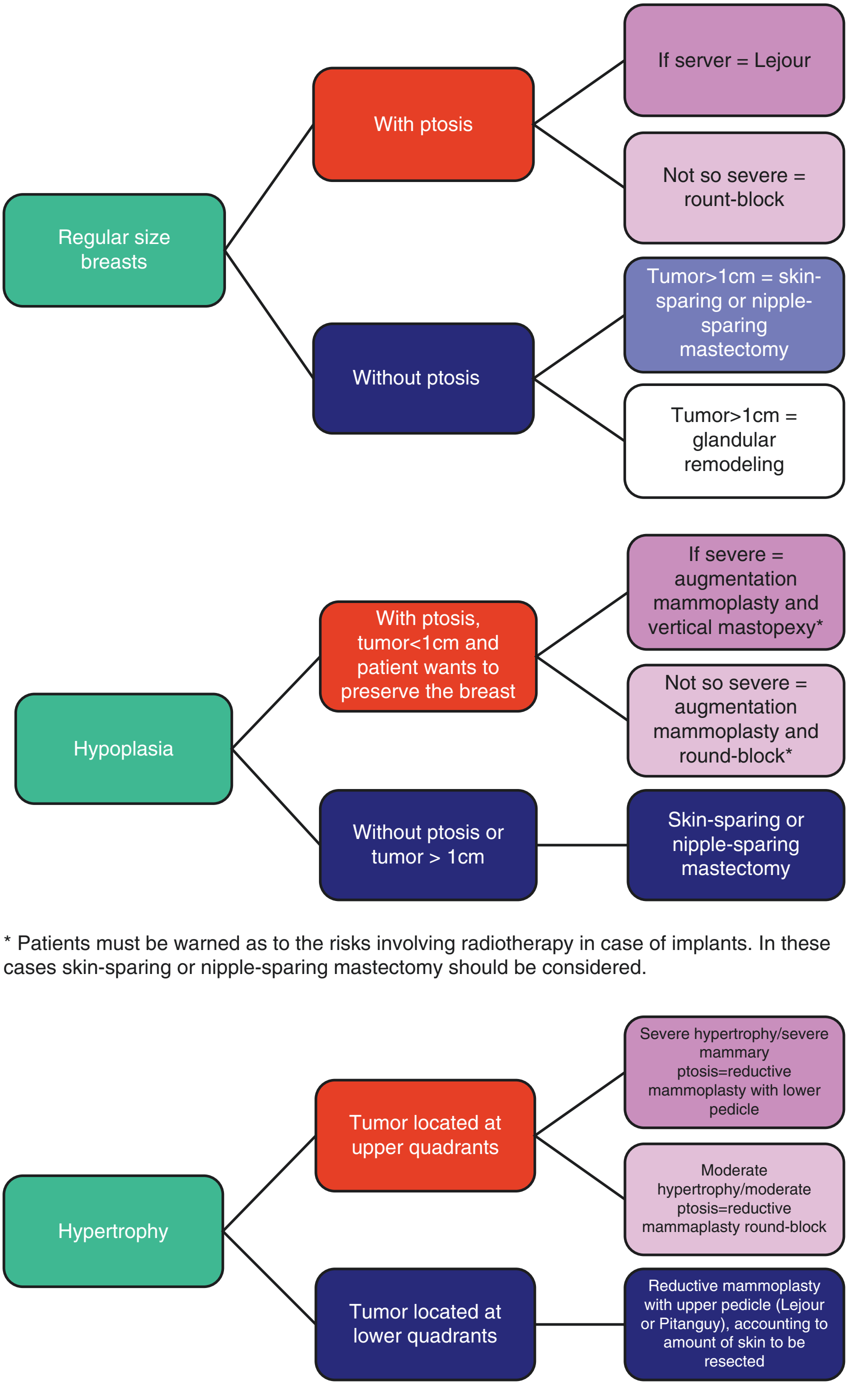


Fig. 1.4 OBCS technique according to tumor location [1]

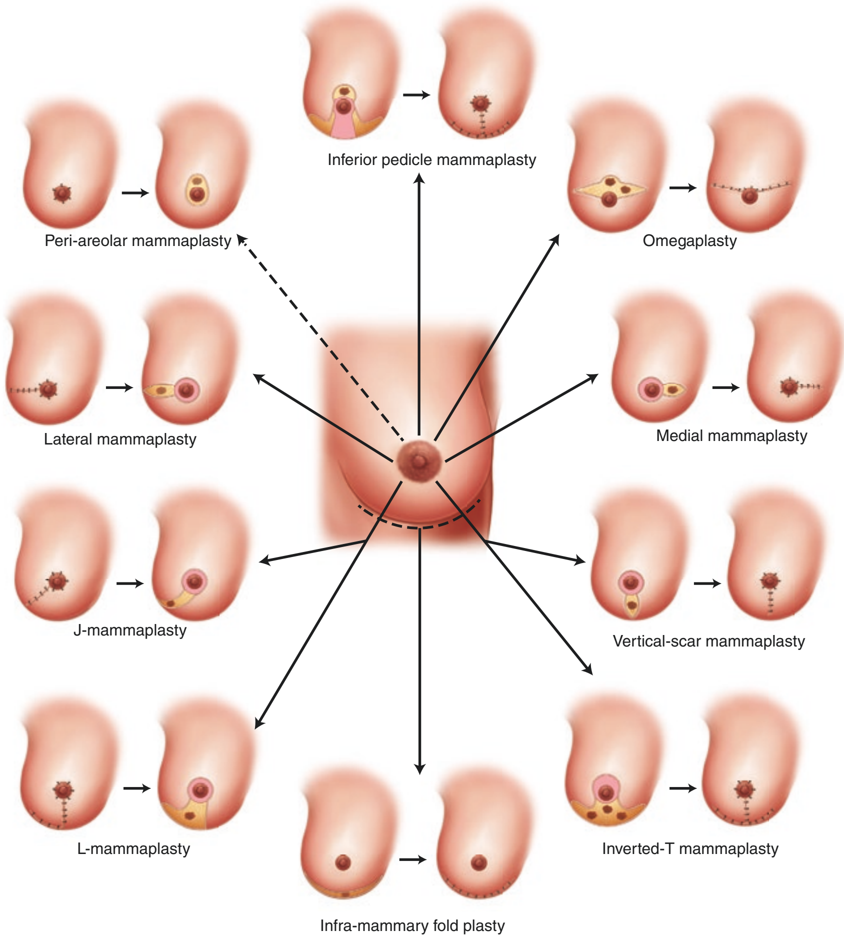


Fig. 1.5 OBCS technique according to tumor location [2]

Breast reconstruction may be compromised by previous radiotherapy, leading to reduced tissue viability and an increased risk of fat necrosis, higher infection rates, delayed wound healing, and failure of reconstruction. Immediate implant-based reconstruction, following mastectomy, in the cases when radiotherapy to the chest wall is predicted to follow, is associated with increased morbidity, however, when performed by a skilled and fully trained oncoplastic breast surgeon, and if the patient lacks significant comorbidities, such as diabetes and obesity and provided that patient is not a smoker, it can be considered as a safe option.

Fig. 1.6 Cosmetic outcomes of different therapeutic mammoplasty techniques [1]

Results (Literature and Data)

The increasing number of OBCS publications in the medical literature is a proof of the advantages and gained popularity of OBCS.

Advantages of OBCS

The first advantage of OBCS is the possibility of resection of wider free margins, since there is a possibility of resection of larger breast volumes (level III evidence) and of better cosmetic results (level IV evidence). Thus, fewer patients may need reoperations for any reason (level IV evidence) [84–86].

Moreover, OBCS extends the indications for BCS, and patients with larger tumors may avoid mastectomy (level IV evidence) [87].

There are also some relative advantages of OBCS that cannot be considered as indications, such as the fact that contralateral procedures done for symmetrization may detect previously unknown cancer [20] and that contralateral reduction mammaplasty may reduce the risk of breast cancer, as breast volume is excised [88].

Disadvantages of OBCS

Longer duration of surgery is a disadvantage of OBCS and especially of level II OBCS techniques. Another disadvantage is more visible and larger scars; however, the position of the scars may be an advantage, if they are periareolar or in the inframammary fold. What is more, there is a higher complication rate, because of more complex procedures or contralateral surgery, but it has been proven that there is no delay of adjuvant treatment [87].

More than one procedure might be necessary, if contralateral symmetrization is not done in one stage and possibility complications might occur in the breast that was not affected with cancer, if contralateral symmetrization is decided. Surgical training in oncoplastic and reconstructive breast surgery is necessary, and this limits the availability of OBCS [87].

Finally, advances in OBCS have been restricted by the diversity of techniques used, the lack of uniformity in classifying oncoplastic techniques, and the limited guidelines of the optimum OBCS procedures in the surgical literature. This causes confusion and difficulty in technique selection.

Oncological Safety of OBCS Compared to Standard BCS

Concerns have been raised about whether OBCS procedures are oncologically safe. There are no randomized trials to compare the outcomes of standard BCS or mastectomy with OBCS [30, 32].

On the other hand, there is growing evidence that OBCS techniques offer patients safe and effective surgical treatment.

There have been numerous large cohort studies, which show that OBCS has acceptable LR rates [89–93].

Acceptable rates of LR are seen even in cases with large primary tumors [90]. This is also confirmed by a recent systematic review [91].

Another large comparison study of consecutive series of 454 OBCS cases including volume displacement and replacement techniques, with a median follow-up of 7.2 years, didn't show any statistically significant difference in overall survival (OS) or disease-free survival (DFS). It demonstrated a slight increase in LR rates in the OBCS group (3.2 vs. 1.8% in 5 years). Re-excision rate was 15.4% for the OBCS cohort and 28.6% for the BCS cohort [94].

Similarly, A. Chakravorty et al. found a re-excision rate of 2.7% and an LR rate or 2.7% for OBCS versus 13.4% and 2.2% for BCS, respectively [92].

A prospective analysis of over 100 patients undergoing OBCS demonstrated 5-year OS and DFS rates of 95.7% and 82.8%, respectively [89].

The cosmetic results at a median follow-up of 49 months in a recent series of 175 patients were favorable in 85% of patients. Delay in adjuvant treatment was related to slow wound healing in only four patients, but all patients were able to receive appropriate postoperative radiotherapy and chemotherapy during the study [80].

A more recent retrospective review of 298 patients treated with OPS demonstrated a 5-year recurrence-free rate of 93.7% and 94.6% OS. This large review confirms the equivalent outcomes of OBCS and standard BCS [95]. Rietjens et al. have reported long-term results from the European Institute of Oncology indicating no local relapse in the pT1 cohort. The pT2 and pT3 combined group had a 5-year LR rate of 8% and a mortality rate of 15%. The overall LR rate was determined to be 3% [93].

Final cosmetic outcomes and complication rates are not altered in patients undergoing neoadjuvant chemotherapy.

A prospective randomized study [87] compared standard BCS to OBCS. OBCS allowed resection of significantly larger breast volumes, yielded wider free surgical margins, and a lower, however, nonsignificant, number of patients requiring re-excision of margins or conversion to mastectomy. These results were also seen by other authors [84, 86, 89].

Numerous studies regarding OBCS showed that the results are safe from the oncological perspective [89–93], and it has been proven that OBCS does not lead to delay in adjuvant treatment [96] (Table 1.2).

Do we consequently have enough evidence to make OBCS be the standard of care? It is evident that we lack of level 1 evidence comparing OBCS with traditional BCS. The fact that many different techniques are used makes a randomized trial difficult.

Cosmetic Outcomes

Assessing cosmetic outcomes is complex. Initial assessments were subjective and mainly relying on the surgeons' and not on the patients' opinion [55, 89, 96].

However, it was soon realized that this should be less biased and also that patient's satisfaction cannot be ignored, since this is the final goal. Assessing cosmetic outcomes, nowadays, has become more objective and takes into major consideration patient's opinion and satisfaction regarding the look and feel of the cancer-affected and cancer-treated breast, together with the contralateral breast and its influence on the quality of life of the patient.

With the introduction of objective analysis tools, OBCS seems to improve symmetry [97]. Interestingly the patients judged their aesthetic outcome more positively than the software [98, 99].

Breast symmetry doesn't seem to be a major factor for a patient's quality of life and breast self-esteem. Patients consider the oncological outcome of the disease as of immense importance [100].

This can be explained by the so-called "response shift," which is an adaptation process, where patients with a severe disease accommodate their illness. This explains why women with mastectomy and immediate reconstruction for DCIS reported better physical functioning and less bodily pain, not only compared to women who had just undergone wide local excision, but also compared to healthy women as well [101].

Finally, it is important not to evaluate only the immediate results. Oncoplastic breast surgeons, together with their patients, have to be aware that the aesthetic

Table 1.2 OBS does not lead to delay in adjuvant treatment

Summary of evidence for delivery of adjuvant chemotherapy after OBCS

Year	First author	Country/institution	No. of patients	Tumor size	Adjuvant chemotherapy received No. of patients (% of patients)	Delay in adjuvant therapy	Delayed adjuvant therapy No. of patients (% of patients)
1998	Nos et al.	France/Institut Curie Paris	50	Tis – T4	5 (10%)	Yes	3 (6%)
2002	Losken et al.	USA/Emory University Hospital	20	Tis – n/d, benign	n/d	No	0
2003	Clough et al.	France/Institut Curie Paris	101	T1 – T4	0	Yes	4 (4%)
2003	Spear et al.	USA/Georgetown University Hospital	22	n/d	22 (IC0%)	No	0
2005	McCulley et al.	UK/Nottingham City Hospital	50	Tis – n/d	23 (46%)	No	0
2006	Munhoz et al.	Brazil/University of Sao Paolo	74	T1 – T2	22 (29.7%)	No	0
2006	Thornton et al.	USA/University of Kentucky	6	Tl – T2	0	No	0
2007	Kronowitz et al.	USA/M.D. Anderson Cancer Ctr.	41	Tis – T2	18 (44%)	No.	0
2007	Losken et al.	USA/Emory University Hospital	63	Tis – n/d, benign		No	0
2007	Rietjens et al.	Italy/European Institute of Oncology	148	Tl – T3	89 (60%)	No	0
2010	Meretoja et al.	Finland, Helsinki Univ. Ctr. Hosp.	90	Tis – T3	60 (67%)	Yes	2 (2%)
2010	Fitoussi et al.	France/Institut Curie Paris	540	T1 – T3	n/d	Yes	10 (1.9%)
2010	Song et al.	USA/Emory University Hospital	28	Tis	n/a	No	0
2012	Romics Jr. et al.	UK/Glasgow University Hospitals	31	T1 – T3	31 (100%)	No delay compared to adequate control arms	

n/d not disclosed, *n/a* not applicable outcome is likely to be altered in time, and while most women feel pleased with the aesthetic results at 6 months postoperatively [54], the impact of scarring, indentation, and radiotherapy may lead to suboptimal results at 5 or even 10 years of follow-up [102] (Fig. 1.7).

OBCS and Special Training

Training in breast surgery should incorporate surgical oncology together with plastic and reconstructive surgery. Oncoplastic breast training is required for level II techniques, but all surgeons doing breast surgery should be able to perform level I oncoplastic surgical techniques.

A study describing how the breast and plastic surgical workforce has adapted to provide oncoplastic breast surgery showed that the range of procedures performed by plastic surgeons has remained static, while the general and breast surgeons are performing proportionally more OBS. Moreover, it showed that over the years surgeons have become less concerned about the risks of lipomodelling [103].

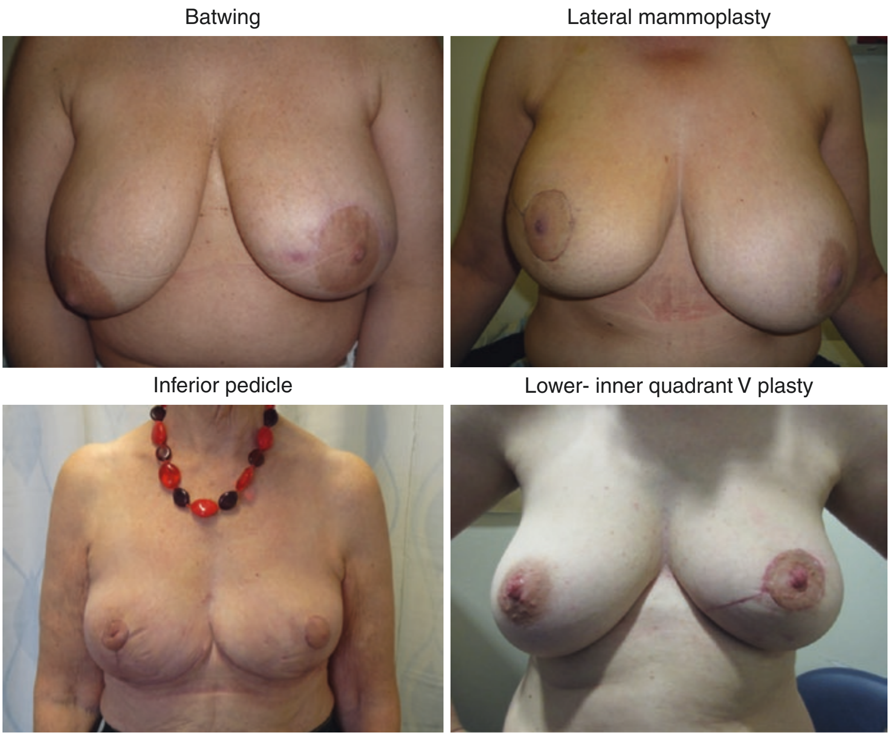


Fig. 1.7 Cosmetic outcomes of different therapeutic mammoplasty techniques [2]

A review showed that disfiguring and mutilating excisions can no longer be justified and are not acceptable in the surgical management of breast cancer and that OBCS requires combined skills, knowledge, and understanding of both oncological and plastic surgery techniques which may be optimally delivered by a single oncoplastic surgeon [104].

Thus, OBCS should be delivered only by surgeons who are trained in both disciplines. However, not all surgeons are "oncoplastic" breast surgeons, trained in both oncological and plastic breast surgery. In that case, a "two-team" approach is necessary, with a close collaboration between oncological and plastic surgeons.

Conclusion

Eventually is OBCS trend or necessity? There is no question that breast cancer patients have become more demanding regarding good cosmetic outcomes following BCS. This increases patients' expectations and drive oncoplastic surgeons toward using more complex surgical techniques. One could argue that no prospective controlled trial has demonstrated that OBCS may improve objective breast cosmesis and long-term quality of life. Thus, is OBCS necessary for the desirable cosmesis and is complications' rate comparable to traditional BCS?

Tenofski et al. have shown that OBCS is not superior to traditional BCS. However, is this really the case [105]?

OBCS extends the role of BCS by enabling complete excision of a greater range of tumors, and it aims to achieve conservation in cases with large tumors, where a mastectomy would be unavoidable, in order to achieve clear margins with acceptable cosmesis. This allows for breast conservation, without compromising the oncologic result. On the other hand, it consumes significantly more time and resources and today cost effectiveness is of the utmost concern.

Application of OBCS must be justified, and this has to be based on specific criteria, in order to gain the most out of it and to reduce unnecessary complications. OBCS is unnecessary for small tumors in large breasts; thus, in these cases the use of it may be concerned as a malpractice, since there will be no oncological benefit, as it will not reduce re-excision rates and it will increase complications and possibly scars, with similar cosmetic results, compared to traditional BCS, without adding anything in terms of benefits.

Moreover, when OBCS is the surgical treatment of choice, the correct technique has to be used, as different techniques have different indications and complications [106].

Overall, OBCS is definitely a necessity. Volume replacement and displacement techniques have already become increasingly popular and is the "new gold standard" as an alternative to mastectomy in patients with small breast–tumor ratios and localized disease who wish to avoid more major surgery and the use of implants.

Needless to say, these techniques need to be performed only by adequately trained surgeons, who understand each technique's role in the surgical management of primary breast cancer. Training in oncoplastic surgery is now more widely available, and good quality training programs and guidelines are being developed globally to make these techniques more widely available and enhance quality [107–110].

In conclusion, as the breast is an aesthetic and functional organ, surgery should take into account its importance to feminity and a woman's identity and should not only focus in maximizing loco-regional control [1].

Key Points

- Surgery should take into account the importance of breast to each woman's identity.
- Local recurrence, following breast-conserving surgery (BCS), is related to margin involvement.
- Evidence indicates that oncoplastic breast-conserving surgery (OBCS) is oncologically safe.
- OBCS allows women who may otherwise have mastectomy and immediate reconstruction the choice to conserve their breast and to avoid deformity.
- Oncoplastic breast surgery includes volume replacement and volume displacement techniques.
- The type of technique used needs to be determined by the site of the tumor, the extent of resection, the size of the breast, and patient's personal preference.
- OBCS must be performed only by adequately trained surgeons.

References

1. Urban C, et al. Oncoplastic and reconstructive anatomy of the breast. Oncoplastic and reconstructive breast surgery. Milano: Springer; 2013. p. 13–21.
2. Lebovic GS. Oncoplastic surgery: blending science and art. In: Oncoplastic and reconstructive breast surgery. Milano: Springer; 2013. p. 3–11.
3. Rainsbury RM, Clough KB, Kaufman GJ, Nos C, Dixon JM. Oncoplastic procedures to allow breast conservation and a satisfactory cosmetic outcome. In: Breast surgery: a companion to specialist surgical practice. 5th ed. Edinburgh: Saunders Ltd; 2013. p. 82–109.
4. Fisher B, Redmond C, Posson R, et al. Eight-year results of a randomised clinical trial comparing total mastectomy and lumpectomy with or without irradiation in the treatment of breast cancer. N Engl J Med. 1989;320:822–8.
5. Veronesi U, Saccozzi R, Del Vecchio M, et al. Comparing radical mastectomy with quadrantectomy, axillary dissection and radiotherapy in patients with small cancers of the breast. N Engl J Med. 1981;305:6–11.
6. Veronesi U, Banfi A, Del Vecchio M, et al. Comparison of Halsted mastectomy with quadrantectomy, axillary dissection, and radiotherapy in early breast cancer: long-term results. Eur J Cancer Clin Oncol. 1986;22:1085–9.
7. Abrams J, Chen T, Giusti R. Survival after breast-sparing surgery versus mastectomy. J Natl Cancer Inst. 1994;86:1672–3.

8. Van Dongen JA, Voogd AC, Fentiman IS, et al. Long-term results of a randomized trial comparing breast-conserving therapy with mastectomy: European Organization for Research and Treatment of Cancer 10,801 trial. J Natl Cancer Inst. 2000;92:1143–50.
9. Veronesi U, Cascinelli N, Mariani L, Greco M, Saccozzi R, Luini A, Aguilar M, Marubini E. Twenty-year follow-up of a randomized study comparing breast-conserving surgery with radical mastectomy for early breast cancer. N Engl J Med. 2002;347:1227–32.
10. Poggi MM, Danforth DN, Sciuto LC, Smith SL, Steinberg SM, Liewehr DJ, Menard C, Lippman ME, Lichter AS, Altemus RM. Eighteen-year results in the treatment of early breast carcinoma with mastectomy versus breast conservation therapy: the National Cancer Institute Randomized Trial. Cancer. 2003;98:697–702.
11. Blichert-Toft M, Rose C, Andersen JA, Overgaard M, Axelsson CK, Andersen KW, Mouridsen HT. Danish randomized trial comparing breast conservation therapy with mastectomy: six years of life-table analysis. Danish Breast Cancer Cooperative Group. J Natl Cancer Inst Monogr. 1992;11:19–25.
12. Arriagada R, Lê MG, Rochard F, Contesso G. Conservative treatment versus mastectomy in early breast cancer: patterns of failure with 15 years of follow-up data. Institut Gustave-Roussy Breast Cancer Group. J Clin Oncol. 1996;14:1558–64.
13. Fisher B, Anderson S, Bryant J, Margolese RG, Deutsch M, Fisher ER, Jeong JH, Wolmark N. 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. 2002;347:1233–41.
14. Horiguchi J, Iino Y, Takei H, et al. Surgical margin and breast recurrence after breast-conserving therapy. Oncol Rep. 1999;6:135–8.
15. Di Biase SJ, Komarnicky LT, Schwarzt GF, et al. The number of positive margins influences the outcome of women treated with breast preservation for early stage breast carcinoma. Cancer. 1998;82:2212–20.
16. Meric F, Mirza NQ, Vlastos G, et al. Positive surgical margins and ipsilateral breast tumor recurrence predict disease-specific survival after breast-conserving therapy. Cancer. 2003;97:926–33.
17. Dixon J. Histological factors predicting breast recurrence following breast-conserving therapy. Breast. 1993;2:197.
18. Veronesi U, Voltarrani F, Luini A, et al. Quadrantectomy versus lumpectomy for small size breast cancer. Eur J Cancer. 1990;26:671–3.
19. Audretsch WP. Reconstruction of the partial mastectomy defect: classification and method. In: Spear SL, editor. Surgery of the breast: principles and art. Philadelphia: Lippincott-Raven; 1998. p. 155–95.
20. Petit JY, Rietjens M, Contesso G, Bertin F, Gilles R. Contralateral mastoplasty for breast reconstruction: a good opportu- nity for glandular exploration and occult carcinomas diagnosis. Ann Surg Oncol. 1997;4:511–5.
21. Cochrane RA, Valasiadou P, Wilson AR, Al-Ghazal SK, Macmillan RD. Cosmesis and satisfaction after breast-conserving surgery correlates with the percentage of breast volume excised. Br J Surg. 2003;90:1505–9.
22. Pearl RM, Wisnicki J. Breast reconstruction following lumpectomy and irradiation. Plast Reconstr Surg. 1985;76:83–6.
23. Berrino P, Campora E, Sauti P. Postquadrantectomy breast deformities: classification and techniques of surgical correction. Plast Reconstr Surg. 1987;79:567–72.
24. Borger JH, Keijser AH. Conservative breast cancer treatment: analysis of cosmetic role and the role of concomitant adjuvant chemotherapy. Int J Radiat Oncol Biol Phys. 1987;13:1173–7.
25. Van Limbergen E, Rijnders A, van der Schueren E, et al. Cosmetic evaluation of conserving treatment for mammary cancer. 2. A quantitative analysis of the influence of radiation dose, fractionation schedules and surgical treatment techniques on cosmetic results. Radiother Oncol. 1989;16:253–67.

26. Van Limbergen E, Van der Schueren E, Van Tongelen K. Cosmetic evaluation of breast conserving treatment for mammary cancer. 1. Proposal of quantitative scoring system. Radiother Oncol. 1989;16:159–67.
27. Olivotto IA, Rose MA, Osteen RJ, et al. Late cosmetic outcome after conservative surgery and radiotherapy: analysis of causes of cosmetic failure. Int J Radiat Oncol Biol Phys. 1989;17:747–53.
28. Yoon JJ, Green WR, Kim S, Kearney T, Haffty BG, Eladoumikdachi F, Goyal S. Oncoplastic breast surgery in the setting of breast-conserving therapy: a systematic review. Adv Radiat Oncol. 2016;1:205–15.
29. Kelsall JE, McCulley SJ, Brock L, Akerlund MTE, Macmillan RD. Comparing oncoplastic breast conserving surgery with mastectomy and immediate breast reconstruction: case-matched patient reported outcomes. J Plast Reconstr Aesthet Surg. 2017;70:1377–85.
30. Weber WP, Soysal SD, Zeindler J, Kappos EA, Babst D, Schwab F, Kurzeder C, Haug M. Current standards in oncoplastic breast conserving surgery. Breast. 2017;34(Suppl 1):S78–81.
31. Schaverien MV, Doughty JC, Stallard S. Quality of information reporting in studies of standard and oncoplastic breast-conserving surgery. Breast. 2014;23:104–11.
32. Sanidas EE, Fitzal F. Oncoplastic breast-concerving therapy. Breast cancer management for surgeons. Switzerland: Springer International Publishing AG; 2018. p. 229–44.
33. Slavin SA, Love SM, Sadowsky NL. Reconstruction of the irradiated partial mastectomy defect with autogenous tissues. Plast Reconstr Surg. 1992;90:854–65.
34. MacNeill F, Karakatsanis A. Over surgery in breast cancer. Breast. 2017;31:284–9.
35. Clough KB, Kaufman GJ, Nos C, Buccimazza I, Sarfati IM. Improving breast cancer surgery: a classification and quadrant per quadrant atlas for oncoplastic surgery. Ann Surg Oncol. 2010;17:1375–91.
36. Chung AP, Huynh K, Kidner T, Mirzadehgan P, Sim MS, Giuliano AE. Comparison of outcomes of breast conserving therapy in multi- focal and unifocal invasive breast cancer. J Am Coll Surg. 2012;215:137–46. discussion 46–7.
37. Yerushalmi R, Tyldesley S, Woods R, Kennecke HF, Speers C, Gelmon KA. Is breast-conserving therapy a safe option for patients with tumor multicentricity and multifocality? Ann Oncol. 2012;23:876–81.
38. Tan MP, Sitoh NY, Sitoh YY. Optimising breast conservation treat- ment for multifocal and Multicentric breast cancer: a worthwhile Endeavour? World J Surg. 2016;40:315–22.
39. Macmillan RD, James R, Gale KL, McCulley SJ. Therapeutic mamma- plasty. J Surg Oncol. 2014;110:90–5.
40. Hernanz F, Regano S, Vega A, Gomez FM. Reduction mammaplasty: an advantageous option for breast conserving surgery in large- breasted patients. Surg Oncol. 2010;19:e95–e102.
41. McIntosh J, O'Donoghue JM. Therapeutic mammaplasty-a systematic review of the evidence. Eur J Surg Oncol. 2012;38:196–202.
42. Schwartz GF, Veronesi U, Clough KB, et al. Proceedings of the consensus conference on breast conservation, April 28 to May 1, 2005, Milan, Italy. Cancer. 2006;107:242–50.
43. Nijenhuis MV, Rutgers EJ. Conservative surgery for multifocal/multicentric breast cancer. Breast. 2015;24(Suppl 2):S96–9.
44. Silverstein MJ, Savalia N, Khan S, Ryan J. Extreme oncoplasty: breast conservation for patients who need mastectomy. Breast J. 2015;21:52–9.
45. Munhoz AM, Montag E, Arruda E, et al. Assessment of immediate conservative breast surgery reconstruction: a classification system of defects revisited and an algorithm for selecting the appropriate technique. Plast Reconstr Surg. 2008;121:716–27.
46. Buchanan CL, Morris EA, Dorn PL, Borgen PI, Van Zee KJ. Utility of breast magnetic resonance imaging in patients with occult primary breast cancer. Ann Surg Oncol. 2005;12:1045–53.
47. Criscitiello C, Curigliano G, Burstein HJ. Breast conservation following neoadjuvant therapy for breast cancer in the modern area: are we losing the opportunity? Eur J Surg Oncol. 2016;42:1780–6.

48. Papa M, Zippel D, Koller M, Klein E, Chetrit A, Ben AG. Positive margins of breast biopsy: is re-excision always neces- sary? J Surg Oncol. 1999;70:167–71.
49. Kronowitz SJ, Robb GL. Breast reconstruction with postmastectomy radiation therapy: current issues. Plast Reconstr Surg. 2004;114:950–60.
50. Volleamere AJ, Kirwan CC. National survey of breast cancer specimen orientation marking systems. Eur J Surg Oncol. 2013;39:255–9.
51. Gradishar WJ, Anderson BO, Balassanian R, Blair SL, Burstein HJ, Cyr A, et al. Invasive breast cancer version 1.2016, NCCN clinical practice guidelines in oncology. J Natl Compr Canc Netw. 2016;14:324–54.
52. Molina MA, Snell S, Franceschi D, Jorda M, Gomez C, Moffat FL, et al. Breast specimen orientation. Ann Surg Oncol. 2009;16:285–8.
53. Azu M, Goyal S, Patel U, Haffty B, Kearney T. Has placement of surgical clips in the lumpectomy bed fallen out of favor? Ann Surg Oncol. 2011;18:1529–32.
54. Losken A, Styblo TM, Carlson GW, Jones GE, Amerson BJ. Management algorithm and outcome evaluation of partial mastectomy defects treated using reduction or mastopexy techniques. Ann Plast Surg. 2007;59:235–42.
55. Clough KB, Kroll S, Audretsch W. An approach to the repair of partial mastectomy defects. Plast Reconstr Surg. 1999;104:409–20.
56. Galimberti V, Zurrida S, Zanini V, Callegari M, Veronesi P, Catania S, Luini A, Greco M, Grisotti A. Central small size breast cancer: how to overcome the problem of nipple and areola involvement. Eur J Cancer. 1993;29:1093–6.
57. Anderson BO, Masetti R, Silverstein MJ. Oncoplastic approaches o partial mastectomy: an overview of volume-displacement techniques. Lancet Oncol. 2005;6:145–57.
58. Benelli LC. Periareolar Benelli mastopexy and reduction: the “round block”. In: Spear SL, editor. Surgery of the breast. Principles and art, vol. 2. 2nd ed. Philadelphia: Lippincott Williams and Wilkins; 2006. p. 977–90.
59. Dewar JA, Benhamou E, Arrigada R, et al. Cosmetic results following lumpectomy, axillary dissection and radiotherapy for small breast cancer. Radiother Oncol. 1988;12:273–80.
60. Berrino P, Campora E, Leone S, et al. Correction of type II breast deformities following conservative cancer surgery. Plast Reconstr Surg. 1992;90:846–53.
61. Bostwick J, Paletta C, Hartampf CR. Conservative treatment for breast cancer: complications requiring reconstructive surgery. Ann Surg. 1986;203:481–90.
62. Weber WP, Soysal SD, Fulco I, Barandun M, Babst D, Kalbermatten D, Schaefer DJ, Oertli D, Kappos EA, Haug M. Standardization of oncoplastic breast conserving surgery. Eur J Surg Oncol. 2017;43:1236–43.
63. Volders JH, Haloua MH, Krekel NM, et al. Intraoperative ultrasound guidance in breast-conserving surgery shows superiority in oncological outcome, long-term cosmetic and patient-reported outcomes: final outcomes of a randomized controlled trial (COBALT). Eur J Surg Oncol. 2017;43:649–57.
64. O’Brien W, Hasselgren PO, Hummel RP, et al. Comparison of postoperative wound complications in early cancer recurrence between patients undergoing mastectomy with or without immediate breast reconstruction. Am J Surg. 1993;166:1–5.
65. Eberlein TJ, Crespo LD, Smith BL, et al. Prospective evaluation of immediate reconstruction after mastectomy. Ann Surg. 1993;218:29–36.
66. Elkowitz A, Colen S, Slavin S, et al. Various methods of breast reconstruction after mastectomy: an economic comparison. Plast Reconstr Surg. 1993;92:77–83.
67. Dean C, Chetty U, Forrest APM. Effect of immediate breast reconstruction on psychosocial morbidity after mastectomy. Lancet. 1983;321:459–62.
68. Clough KB, Cuminet J, Fitoussi A, et al. Cosmetic sequelae after conservative treatment for breast cancer: classification and results of surgical correction. Ann Plast Surg. 1998;41:471–81.
69. Clough KB, Thomas SS, Fitoussi AD, et al. Reconstruction after conservative treatment for breast cancer: cosmetic sequelae classification revisited. Plast Reconstr Surg. 2004;114:1743–53.

70. Eaves FF, Bostwick J, Nahai F, et al. Endoscopic techniques in aesthetic breast surgery. Clin Plast Surg. 1995;22:683–95.
71. Rainsbury R. Surgery insight: oncoplastic breast-conserving reconstruction-indications, benefits, choices and outcomes. Nat Clin Pract Oncol. 2007;4:657–64.
72. Bulstrode NW, Shortri S. Prediction of cosmetic outcome following conservative breast surgery using breast volume measurements. Breast. 2001;10:124–6.
73. Pukancsik D, Kelemen P, Újhelyi M, et al. Objective decision making between conventional and oncoplastic breast-conserving surgery or mastectomy: an aesthetic and functional prospective cohort study. Eur J Surg Oncol. 2017;43:303–10.
74. American College of Radiology. American College of Radiology: breast imaging reporting and data systems (BI-RADS). Reston: American College of Radiology; 2003.
75. Shiina N, Sakakibara M, Fujisaki K, et al. Volumetric breast density is essential for predicting cosmetic outcome at the late stage after breast-conserving surgery. Eur J Surg Oncol. 2016;42:481–8.
76. Kraissl CJ. The selection of appropriate lines for elective surgical incisions. Plast Reconstr Surg. 1951;8:1–28.
77. Schlenz I, Rigel S, Schemper M, et al. Alteration of nipple and areola sensitivity by reduction mammaplasty: a prospective comparison of five techniques. Plast Reconstr Surg. 2005;115:743–51.
78. O'Dey D, Prescher A, Pallua N. Vascular reliability of the nipple–areola complex-bearing pedicles: an anatomical microdissection study. Plast Reconstr Surg. 2007;119:1167–77.
79. Smith ML, Evans GR, Gurlek A, et al. Reduction mammoplasty: its role in breast conservation surgery for early-stage breast cancer. Ann Plast Surg. 1998;41:234–9.
80. Clough KB, Ihrai T, Oden S, et al. Oncoplastic surgery for breast cancer based on tumour location and a quadrant-per-quadrant atlas. Br J Surg. 2012;99:1389–95.
81. Urban C, Lima R, Schunemann E, Spautz C, Rabinovich I, Anselmi K. Oncoplastic principles in breast conserving surgery. Breast. 2011;20(Suppl 3):S92–5.
82. Berry MG, Fitoussi AD, Curnier A, Couturaud B, Salmon RJ. Oncoplastic breast surgery: a review and systematic approach. J Plast Reconstr Aesthet Surg. 2010;63:1233–43.
83. Spear SL, Evans KK. Complications and secondary corrections after breast reduction and mastopexy. Surg Breast. 2006;2:1220–34.
84. Kaur N, Petit JY, Rietjens M, Maffini F, Luini A, Gatti G, Rey PC, Urban C, DeLorenzi F. Comparative study of surgical mar- gins in oncoplastic surgery and quadrantectomy in breast cancer. Ann Surg Oncol. 2005;12:539–45.
85. Schrenk P, Huemer GM, Sir A, Moser F, Wayand W. Tumor quadrantectomy combined with reduction mammaplasty for the treatment of breast cancer. Eur Surg. 2006;38:424–32.
86. Giacalone PL, Roger P, Dubon O, El Gareh N, Rihaoui S, Taourel P, Daures JP. Comparative study of the accuracy of breast resection in oncoplastic surgery and quad- rantectomy in breast cancer. Ann Surg Oncol. 2007;14:605–14.
87. Schrenk P. Oncoplastic breast surgery. In: Fitzal F, Schrenk P, editors. Oncoplastic breast surgery-a guide to clinical practice. Vienna: Springer; 2010. p. 29–42.
88. Boice JD, Perrson I, Brinton LA, Hober M, McLaughlin JK, Blot WJ, Fraumeni JF, Nyren O. Breast cancer following breast reduction surgery in Sweden. Plast Reconstr Surg. 2000;106:755–62.
89. Clough KB, Lewis JS, Couturaud B, Fitoussi A, Nos C, Falcou MC. Oncoplastic techniques allow extensive resections for breast- conserving therapy of breast carcinomas. Ann Surg. 2003;237:26–34.
90. Piper ML, Esserman LJ, Sbitany H, Peled AW. Outcomes following Oncoplastic reduction mammoplasty: a systematic review. Ann Plast Surg. 2016;76(Suppl 3):S222–6.
91. De La Cruz L, Blankenship SA, Chatterjee A, Geha R, Nocera N, Czerniecki BJ, et al. Outcomes after Oncoplastic breast-conserving surgery in breast cancer patients: a systematic literature review. Ann Surg Oncol. 2016;23:3247–58.
92. Chakravorty A, Shrestha AK, Sanmugalingam N, Rapisarda F, Roche N. Querci Della Rovere G, et al. how safe is oncoplastic breast con- servation? Comparative analysis with standard breast conserving surgery. Eur J Surg Oncol. 2012;38:395–8.

93. Rietjens M, Urban CA, Rey PC, Mazzarol G, Maisonneuve P, Garusi C, et al. Long-term oncological results of breast conservative treatment with oncoplastic surgery. Breast. 2007;16:387–95.
94. De Lorenzi F, Hubner G, Rotmensz N, et al. Oncological results of oncoplastic breast-conserving surgery: long term follow-up of a large series at a single institution: a matched-cohort analysis. Eur J Surg Oncol. 2016;42:71–7.
95. Staub G, Fitoussi A, Falcou MC, et al. Breast cancer surgery: use of mammaplasty. Results from a series of 298 cases. Ann Chir Plast Esthet. 2007;53:124–34.
96. Khan J, Barrett S, Forte C, Stallard S, Weiler-Mithoff E, Doughty JC, Romics L Jr. Oncoplastic breast conservation does not lead to a delay in the commencement of adjuvant chemotherapy in breast cancer patients. Eur J Surg Oncol. 2013;39:887–91.
97. Fitzal F, Mittlboeck M, Trischler H, Krois W, Nehrer G, Deutinger M, et al. Breast-conserving therapy for centrally located breast cancer. Ann Surg. 2008;247:470–6.
98. Heil J, Carolus A, Dahlkamp J, Golatta M, Domschke C, Schuetz F, et al. Objective assessment of aesthetic outcome after breast con- serving therapy: subjective third party panel rating and objective BCCT. Core software evaluation. Breast. 2012;21:61–5.
99. Heil J, Dahlkamp J, Golatta M, Rom J, Domschke C, Rauch G, et al. Aesthetics in breast conserving therapy: do objectively measured results match patients' evaluations? Ann Surg Oncol. 2011;18:134–8.
100. Exner R, Krois W, Mittlbock M, Dubsky P, Jakesz R, Gnant M, et al. Objectively measured breast symmetry has no in uence on quality of life in breast cancer patients. Eur J Surg Oncol. 2012;38:130–6.
101. Sackey H, Sandelin K, Frisell J, Wickman M, Brandberg Y. Ductal carcinoma in situ of the breast. Long-term follow-up of health-related quality of life, emotional reactions and body image. Eur J Surg Oncol. 2010;36:756–62.
102. Nahabedian MY, Ellsworth WA, Bass BL, Skoracki RJ, Heller L. Breast reconstruction in women under 30: a 10-year experience. Breast J. 2011;17:1–2.
103. Challoner T, Skillman J, Wallis K, et al. Oncoplastic techniques: attitudes and changing practice amongst breast and plastic surgeons in Great Britain. Breast. 2017;34:58–64.
104. Noguchi M, Yokoi-Noguchi M, Ohno Y, et al. Oncoplastic breast conserving surgery: volume replacement vs. volume displacement. Eur J Surg Oncol. 2016;42:926–34.
105. Tenofsky PL, Dowell P, Topalovski T, Helmer SD. Surgical, oncologic, and cosmetic differences between oncoplastic and nononcoplastic breast conserving surgery in breast cancer patients. Am J Surg. 2014;207:398–402; discussion 402.
106. Moris D, Kontos M. Oncoplastic surgery: fashion or necessity? Am J Surg. 2015;210:199.
107. Cardoso MJ, Macmillan RD, Merck B, Munhoz AM, Rainsbury R. Training in oncoplastic surgery: an international consensus. The 7th Portuguese Senology congress, Vilamoura, 2009. Breast. 2010;19:538–40.
108. Cutress RI, Summerhayes C, Rainsbury R. Guidelines for oncoplastic breast reconstruction. Ann R Coll Surg Engl. 2013;95:161–2.
109. Yunaev M, Hingston G. Oncoplastic breast surgery in Australia and New Zealand-2014 and beyond. Gland Surg. 2014;3:77–80.
110. Dixon JM. Breast surgery: a companion to specialist surgical practice. 5th ed. Edinburgh: Saunders Ltd; 2013.

Topographic Anatomical Relationships of the Breast, Chest Wall, Axilla, and Related Sites of Metastases

2

Kirby I. Bland

Growth and differentiation of the breasts is a hallmark feature for both sexes (Morehead [1]). Embryological maturation of mammalian organs is evolutionary biological tenets of the nascent paired glands that develop along parallel planes of the "milk lines" Mammary Milk Lines of the Breast- (Fig. 2.1) of mammals; the paired structures extend between the limb buds of the developmental axilla to both inguinal sites. The number of paired glands in mammalians of the lower phylogenetic phylum is determined by the number of fetuses evident with each litter of the individual species. For humans, and most primate species, only one gland matures ipsilaterally in the pectoral regions. However, presentation of extra breast tissue (*polymastia*) or nipple (*polythelia*) is routinely recognized, first by the pediatrician or mother, as a heritable condition with known frequency of 1% in the female population; the presentation is evident within the milk line. These relatively rare conditions also may occur in the male gender. When present, these multiple (*supernumerary*) breast(s) or nipple(s) usually form appendages within the milk lines; approximately one-third of similarly affected individuals have supernumerary presentations of breasts or nipples.

For the evolutionary superior *Homo sapiens* and other phylogenetically inferior mammalian species, these glands evolve as milk-producing organs of nutrition and caloric support of the feeding infant. This crucial evolutionary genetic trait for infant survival provides nourishment to the offspring in a relatively immature and dependent state with embryonic development in utero. The organ develops from the primordial-derived breast tissue which anatomically matures as a modified sweat gland. The act of nursing the young provides physiologic benefit to the mother by

K. I. Bland (✉)
UAB Hospitals and Clinics, Birmingham, AL, USA

University of Alabama in Birmingham, School of Medicine, Birmingham, AL, USA

UAB O'Neal Comprehensive Cancer Center, Birmingham, AL, USA
e-mail: kbland@uabmc.edu

V. S. Klimberg et al. (eds.), *Oncoplastic Breast Surgery Techniques for the General Surgeon*, https://doi.org/10.1007/978-3-030-40196-2_2

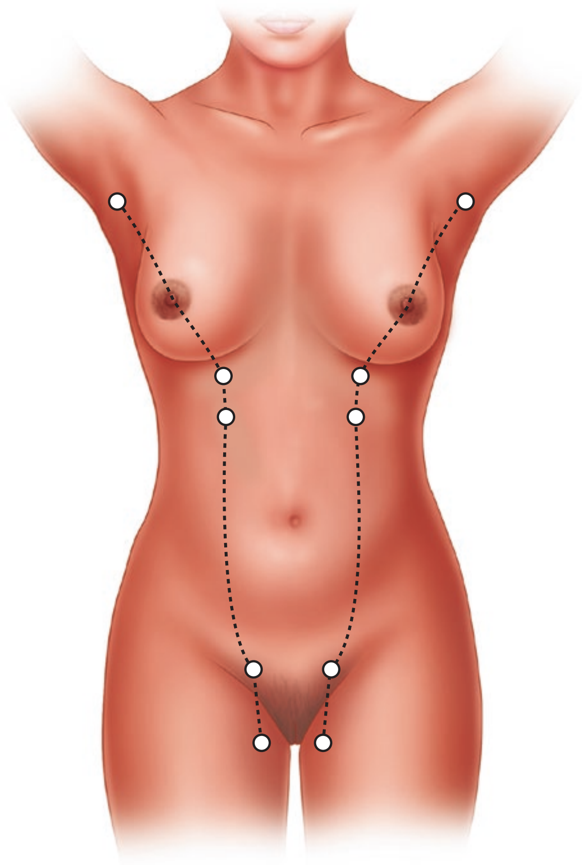


Fig. 2.1 Mammary milk line. The mammary milk line, "milk streak," which extends from the axilla bilaterally to the inguinal area atrophies expect for the supernumerary nipples of the breast

aiding in postpartum uterine involution. Moreover, postpartum feeding of the newborn with nutritional transport allows mother-infant transfer of passive antibody immunity from bacterial, protozoan, and viral infestation. Nursing of the offspring also allows significant emotional bonding between the mother and her infant.

Specifically within the female gender, hormonal influence with regulation of mammary parenchymal growth begins immediately within the postnatal era, which correlates with age and is exclusively regulated by ovarian and pituitary hormones that influence reproductive function. Principally influenced by ovarian hormonal secretion, by 20 years of age, the majority of females have reached developmental maturity for the organ. Typically by age 40, breast ducts and lobules enter early phases of atrophic microscopic structural alteration, months to years, before formal presentation of *menopause*. During each menstrual cycle of the premenopausal era, structural element aging is accelerated each decade within the parenchyma and is regulated by the influence of *fluctuations* of ovarian hormone levels. During *pregnancy* and *lactation*, striking changes occur—not only in the functional activity of the breast—but are evident with the volume, structural contour, and the gravitational distribution of glandular tissue [2]. The actual secretion and production of lactation ductal milk from the lobules results in stimuli by prolactin from the pituitary and somatomammotropin (lactogenic hormones) secretion from the placenta. With changes of the hormonal secretory volume reduction that are evident at *menopause*, the glandular components of the breast regress, involute, and are replaced by fatty connective tissue stroma allowing gravitational dependency and loss of breast form and contour.

Surface Anatomy: Compositional Form and Size

Mammary glands are positioned within the superficial and deep compartments of the anterior thoracic wall, limited anteriorly by skin and posteriorly by deep fascia of the chest wall. The parenchyma is composed of 15–20 lobes of glandular tissue of the tubule-alveolar type. Longitudinal fibrous connective stroma comprises a latticed framework that supports the lobes; abundant adipose tissue adds tissue volume between spaces of the lobes [3]. In the premenopausal female, structure and parenchymal stroma are dense; the organ remains mobile on the chest wall residing on the mammary bursae. Subcutaneous connective tissue surrounds the gland and extends as septae between the lobes and lobules, providing support for the glandular elements; however, the septae connective tissue does *not* form a distinctive circumferential capsule around any component of the structure. The deep layer of superficial fascia lies upon the posterior (deep) surface of the breast and resides upon the (deep) pectoral fascia of the thoracic wall. A distinct space, the *retromammary bursa*, can be identified surgically on the posterior aspect of the breast between the deep layer of the superficial fascia and the deep-investing fascia of the pectoralis major with its contiguous muscles of the thoracic wall (Fig. 2.2). As noted above, the retromammary bursa contributes to the mobility of the premenopausal breast on the thoracic wall. Of note, fibrous thickenings of connective tissue interdigitate between the parenchymal glandular tissues of the breast. This connective tissue extends from the deep layer of the superficial fascia (hypodermis) and attaches to the dermis of the skin. In the nineteenth century, renowned surgeon and anatomist, Sir Astley Cooper, described these suspensory structures, *Cooper's ligaments*, which are distinctively evident as a perpendicular insertion into the delicate superficial fascial layers of the cutis reticularis of the dermis, or corium, permitting remarkable mobility of the breast, while providing central supportive immobility of the organ.

With advancing maturity, the glandular portion of the female breast has a unique and distinctive protuberant conical appearance. The base of the cone is roughly circular, measuring 10–12 cm in diameter and 5–7 cm in thickness. Commonly, breast tissue extends into the axilla as the axillary tail (*of Spence*). There is tremendous variation in the size of the breast with visual distinctive asymmetry in any individual. The average *non-lactating breast* weighs between 150 and 225 g, whereas the lactating breast may exceed 500 g [4, 5]. In a study of breast volume in 55 women, Smith and colleagues [6] reported that the mean volume of the *right* breast was 275.46 mL (SD = 172.65; median = 217.7; minimum = 94.6; maximum = 889.3) and the *left* breast was 291.69 mL (SD = 168.23; median = 224; minimum = 106.9; maximum = 893.9) (Fig. 2.3).

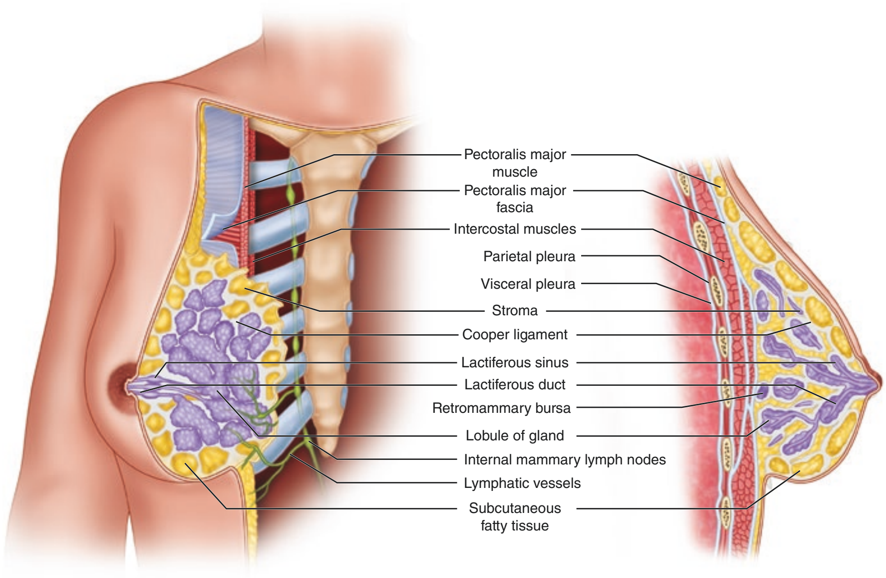


Fig. 2.2 Anterior and tangential depiction of the breast on the chest wall attached to the skin by suspensory ligaments. Cooper's ligaments form septae in the stroma that provide support for the breast parenchyma. Fifteen to 20 lobules comprised of glandular epithelium-lined lactiferous ducts extend to openings located on the nipple. A dilation of the duct, the lactiferous sinus, is present near the opening of the duct in the subareolar tissue. Lymphatic vessels pass through the stroma surrounding the lobules of the gland and convey lymph to collecting ducts. Lymphatic channels ending in the internal mammary (or parasternal) lymph nodes are shown

The nulliparous female breast has a typical hemispheric configuration with distinct flattening above the nipple [7]. The multiparous breast has often been exposed to repetitive hormonal stimulation associated with pregnancy and lactation and is usually larger and more dense with supported tissues and typically more pendulous. As noted above, pregnancy and induction of lactation allows the breast to dramatically increase in size and with weight of harbored milk to assume the more pendulous configuration. Further, with increasing age, the *postmenopausal* breast typically assumes a reduction in volume, becomes somewhat flattened, and becomes gravitationally pendulous; thereafter, the organ becomes less dense, second to rapid replacement of parenchyma with fatty tissues.

Chest Wall Orientation

With maturity, the female breast vertically extends inferiorly from the level of the second or third rib to the inframammary fold, which is consistently the level of the sixth or seventh rib, and extends transversely from the lateral border of the sternum to the anterior or, on occasion, the midaxillary line. The deep or posterior surface of

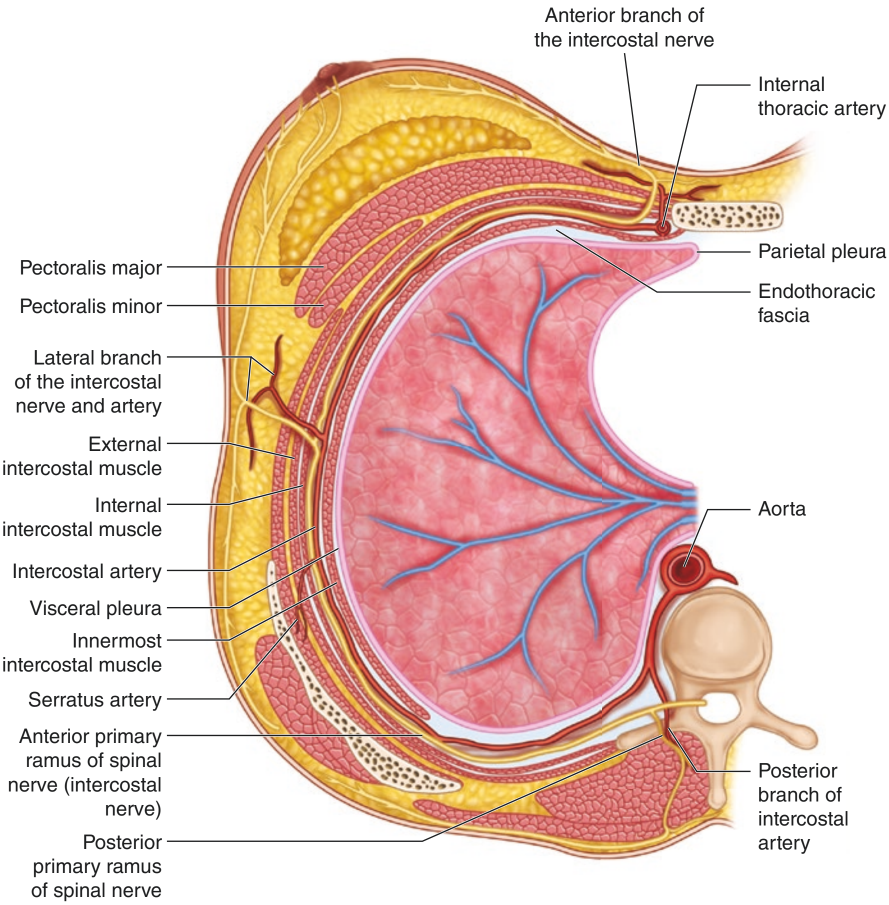


Fig. 2.3 Layers of the thoracic wall and paths of blood vessels and nerves. The intercostal muscles occur in three layers: external, internal, and innermost. The intercostal vessels and nerves pass between the internal and innermost layers. The posterior intercostal arteries arise from the aorta and pass anterior to anastomose with the anterior intercostal arteries that are branches of the internal thoracic artery. The intercostal nerves are direct continuations of the anterior primary rami of thoracic spinal nerves and supply the overlying skin of the breast. The serratus anterior muscle originates from eight or nine fleshy digitations on the outer lateral surface of the ribs and inserts on the medial (vertebral) border of the scapula

the breast rests on portions of the deep-investing fasciae of the pectoralis major, serratus anterior, and external abdominal oblique muscles and the uppermost superior extent of the rectus sheath. The axillary tail (*of Spence*) of the breast extends into the anterior axillary fold. The upper one-half of the breast—and particularly the upper outer quadrant—contains more glandular tissue than does the remainder of the gland. This consistent anatomical feature accounts for the higher frequency of breast cancer in this quadrant of the organ in most clinical trials.

Structural Microscopic Anatomical Features

Nipple and Areola

The nipple and areola epidermis is highly pigmented and may appear wrinkled, even in the premenopausal individual, as a result of active periareolar muscular contraction with stimulation. Both are covered by keratinized, stratified squamous epithelium. The deep surface of the epidermis is permeated by unusually elongated dermal papillae that allow capillaries to allow blood perfusion to its surface, giving the nipple-areola a pinkish color in young, fair-skinned individuals. Upon puberty, the pigmentation of the nipple and areola increases and the nipple becomes more prominent. With the gravid state, the areola enlarges and the degree of pigmentation increases. Deep to the areola and nipple, bundles of smooth muscle fibers are arranged radially and circumferentially in the dense connective tissue and longitudinally along the lactiferous ducts that extend up into the nipple. These muscle fibers are responsible for the erection of nipple that occurs in response to various stimuli (for a review of the anatomy of the nipple and areola, see Giacometti and Montague [8]). The areola robustly harbors sebaceous glands, sweat glands, and accessory areolar glands (*of Montgomery*), which are intermediate in their structure between true mammary glands and sweat glands. These accessory areolar glands produce small elevations on the surface of the areola. The sebaceous glands (which usually lack associated hairs) and sweat glands are located along the margin of the areola. Whereas the apex of the nipple contains numerous free sensory nerve cell endings as *Meissner's corpuscles* (rapidly adapting mechanoreceptors of sensory discrimination and touch) in the dermal papillae, the areola contains fewer of these structures [9]. In a review of the innervation of the nipple and areola, Montagna and Macpherson [10] observed fewer nerve endings than described by many investigators. They reported that most of the sensory endings were at the apex of the nipple. Robust neuronal plexuses are also present around hair follicles in the skin peripheral to the areola, with *Pacinian corpuscles* (vibratory pressure sensation, pressure, and touch) present in the subdermis and subcutaneous fat and in the glandular tissue. The rich sensory innervation of the breast, particularly the nipple and areola [11, 12], is of great functional significance. The suckling infant initiates a reflex chain of neural and neurohumoral events with nipple-areolar stimuli of feeding, resulting in the release of milk and maintenance of glandular differentiation that is essential for continuance of lactation.

Inactive Mammary Gland

The adult mammary gland is composed of 15–20 irregular lobes of branched tubuloalveolar glands. The lobes, separated by fibrous bands of connective tissue, radiate from the mammary papilla, or nipple, and are further subdivided into numerous lobules. Those fibrous bands that connect with the dermis are the suspensory ligaments of Cooper. Abundant adipose tissue is present in the dense connective tissue of the interlobular spaces. The intralobular connective tissue is much less dense and contains little fat (Fig. 2.2).

Each lobe of the mammary gland ends in a lactiferous duct (2–4 mm in diameter) that opens through a constricted orifice (0.4–0.7 mm in diameter) onto the nipple (see Fig. 2.2). Beneath the areola, each duct has a dilated portion, the lactiferous sinus. Near their openings, the lactiferous ducts are lined with stratified squamous epithelium. The epithelial lining of the duct shows a gradual transition to two layers of cuboidal cells in the lactiferous sinus and then becomes a single layer of columnar or cuboidal cells through the remainder of the duct system. Myoepithelial cells of ectodermal origin are located within the epithelium between the surface epithelial cells and the basal lamina [12]. These cells, arranged in a basketlike network, are present in the secretory portion of the gland but are more apparent in the larger ducts. They contain myofibrils and are strikingly similar to smooth muscle cells in their cytology.

Under light microscopy, epithelial cells are characteristically seen to be attached to an underlying layer called the basement membrane. With electron microscopy, the substructure of the basement membrane can be identified. The inner layer of the basement membrane is called the basal lamina. In the breast, the parenchymal cells of the tubuloalveolar glands, as well as the epithelial and myoepithelial cells of the ducts, rest on a basement membrane or basal lamina. The integrity of this supporting layer is of significance in evaluating biopsy specimens of breast tissue. Changes in the basement membrane have important implications in immune surveillance, transformation, differentiation, and metastasis [13–16].

Morphologically, the secretory portion of the normal mammary gland varies greatly with age and during pregnancy and lactation. In the *inactive gland*, the glandular component is sparse and consists chiefly of duct elements. Most investigators believe that the secretory units in the inactive breast are not organized as alveoli and consist only of ductules. During the menstrual cycle, the inactive breast undergoes slight cyclical changes. Early in the cycle, the ductules appear as cords with little or no lumen. Under estrogen stimulation, at about the time of ovulation, secretory cells increase in height, lumina appear as small amounts of secretions accumulate, and fluids and lipid accumulate in the connective tissue. Then, in the absence of continued hormonal stimulation, the gland regresses to a more inactive state through the remainder of the cycle.

Active Mammary Glands: Pregnancy and Lactation

During pregnancy, in preparation for lactation, the mammary glands undergo dramatic proliferation and development. These changes in the glandular tissue are accompanied by relative decreases in the amount of connective and adipose tissue. Plasma cells, lymphocytes, and eosinophils infiltrate the fibrous component of the connective tissue as the breast develops in response to hormonal stimulation. The development of the glandular tissue is not uniform, and variation in the degree of development may occur within a single lobule. The cells vary in shape from low columnar to flattened. As the cells proliferate by mitotic division, the ductules branch and alveoli begin to develop. In the later stages of *pregnancy*, alveolar development becomes more prominent. Near termination of pregnancy, the actual proliferation of cells declines, and subsequent enlargement of the breast occurs through hypertrophy of the alveolar cells and accumulation of their secretory product in the lumina of the ductules.

The secretory cells contain abundant endoplasmic reticulum, a moderate number of large mitochondria, a supranuclear Golgi complex, and a number of dense lysosomes [17, 18]. Depending on the secretory state of the cell, large lipid droplets and secretory granules may be present in the apical cytoplasm. Two distinct products produced by the cells are released by different mechanisms [19]. The protein component of the milk is synthesized in the granular endoplasmic reticulum, packaged in membrane-limited secretory granules for transport in the Golgi apparatus, and released from the cell by fusion of the granule's limiting membrane with the plasma membrane. This variant of secretion is known as *merocrine secretion* (continuous, recurrent variant of the lipid, or fatty, component of the milk arises as free lipid droplets in the cytoplasm. The lipid coalesces into large droplets that pass to the apical region of the cell and project into the lumen of the acinus prior to their release. As they are released from the cell, the droplets are invested with an envelope of plasma membrane. A thin layer of cytoplasm is trapped between the lipid droplet and plasma membrane as lipid is being released. It should be emphasized that only a very small amount of cytoplasm is lost during this secretory process, classically known as apocrine secretion.

The milk released during the first few days after childbirth is known as colostrum. It has *low lipid content* but is believed to contain considerable quantities of *antibodies* that provide the newborn with some degree of passive immunity. The lymphocytes and plasma cells that infiltrate the stroma of the breast during its proliferation and development are believed to be, in part, the source of the components of the colostrum. As the plasma cells and lymphocytes decrease in number, the production of colostrum stops and lipid-rich milk is produced.

Hormonal Regulation of the Mammary Gland

Physiologically enhanced production of estrogens and progesterone by the ovary at puberty induces the initial growth of the mammary gland. Subsequent to this nascent development, slight changes occur in the morphology of the glandular tissue with each ovarian, or menstrual, cycle. With pregnancy, the corpus luteum and placenta continuously produce estrogens (estrone, estradiol, estriol) and progesterone, which further stimulate proliferation and development of the *active*, *proliferative mammary gland*. The growth of the glands is also dependent upon the presence of prolactin, produced by the adenohypophysis; somatomammotropin (lactogenic hormone), produced by the placenta; and adrenal corticoids. The level of circulating estrogens and progesterone diminishes acutely at *parturition* with the degeneration of the uterine corpus luteum and synchronous loss of the placenta. The genesis of milk is resultant from secretory production of prolactin and adrenal cortical steroids. A neurohormonal reflex regulates the high level of prolactin production and release. The act to initiate the *suckling reflex* by the infant initiates impulses from receptors in the nipple; these impulses provide feedback regulation for neurological cells of the hypothalamus—stimuli with suckling and inhibition of the feedback loop with absentia of stimulatory impulses. The impulses initiate feedback-controlled release of oxytocin in the neurohypophysis. Oxytocin stimulates the myoepithelial cells of the mammary glands, causing them to contract and eject milk with suckling stimuli [20]. With abatement of the *suckling reflex stimulus*, secretion of milk ceases and the lobular glands regress to assume to an *inactive state*. After onset of *menopause*, the gland atrophies or involutes. As the release of ovarian hormones is diminished, the secretory cells of the alveoli degenerate and disappear, but many of the ducts remain viable despite inactive secretory activity. The connective tissue also demonstrates degenerative changes that are marked by a decrease in the number of stromal cells and collagen fibers.

Thoracic Wall

The thoracic wall is composed of both skeletal and muscular components. The skeletal components include the 12 thoracic vertebrae, the 12 ribs and their costal cartilages, and the sternum. The spaces between the ribs, the intercostal spaces, are filled with the external, internal, and innermost intercostal muscles and the associated intercostal vessels and nerves (Fig. 2.3). Some anatomists refer to the innermost layer as the intima of the internal intercostal muscle. The terminology chosen is of no particular consequence; the relationship that should be appreciated is that the intercostal veins, arteries, and nerves pass in the plane that separates the internal intercostal muscle from the innermost (or intimal) layer. The endothoracic fascia, a thin fibrous layer of connective tissue forming a fascial plane continuous with the most internal component of the investing fascia of the intercostal muscles and the adjacent layer of the periosteum, marks the internal limit of the thoracic wall. The parietal pleura rests on the endothoracic fascia.

It is important to recognize that the muscles and skeletal girdles of the upper extremities almost completely cover the thoracic wall anteriorly, laterally, and posteriorly. For the surgeon concerned with the breast diseases, knowledge of the anatomy of the axilla and pectoral region is essential.

The 11 pairs of external intercostal muscles whose fibers run downward and forward form the most superficial layer (see subsequent section on the innervation of the breast). The muscle begins posteriorly at the tubercles of the ribs and extends anteriorly to the costochondral junction. Between the costal cartilages, the muscle is replaced by the external intercostal membrane. The fibers of the 11 pairs of internal intercostal muscles run downward and posteriorly. The muscle fibers of this layer reach the sternum anteriorly. Posteriorly, the muscle ends at the angle of the ribs and then the layer continues as the internal intercostal membrane. The innermost intercostal muscles (intercostales intimi) form the most internal layer and have fibers that are oriented more vertically but almost in parallel with the internal intercostal muscle fibers. The muscle fibers of this layer occupy approximately the middle half of the intercostal space. This is the least well developed of the three layers. It can best be distinguished by the fact that its fibers are separated from the internal intercostals by the intercostal vessels and nerves.

The subcostalis and transversus thoracis muscles are located on the internal surface of the thoracic wall. They occur in the same plane as the innermost intercostal

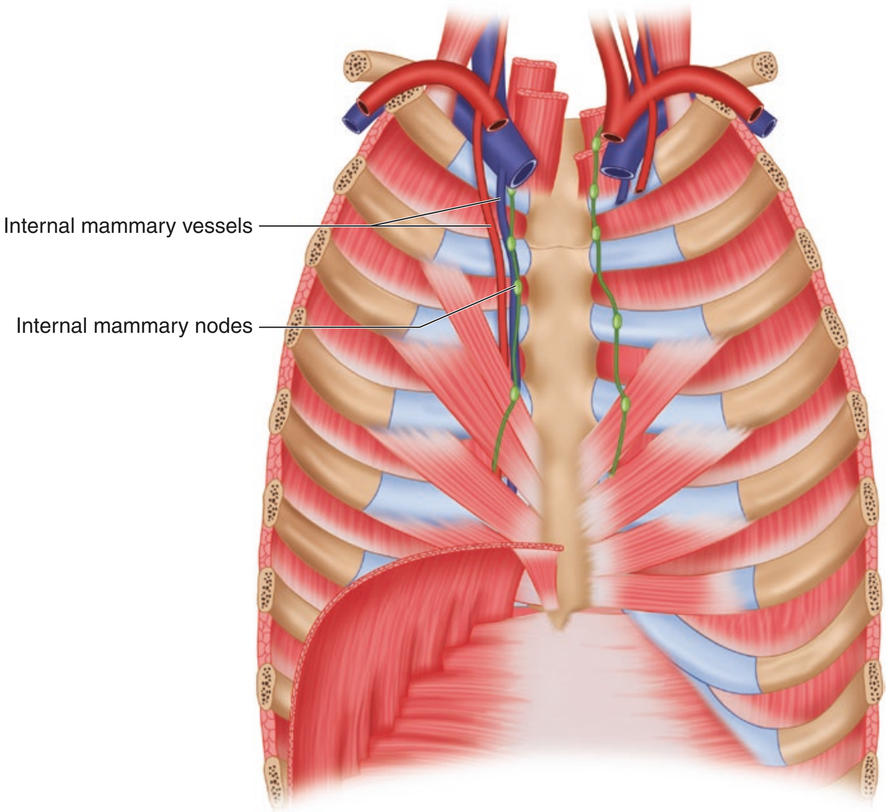


Fig. 2.4 Internal view of anterior thoracic wall. The internal thoracic arteries, veins and lymphatics can be seen as they pass parallel to and about 1 cm from the sternal margin

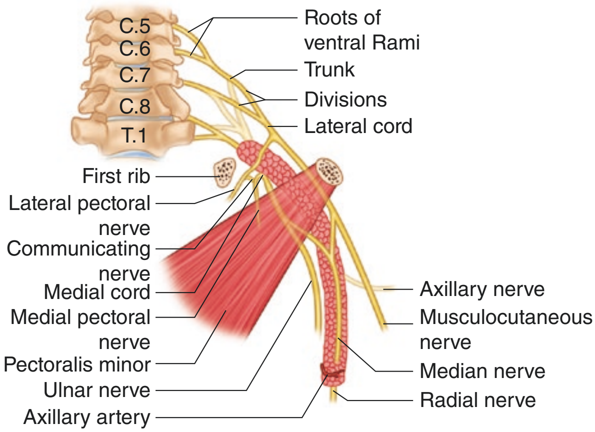
muscles and are considered anterior and posterior extensions of this layer. The subcostal muscles are located posteriorly and have the same orientation as the innermost intercostal muscles. They are distinct because they pass to the second or third rib below (i.e., they pass over at least two intercostal spaces). Anteriorly, the transversus thoracis muscles form a layer that arises from the lower internal surface of the sternum and extends upward and laterally to insert on the costal cartilages of the second to sixth ribs (Fig. 2.4). These fibers pass deep to the internal thoracic artery and accompanying veins.

All of these muscles are innervated by the intercostal nerves associated with them. These nerves also give branches to the overlying skin. In a similar fashion, the intercostal vessels supply intercostal muscles and give branches to the overlying tissues. The intercostal nerves are direct continuations of the ventral primary rami of the upper 11 thoracic spinal nerves. As the nerves pass anteriorly, they give branches to supply the intercostal muscles. In addition, each nerve gives a relatively large lateral cutaneous branch, which exits the intercostal space along the midaxillary line near the attachment sites of the serratus anterior muscle on the ribs. The lateral cutaneous nerves then give branches that extend anteriorly and posteriorly. As the intercostal nerve continues anteriorly, it gives additional branches to the intercostal muscles. Just lateral to the border of the sternum, the upper five intercostal nerves pierce the internal intercostal muscle and the external intercostal membrane to end superficially as the anterior cutaneous nerves of the chest. These nerves give rise to medial and lateral branches that supply the overlying skin. The lower six intercostal nerves continue past the costal margin into the anterior abdominal wall and are therefore identified as thoracoabdominal nerves.

Each intercostal artery originates in two groups: the anterior and posterior intercostal artery distribution. The posterior intercostal arteries, except for the first two spaces, arise from the thoracic aorta. The *posterior intercostals* for the first two spaces arise from the superior intercostal arteries, which include the left- and right-side branches from the costocervical trunk. The anterior intercostals are usually small paired arteries that extend laterally to the region of the costochondral junction. The anterior intercostal arteries of the upper five intercostal spaces arise from the *internal thoracic* (*or mammary*) *artery*; those of the lower six intercostal spaces arise from the musculophrenic artery. The anterior and posterior *intercostal veins* demonstrate a similar distribution. Anteriorly, the veins drain into the *musculophrenic* and *internal thoracic* veins. Posteriorly, the intercostal veins drain into the azygos and hemiazygos systems of veins.

The superficial muscles of the pectoral region include the pectoralis major and minor muscles and the subclavius muscle superficial to the chest wall, sternum, ribs, scapula, and cartilage. The pectoralis major muscle is a fan-shaped muscle with two divisions. The clavicular division (or head) originates from the clavicle and is easily distinguished from the larger costo-sternal divisions that originate from the sternum and costal cartilages of the second through sixth ribs. The fibers of the two divisions converge laterally and insert into the crest of the greater tubercle of the humerus along the lateral lip of the bicipital groove. The cephalic vein serves as a convenient landmark defining the separation of the upper lateral border of the pectoralis major muscle from the deltoid muscle. The cephalic vein can be followed to the deltopectoral triangle, where it pierces the clavipectoral fascia and joins the axillary vein. The pectoralis major muscle acts primarily in flexion, adduction, and medial rotation of the arm at the shoulder joint. This action brings the arm across the chest. In climbing, the pectoralis major muscles, along with the latissimus dorsi muscles, function to elevate the trunk when the arms are fixed. The *pectoralis major muscle* is innervated by both the *medial* and the *lateral pectoral nerves*, which arise from the *medial* and *lateral cords* of the brachial plexus, respectively. Located deep to the pectoralis major muscle, the *pecto*ralis *minor muscle* arises from the external surface of the second to the fifth ribs and inserts on the coracoid process of the scapula. Although its main action is to lower the shoulder, it may serve as an accessory muscle of respiration. It is innervated by the *medial pectoral nerve* (Figs. 2.5 and 2.6). The *subclavius muscle* arises from the first rib near its costochondral junction and extends laterally to insert into the inferior surface of the clavicle. It functions to lower the clavicle and stabilize it during movements of the shoulder girdle. It is innervated by the *nerve to the subclavius* muscle, which arises from the upper trunk of the brachial plexus.

Fig. 2.5 Brachial plexus illustrating its anatomical components. The names of the cords of the brachial plexus reflect their positioning in regard to the artery all of which lie behind the pectoralis minor muscle



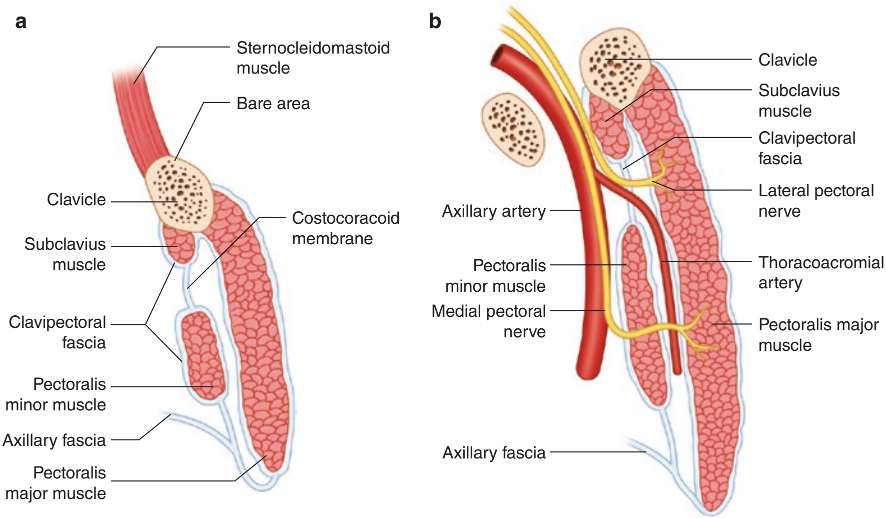


Fig. 2.6 The chest wall, breast, and axilla. On the right side, the pectoralis major muscle has been cut and reflected laterally to demonstrate the contents of the axilla. The *long thoracic nerve*, which is a branch of the brachial plexus, can be seen running along the serratus. The thoracodorsal artery and nerve are shown running deep in the posterior axillary triangle on the teres major

Axilla

Knowledge of the anatomy of the axilla and its contents is of paramount importance to the breast and thoracic surgeon. It is also essential that the surgeon be thoroughly familiar with the organization of the deep fascia and neurovascular relationships of the axilla.

Boundaries of the Axilla

The axilla is a pyramidal compartment between the upper extremity and the thoracic walls (Fig. 2.7). It is described as having four walls, an apex, and a base. The curved base is made of axillary fascia and skin. Externally, this region, the armpit, appears dome-shaped (and covered with hair after puberty). The apex is not a roof but an aperture that extends into the posterior triangle of the neck through the cervicoaxillary canal. The cervicoaxillary canal is bounded anteriorly by the clavicle, posteriorly by the scapula, and medially by the first rib. Most structures pass through the cervical axillary canal as they course between the neck and upper extremity. The anterior wall and shoulder musculature are supported and provided by motility of the pectoralis major and minor muscles and their associated fasciae. The posterior wall is composed primarily of the subscapularis muscle, located on the anterior surface of the scapula, and to a lesser extent by the teres major and latissimus dorsi muscles and their associated tendons. The lateral wall is a thin strip of the humerus, the bicipital groove, between the insertions of the muscles of the anterior and posterior walls. The medial wall is made up of serratus anterior muscle that covers the thoracic wall in this region (over the upper four or five ribs and their associated intercostal muscles).

Contents of the Axilla

The axilla contains the great vessels and nerves of the upper extremity. These, along with the other contents, are surrounded by loose connective tissue. Figure 2.8 illustrates many of the key relationships of structures within the axilla. The vessels and

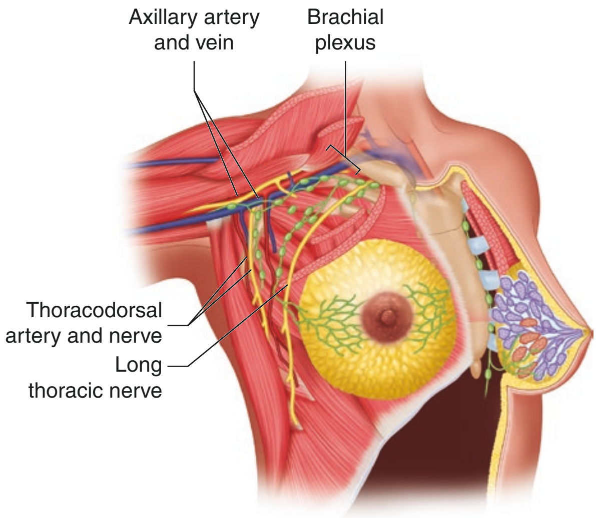


Fig. 2.7 Chest wall in the axillary region, sagittal view. (**a**) Demonstrates relationship of pectoralis major and minor muscles to the breast parenchyma and ith pectoralis minor lying within investing fascia on the chest wall. The axillary contents are lateral and posterior to the breast content. (**b**) Demonstrates the axillary artery and medial and lateral pectoral nerves and their relationship to the clavipectoral fascia

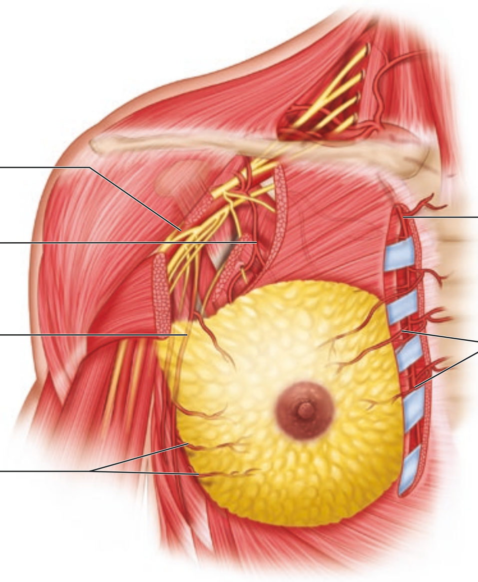


Fig. 2.8 Arterial supply to the breast, axilla, and chest wall. The anterior perforating intercostal branches arising from the internal thoracic artery supply the breast medially. Branches of the lateral thoracic artery (the thoracoacromial trunk and the lateral thoracic arteries are branches of the axillary artery) and the pectoral branches of the thoracoacromial trunk supply the breast laterally. Additionally, lateral cutaneous branches of the intercostal arteries are associated with the overlying breast

nerves are closely associated with each other and are enclosed within a layer of fascia, the axillary sheath. This layer of dense connective tissue extends from the neck and gradually disappears as the nerves and vessels branch.

The *axillary artery* may be divided into three parts within the axilla:

1. The first portion, located medial to the pectoralis minor muscle, gives one branch—the supreme thoracic artery that supplies the thoracic wall over the first and second intercostal spaces.
2. The second portion, located posterior to the pectoralis minor muscle, gives two branches—the thoracoacromial artery and the lateral thoracic artery. The thoracoacromial artery divides into the acromial, clavicular, deltoid, and pectoral branches. The lateral thoracic artery passes along the lateral border of the pectoralis minor on the superficial surface of the serratus anterior muscle. Pectoral branches of the thoracoacromial and lateral thoracic arteries supply both the pectoralis major and minor muscles and must be identified during surgical dissection of the axilla. The lateral thoracic artery is of particular importance in surgery of the breast as it supplies the lateral mammary branches.
3. The third portion, located lateral to the pectoralis minor, gives off three branches—the anterior and posterior circumflex humeral arteries, which supply

the upper arm and contribute to the collateral circulation around the humerus, and the subscapular artery. Although the latter artery does not supply the breast, it is of particular importance in the surgical dissection of the axilla. It is the largest branch within the axilla, giving rise after a short distance to its terminal branches, the subscapular circumflex and the thoracodorsal arteries, and it is closely associated with the central and subscapular lymph node groups. In the axilla, the thoracodorsal artery crosses the subscapularis and gives branches to it and to the serratus anterior and the latissimus dorsi muscles. A surgeon must use care in approaching this vessel and its branches to avoid undue bleeding that obscures the surgical field.

The *axillary vein* has tributaries that follow the course of the arteries just described. They are usually in the form of *venae comitantes*, paired veins that follow an artery. The cephalic vein passes in the groove between the deltoid and pectoralis major muscles and then joins the axillary vein after piercing the clavipectoral fascia.

Throughout its course in the axilla, the axillary artery is associated with various parts of the brachial plexus (Fig. 2.5). The cords of the brachial plexus—medial, lateral, and posterior—are named according to their relationship with the axillary artery. A majority of the branches of the brachial plexus arise in the axilla. The *lateral cord* gives four branches, namely, the lateral pectoral nerve, which supplies the pectoralis major; a branch that communicates with the medial pectoral nerve, which is called the ansapectoralis [21]; and two terminal branches, the musculocutaneous nerve and the lateral root of the median nerve. Injury to the medial or lateral pectoral nerves, or the *ansapectoralis* [21], which joins them, may lead to atrophy with loss of muscle mass and fat necrosis of the pectoralis major or minor muscles [22], depending on the level of nerve injury. The ansapectoralis lies anterior to the axillary artery, making it vulnerable to injury during lymph node dissection in the axilla.

The *medial cord* usually gives five branches, the medialand minor, the median brachial cutaneous nerve, the medial antebrachial cutaneous nerve, and two terminal branches—the ulnar nerve and the lateral root of the median nerve. The *posterior cord* usually has five branches. Three of these nerves arise from the posterior cord in the superior aspect of the axilla—the upper subscapular, the thoracodorsal, and the lower subscapular; the cord then divides into its two terminal branches—the axillary and radial nerves (Fig. 2.5).

Two additional nerves are of particular clinical interest to surgeons because they are vulnerable to injury during axillary dissection: the *long thoracic nerve*, which is a branch of the brachial plexus, and the *intercostobrachial nerve*. The long thoracic nerve is located on the medial wall of the axilla (Fig. 2.6). It arises in the neck from the fifth, sixth, and seventh roots of the brachial plexus and then enters the axilla through the cervicoaxillary canal. This nerve lies longitudinally upon the surface of the serratus anterior muscle, to which it provides motor innervation. The long thoracic nerve is invested by the serratus fascia and is sometimes accidentally injured/removed, together with this membrane of fascia during surgery of the axilla. This anatomical feature requires preferential dissection in a longitudinal plane of the course of the nerve to abrogate surgical injury. Injury or division results in paralysis of part or all of the serratus anterior muscle ("winged scapula deficit"). The functional deficit is an inability to raise the arm above the level of the shoulder (or extreme weakness when one attempts this movement). A second nerve, the *intercostobrachial*, is formed by the joining of a lateral cutaneous branch of the second intercostal nerve with the medial cutaneous nerve of the arm. This nerve supplies the skin of the floor of the axilla and the upper medial aspect of the arm. Sometimes, a second intercostobrachial nerve may form an anterior branch of the third lateral cutaneous nerve. This nerve is also commonly injured in axillary dissection, resulting in numbness of the skin of the floor of the axilla and the medial aspect of the arm.

Lymph nodes are also present in the axilla and are found in close association with the blood vessels. The lymph node groups and their location are described in the section on the lymphatic drainage of the breast.

Axillary Fasciae

The anterior wall of the axilla is composed of the pectoralis major and minor muscles and the fascia that covers them. The fasciae occur in two layers: (1) a superficial layer investing the pectoralis major muscle, called the pectoral fascia, and (2) a deep layer that extends from the clavicle to the axillary fascia in the floor of the axilla, called the clavipectoral (or costocoracoid) fascia. The clavipectoral fascia is an investing fascia of the subclavius muscle located below the clavicle and the pectoralis minor muscle (Fig. 2.7).

The upper portion of the clavipectoral fascia, the costocoracoid membrane, is pierced by the cephalic vein, the lateral pectoral nerve, and branches of the thoracoacromial artery. The medial pectoral nerve does not pierce the costocoracoid membrane but enters the deep surface of the pectoralis minor muscle, supplying it, and passes through the anterior investing layer of the pectoralis minor muscle to innervate the pectoralis major muscle. The lower portion of the clavipectoral fascia, located below the pectoralis minor muscle, is sometimes called the suspensory ligament of the axilla. *Halsted's ligament*, a dense condensation of the clavipectoral fascia, extends from the medial end of the clavicle and attaches to the first rib (Fig. 2.7). The ligament covers the subclavian artery and vein as it crosses and inserts on the first rib.

Fascial Relationship of the Breast

The breast is located in the superficial fascia in the layer just deep to the dermis, the hypodermis. In approaching the breast, a surgeon may dissect in a bloodless plane just deep to the dermis. This dissection plane ensures a residual dense layer 6–8 mm in thickness in thin individuals in association (attachment) with the skin flap. The layer may be several millimeters (8–10 mm) thick in the more obese individual.

The blood vessels and lymphatics that meander in the deeper layer of the superficial fascia are left undisturbed.

Anterior fibrous processes, the *suspensory ligaments of Cooper*, pass from the septa that divide the lobules of the breast to insert into the cutis of the skin. The posterior aspect of the breast is separated from the deep, or investing, fascia of the pectoralis major muscle by a space filled with loose areolar tissue, the retromammary space or bursa (Fig. 2.2). The existence of the suspensory ligaments of Cooper and the retromammary space allows the breast to move freely against the thoracic wall. The space between the well-defined fascial planes of the breast deep to (posterior) the pectoralis major muscle is easily identified by the surgeon in the conduct for full extirpation of the whole organ (radical mastectomy). Connective tissue thickenings, called posterior suspensory ligaments, extend from the deep surface of the breast to the deep pectoral fascia. Because breast parenchyma may follow these fibrous processes, it has been common practice to remove the adjacent portion of the pectoralis major muscle together with the entire breast.

It is important to recognize, particularly with movements and variation in the size of the breast, that its deep surface contacts the investing fascia of other muscles in addition to the pectoralis major. Only about two-thirds of the breast overlies the pectoralis major muscle. The lateral portion of the breast may contact the fourth through seventh slips of the serratus anterior muscle at its attachment to the thoracic wall. Medial to this anatomical area, the breast may contact the upper portion of the abdominal oblique muscle, where it interdigitates with the attachments of the serratus anterior muscle. With the full expanse of the organ to the axilla, the breast has a contiguous presence with the deep fascial envelope present in this anatomical region.

Blood Supply of the Breast

Parenchyma and skin of the breast receive their blood supply from:

1. Perforating branches of the internal mammary artery
2. Lateral branches of the posterior intercostal arteries
3. Several branches from the axillary artery, including highest thoracic, lateral thoracic, and pectoral branches of the thoracoacromial artery (Fig. 2.8)

For reviews of the blood supply of the breast, see Cunningham [23], Maliniac [24], and Sakki [25].

Branches from the second, third, and fourth anterior perforating arteries (Fig. 2.9) pass to the breast as *medial mammary arteries*. These vessels enlarge considerably during lactation. The lateral thoracic artery gives branches to the serratus anterior muscle, both pectoralis muscles, and the subscapularis muscle. The lateral thoracic artery also gives rise to lateral mammary branches that wrap around the lateral border of the pectoralis major muscle to reach the breast. In the second, third, and fourth intercostal spaces, the posterior intercostal arteries give off *mammary branches*; these vessels increase in size during lactation.

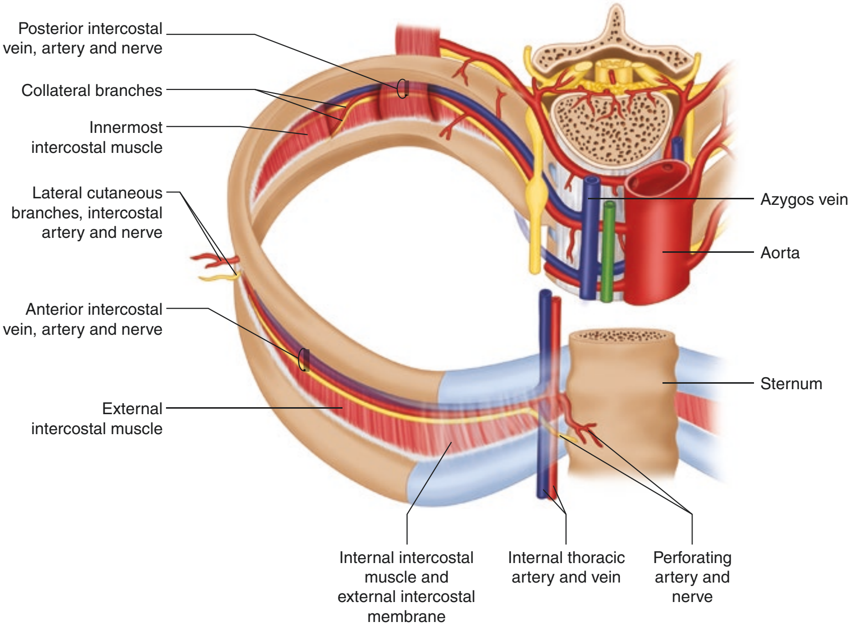


Fig. 2.9 Segmental depiction of the body. The intercostal nerve and vessels pass through the intercostal space in the plane between the internal and innermost (or intima of the internal) intercostal muscle layers. Anterior intercostal arteries and veins arise from the internal thoracic artery and vein. Posterior intercostal arteries arise from the aorta and azygos vein on the right and the hemiazygos vein on the left. Lymphatics follow the path of the blood vessels

The thoracodorsal branch of the subscapular artery is not contributory to the supply of blood to the breast, but it is important to the surgeon who must deal with this artery during the dissection of the axilla. The central and scapular lymph node groups are intimately associated with this vessel. Bleeding that is difficult to control may result from cutting of branches of these vessels.

A fundamental knowledge of the pattern of venous drainage is important as carcinoma of the breast may metastasize through the veins and because lymphatic vessels often follow the course of the blood vessels. Venae comitanes of the breast closely accompany the path of the arteries, with net venous drainage toward the axilla. The superficial veins demonstrate extensive anastomoses that may be apparent through the skin overlying the breast. The distribution of these veins has been studied by Massopust and Gardner [26] and Haagensen [27] using photographs taken in infrared light. Around the nipple-areolar complex, venae comitanes form an anastomotic circle, the *circulus venosus*. Veins from this circle and from the substance of the gland transmit blood to the periphery of the breast and then into vessels joining the internal thoracic, axillary, and internal jugular veins.

Three principal groups of veins are involved in the venous drainage of the thoracic wall and the breast:

1. Perforating branches of the internal thoracic vein
2. Tributaries of the axillary vein
3. Perforating branches of posterior intercostal veins

Metastatic emboli traveling through any of these venous routes will pass through the venous return to the heart and then be stopped as they reach the capillary bed of the lungs, providing a direct venous route for metastasis of breast carcinoma to the lungs.

The *vertebral plexus of veins (Batson's plexus)* may provide a second route for metastasis of breast carcinoma via racemose venous tributaries of intrinsic connectivity [28–30]. This venous plexus surrounds the vertebrae and fully extends from the base of the skull to the sacrum. Venous channels exist between this plexus and veins associated with the breast, lung, thoracic wall, abdominal visceral, and pelvic gynecological organs. In general, these veins do not have valves, thus allowing for blood-borne metastases of these organs to flow through them bidirectionally. Furthermore, it is known that elevation in intra-abdominal pressure may force blood to enter these channels. These vessels provide a route for *metastatic emboli* to invade directly the vertebral bodies, ribs, and central nervous system. These venous communications are of particular significance in the breast, where the posterior intercostal arteries are in direct continuity with the vertebral plexus.

Innervation of the Breast

Miller and Kasahara [31] have described the microscopic anatomical features of the innervation of the skin over the breast. They suggest that the specialization of the innervation of the breast, areola, and nipple is associated with sensory stimuli (thermal changes; discriminatory touching; pressure; and the suckling reflex) to initiate erection of the nipple [11] and even flow of milk mediated through a neurohormonal reflex. The infantile suckling reflex initiates impulses from receptors in the nipple that regulate cells in the hypothalamus. In response to the impulses, oxytocin is released in the neurohypophysis. Oxytocin stimulates the myoepithelial cells of the mammary glands, initiating contraction and ejection of milk from the glands. In the dermis of the nipple, Miller and Kasahara [31] found large numbers of multi-branched free nerve endings and, in the dermis of the areola and peripheral, Ruffini-like endings and Krause end bulbs. The latter two receptor types are associated with tactile reception of stretch and pressure.

Sensory innervation of the breast is supplied primarily by the *lateral and anterior cutaneous branches of the second through sixth intercostal nerves* (Fig. 2.9). Although the second and third intercostal nerves may give rise to cutaneous branches to the superior aspect of the breast, the nerves of the breast are derived primarily from the fourth, fifth, and sixth intercostal nerves. A limited region of the skin over the upper portion of the breast is supplied by nerves arising from the cervical plexus, specifically the anterior, or medial, branches of the *supraclavicular nerve.* All of these nerves convey sympathetic fibers to the breast and overlying skin and therefore influence flow of blood through vessels accompanying the nerves and secretory function of the sweat glands of the skin. However, the secretory activity of the breast is chiefly under the control of ovarian and hypophyseal (pituitary) hormones.

Lateral branches of the intercostal nerves exit the intercostal space at the attachment sites of the slips of serratus anterior muscle. The nerves divide into anterior and posterior branches as they pass between the muscle fibers. As the anterior branches pass in the superficial fascia, they supply the anterolateral thoracic wall; the third through sixth branches, also known as lateral mammary branches, supply the breast. The lateral branch of the second intercostal nerve is of special significance because a large nerve, the *intercostal brachial*, arises from it. This nerve, which can be seen during surgical dissection of the axilla, passes through the fascia of the floor of the axilla and usually joins the medial cutaneous nerve of the arm. However, it is of limited functional significance. If this nerve is injured during surgery, the patient will have loss of cutaneous sensation from the upper medial aspect of the arm and floor of the axilla.

The anterior branches of the intercostal nerves exit the intercostal space near the lateral border of the sternum. These nerves send branches medially and laterally over the thoracic wall. The branches that pass laterally reach the medial aspect of the breast and are sometimes called *medial mammary nerves.*

Lymphatic Drainage of the Breast

Lymph Nodes of the Axilla

Principal route for lymphatic drainage of the breast is via the axillary lymph node groups (Figs. 2.7, 2.10, 2.11, and 2.12). Therefore, it is essential that the clinician understand the anatomy of the grouping of lymph nodes within the axilla. Unfortunately, the boundaries of groups of lymph nodes found in the axilla are not well demarcated. Thus, there has been considerable variation in the names provided to the lymph node groups. *Anatomists* usually define *five groups* of axillary lymph nodes [32, 33]; *surgeons* usually identify *six primary drainage groups* [27]. Both professions define these lymphatic groups based upon anatomical boundary and contiguous neurovascular structures. The most common terms used to identify the lymph nodes are indicated as follows:

1. The *axillary vein group* (*lateral group*), usually identified by anatomists as the lateral group, consists of four to six lymph nodes that lie just medial or posterior to the axillary vein in Level I. These lymph nodes receive most of the lymph draining from the upper extremity (Fig. 2.12). The exception is lymph that drains into the deltopectoral lymph nodes, a lymph node group sometimes

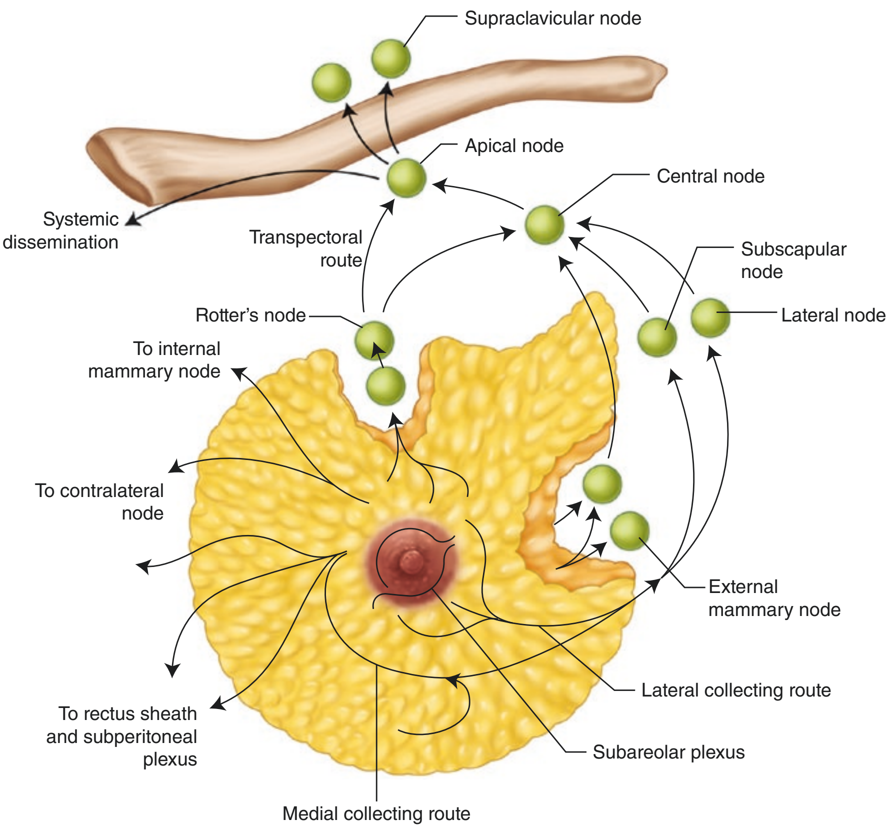


Fig. 2.10 Illustration of mammary lymph nodes and drainage. *Level I* lymph nodes include the external mammary (or anterior), axillary vein (or lateral), and scapular (or posterior) groups; *Level II*, the central group; and *Level III*, the subclavicular (or apical). Arrows indicate the direction of flow of the lymph

called infraclavicular. The deltopectoral lymph nodes are not considered part of the axillary lymph node group but rather are outlying lymph nodes that drain into the subclavicular (or apical) lymph node group (see later discussion).

2. The *external mammary group* (Figs. 2.11 and 2.12), in Level I, is usually identified by anatomists as the anterior or pectoral group, consisting of four or five lymph nodes that lie along the lower border of the pectoralis minor muscle in association with the lateral thoracic vessels. These lymph nodes receive the major portion of the lymph draining from the breast. Lymph drains primarily from these lymph nodes into the central lymph nodes. However, lymph may egress directly from the external mammary nodes into the subclavicular lymph nodes.
3. The *scapular* and *subscapular group* (Figs. 2.10, 2.11, and 2.12), also Level I, is usually identified by anatomists as the posterior or subscapular group, consisting of six or seven lymph nodes that lie along the posterior wall of the axilla at the

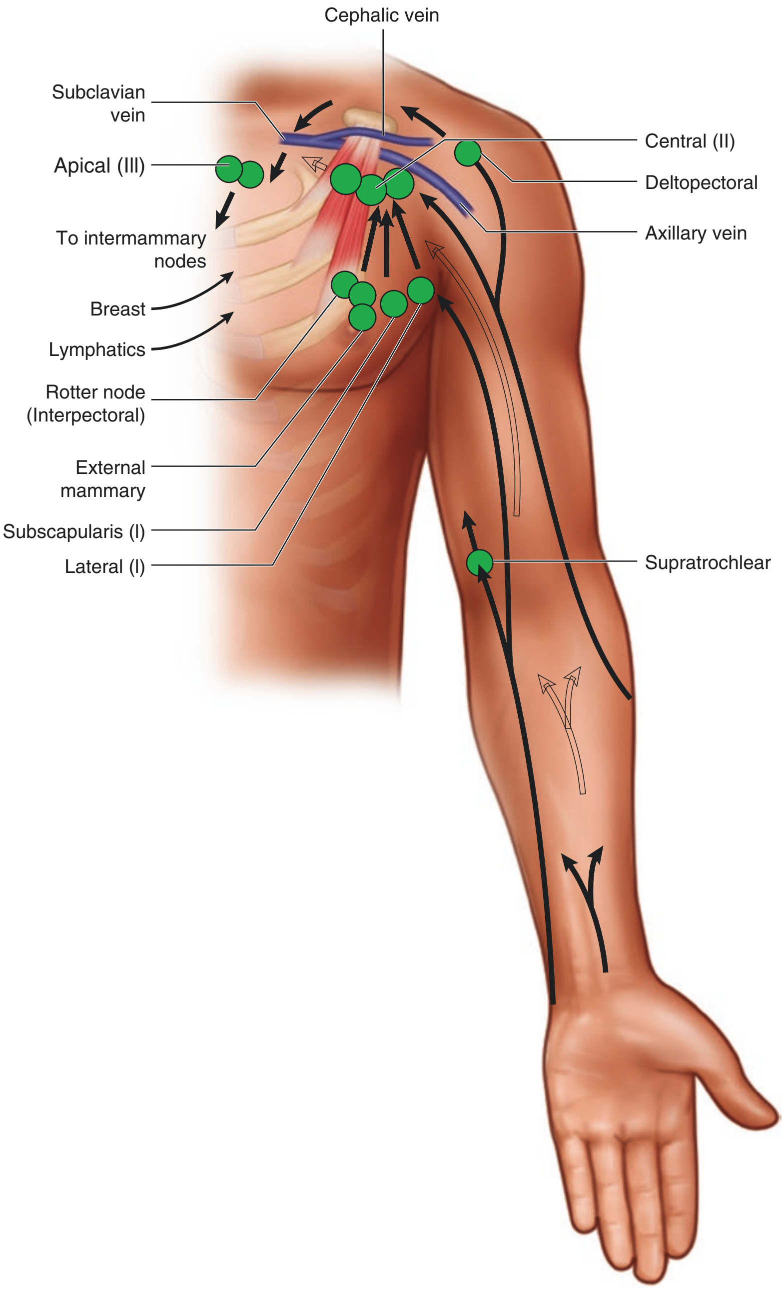


Fig. 2.11 Lymphatic drainage in the upper extremity. Arrows indicate the directional flow of lymph from the upper extremity into the axillary lymph nodes. The supratrochlear lymph nodes are located above the medial epicondyle of the humerus adjacent to the basilic vein. The deltopectoral lymph nodes are located beside the cephalic vein in the deltopectoral groove. A few nodes can also be found in the cubital fossa or along the medial side of the brachial vessels

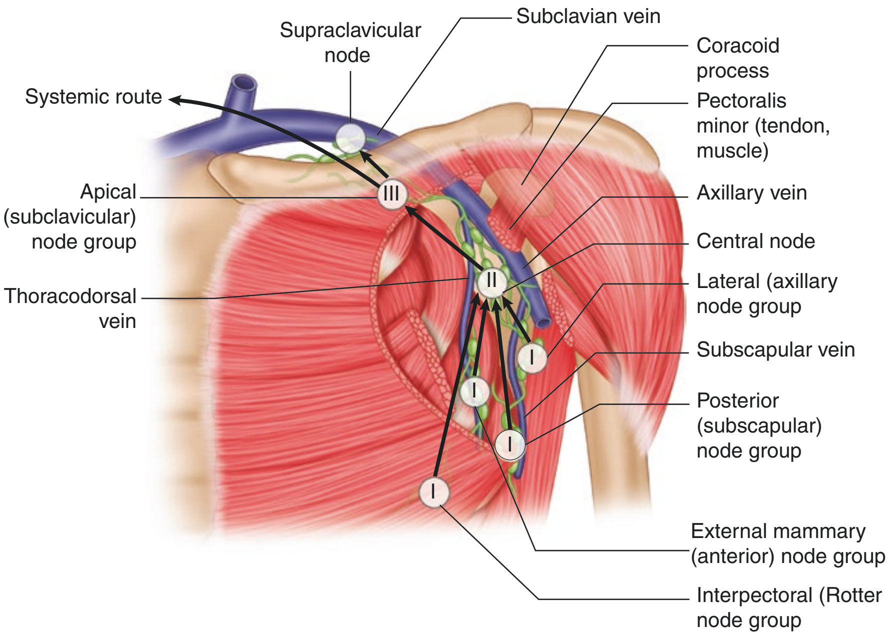


Fig. 2.12 Lymphatic drainage of the breast. Flow of lymph node drainage is reflected by the arrows. Reflection of the pectoralis major and minor demonstrates the lymph node groups (indicated with Roman numerals) of the axilla and the internal mammary nodes. The long thoracic nerve runs along the surface of the serratus anterior muscle (on the medial wall of the axilla). The thoracodorsal nerve and accompanying scapular lymph node group run posteriorly on the teres major

lateral border of the scapula in association with the subscapular vessels. These lymph nodes receive lymph primarily from the inferior aspect of the posterior region of the neck, the posterior aspect of the trunk as far inferior as the iliac crest, and the posterior aspect of the shoulder region. Lymph from the scapular nodes passes to the central and subclavicular nodes.

4. The *central group* (Figs. 2.10, 2.11, and 2.12) (both anatomists and surgeons use the same terminology for this group) consists of three or four large lymph nodes that are deeply embedded within the fatty compartments of the axilla and are, typically, usually posterior to the pectoralis minor muscle. This Level II group receives lymph from the three preceding groups and may receive afferent lymphatic vessels directly from the breast. Lymph from the central nodes passes directly to the subclavicular (apical) nodes. This group is often superficially placed beneath the skin and fascia of the mid-axilla and is centrally located between the posterior and anterior axillary folds. This nodal group is commonly palpable because of its superficial position and allows the clinical estimation of metastatic disease [27, 34].
5. The *subclavicular* (Fig. 2.12) *group*, Level III, usually identified by anatomists as the *apical group*, consists of 6–12 lymph nodes located partly posterior to the upper border of the pectoralis minor and partly superior to it. These lymph nodes

extend into the apex of the axilla along the medial side of the axillary vein. They may receive lymph directly or indirectly from all the other groups of axillary lymph nodes. The efferent lymphatic vessels from the subclavicular lymph nodes unite to form the subclavian trunk. The course of the subclavian trunk is highly variable. It may directly join the internal jugular vein, the subclavian vein, or the junction of these two; likewise, on the right side of the trunk, it may join the right lymphatic duct, and on the left side, it may join the thoracic duct. Efferent vessels from the subclavicular lymph nodes may also pass to deep cervical lymph nodes.

6. The *interpectoral or Rotter's group* [35, 36], a group of nodes identified by surgeons [27] but considered less prominent by anatomists, is anatomically Level I group and consists of an infrequent number (one to four) of small lymph nodes that are located between the pectoralis major and minor muscles in association with the pectoral branches of the thoracoacromial vessels. Lymph from these nodes passes directly into the central and subclavicular nodes.

Surgeons also define the axillary lymph nodes with respect to their relationship with the pectoralis minor muscle. These relationships are illustrated schematically in Fig. 2.10. Lymph nodes that are located lateral to or below the lower border of the pectoralis minor muscle are called *Level I* and include the *external mammary*, *axillary vein* (*lateral*), and *scapular lymph node groups*. Those lymph nodes located deep or posterior to the pectoralis minor muscle are called *Level II* and include the *central lymph node group* and possibly some of the *subclavicular lymph node* group. Those lymph nodes located medial or superior to the upper border of the pectoralis minor muscle are indicated as Level III and include the subclavicular or apical lymph node group (Fig. 2.10).

Surgeons use the term *prepectoral lymphatics* to identify (often) single lymph nodes that are only rarely identified (at necropsy of specimen) in the subcutaneous tissues associated within breast parenchyma or anterior surface of the organ in its upper outer sector [27]. Cushman Haagensen, a renowned surgeon, pathologist, and anatomist of Columbia University, reported finding only one or two prepectoral nodes each year among the several hundred mammary specimens procured in practice annually.

Sentinel Lymph Node Biopsy

Several reviews [37–55] have discussed the potential benefits and risks of sentinel lymph node (SLN) identification and biopsy in breast cancer surgery and treatment. The basic tenet of SLN biopsy is that the first lymph node that receives drainage from a tumor is the first site of lymphatic metastasis. The status of the SLN reflects the status of the more distal lymph nodes along the lymphatic chain. The report by Lee and colleagues [39] on several studies confirmed that should only one lymph node harbor metastatic involvement, it is almost universally the SLN; furthermore, in early stages of breast cancer, it is often the *only recognized site* of metastasis.

The three most important pathologic determinants for the prognosis of early breast cancer are the status of the axillary lymph nodes, histologic grade, and tumor size. Currently, molecular and genetic profiling of tumor and/or archival specimens are objectively correlative of metastatic burden and constitute the indices of metastatic risk and outcomes assessment. For the past century, axillary lymph node dissection (ALND) has been an integral component of breast cancer management. The *presence* of axillary metastasis is associated with reduced disease-free and overall survival and of the *number of involved axillary n*odes has an inverse order of prognostic significance for clinical outcomes. Both are the principle defining tenets of optimal therapeutic strategies. SLN biopsy further defines the probability of accurate, objective pathological clinical stage with anatomical sampling of involved/negative SLN axillary nodes of the axilla.

A number of techniques may be required to optimize the identification of the SLN. The two proven methods utilized are blue dye (lymphozurin/methylene blue) and/or technetium radiolabeled sulfa-colloid protein. In both techniques, the dye or radiolabeled isotope is injected around quadrated sectors of the tumor or deep dermis to enter lymphatics of the overlying skin. With blue dye utilization, the location of the SLN tracer path is not known preoperatively, and the blue-stained lymphatics are followed intraoperatively to locate the SLN within the axilla. The use of radiolabeled material (Tc99msulfa-colloid) allows the tracer to be detected preoperatively with lymphoscintigraphy or intraoperatively with a gamma probe or the combination of both. Lee and colleagues [39] reported that in recent large studies, the SLN was identified 93–99% of the time. They also reported that in the larger series of studies, the false-negative SLN with metastasis elsewhere in the axilla was in the range of 1–11%.

In practice, SLN biopsy can be used to determine specific surgical approaches and the extent of adjuvant chemotherapy and regional radiation therapy planning; however, there must be consensus on the sensitivity of the method and the acceptable false-negative rates. Von Smitten [41] reported rates of detection of sentinel nodes ranging from 66% to 100%, and false-negative rates of 17–0% have been reported. Von Smitten [41] suggested that a theoretical false-negative rate of 2–3% may be acceptable; Cody [37] suggested that a goal for surgeons and institutions using SLN biopsy may be at least 90% successful in finding the SLN with no more than 5–10% false-negative findings. In the case of SLN biopsy, as is true in most areas of medicine, the skill, expertise, and thoroughness of the pathologist who reads the specimen are of utmost importance.

Numerous recent reviews provide insight into the controversy with respect to SLN biopsy. A few recent articles are cited [39, 40, 42–56]. Many investigators have supported the positive aspect of more limited lymph node dissection by taking advantage of information gained via findings from carefully assessed SNL biopsy. The reader of this text is further referred to the chapter on SLN identification techniques and outcomes.

Lymph Flow

Anatomic familiarity and physiological conceptualization of lymphatic drainage of the breast are essential to the student of breast pathophysiology. Metastatic dissemination of breast cancer occurs predominantly within the rich and extensive lymphatic routes that arborize multidirectionality through the skin and mesenchymal (intraparenchymal) lymphatics. The delicate lymphatics of the corium are valveless; flow encompasses the lobular parenchyma and, thereafter, parallels major venous tributaries to enter the regional lymph nodes. This unidirectional lymphatic flow is pulsatile as a consequence of the wavelike contractions of the lymphatics to allow rapid transit and emptying of the lymphatic vascular spaces that interdigitate the extensive periductal and perilobular networks. As a consequence of obstruction to lymph flow by inflammatory or neoplastic diseases, a reversal in lymphatic flow is evident and can be appreciated microscopically as endolymphatic metastases within the dermis or breast parenchyma. This obstruction of lymphatic flow accounts for the neoplastic growth in local and regional sites remote from the primary neoplasm. Lymphatic flow is typically unidirectional, except in the pathologic state, and has preferential flow from the periphery toward larger collecting ducts. Lymphatic capillaries begin as blind-ending ducts in tissues from which the lymph is collected; throughout their course, these capillaries anastomose and fuse to form larger lymphatic channels that ultimately terminate in the thoracic duct on the left side of the body or the smaller right lymphatic duct on the right side. The thoracic duct empties into the region of the juncture of the left subclavian and left internal jugular veins, whereas the right lymphatic duct drains into the right subclavian vein near its juncture with the right internal jugular vein.

Anson and McVay [34] and Haagensen [27] acknowledged two accessory directions for lymphatic flow from breast parenchyma to nodes of the apex of the axilla: the *transpectoral* and *retropectoral* routes (Fig. 2.10). Lymphatics of the transpectoral route (i.e., interpectoral nodes) lie between the pectoralis major and minor muscles and are referred to as *Rotter's nodes*. The transpectoral route begins in the loose areolar tissue of the retromammary plexus and interdigitates between the pectoral fascia and breast to perforate the pectoralis major muscle and follow the course of the thoracoacromial artery and terminate in the subclavicular (Level III) group of nodes.

The second accessory lymphatic drainage group, the *retropectoral pathway*, drains the superior and internal aspects of the breast. Lymphatic vessels from this region of the breast join lymphatics from the posterior and lateral surfaces of the pectoralis major and minor muscles. These lymphatic channels terminate at the apex of the axilla in the *subclavicular* (*Level III*) *group*. This route of lymphatic drainage is found in approximately one-third of individuals and is a more direct mechanism of lymphatic flow to the subclavicular group. This accessory pathway is also the major lymphatic drainage by way of the external mammary and central axillary nodal groups (Levels I and II, respectively) [27, 34]

The recognition of metastatic spread of breast carcinoma into internal mammary nodes as a primary route of systemic dissemination is credited to the British surgeon R.S. Handley [56]. Extensive investigation confirmed that central and median lymphatics of the breast pass medially and parallel the course of major blood vessels to perforate the pectoralis major muscle and thereafter terminate in the internal mammary nodal chain.

The internal mammary nodal group (Figs. 2.4 and 2.13) is anatomically situated in the retrosternal interspaces between the costal cartilages approximately 2–3 cm within the sternal margin. These nodal groups also traverse and parallel the internal mammary vasculature and are invested by endothoracic fascia. The internal mammary lymphatic trunks eventually terminate in subclavicular nodal groups. The right internal mammary nodal group enters the right lymphatic duct and the left enters the thoracic duct (Fig. 2.14). The presence of supraclavicular nodes (stage IV

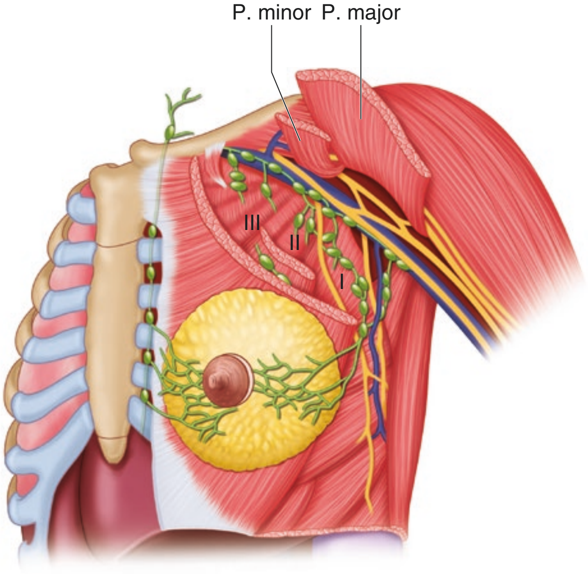


Fig. 2.13 Major lymph node groups associated with the lymphatic drainage of the breast. Level I lymph nodes are located lateral to the pectoralis minor and generally flow to Level II lymph nodes located deep to the muscle which in turn flow to Level III lymph nodes located medial to the muscle

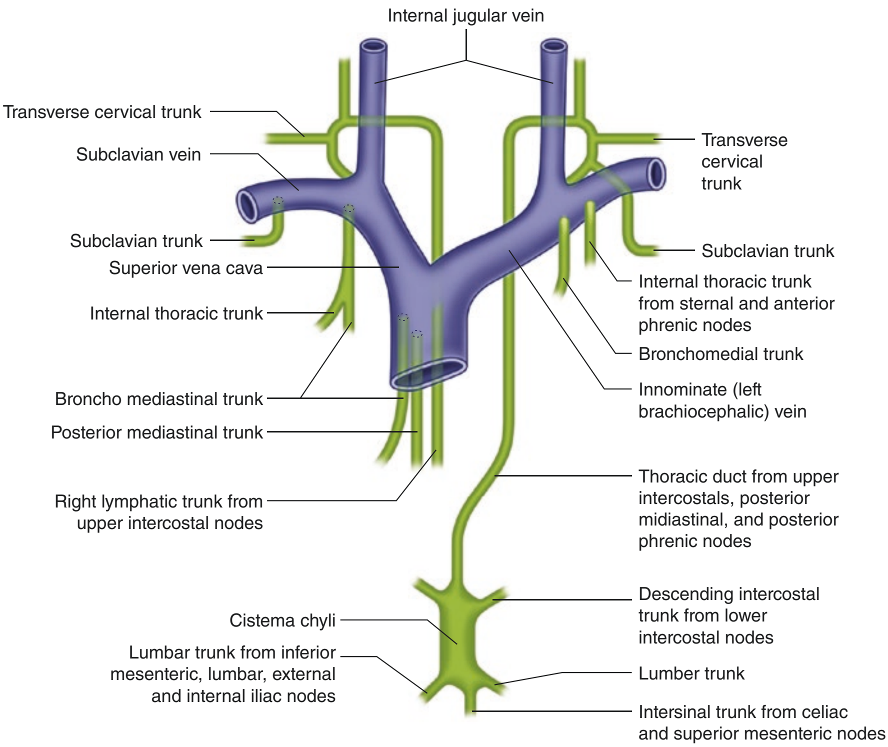


Fig. 2.14 Major lymphatic vessels of the thorax. The thoracic duct begins at the cisterna chyli, with the thoracic and right lymphatic ducts ending at or near the confluence of the internal jugular with the subclavian veins

disease) results from lymphatic permeation and subsequent obstruction of the inferior, deep cervical group of nodes of the jugular-subclavian confluence. In effect, the supraclavicular nodal group represents the termination of efferent trunks from subclavian nodes of the internal mammary nodal group. These nodes are situated beneath the lateral margin of the inferior aspect of the sternocleidomastoid muscle beneath the clavicle and represent common sites of distant metastases from mammary carcinoma.

Evidence of cross-communication from interstices of connecting lymphatic channels from each breast provides ready access of lymphatic flow to the opposite axilla. This observation of communicating dermal lymphatics to the contralateral breast explains occasional metastatic involvement of the opposite breast and axilla. Structures of the chest wall, including the internal and external intercostal musculature (Fig. 2.9), have extensive lymphatic drainage that parallels the course of their major intercostal blood supply. As expected, invasive neoplasms of the lateral breast that involve deep musculature of the thoracic cavity have preferential flow toward the axilla. Invasion of medial musculature of the chest wall allows preferential drainage toward the internal mammary nodal groups, whereas bidirectional metastases may be evident with invasive central or subareolar cancers.

The lymphatic vessels that drain the breast occur within three *interconnecting* groups [57]:

1. A primary set of vessels originates as channels within the gland in the interlobular spaces and along the lactiferous ducts.
2. Vessels draining the glandular tissue and overlying skin of the central part of the gland pass to an interconnecting network of vessels located beneath the areola, called the *subareolar plexus* [58].
3. The plexus on the deep surface of the breast communicates with minute vessels in the deep fascia underlying the breast parenchyma [57, 58].

Along the medial border of the breast, lymphatic vessels within the substance of the gland anastomose with vessels passing to parasternal nodes.

Using autoradiographs of surgical specimens, Turner-Warwick [57] demonstrated that the main lymphatic drainage of the breast is via the system of lymphatic vessels occurring within the substance of the gland and not through the vessels on the superficial or deep surface. The main collecting trunks run laterally as they pass through the axillary fascia in the substance of the axillary tail. The subareolar plexus plays no essential part in the lymphatic drainage of the breast [57]. Using vital dyes, Halsell and coworkers [59] demonstrated that this plexus receives lymph primarily from the nipple and the areola and conveys it toward the axilla. The lymphatics communicating with minute vessels in the deep fascia play no role in the principal lymphatic drainage of the breast and provide an alternative route only when the normal pathways are obstructed. More than 75% of the lymph from the breast passes to the axillary lymph nodes. Most of the remainder of the lymph passes to parasternal nodes. Some authorities have suggested that the parasternal nodes receive lymph primarily from the medial part of the breast. However, Turner-Warwick [57] reported that both the axillary and the parasternal lymph node groups receive lymph from all quadrants of the breast, with no striking tendency for any quadrant to drain in a particular direction.

Other routes for the flow of lymph from the breast have been identified. Occasionally, lymph from the breast reaches intercostal lymph nodes, located near the heads of the ribs (see later discussion). Lymphatic vessels reach this location by following lateral cutaneous branches of the posterior intercostal arteries. Lymph may pass to lymphatics within the rectus sheath or sub-peritoneal plexus by following branches of the intercostal and musculophrenic vessels. Lymph may pass directly to subclavicular, or apical, nodes from the upper portion of the breast. SLN biopsy has confirmed the direct metastasis from the breast to the supraclavicular nodes.

The skin over the breast has lymphatic drainage via the *superficial lymphatic vessels*, which ramify subcutaneously and converge on the axillary lymph nodes. The anterolateral chest and the upper abdominal wall above the umbilicus demonstrate striking directional flow of lymph toward the axilla. Lymphatic vessels near the lateral margin of the sternum pass through the intercostal space to the parasternal lymph nodes, which are associated with the internal thoracic vessels. Some of the lymphatic vessels located on adjacent sides of the sternum may anastomose in front of the sternum. In the upper pectoral region, a few of the lymphatic vessels may pass over the clavicle to inferior deep cervical lymph nodes.

The SLN biopsy identification is also providing better evidence of the paths of axillary lymphatic drainage of the breast. This technique is especially useful in identifying the lymphatic drainage into the parasternal or internal mammary lymph nodes [38]. The lymphatic vessels from the deeper structures of the thoracic wall drain primarily into parasternal, intercostal, or diaphragmatic lymph nodes (see subsequent discussion).

Lymph Nodes of the Thoracic Wall

The lymphatic drainage of the skin and superficial tissues of thoracic and anterior abdominal walls is described in the section on the lymphatic drainage of the breast. Three sets of lymph nodes and associated vessels—parasternal, intercostal, and diaphragmatic—are involved in the lymphatic drainage of the deeper tissues of the thoracic wall:

The parasternal or internal thoracic lymph nodes consist of small lymph nodes located about 1 cm lateral to the sternal border in the intercostal spaces along the internal thoracic, or mammary, vessels (Figs. 2.3 and 2.4). The parasternal nodes lie in the areolar tissue underlying the endothoracic fascia that borders the space between the adjacent costal cartilages. The distribution of the nodes in the upper six intercostal spaces has been the subject of several studies since Stibbe's report in 1918 of an average total of 8.5 internal mammary nodes per subject, including both sides [60]. Stibbe reported that they usually occurred in the pattern of four on one side and five on the other. Each of the three upper spaces usually contained one lymph node, as did the sixth space. Often, there were no lymph nodes in the fourth or fifth space; an extra node usually was found in one of the upper three spaces on one of the sides. Soerensen [61] reported finding an average of seven nodes of minute size per subject in 39 autopsies, with an average of 3.5 on each side. Ju (as reported by Haagensen [27]) studied 100 autopsy subjects and found an average of 6.2 parasternal nodes per subject, with an average of 3.1 per side. A majority was found in the upper three spaces. However, in contradiction to Stibbe's findings, a lower but similar frequency of nodes was seen in all three of the lower intercostal spaces. Putti [57] studied 47 cadavers and found an average of 7.7 nodes per subject—again, with a majority of the nodes in the upper three spaces and many fewer in the lower spaces. Arão and Abrão [63] studied 100 autopsy specimens and found a much higher frequency of lymph nodes than had been previously reported. They found an average total of 16.2 per subject, with an average of 8.9 on the right side and 7.3 on the left. In 56.6% of the subjects, they found retromanubrial nodes between the right and left lymphatic trunks at the level of the first intercostal space. An average of 6.6 nodes were seen when the retromanubrial nodes were present.

The *intercostal lymph nodes* consist of small lymph nodes located in the posterior part of the thoracic cavity within the intercostal spaces near the head of the ribs (Figs. 2.3 and 2.4). One or more may be found in each intercostal space in relationship with the intercostal vessels. These lymph nodes receive the deep lymphatics from the posterolateral thoracic wall, including lymphatic channels from the breast. Occasionally, small lymph nodes occur in the intercostal spaces along the lateral thoracic wall. Efferent lymphatics from the lower four or five intercostal spaces, on both the right and the left sides, join to form a trunk that descends to open into either the cisterna chyli or the initial portion of the thoracic duct. The upper efferent lymphatics from the intercostal nodes on the left side terminate in the thoracic duct; the efferent lymphatics from the corresponding nodes on the right side end in the right lymphatic duct.

The *diaphragmatic lymph nodes* consist of three sets of small lymph nodes (anterior, lateral, and posterior) located on the thoracic surface of the diaphragm.

The *anterior group of diaphragmatic lymph nodes* includes two or three small lymph nodes (also known as *prepericardial lymph nodes*) located behind the sternum at the base of the xiphoid process, which receive afferent lymphatics from the convex surface of the liver, and one or two nodes located on each side near the junction of the seventh rib with its costal cartilage, which receive afferents from the anterior aspect of the diaphragm. Afferent lymphatics also reach the prepericardial nodes by accompanying the branches of the superior epigastric blood vessels that pass from the rectus abdominis muscle and through the rectus sheath. Efferent lymphatics from the anterior diaphragmatic nodes pass to the parasternal nodes. This lymphatic channel is a potential route by which metastases from the breast may invade the parasternal region, with the potential for spread to the liver. As Haagensen [27] suggests, metastasis via this (rectus abdominis muscle) route most likely occurs only when the internal mammary lymphatic trunk is blocked higher in the upper intercostal spaces. When blockage occurs, the flow of lymph may be reversed and carcinoma emboli from the breast may reach the liver. It is significant to note that the autopsy subjects studied by Handley and Thackray [56], who demonstrated this route of metastasis, had locally advanced breast carcinoma. Handley and Thackray [56] described the importance of the parasternal lymph nodes in carcinoma of the breast. Clearly, as Haagensen [27] and others have suggested, this route is not of importance in early cancer of the breast unless the primary tumor is located in the extreme lower inner portion of the breast where it overlies the sixth costal cartilage.

The *lateral group of diaphragmatic lymph nodes* consists of two or three small lymph nodes on each side of the diaphragm adjacent to the pericardial sac where the phrenic nerves enter the diaphragm. On the right side, they are located near the vena cava and, on the left side, near the esophageal hiatus. Afferent lymphatic vessels reach these nodes from the middle region of the diaphragm; on the right side, afferent lymphatics from the convex surface of the liver also reach these nodes. Efferent lymphatics from the lateral diaphragmatic nodes may pass to the parasternal nodes via the anterior diaphragmatic nodes, to posterior mediastinal nodes, or to anterior nodes via vessels that follow the course of the phrenic nerve.

The *posterior set of diaphragmatic lymph nodes* consists of a few lymph nodes located adjacent to the crura of the diaphragm. They receive lymph from the posterior aspect of the diaphragm and convey it to posterior mediastinal and lateral aortic nodes.

Lymph Nodes of the Thoracic Cavity

Three sets of nodes are involved in the lymphatic drainage of the thoracic viscera—*anterior mediastinal* (*brachiocephalic*), *posterior mediastinal*, and *tracheobronchial*. Although knowledge of the lymphatic drainage of the thoracic viscera may not be particularly significant in treating carcinoma of the breast, it is important that one understand the system of collecting lymphatic trunks in this region (Fig. 2.14) and that lymphatic flow converges into the confluence of the internal jugular and subclavian veins.

For better comprehension of the pattern of lymphatic drainage in this region, a brief description of the regions and organs drained by the three thoracic lymph node groups is provided. The anterior mediastinal group consists of six to eight lymph nodes located in the upper anterior part of the mediastinum in front of the brachiocephalic veins and the large arterial trunks arising from the aorta. These correspond to the retromanubrial nodes as identified by Putti [62] and Arão and Abrão [63]. The *anterior mediastinal nodes* receive afferent lymphatics from the thymus, thyroid, pericardium, and lateral diaphragmatic lymph nodes. Their efferent lymphatic vessels join with those from the tracheobronchial nodes to form the *bronchomediastinal trunks*. The *posterior mediastinal group* consists of eight to ten nodes located posterior to the pericardium in association with the esophagus and descending thoracic aorta. They receive afferent lymphatics from the esophagus, the posterior portion of the pericardium, the diaphragm, and the convex surface of the liver. Most of their efferent lymphatic vessels join the thoracic duct, but some provide egress into *tracheobronchial nodes.*

The *tracheobronchial group* consists of a chain of five subgroups of lymph nodes—tracheal, superior tracheobronchial, inferior tracheobronchial, bronchopulmonary, and pulmonary—located adjacent to the trachea and bronchi, as is indicated by the descriptive names. The bronchopulmonary nodes are found in the hilum of each lung; the pulmonary nodes are found within the substance of the lung in association with the segmental bronchi. The tracheal nodes receive afferent lymphatics from the trachea and upper esophagus. The remaining nodes within this group form a continuous chain with boundaries of lymphatic drainage that are not well defined. The pulmonary and bronchopulmonary nodes receive afferent lymphatic vessels from the lungs and bronchial trees. The inferior and superior tracheobronchial nodes receive afferent lymphatic vessels from the lungs and bronchial trees. The inferior and superior tracheobronchial nodes receive nodes; the inferior tracheobronchial nodes also receive some afferent lymphatic vessels from the heart and posterior mediastinal organs. Efferent vessels from the subgroups of the tracheobronchial group pass sequentially to the level of the tracheal nodes. Efferents from the latter unite with efferents from parasternal and anterior mediastinal nodes to form the right and left bronchomediastinal lymphatic trunks. The left trunk may terminate by joining the thoracic duct, and the right trunk may join the right lymphatic duct. However, it is more common for the right and left trunks to open independently into the junction of the internal jugular and subclavian veins, each on their own side (Fig. 2.14).

Venous Drainage of the Mammary Gland

Lymphatic drainage of the epithelial and mesenchymal components of the breast is the primary route for metastatic dissemination of adenocarcinoma of this organ. However, the vascular route for tumor embolization via venous drainage systems plays a major role in dissemination of neoplasms to the lung, bone, brain, liver, and so forth.

The three groups of deep veins that drain the breast (Fig. 2.15) and serve as vascular routes include the following:

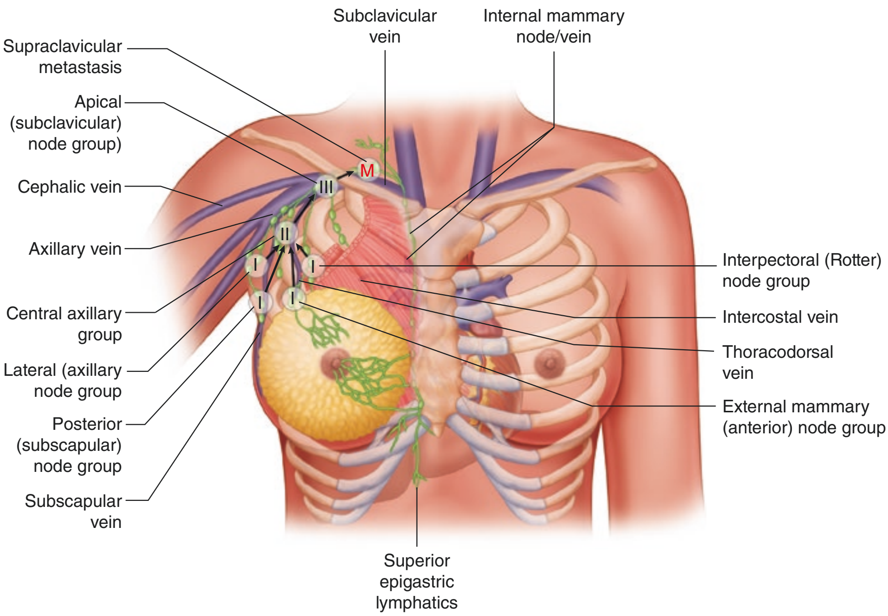


Fig. 2.15 Venous and lymphatic drainage of the breast. Lymphatic vessels and the three major groups of veins serving the breast run in parallel and provide routes for metastasis: intercostal, axillary, and internal mammary veins

1. The *intercostal veins*, which traverse the posterior aspect of the breast from the second to the sixth intercostal spaces and arborize to enter the vertebral veins posteriorly and the azygos vein centrally to terminate in the superior vena cava
2. The *axillary vein*, which may have variable tributaries that provide segmental drainage of the chest wall, pectoral muscles, and the breast
3. The *internal mammary vein perforators*, which represent the largest venous plexus to provide drainage of the mammary gland

This venous network traverses the rib interspaces to enter the brachiocephalic (innominate) veins. Thus, perforators that drain the parenchyma and epithelial components of the breast allow direct embolization to the pulmonary capillary spaces to establish metastatic disease [3, 27].

Reference Video

- https://youtu.be/k8SlTuDrIA8
- https://youtu.be/KaXaTGX6poA
- https://youtu.be/Wai_Di0eeFA

References

1. Morehead JR. Anatomy and embryology of the breast. Clin Obstet Gynecol. 1982;25:353–7.
2. Helminen HJ, Ericsson JL. Studies on mammary gland involution. I. On the ultrastructure of the lactating mammary gland. J Ultrastruct Res. 1968;25:193–213.
3. Cowie AT. Overview of mammary gland. J Invest Dermatol. 1974;63:2–9.
4. Spratt JS. Anatomy of the breast. Major Probl Clin Surg. 1979;5:1–13.
5. Spratt JS Jr, Donegan WL. Anatomy of the breast. In: Donegan WL, Spratt Jr JS, editors. Cancer of the breast. 3rd ed. Philadelphia: WB Saunders; 1979.
6. Smith DJ Jr, et al. Breast volume and anthropomorphic measurements: normal values. Plast Reconstr Surg. 1986;78:331–5.
7. Montagu A. Natural selection in the form of the breast in the female. JAMA. 1962;180:826–7.
8. Giacometti L, Montagna W. The nipple and areola of the human female breast. Anat Rec. 1962;144:191–7.
9. Sykes PA. The nerve supply of the human nipple. J Anat (Lond). 1969;105:201.
10. Montagna W, Macpherson EA. Some neglected aspects of the anatomy of the human breasts. J Invest Dermatol. 1974;63:10–6.
11. Cathcart EP, Gairns FW, Garven HSD. The innervation of the human quiescent nipple, with notes on pigmentation, erection, and hyperneury. Trans R Soc Edinb. 1948;61:699–717.
12. Radnor CJ. Myoepithelium in the prelactating and lactating mammary glands of the rat. J Anat (Lond). 1972;112:337–53.
13. Hoffman S, Dutton SL, Ernst H, et al. Functional characterization of antiadhesion molecules. Perspect Dev Neurobiol. 1994;2:101–10.
14. Stampfer MR, Yaswen P. Culture systems for study of human mammary epithelial cell proliferation, differentiation and transformation. Cancer Surv. 1993;18:7–34.
15. Thompson EW, Yu M, Bueno J, et al. Collagen induced MMP-2 activation in human breast cancer. Breast Cancer Res Treat. 1994;31:357–70.

16. Verhoeve D, Van-Marck E. Proliferation, basement membrane changes, metastasis and vascularization patterns in human breast cancer. Pathol Res Pract. 1993;189:851–61.
17. Tobon H, Salazar H. Ultrastructure of the human mammary gland. I. Development of the fetal gland throughout gestation. J Clin Endocrinol Metab. 1974;39:443–56.
18. Waugh D, Van Der Hoeven E. Fine structure of the human adult female breast. Lab Investig. 1962;11:220–8.
19. Wellings SR, Grunbaum BW, DeOme KB. Electron microscopy of milk secretion in the mammary gland of the C3H/Crgl mouse. J Natl Cancer Inst. 1960;25:423–37.
20. Linzell JL. The silver staining of myoepithelial cells particularly in the mammary gland, and their relation to ejection of milk. J Anat (Lond). 1952;86:49–57.
21. Grife RM, Sullivan RM, Colborn GL. The ansapectoralis: anatomy and applications. Gainesville: American Association of Clinical Anatomists; 2002.
22. Moosman DA. Anatomy of the pectoral nerves and their preservation in modified mastectomy. Am J Surg. 1980;139:883–6.
23. Cunningham L. The anatomy of the arteries and veins of the breast. J Surg Oncol. 1977;9:71–85.
24. Maliniac JW. Arterial blood supply of the breast. Arch Surg. 1943;47:329–43.
25. Sakki S. Angiography of the female breast. Ann Clin Res. 1974;6(suppl 12):1–47.
26. Massopust LC, Gardner WD. Infrared photographic studies of the superficial thoracic veins in the female. Surg Gynecol Obstet. 1950;91:717–27.
27. Haagensen CD. Anatomy of the mammary glands. In: Haagensen CD, editor. Diseases of the breast. 3rd ed. Philadelphia: WB Saunders; 1986.
28. Batson OV. The function of the vertebral veins and their role in the spread of metastases. Ann Surg. 1940;112:138–49.
29. Batson OV. The role of the vertebral veins and metastatic processes. Ann Intern Med. 1942;16:38–45.
30. Henriques C. The veins of the vertebral column and their role in the spread of cancer. Ann R Coll Surg Engl. 1962;31:1–22.
31. Miller MR, Kasahara M. Cutaneous innervation of the human breast. Anat Rec. 1959;135:153–67.
32. Gray H. The lymphatic system. In: Clemente CD, editor. Anatomy of the human body. 30th ed. Philadelphia: Lea & Febiger; 1985.
33. Mornard P. Sur deuxas de tumeursalignes des mammelles axillaires aberrantes. Bull Mem Soc Chir Paris. 1929;21:487.
34. Anson BJ, McVay CB. Thoracic walls: breast or mammary region. In: Surgical anatomy, vol. 1. Philadelphia: WB Saunders; 1971.
35. Grossman F. Ueber die Axillaren Lymphdrusen Inaug Dissert. Berlin: C. Vogt; 1986.
36. Bland KI, Copeland EM, Klimberg VS. Anatomy of the breast, Axilla, Chest Wall. In: Bland KI, et al. editors, The Breast: comprehensive management of benign and malignant diseases, Philadelphia: Elsevier; 2018; p. 20–36.
37. Cody HS III. Clinical aspects of sentinel node biopsy. Breast Cancer Res. 2001;3:104–8.
38. Cserni G, Szekeres JP. Internal mammary lymph nodes and sentinel node biopsy in breast cancer. Surg Oncol. 2001;10:25–33.
39. Lee AH, Ellis IO, Pinder SE, et al. Pathological assessment of sentinel lymph-node biopsies in patients with breast cancer. Virchows Arch. 2000;436:97–101.
40. Nieweg OE, Rutgers EJ, Jansen L, et al. Is lymphatic mapping in breast cancer adequate and safe? World J Surg. 2001;25:780–8.
41. Von Smitten K. Sentinel node biopsy in breast cancer. Acta Oncol. 1999;38(13):33–6.
42. Motomura K, Egawa C, Komoike Y, et al. Sentinel node biopsy for breast cancer: technical aspects and controversies. Breast Cancer. 2007;14:25–30.
43. Sato K, Shigenaga R, Ueda S, et al. Sentinel lymph node biopsy for breast cancer. J Surg Oncol. 2007;96:322–9.
44. Tangoku A, Seike J, Nakano K, et al. Current status of sentinel lymph node navigation surgery in breast and gastrointestinal tract. J Med Investig. 2007;54:1–18.

45. Veronesi P, Rodriguez-Fernandez J, Intra M. Controversies in the use of sentinel nodes: microinvasion, post surgery and after preoperative systemic treatment. Breast. 2007;16(suppl 2):67–70.
46. Newman EA, Newman LA. Lymphatic mapping techniques and sentinel lymph node biopsy in breast cancer. Surg Clin North Am. 2007;87:353–64.
47. Nos C, Lesieur B, Clough KB, Lecuru F. Blue dye injection in the arm in order to conserve the lymphatic drainage of the arm in breast cancer patients requiring an axillary dissection. Ann Surg Oncol. 2007;14:2490–6.
48. Rivers A, Hansen N. Axillary management after sentinel lymph node biopsy in breast cancer patients. Surg Clin North Am. 2007;87:365–77.
49. Rutgers EJ. Sentinel node biopsy: interpretation and management of patients with immunohistochemistry-positive sentinel nodes and those with micrometastases. J Clin Oncol. 2008;26:698–702.
50. Veronesi U, Viale G, Paganelli G, et al. Sentinel lymph node biopsy in breast cancer: ten-year results of a randomized controlled study. Ann Surg. 2010;251(4):595–600.
51. Giuliano AE, Chung AP. Long-term follow-up confirms the oncologic safety of sentinel node biopsy without axillary dissection in node-negative breast cancer patients. Ann Surg. 2010;251(4):601–3.
52. Johnson CB, Boneti C, Korourian S, et al. Intraoperative injection of subareolar or dermal radioisotope results in predictable identification of sentinel lymph nodes in breast cancer. Ann Surg. 2011;25494:612–8.
53. Omair M, Al-Azawi D, Mann GB. Sentinel node biopsy in breast cancer revisited. Surgeon. 2014;12(3):158–65.
54. Snook KL, Layer GT, Jackson PA, et al. Multicentre evaluation of intraoperative molecular analysis of sentinel lymph nodes in breast carcinoma. Br J Surg. 2011;98:527–35.
55. Wetzig N, Gill PG, Zannino D, et al. Sentinel lymph node based management or routine axillary clearance? Three-year outcomes of the RACS sentinel node biopsy versus axillary clearance (SNAC) 1 trial. Ann Surg Oncol. 2015;22:17–23.
56. Handley RS, Thackray AC. The internal mammary lymph chain in carcinoma of the breast. Lancet. 1949;2:276–8.
57. Turner-Warwick RT. The lymphatics of the breast. Br J Surg. 1959;46:574–82.
58. Grant RN, Tabah EJ, Adair FF. The surgical significance of subareolar lymph plexus in cancer of the breast. Surgery. 1953;33:71–8.
59. Halsell JT, et al. Lymphatic drainage of the breast demonstrated by vital dye staining and radiography. Ann Surg. 1965;162:221–6.
60. Stibbe EP. The internal mammary lymphatic glands. J Anat. 1918;52:527–64.
61. Soerensen B. Recherchessur la localisation des ganglions lymphatiques parasternaux par rapport aux espacesintercostaux. Int J Chir. 1951;11:501–9.
62. Putti F. Ricerche anatomiche sui linfonodi mammari interni. Chir Ital. 1953;7:161–7.
63. Arão A, Abrão A. Estudo anatomico da cadeia ganglionar mamária interna em 100 caso. Rev Paul Med. 1954;45:317–26.

Recommended Reading

Bland KI. Anatomy of the breast. In: Fisher's Mastery of Surgery: LWW; 2019.

Bland KI, Klimberg VS, Copeland EMIII. Anatomy of the breast, axilla, chest wall, and related sites. In: The breast: comprehensive management of benign and malignant diseases. 5th ed: Elsevier.

Hunt KK, Robertson JF, Bland KI. The breast. In: Brunicardi F, Anderson DK, Billar TR, et al., editors. Schwartz's principles of surgery. 10th ed. New York: McGraw Hill; 2015. p. 497–564.

Imaging for Oncoplastic Procedures

3

Gwendolyn Bryant-Smith and Ronda S. Henry-Tillman

Introduction

Breast imaging and surgical oncoplastic techniques are used in concert. Both tools equip the surgeon with the information needed to achieve excellent oncologic outcomes and satisfactory postsurgical cosmetic results. Imaging plays a critical role in surgical planning by providing the location, tumor size, and breast density in patients desiring breast conservation or mastectomy with or without reconstruction following a breast cancer diagnosis. The information received by imaging allows the surgeon to estimate the volume of resection.

Oncoplastic surgery (OPS) encompasses surgical removal of the tumor, details the recreation of the breast mound, and allows for symmetrization of the opposite breast. It enables contoured mastectomies without redundant adiposity, laterally or medially. The combination of oncologic and reconstructive surgery aims to remove all malignant breast tissue while using the remaining normal fibroglandular tissue or implants to achieve the best cosmetic results. OPS encompasses both volume replacement and volume displacement techniques. Volume replacement involves importing additional tissue from the outside the breast (tissue flap or an implant) to compensate for volume loss. Volume displacement uses the remaining breast tissue to manage the volume loss which allows reshaping of the breast. Clough et al. [1]

G. Bryant-Smith (✉)
Breast Imaging, University of Arkansas for Medical Sciences, Little Rock, AR, USA
e-mail: smithGwendolynB@uams.edu; gmbryantsmith@uams.edu

R. S. Henry-Tillman
Department of Surgery, University of Arkansas for Medical Sciences and the Winthrop P. Rockefeller Institute, Little Rock, AR, USA
e-mail: henryrondas@uams.edu

V. S. Klimberg et al. (eds.), *Oncoplastic Breast Surgery Techniques for the General Surgeon*, https://doi.org/10.1007/978-3-030-40196-2_3

described breast volume displacement on two levels utilizing the volume removed and the complexity of the tissue rearrangement. Level I is defined as less than 20% removal of the breast volume and recreating the breast mound by simple mobilization of the breast. Level II is defined as removal of 20–50% of the breast volume and reshaping the breast mound.

Imaging tools most commonly used to support surgical planning include mammography (2D mammography), mammography with tomosynthesis (3D mammography), breast ultrasound, and breast MRI. These imaging tools help determine if disease is limited to one region of the breast (unifocal), involving a region of the breast with associated satellite nodules (multifocal), or involving more than one quadrant of the breast or separated by more than 5 cm (multicentric).

Indications

OPS in breast cancer management has progressively increased since its evolution in the 1990s [1]. It has become a major component of breast surgical techniques. Imaging has also continued to change and parallel this breast surgical evolution.

Volume removal can lead to deformity. The utilization of volume replacement or volume displacement techniques can impact surgical outcomes. Breast size to volume removed ratios utilizing level I or level II oncoplastic techniques are important to avoid potential deformities.

Oncoplastic selection criteria is very important in determining surgical success. Selection elements include excision volume, tumor location, and glandular density. Imaging helps in these selection elements. Excision volume is the most predictive factor for surgical success. If 20% of the breast volume is excised, deformity risk is heightened [1]. Volume to be excised relative to total breast volume is estimated preoperatively. Tumor location is the second most important step in OPS planning. The upper outer quadrant of the breast is the most forgiving area while the lower pole or the upper inner quadrants create significant risk for deformity [1]. Breast density is the last component in ensuring a complete evaluation prior to surgery.

Mammography is helpful for breast density assessment because of its reproducibility. Mammographic breast density is classified by the American College of Radiology Breast Imaging and Reporting Data System (BIRADS) into four categories [1]. Category A (Fig. 3.1), the breasts are almost entirely fatty; Category B (Fig. 3.2), there are scattered areas of fibroglandular density; Category C (Fig. 3.3), the breasts are heterogeneously dense, which may obscure small masses; or Category D (Fig. 3.4), the breasts are extremely dense, which lowers the sensitivity of mammography. Categories C and D breast densities are easier to mobilize surgically. Categories A and B are associated with a higher risk of fat necrosis with surgical mobilization.

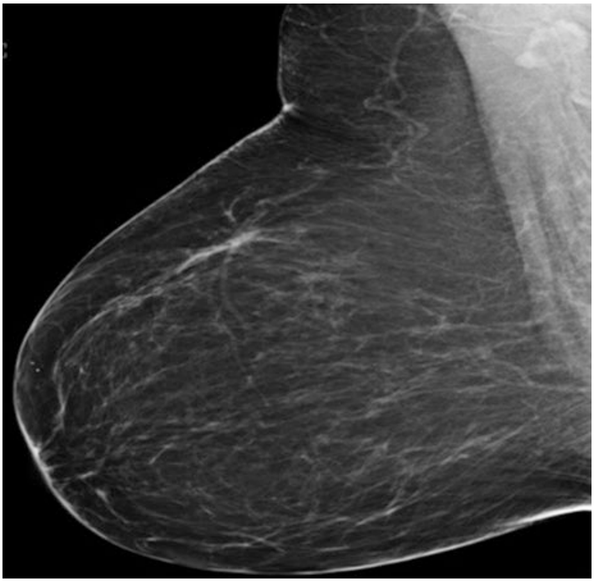


Fig. 3.1 BIRADS breast density. Category A: The breasts are almost entirely fatty

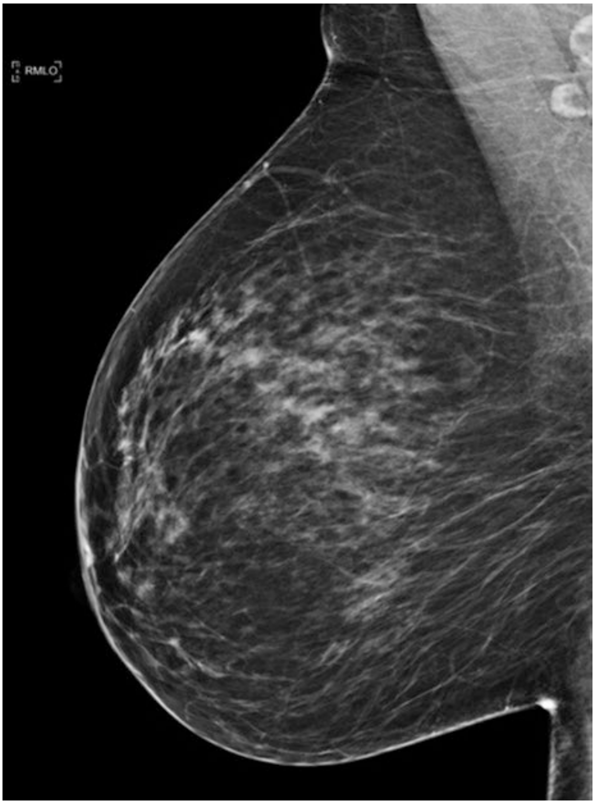


Fig. 3.2 BIRADS breast density. Category B: There are scattered areas of fibroglandular density

Fig. 3.3 BIRADS breast density. Category C: The breasts are heterogeneously dense, which may obscure small masses

Preoperative Evaluation and Planning

Mammography and ultrasound are the standard imaging tests for breast cancer diagnosis and play a pivotal role in overall medical and surgical management. However, breast density, even with 3D mammography, remains a limiting feature of mammography. Dense fibroglandular tissue is white on a mammogram, and cancer is also white on the mammogram. Finding a white cancer on a mammographic white fibroglandular dense background is challenging. Mammography has a breast cancer detection sensitivity of up to 80% in category A breast density, but the sensitivity can decrease to as low as 30% in category D breast density [4]. The specificity of mammography is approximately 96% [5]. Digital Breast Tomosynthesis (DBT), also known as 3D mammography, has improved mammography detection of breast masses and architectural distortion in dense breast tissue. DBT increases invasive breast cancer detection by 1.2/1000 [6].

Breast ultrasound is a useful adjunctive tool to mammography, and the combination of mammography plus ultrasound yields a sensitivity of 92% and a specificity

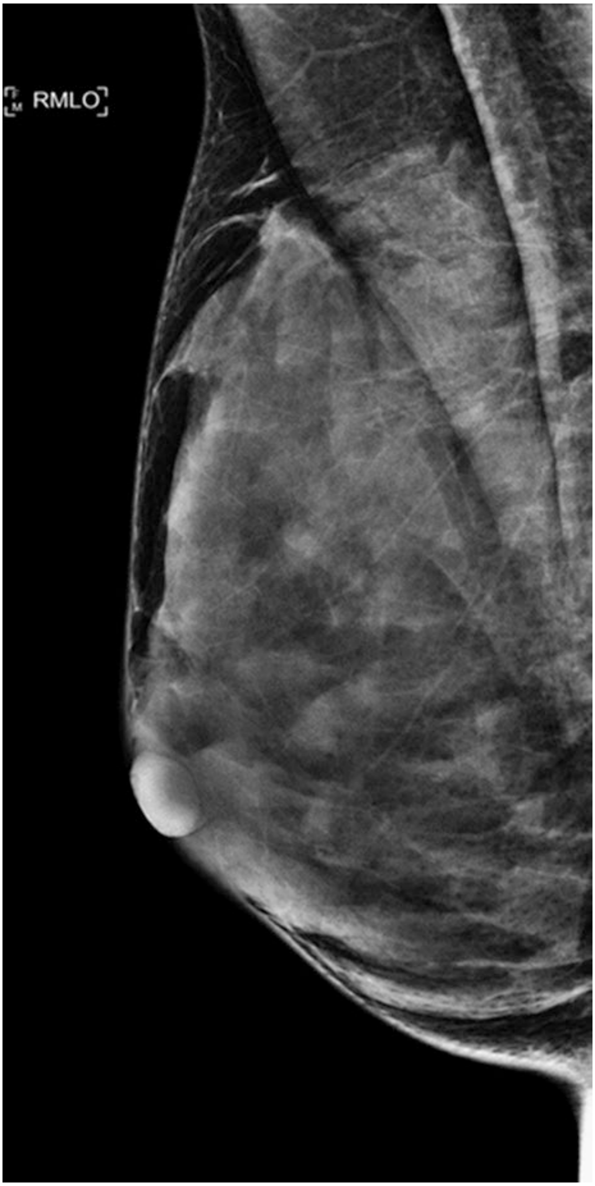


Fig. 3.4 BIRADS breast density. Category D: The breasts are extremely dense, which lowers the sensitivity of mammography

of 96% [7]. However, ultrasound still lacks the sensitivity of breast MRI as it can often fail to detect ductal carcinoma in situ.

Breast MRI alone has a sensitivity of 91%, specificity of 88%, and a negative predictive value of 99% [8]. Unlike mammography, breast MRI is not limited by breast density. MRI has been shown to identify additional foci of disease that would not have been detected with conventional mammography and breast ultrasound imaging [9]. It can also be helpful in further characterizing the extent of disease (multifocality, multicentricity, and bilaterality). In a study by Hata et al. [10], MRI was shown to detect intraductal spread of tumor more accurately than mammography or ultrasound. Tsina and Simon conducted a retrospective study of breast MRI and its impact on surgical treatment of breast cancer by evaluation of preoperative breast MRI in 833 patients [11]. In 18% of their studied patients, breast MRI detected more disease than was initially diagnosed. There was no increase in mastectomies as a result and reoperations were decreased. Neoadjuvant chemotherapy was also used more often as a result of the additional disease detected by Breast MRI [11]. In a study by Hicks et al. [2], MRI was shown to more closely correlate with the final histological size compared to mammography in the assessment of invasive carcinoma. Garcia-Lallana et al. [12] found in a retrospective study that OPS and neoadjuvant chemotherapy were used more frequently when breast MRI was used for preoperative staging. Also, the mastectomy rate decreased, and the number of re-excisions for positive margins did not increase [12]. Using MRI for staging can change the therapeutic management in patients with breast cancer. Breast MRI is helpful in determining the extent of ipsilateral breast cancer and in detecting contralateral disease. Contralateral breast cancer has been found by MRI in 3–7% of patients evaluated in the literature.

A right MLO view mammogram (Fig. 3.5a) shows Category d breast tissue (extremely dense). Palpable cyst identified on the corresponding ultrasound (Fig. 3.5b) cannot be distinguished on the mammogram due to extreme breast density. The mammogram is decreased in sensitivity for cancer detection in this patient.

Pre-planning Surgical Technique and Imaging

Preoperative planning of women suitable to oncoplastic techniques consists of breast size determination, evaluation of tumor location and tumor size, and careful thought about how the breast will be reconstituted in terms of its shape [2]. Removal of large breast tumors with oncoplastic resection can yield satisfactory cosmetic outcomes. A determination between the ratio of tumor volume and breast volume is essential prior to resection.

A palpable lump in the upper outer quadrant of the left breast is noted by a triangle on the left CC (Fig. 3.6a) and Left MLO (Fig. 3.6b) mammogram and corresponds to an irregular, high density mass with spiculated margins. A corresponding ultrasound (Fig. 3.6c) shows an irregular, hypoechoic mass with angular margins and posterior acoustic shadowing. These findings are consistent with a pathological diagnosis of invasive ductal carcinoma of the left breast.

The mammogram and ultrasound are helpful in showing the distance of the mass from the nipple and chest wall. This information will help guide the decision for the oncoplastic approach. The mass in this case is located at 2 o'clock in the upper outer

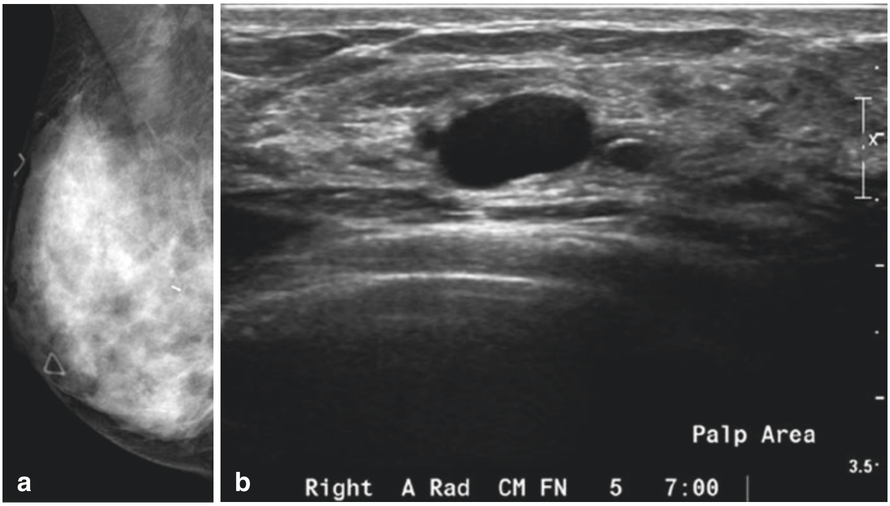


Fig. 3.5 (**a**) Right MLO view mammogram. (**b**) Right targeted breast ultrasound

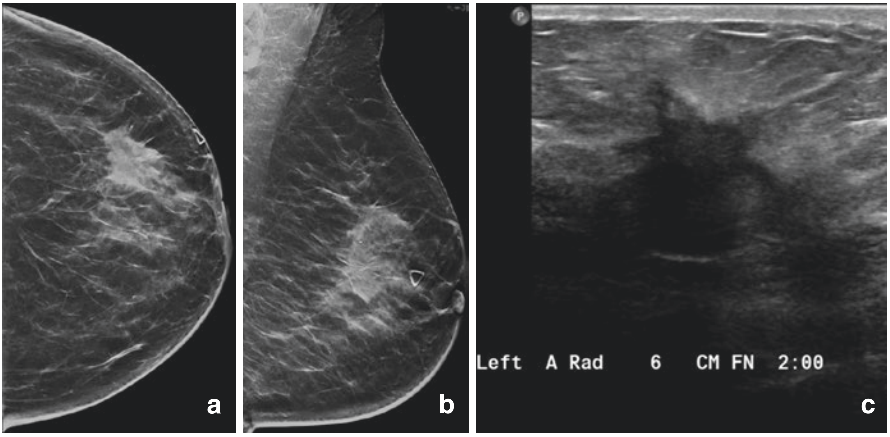


Fig. 3.6 Mammogram. (**a**) Left CC view. (**b**) Left MLO view. (**c**) Targeted left breast ultrasound

quadrant of the left breast 6 cm from the nipple areolar complex (NAC). The best oncoplastic approach in this case would be a level I volume resection lateral to the NAC. This approach should be adequate to achieve clear margins.

Simple undermining of the breast tissue to assure coverage over the pectoralis fascia should prevent deformity. This is paramount to achieving a nice contour of the breast in this location. Marking of the cavity with clips or tissue markers should be considered in planning for postsurgical radiation.

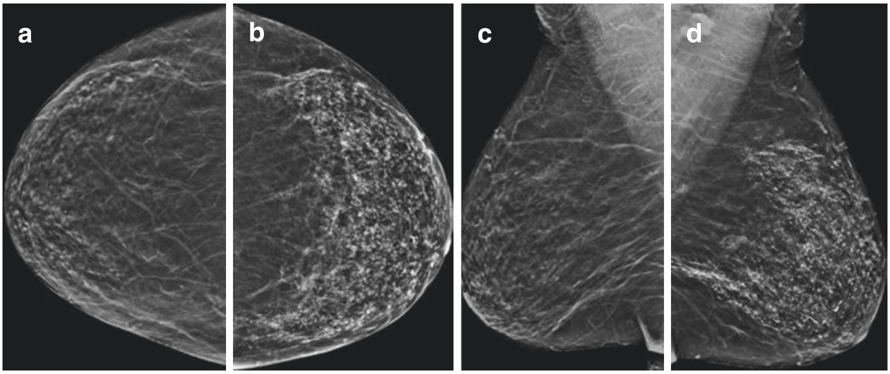


Fig. 3.7 Mammogram. (**a**) Right CC view. (**b**) Left CC view. (**c**) Right MLO view. (**d**) Left MLO view

CC and MLO views of the left and right breasts (Fig. 3.7a–d) show unilateral diffuse pleomorphic microcalcifications involving the entire left breast (Fig. 3.7b, d). Pathology revealed extensive high-grade ductal carcinoma in situ with comedonecrosis. A small irregular, equal density mass with non-circumscribed margins was also noted in the left breast at approximately 9 o'clock at posterior depth and proved to be an invasive ductal carcinoma.

The mammogram shows the DCIS in the left breast to be extensive (Fig. 3.7b, d). Microcalcifications extend from the nipple to the posterior left breast and involve all quadrants. Knowing the extent of this DCIS and invasive ductal carcinoma are crucial to the surgical approach and management in this case. Based on current recommendations for extensive DCIS involving the entire breast with extension to the nipple, mastectomy with or without reconstruction would be this patient's best option. Nipple sparing would not be an appropriate option on the left, but the patient will have the option for nipple reconstruction, 3D tattooing, or a nipple prosthesis.

No definite abnormality is noted within the contralateral right breast on mammography. However, given the extent of left breast disease, an MRI would be of value to exclude noncalcified DCIS within the right breast. The information obtained from MRI will help further direct surgical discussion and assist with shared decision making. The patient may opt for a contralateral mastectomy for symmetry.

While there are many benefits to obtaining a presurgical breast MRI in a newly diagnosed breast cancer patient, an enhancing finding that does not prove to be cancer is always a possibility. A false positive area of enhancement on MRI may lead to heightened anxiety and additional surgery and should be discussed with the patient.

MLO and CC mammogram views of the right and left breasts (Fig. 3.8a–d) show segmental fine linear branching microcalcifications in the upper outer quadrant of the left breast (Fig. 3.8b, d). Pathology from a left breast stereotactic core biopsy revealed high-grade ductal carcinoma in situ with comedonecrosis.

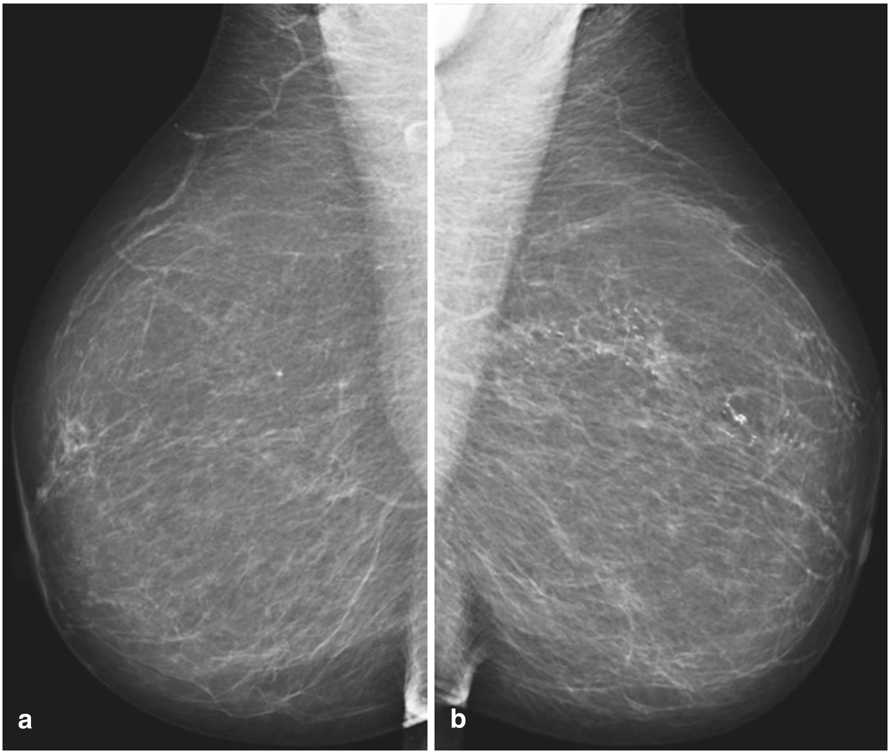


Fig. 3.8 Mammogram. (**a**) Right MLO view. (**b**) Left MLO view. (**c**) Right CC view. (**d**) Left CC view

This mammogram (Fig. 3.8a–d) shows category B breast density (scattered fibroglandular densities). Segmental malignant calcifications are noted to extend from the axillary left chest wall to the nipple in the upper outer quadrant of the left breast (Fig. 3.8b, d). The segmental pattern of the malignant calcifications in this case would require a level II oncoplastic resection or quadrantectomy. The options for resection require extensive mobilization with reduction of the skin envelope. The techniques to consider in this case are a lateral hemi-batwing [13] or lateral racquet mammoplasty [1]. Bracketed needle localization could be utilized to help with this resection.

An axial fat suppressed T1-weighted post-contrast breast MRI image (Fig. 3.9a) and an axial maximum intensity projection (MIP) image (Fig. 3.9b) show a unifocal, round, homogeneously enhancing mass in the left breast at approximately 12:00 which is a pathology proven invasive ductal carcinoma.

MRI is helpful in the surgical management of this case in that it shows a clear fat plane between the unifocal mass and the left pectoralis muscle. With imaging, the distance of the mass from the nipple can be measured. This MRI also shows that there is no multifocal or multicentric disease in the ipsilateral breast. No suspicious

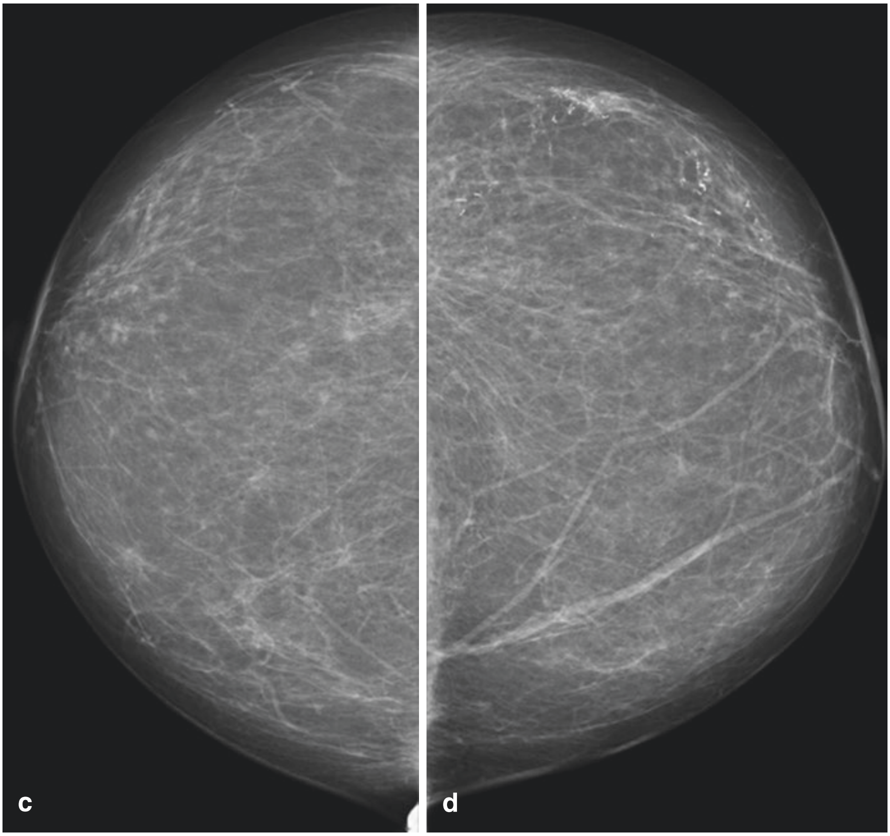


Fig. 3.8 (continued)

enhancement is noted in the contralateral breast. The options for oncoplastic reconstruction in this patient are a level I or a level II resection. This patient requested a reduction with symmetry surgery. With the tumor located at the 12:00 axis, an inferior pedicle mammoplasty was chosen which allowed resection of the tumor in the upper pole with adequate margins. Reduction of the breast, and mirror image symmetry surgery in the contralateral breast were also performed.

An axial fat suppressed T1-weighted post-contrast breast MRI (Fig. 3.10a) with an accompanying maximum intensity projection subtraction image (Fig. 3.10b) showing two separate rim enhancing masses in the same quadrant of the left breast (multifocal disease).

Breast MRI in this case alerts the surgeon that there is multifocal disease so an appropriate surgical margin can be obtained. The additional enhancing mass can be biopsied by MRI guidance. A biopsy marker clip will be placed during the biopsy. The masses can be localized by intraoperative ultrasound if hematomas are present

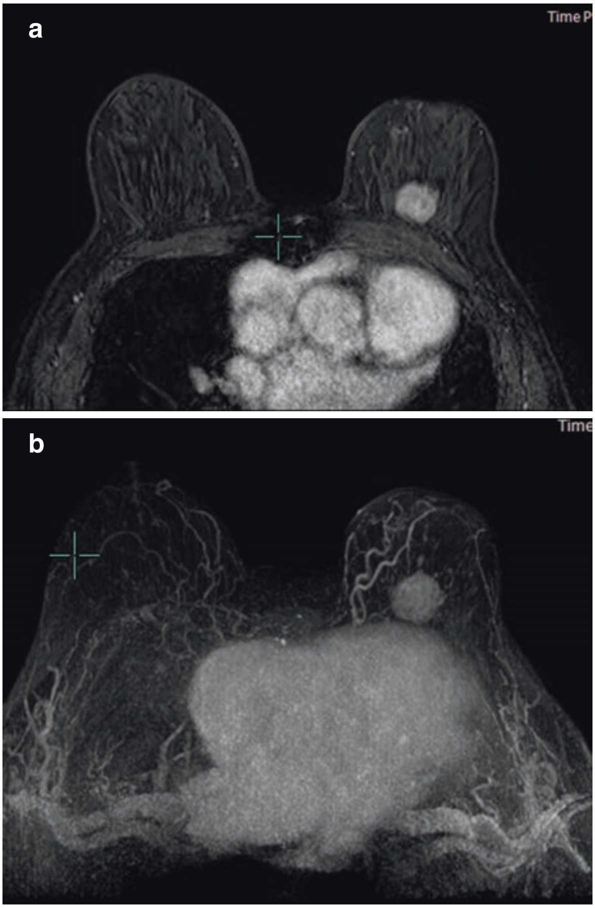


Fig. 3.9 (**a**) Axial fat suppressed T1-weighted post-contrast breast MRI. (**b**) Axial post-contrast maximum intensity projection breast MRI

from the core biopsies at the time of surgery, or the biopsy marker clips can be localized by needle localization to guide the surgical approach.

Left CC mammogram from a case (Fig. 3.11) showing localization of two biopsy marker clips from core biopsies using needles and wires.

MLO and CC mammographic views of the left breast (Fig. 3.12a, b) were obtained. A triangle denotes a palpable abnormality in the upper outer quadrant of the left breast corresponding to a round, equal density, mass with obscured margins, and pleomorphic microcalcifications. Targeted US (Fig. 3.12c) over the upper outer quadrant of the left breast reveals a round, hypoechoic mass with angular margins. Pathology revealed an invasive ductal carcinoma with associated ductal carcinoma in situ.

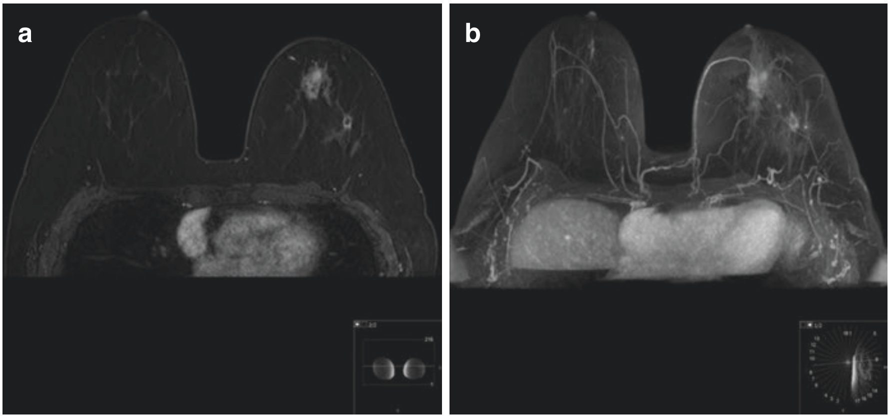


Fig. 3.10 (**a**) Axial fat suppressed T1-weighted post-contrast breast MRI. (**b**) Axial post-contrast maximum intensity projection breast MRI

Imaging by mammography and ultrasound in this case are very helpful for surgical management. Not only is a solid round hypoechoic mass present with angular margins denoting an invasive carcinoma, but also there are extensive associated microcalcifications signifying extensive ductal carcinoma in situ involving the entire upper outer quadrant of the left breast. This alerts the surgeon that a large level II resection will be necessary to achieve clear margins as well as possible bracketing of the calcifications using mammography needle localization. Confirmation of removal of the entire lesion can be evaluated intraoperatively with imaging.

Left CC mammogram of another case (Fig. 3.13a) showing a bracketed needle localization of microcalcifications in the central breast. The central calcifications constitute greater than 20% of the left breast volume in the 11:00 axis. A round block technique should be considered. This will allow for removal of skin, removal of tissue down to the chest wall, and rearrangement of tissue to create an appropriate breast mound. If there is a size discrepancy of the right breast after removal of the left breast microcalcifications, symmetry surgery could be performed.

Surgical specimen radiograph (Fig. 3.13b) showing the bracketed microcalcifications in the surgical specimen.

MLO and CC mammographic views of the right breast (Fig. 3.14a, b) show a focal asymmetry, trabecular parenchymal thickening, and skin thickening with adenopathy. The patient in this case desired breast conservation.

MRI was obtained to characterize the extent of disease. Axial fat suppressed T1-weighted post-contrast MRI images (Fig. 3.14c, d) show adenopathy, regional non-mass enhancement, and skin thickening of the right breast. Pathology revealed invasive ductal carcinoma with metastatic nodal involvement and involvement of the skin.

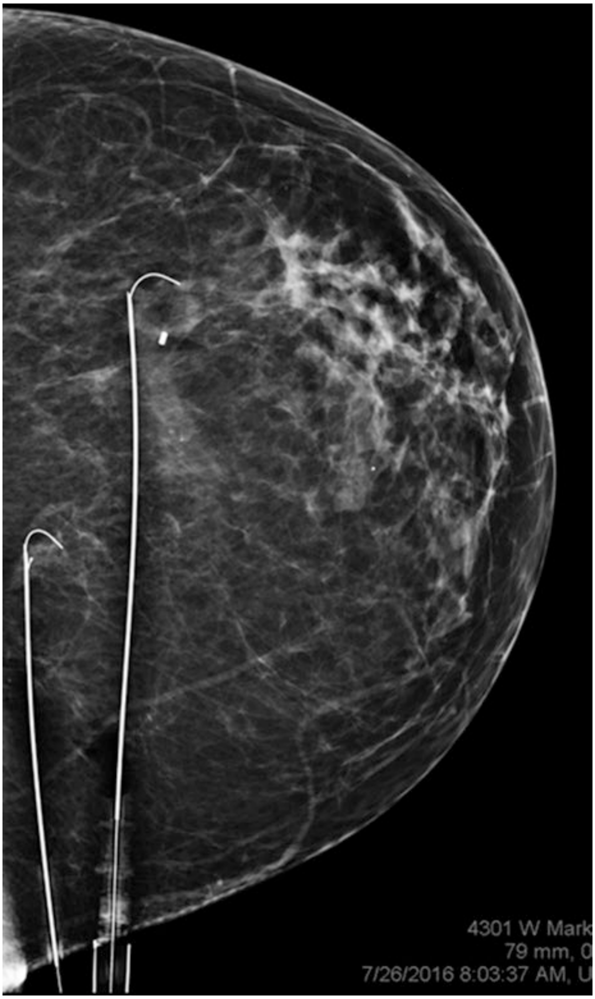


Fig. 3.11 Left CC view mammogram

The extensive right breast disease precluded her from breast conserving surgery. With her history of smoking, mastectomy with immediate tissue expander reconstruction was not an option. She underwent unilateral mastectomy with plans for delayed reconstruction and symmetry surgery after smoking cessation.

CC and MLO mammographic views of the right and left breasts (Fig. 3.15a–d) with Digital Breast Tomosynthesis show category D breast density. The breasts are extremely dense, which lowers the sensitivity of mammography.

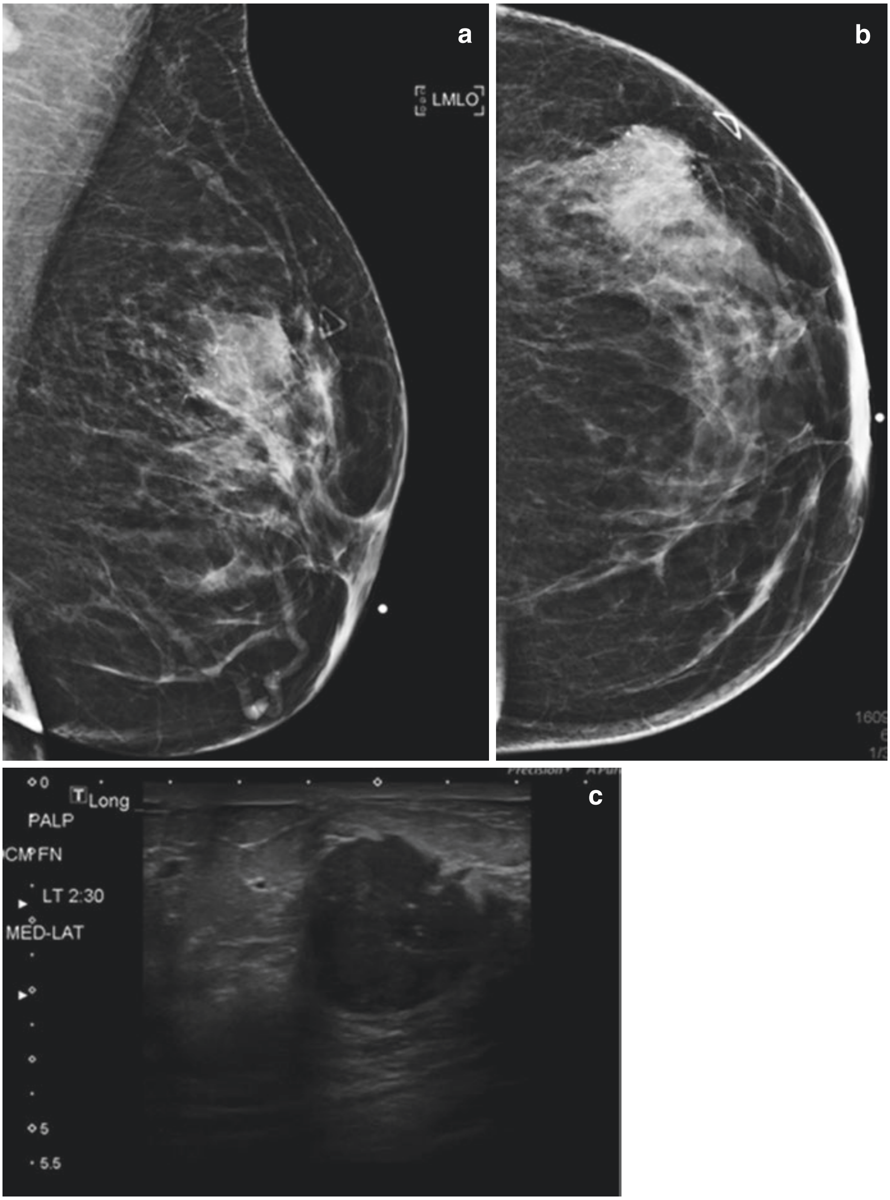


Fig. 3.12 Mammogram. (**a**) Left MLO view. (**b**) Left CC view. (**c**) Targeted left breast ultrasound

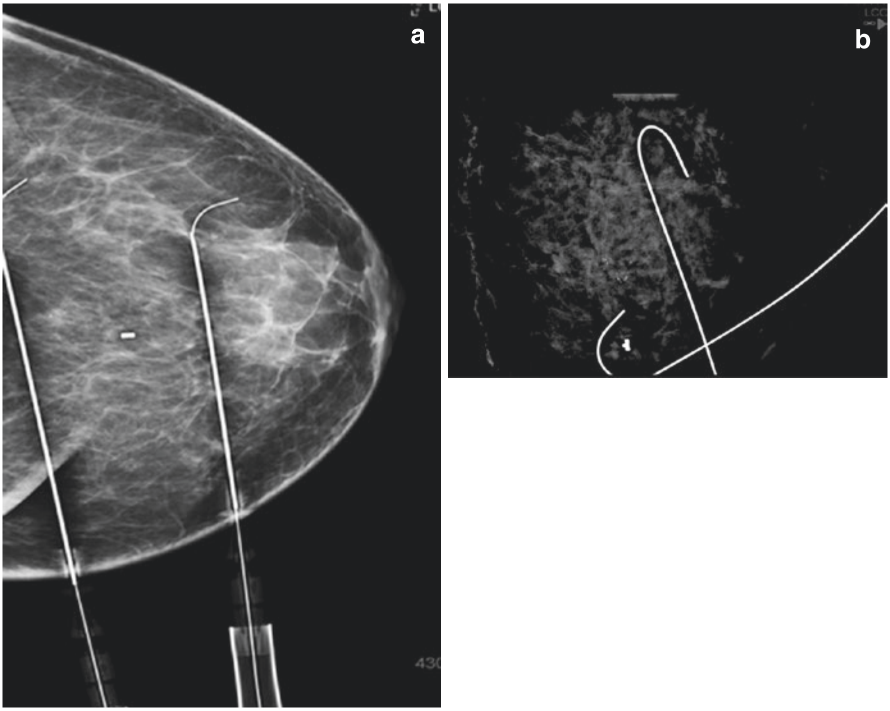


Fig. 3.13 (**a**) Left CC view mammogram. (**b**) Surgical specimen radiograph

Mammography shows an area of architectural distortion in the right breast along the posterior nipple line and corresponds to the patient's palpable lump which is noted by a triangle (Fig. 3.15a, c). This area of distortion was biopsied and revealed an invasive ductal carcinoma. No abnormality is seen in the left breast on mammography (Fig. 3.15b, d).

A preoperative breast MRI was obtained due to the patient's extreme breast density and desire for breast conservation (Fig. 3.15e–i). The MRI (Fig. 3.15e–i) shows the biopsy proven invasive carcinoma in the right breast noted on mammography and ultrasound. MRI also showed an extensive area of segmental non-mass enhancement in the left breast which was invasive ductal carcinoma with associated ductal carcinoma in situ. The left breast cancer is obscured on the mammogram (Fig. 3.15b, d) due to the increased breast density. Without breast MRI as an imaging tool in this case, the extensive invasive cancer in the left breast would not have been detected prior to surgery.

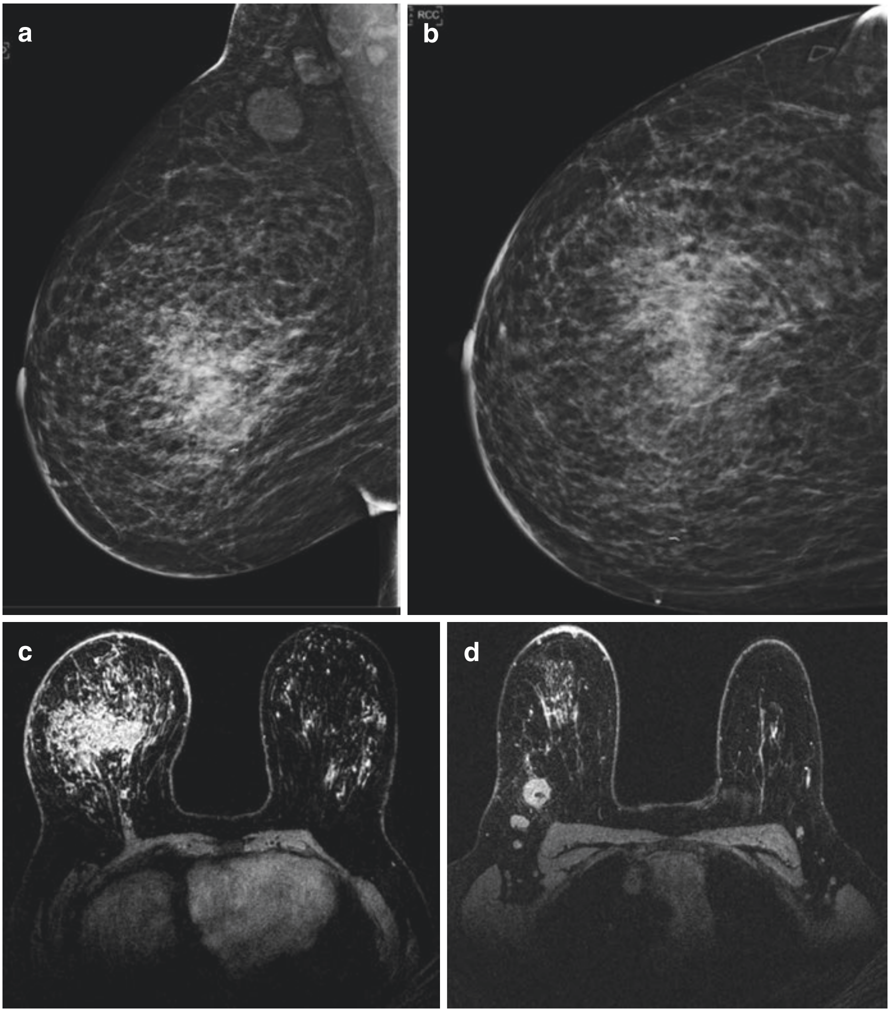


Fig. 3.14 Mammogram. (**a**) Right MLO view. (**b**) Right CC view. (**c**, **d**) Axial fat suppressed T1-weighted post-contrast breast MRI images

Axial fat suppressed post-contrast subtraction MRI images (Fig. 3.15f, g), an axial fat suppressed 3D maximum intensity projection MRI image (Fig. 3.15e), and sagittal fat suppressed T1-weighted post-contrast breast MRI images (Fig. 3.15h, i) show an irregular heterogeneous enhancing mass with spiculated margins in the right breast (Fig. 3.15h), a pathology proven invasive ductal carcinoma. Extensive segmental non-mass enhancement is noted within the upper outer left breast

(Fig. 3.15i) which is pathology proven invasive ductal carcinoma with associated ductal carcinoma in situ.

A level I oncoplastic procedure was initially planned for the right breast in this patient. However, given the extensive contralateral disease discovered by MRI in the left breast (Fig. 3.15i), bilateral total skin sparing mastectomies with immediate reconstruction was performed. Anterior biopsies of the left breast skin were taken secondary to enhancement noted close to the skin surface on breast MRI.

Surgical Complications and Solutions

Oncoplastic surgery has many advantages. One of the major advantages is preventing breast deformity without the need for secondary reconstructions [14]. Postoperative repair is difficult in an irradiated breast. Immediate volume reshaping

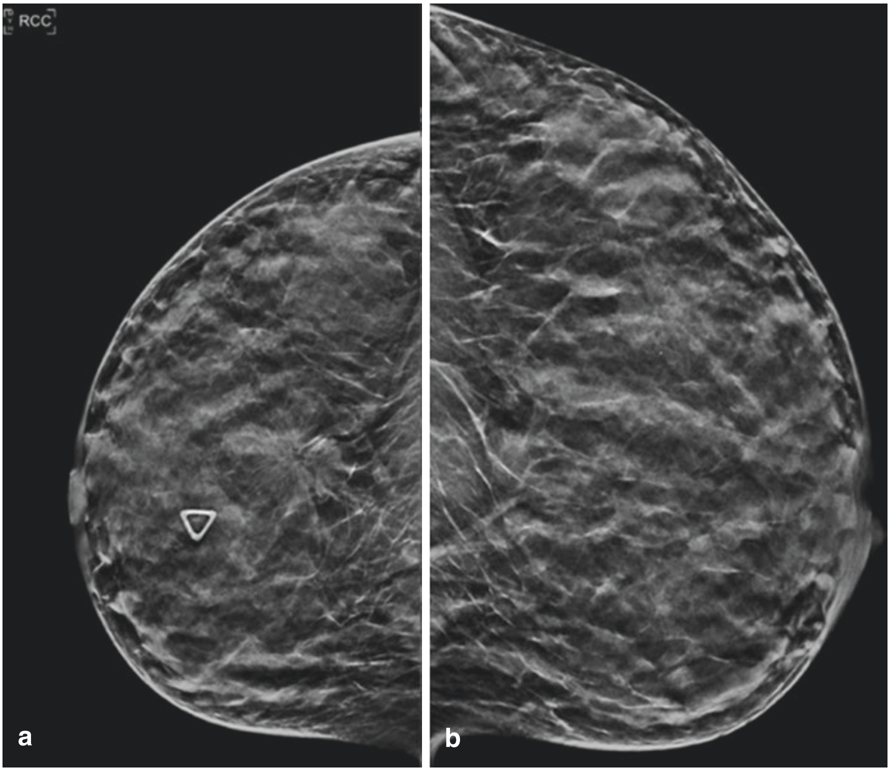


Fig. 3.15 (**a**) Right CC view. (**b**) Left CC view. (**c**) Right MLO view. (**d**) Left MLO view. (**e**–**g**) Axial post-contrast breast MRI. (**e**) Maximum intensity projection MRI. (**f**, **g**) Axial fat suppressed T1 post-contrast. (**h**, **i**) Sagittal post-contrast MRI. (**h**) Right breast. (**i**) Left breast

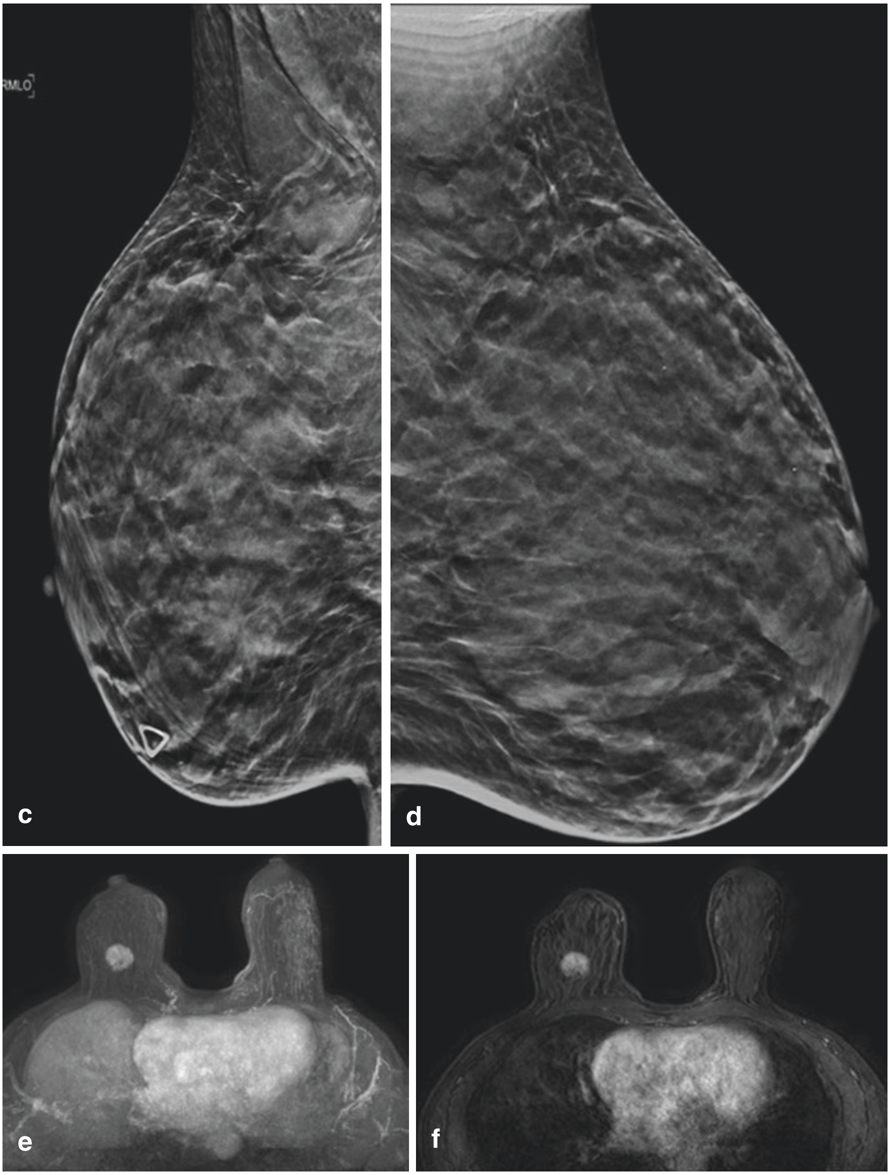


Fig. 3.15 (continued)

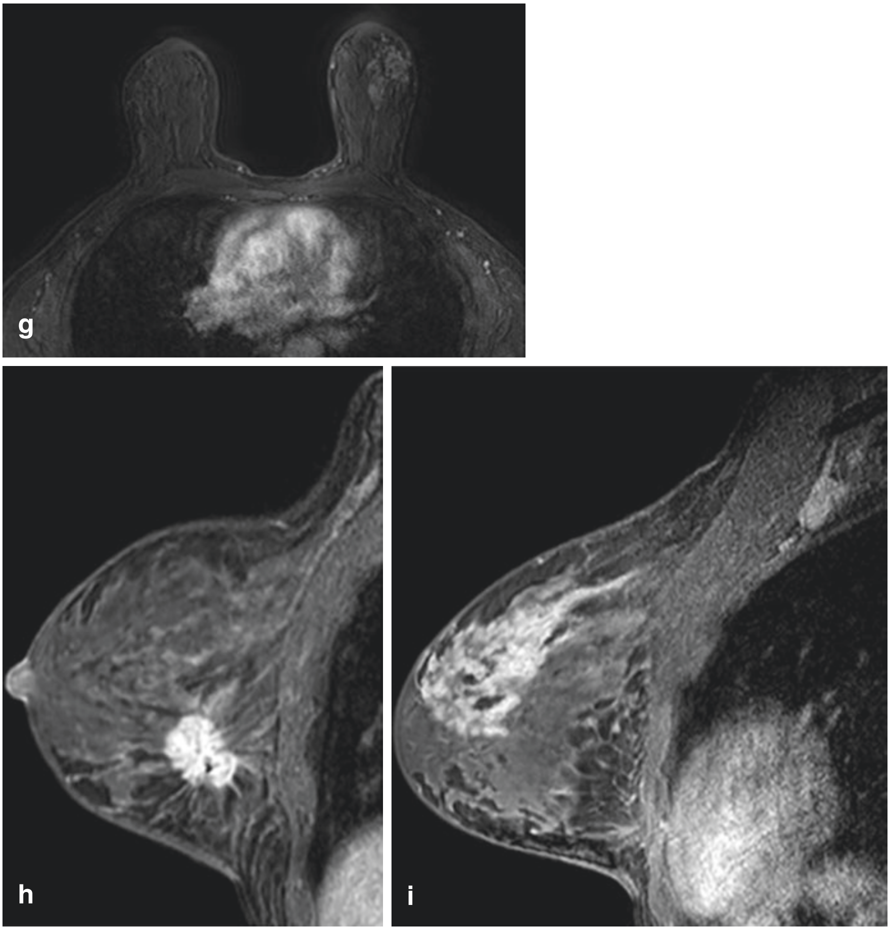


Fig. 3.15 (continued)

yields a better outcome. While there are significant advantages of oncoplastic immediate postsurgical reshaping of the breast, there are associated risks and complications following these procedures. Fat necrosis is one of the most important issues to consider and is of more risk in those patients with BIRADS category A fatty breasts. Extensive fat necrosis can cause a delay in wound healing [1]. As in any surgery, there is always a risk of bleeding, infection, seromas, and hematomas. At our institution, the major difference in performing oncoplastic procedures versus standard lumpectomy is the increase in operative time. Other authors have reported this increased operative time as well. In the analysis of the NSQIP database which included 75,972 patients who underwent BCS for breast cancer, no significant increase in complications were noted compared to standard lumpectomy techniques other than longer operative times [16]. As discussed earlier, understanding the relationship between breast density, extent of disease, and volume of resection by imaging is a necessity as we continue to improve breast surgical outcomes in breast cancer patients.

Results

Over the past 10 years, the utilization of oncoplastic techniques to improve standard breast surgical outcomes has increased. The incorporation of evolving breast imaging tools with OPS has improved decision making. More extensive preoperative planning utilizing imaging has lead to better outcomes. In a meta-analysis comparing breast conservation therapy alone to oncoplastic technique by Losken et al. [15], the larger resections with OPS had lower positive margin rates with subsequent less re-excisions. The local recurrence rate was also lower at 4% in the oncoplastic group compared to 7% in the breast conservation alone group. Most importantly, patient satisfaction was significantly higher in the oncoplastic group. This finding demonstrates the need to not only focus on the oncologic component of breast care but to also take into account the cosmetic and quality issues that may be associated with breast cancer surgery.

Conclusion

The development of oncoplastic techniques has created more options for the patient. Mastectomy and segmental excision are no longer the only two options. The integration of plastic surgery techniques now allows surgeons to resect more than 20% of the breast volume without a negative cosmetic result [1]. This integrative process also eliminates the need for secondary reconstruction which prevents an additional surgery and avoids the complications of postoperative repair in an irradiated breast [1].

Preoperative planning with collaborative discussion between the surgeon and radiologist will allow the surgeon to estimate surgical resection volumes as well as prepare and plan for possible intraoperative needs. This preparation will allow for the best outcomes and help in the prevention of postoperative breast deformities. Specifically, knowing if the disease extends across segments and follows the ductal anatomy of the breast, if the disease extends to the nipple in a radial fashion, or if the disease extends peripherally in the breast to occupy a large portion of a breast quadrant aids in planning a technique that will yield the best outcome [17]. Very careful surgical planning is required to balance the oncological needs with the aesthetic desires of the patient [17].

Suggested Readings

1. Clough KB, Kaufman GJ, Nos C, Buccimazza I, Sarfati IM. Improving breast cancer surgery: a classification and quadrant per quadrant atlas for oncoplastic surgery. Ann Surg Oncol. 2010;17(5):1375–91.

2. Hicks G, Turton P, Rajan S, Nunn A, Sharma N, Achuthan R. The role of magnetic resonance imaging in preoperative planning for patients undergoing therapeutic mammoplasty. ISRN Oncol. 2013;2013:260260.
3. D'Orsi CJ, Sickles EA, Mendelson EB, Morris EA, et al. ACR BI-RADS atlas, breast imaging reporting and data system. Reston: American College of Radiology; 2013.
4. Mandelson MT, Oestreicher N, Porter P, White D, Finder CA, Taplin SH, White E. Breast density as a predictor of mammographic detection: comparison of interval and screen detected cancers. JNCI. 2000;92(13):1081–7.
5. Banks E, Reeves G, Beral V, Bull D, et al. Influence of personal characteristics of individual women on sensitivity and specificity of mammography in the Million Women Study; cohort study. BMJ. 2004;329(7464):477.
6. Friedewald SM, Rafferty EA, Rose SL, Durand MA, et al. Breast cancer screening using tomosynthesis in combination with digital mammography. JAMA. 2014;311:2499–507.
7. Tejerina BT, Antonio DR, Francisco GA d L. Breast imaging: how we manage diagnostic technology atmultidis. J Oncol. 2012;2012:213421.
8. Lehman CD, Gatsonis C, Kuhl CK, et al. MRI evaluation of the contralateral breast in women with recently diagnosed breast cancer. N Engl J Med. 2007;356(13):1295–303.
9. Houssami N, Ciatto S, Macaskill P, et al. Accuracy and surgical impact of magnetic resonance imaging in breast cancer staging: systematic review and meta-analysis in detection of multifocal and multicentric cancer. J Clin Oncol. 2008;26(19):3248–58.
10. Hata T, Takahashi H, Watanabe K, et al. Magnetic resonance imaging for preoperative evaluation of breast cancer: a comparative study with mammography and ultrasonography. J Am Coll Surg. 2004;198(2):190–7.
11. Tsina G, Simon P. Breast magnetic resonance imaging and its impact on the surgical treatment of breast cancer. Obstet Gynecol Int. 2014;2014:632074, 5 pages.
12. Garcia-Lallana A, Anton I, Saiz-Mendiguren R, et al. Using magnetic resonance imaging for staging can change the therapeutic management in patients with breast cancer. Radiologia. 2012;54(4):350–6.
13. Sliverstein M, Mai T, Savalia N, et al. Oncoplastic breast conservation surgery: the new paradigm. J Surg Oncol. 2014;110(1):82–9.
14. Dewar JA, Benhamou E, Arrigada R, et al. Cosmetic results following lumpectomy, axillary dissection and radiotherapy for small breast cancer. Radiother Oncol. 1998;12(4):273–80.
15. Losken A, Dugal CS, Styblo TM, Carlson GW. A met-analysis comparing breast conservation therapy alone to the oncoplastic technique. Ann Plast Surg. 2014;72(2):145–9.
16. Cil TD, Cordeiro E. Complications of oncoplastic breast surgery involving soft tissue transfer versus breast-conserving surgery: an analysis of the NSQIP database. Ann Surg Oncol. 2016;23(10):3266–71.
17. Anderson BO, Masetti R, Silverstein M. Oncoplastic approaches to partial mastectomy: an overview of volume-displacement techniques. Lancet Oncol. 2005;6(3):145–57.
18. Sardanelli F, Boetes C, Borisch B, Decker T, Federico M, et al. Magnetic resonance imaging of the breast: recommendations from the EUSOMA working group. Eur J Cancer. 2010;46(8):1296–316.
19. American College of Radiology (ACR). ACR practice guideline for the performance of contrast-enhanced magnetic resonance imaging (MRI) of the breast. 2008. http://www.acr.org/.
20. Saslow D, Boetes C, Burke W, et al. American Cancer Society guidelines for breast screening with MRI as an adjunct to mammography. CA Cancer J Clin. 2007;57(2):75–89.
21. Morrow M, Waters J, Morris E. MRI for breast cancer screening, diagnosis, and treatment. Lancet. 2011;378(9805):1804–11.
22. Esserman LJ, Hylton N, Yassa L, Barclay J, Frankel S, Sickles E. Utility of magnetic resonance imaging in the management of breast cancer: evidence for improved preoperative staging. J Clin Oncol. 1999;17(1):1110–9.
23. Boetes C, Mus RDM, Holland R, et al. Breast tumors: comparative accuracy of MR imaging relative to mammography and US for demonstrating extent. Radiology. 1995;197(3):743–7.

24. Painter TJ, Dipasco PJ, Misra S, Avisar E. Effect of magnetic resonance imaging on breast conservation therapy versus mastectomy: a review of the literature. Int J Surg Oncol. 2011;2011:428653, 6 pages.
25. Turnbull L, Brown S, Harvey I, et al. Comparative effectiveness of MRI in breast cancer (COMICE) trial; a randomized controlled trial. Lancet. 2010;375(9714):563–71.
26. Marcotte-Bloch C, Balu-Maestro C, Chamorey E, et al. MRI for the size assessment of pure ductal carcinoma in situ (DCIS): a prospective study of 33 patients. Eur J Radiol. 2011;77(3):462–7.
27. Smith RA. The evolving role of MRI in the detection and evaluation of breast cancer. N Engl J Med. 2007;356(13):1362–4.
28. Perono BC, Davide B, Franco G, Eugenio Z, Marco C, Francesco D. Breast cancer preoperative staging: does contrast-enhanced magnetic resonance mammography modify surgery*?* Int J Breast Cancer. 2011;2011:757234.
29. Pediconi F, Miglio E, Telesca M, et al. Effect of preoperative breast magnetic resonance imaging on surgical decision making and cancer recurrence rates. Investig Radiol. 2012;47(2):128–35.
30. Grady I, Gorsuch-Rafferty H, Hadley P. Preoperative staging with magnetic resonance imaging, with confirmatory biopsy, improves surgical outcomes in women with breast cancer without increasing rates of mastectomy. Breast J. 2012;18(3):214–8.
31. Liu Q, Ye JM, Xu L, Duan XN, Zhao JX, Liu YH. Correlation between dynamic contrast-enhanced MRI and hystopathology in the measurement of tumor and breast volume and their ratio in breast cancer patients: a prospective study. Chin Med J. 2012;125(21):3856–60.

4 Measurement and Optimizing Cosmetic Outcomes for Breast Excisions/Factors Influencing Aesthetic Outcomes of Breast Conservation Surgery

Joerg Heil, Fabian Riedel, Michael Golatta, and André Hennigs

Oncological Outcome of Breast Conservation Surgery

Oncological safety is the priority outcome parameter in breast cancer surgery and is measured with standardized parameters which relate to events of survival or tumor relapse after treatment. In the context of primary breast cancer today with overall survival (OS) and relative (age-adjusted) overall survival (ROS) rates of more than 90% over a 5-year period in unselected cohorts [1], the usage of surrogate end points for OS, such as (distant-) disease-free survival, is increasingly common, especially in randomized trials, but also in cancer registry outcome analyses [1]. These parameters allow the reasonable comparison between different treatment approaches in an oncological setting.

Breast conservation surgery (BCS) is nowadays the standard surgical procedure for primary breast cancer and fits to most individual situations in breast cancer surgery [2]. Nowadays only a minority of patients need mastectomy. The behind question of adequate oncological safety of a breast-conserving approach has been solved long time ago since the important studies of Fisher et al. [3, 4] and Veronesi et al. [5, 6] more than 25 years ago. Based on their results, BCS has been established as the standard for most patients with primary breast cancer because it can assure equivalent oncological safety in comparison to mastectomy. Before these paradigm-changing studies were published, the decision to perform a mastectomy has been based first on the comprehensible belief that radical surgical approach of the breast (i.e., modified radical mastectomy, MRM) decreases LRR rates compared with BCT and second leads to the reduction of annual follow-up

J. Heil (✉) · F. Riedel · M. Golatta · A. Hennigs
University Hospital Heidelberg, Department of Obstetrics and Gynecology, Heidelberg, Germany
e-mail: Joerg.Heil@med.uni-heidelberg.de; Fabian.Riedel@med.uni-heidelberg.de; Michael.Golatta@med.uni-heidelberg.de; Andre.Hennigs@med.uni-heidelberg.de

V. S. Klimberg et al. (eds.), *Oncoplastic Breast Surgery Techniques for the General Surgeon*, https://doi.org/10.1007/978-3-030-40196-2_4

mammograms and potential recall for further diagnostic and treatment. Breast-conserving treatment consists of breast conservation surgery (lumpectomy, partial mastectomy) in combination with whole breast radiotherapy and implies the intention to achieve long-term local disease control with minimum local morbidity, i.e., a good cosmetic outcome limited side effects of treatment in most cases. A meta-analysis of 10-year survival in seven randomized trials showed equivalence in terms of overall outcome for BCS and mastectomy [7]. It became evident that BCS involved some risk of loco-regional recurrence (LRR) in the remaining tissue, but no significant differences in OS at 10 years [8], confirming these results in a follow-up of 20 years [9, 10]. All studies showed that women with early breast cancer, who were treated with BCS and postoperative radiotherapy to the ipsilateral breast, had higher rates of local recurrence but similar long-term survival when compared with those undergoing mastectomies. Nevertheless, local control is important and has an impact on overall survival, i.e., local recurrence has been estimated as a risk factor for the development of metastatic disease [11]. Higher risk of loco-regional recurrence is associated with higher risk of distant disease and subsequent risk of breast cancer-related death. This estimate may vary substantially with the type of cancers, age at diagnosis, application, and duration of systemic treatments. To limit the negative effect on overall survival through local recurrence, it is generally accepted that for early breast cancer, LRR rates should be within the limit of 1% per year or within 10% at 10 years [12]. Exemplarily for the EORTC 10801 data, initial LRR rates between BCT and mastectomy were 20% after BCT and 12% after mastectomy (but no significant difference was identified in long-term OS, i.e., 44% in the BCS group and 39% in the modified radical mastectomy group) [13]. A longer follow-up of these patients after 20 years confirmed the equivalence in overall survival without having a focus on LRR because the event rate was very low [14].

In general, LRR rates following BCS have fallen over the last two decades as a result of better imaging and more attention to margins so that although local recurrence was considered more common after BCS than mastectomy, it is now almost on the same low level, even for aggressive subtypes like triple-negative breast cancer [15]. The convergence of LCR rates of BCS and mastectomy in recent years was also mainly caused by better systemic treatment options, which also resulted in improved distant disease-free survival [16]. In a large study with over 85,000 patients that were treated in trials with chemotherapy and endocrine therapy between 1990 and 2011, LRR decreased from 30% to 15% without any influence, whether treated with BCS or mastectomy. LRR is dependent particularly on the immunohistochemical subtype, as triple-negative type with the highest rates and hormone receptor-positive and HER2-negative type with the lowest rates of LRR [17]. In a representative routine cohort from a German Breast Care Unit with 70% of the patients treated with BCS, a low LRR rate of 3.9% over 5 years has been described [1]. In summary, the rates of breast cancer recurrence after BCS are nowadays similar to the rates of local recurrence seen after mastectomy. Only the subgroup of young women has disadvantages [18]. Especially this slightly higher risk of loco-regional recurrence after BCT in younger patients has to be mentioned and considered in the individual decision-making process with the patient when presenting BCT as a method that can be labeled as safe as mastectomy. The individual hierarchy of preferences that were exemplarily driven by the avoidance of re-surgery or radiation, aesthetic outcome, or fear of relapse might differ between patients, but they all have in common the need for individual und substantial counseling.

Challenges of Breast Conservation Surgery

The success of BCS in terms of preventing loco-regional recurrence equally to mastectomy seems to be related to the grade of surgical removal of the cancer. Involved margins are one of the most important predictors for LRR. Results of large meta-analyses suggest a twofold higher risk for LRR of patients with positive margins [19]. To obtain clear surgical margins (i.e., “no tumor on ink”), which is meant to minimize the risk of residual tumor in the breast, re-excision might be necessary. The aim of re-excision is to obtain negative margins and ideally to equalize the risk of LRR to the same level as for one-step BCS. The additional surgical procedure is performed under the assumption that the risk of LRR in patients with initial positive margin (R1) but negative margins (R0) after re-excision is comparable to patients with initial negative margins (R0). This is the rationale for recommending this second surgical procedure in multidisciplinary setting with breast surgeons, pathologist, and radiotherapists, aware that it implies a risk of a second anaesthesia, worse aesthetic outcome, psychological distress, and a potential delay in receipt of adjuvant therapy [20]. However, despite its relevance in everyday clinical practice, the precise impact of re-excisions on LRR rates is still unknown. Some studies describe re-excision or residual cancer in the re-excision specimen as predictors for a higher risk of LR than those without [21–23]. Previous studies have demonstrated an absence of residual cancer in up to 65–70% of re-excision specimens, which raises doubts about the benefit of this second surgical procedure for a considerable number of patients [24, 25]. In a study including over 2.500 patients, we could show that re-excision could not reduce the risk of LRR to the same level of a one-step BCS: patients not requiring re-excision surgery had a significantly higher 5-year LRR-free rate than those who underwent a re-excision (98.0% vs. 94.5%, $p < 0.005$) This result was confirmed by an additional multivariable analysis [25].

An effective method to render margin negative during the initial BCS is “cavity shaving”, shown in several retrospective and one prospective study [26]. There are no long-term follow-up results reassuring the influence of this technique on local control. Applying cavity shaving, the rate of positive margins after BCS as well as the need for a second surgical intervention could be halved. Different from what would be expected, negative margin status does not necessarily guarantee complete excision. In the aforementioned randomized-controlled trial, 12% of the patients with negative margins before cavity shaving had further cancer in the cavity shave margin specimen.

Impact of Primary Systemic Treatment on Breast Surgery

A growing molecular genetic understanding in the last decade provided a new view on breast cancer as a heterogeneous disease that can be classified into different intrinsic biological subtypes with miscellaneous clinical and pathological features and different therapeutic responsiveness patterns and outcome perspectives [27–30]. In this context neoadjuvant chemotherapy (NACT) started as a treatment option to enable or improve operability of inflammatory, locally advanced or large breast cancer tumors. After equivalence in survival was confirmed, both adjuvant chemotherapy (ACT) and NACT became the standard treatment options for operable disease. NACT, however, offers several unique benefits in comparison to ACT. It improves the rate of breast-conserving surgery, allows an in vivo testing for drug sensitivity, and provides important prognostic information due to the achieved tumor response (with the influence on further post-neoadjuvant treatment options). The achievement of a pathologic complete response (pCR) defined as no invasive tumor residue in the breast and axilla (ypT0 ypN0) following NACT is associated with improved disease-free and overall survival with the strongest correlation in aggressive breast cancer subtypes [31]. In recent years with the use of modern chemotherapy agents especially in the therapy of aggressive tumor subtypes, i.e., HER2-positive and triple-negative breast cancers, pCR can be achieved in almost 50% of the patients [32]. Several recent innovative study designs want to give an answer to the question, whether increasing rates of pCR will enable to select patients who do not need surgery at all after safe proof of pCR through vacuum biopsy after a neoadjuvant chemotherapy [33, 34]. To date the approach in BCS after NACT is to remove any suspicious clinical or radiologic findings without the necessity to remove the entire volume of tissue initially occupied by the tumor. Although a persistent finding of scattered, viable tumor is present throughout the resection specimen even it does not extend to the margin, a further re-excision should be considered. In addition NACT can downstage the axilla in about 40% of the patients with the potential to consider to decrease the morbidity of the arm and omitting axillary lymph node dissection [35].

Measurement of Aesthetic Outcome

The other important dimension of outcome analyses relates to the evaluation of quality of life patterns (or patient-related outcome patterns) that should be considered in the context of any oncological safety evaluation as well [36] because they reflect the patients' individual perception of treatment outcome sometimes better than abstract survival patterns [37]. These considerations about different definitions of oncological safety patterns lead to another challenge in the specific context of breast cancer surgery. Especially in the concrete evaluation of oncological safety patterns between specific breast-conserving, oncoplastic procedures, there is very little data on oncological outcome nor on patient-reported outcomes.

Breast-conserving therapeutic approaches to breast cancer aim to obtain, besides local tumor control and survival rates equivalent to mastectomy, better aesthetic results. While the oncological outcome of breast conservation procedures can be easily assessed, aesthetic outcome has yet no standard of evaluation. In BCS different incision patterns, tumor resection, and reconstructive techniques aim to improve the aesthetic outcome. To evaluate the differing surgical methods valid, reproducible and comparable aesthetic measurement tools are needed. Unfortunately, there is still no gold standard for the evaluation of the aesthetic outcome of BCS.

Generally, the evaluation of the aesthetic outcome of BCS can be divided into subjective and objective measuring tools. Subjective methods include patient's self-evaluation and third-party evaluation, i.e., nurse, surgeon, research assistant, or a panel of observers. Objective methods include several different types of quantifications. For both groups of methods, evaluation can be carried out on the patient or by means of photographs (prints, slides, or digital images). To evaluate the aesthetic outcome, commonly a comparison between both breasts is used.

The measurement of the aesthetic outcome should ideally include a baseline evaluation preoperatively before the postoperative assessment. Overall, the aesthetic outcome declines over time [38, 39]. Interestingly, in a study by Hennigs et al., the change of the aesthetic outcome is still measurable over 4 years after the surgical procedure with a subjective evaluation, whereas only 1 year with the objective method [38, 40].

Subjective and objective evaluations have to be differentiated:

Subjective Evaluation (Patient-Reported Outcome)

The self-evaluation or patient-reported outcome measurements evaluate the individual perception of the aesthetic outcome. However, its reproducibility is low because it depends somewhat on personal attitudes and expectations not amenable to quantifications. Patient-reported instruments to evaluate the aesthetic and functional outcomes after BCS range from single questions assessing an overall outcome [41] to questionnaires trying to differentiate between various aspects such as breast size and shape, scars, arm pain, and shoulder movement.

The Breast Cancer Treatment Outcome Scale (BCTOS) is a validated questionnaire with 12 questions summed up in the 2 subscales, the aesthetic and functional status [42]. Furthermore, the Breast-Q [43] is a comprehensive questionnaire which includes several scales to cover various domains of patient satisfaction and quality of life before with a breast-conserving therapy module [44].

Objective Evaluation

Objective evaluations are assumed to provide reproducible assessments of surgical but with only limited correlation to patient-reported outcomes [45, 46]. One of the best evaluated methods to obtain objective aesthetic results in BCT seems to be the

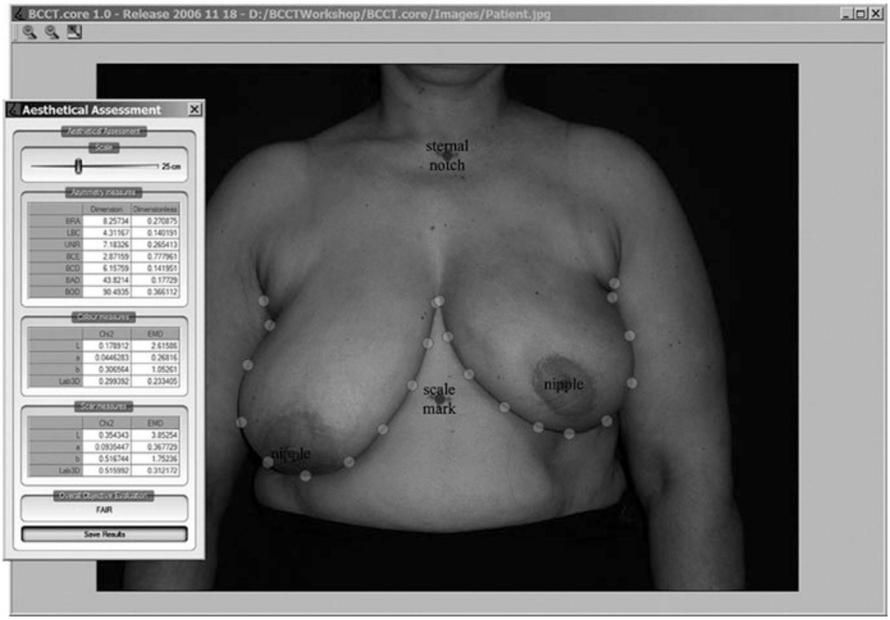


Fig. 4.1 Screenshot BCCT.core software [69]

BCCT.core software (see Fig. 4.1 for screenshot of the BCCT.core software). The BCCT.core software carries out an analysis of a standardized photo of predetermined points designated by the examiner (i.e., semiautomated), followed by an automated software calculation of different objective relations/asymmetries measures including breast volume, skin color, and scars. An overall aesthetic result is calculated by the software.

Factors Influencing Aesthetic Outcome

The primary goal of any "oncoplastic" breast-conserving surgery is to improve aesthetic outcome. Unfortunately, only limited systematic research has been performed. Better aesthetic results correlate with a higher quality of life. As mentioned before, the aesthetic outcome is difficult to measure with no consensus on a gold standard. In a study by Santos et al. better results for oncoplastic surgery in comparison to conventional BCS were measured with the BCCT.core software (22.8% vs. 6.2%, $p = 0.004$) and assessed by breast surgeons (50.9% vs. 18.05%, $p < 0.001$), although there was no difference in the patients' evaluation between these surgical techniques (61.4% vs. 69.2%, $p = 0.32$) [47].

The current literature findings are inhomogeneous with respect to influencing factors of aesthetic outcome. Besides the difference in study design, size, and structure, especially, the different instruments measuring aesthetic outcome make it difficult to compare studies.

Overall, the patients' satisfaction with BCS is high, and a poor aesthetic outcome affects only 20% of the patient although declining over time. Interestingly, in a study examining the change of patient-reported aesthetic outcome over time, no patient with an unfavorable aesthetic outcome improved in the follow-up assessment. This means that a woman who is dissatisfied with her aesthetic outcome postoperatively will not become more satisfied over time. In this study the BCTOS questionnaire was administered in a median of 4 days after surgery with a follow-up of 2–6 years after surgery [38].

Generally, influencing factors of aesthetic outcome can be divided into patient-, tumor-, and treatment-related factors. However, the majority of examined factors are predictors leading to an unfavorable cosmetic result. In a study by Cardoso et al. using a panel rating of 24 breast surgeons from different countries of 120 photographs from women with unilateral breast cancer showed younger and thinner patients as well as patients with lower body mass index (BMI) and premenopausal status as predictors for better cosmetic results. Concerning tumor-related factors, localizations in the inferior, inner quadrants and at a 12 o'clock position are commonly found as features that portend a poor cosmetic outcome in BCS [48]. In a prospective cohort study evaluation, the long-term objective aesthetic outcome with the BCCT.core software including 356 patients revealed axillary lymph node dissection, larger tumors (> pT2), and higher specimen weight to be the main risk factors for poor aesthetic outcome. A lower resected specimen volume was associated with improvement of the aesthetic outcome over time in this study [40].

Patients who underwent one or more re-excisions reported worse aesthetic outcome [49, 50]. Concerning the incision methods, circular and periareolar incision techniques have been described leading to the most favorable AO. Fishmouth-shaped (elliptic) incisions, always accompanied by resection of the NAC, lead to the worst cosmetic reflecting the importance of the NAC for AO. Furthermore, postoperative complications such as impaired wound healing and the need of punctured seroma led to an impaired AO [51]. In a study using the Breast-Q questionnaire including 200 patients showed high BMI, delayed wound healing, and axillary surgery are risk factors for lower patient satisfaction [44].

Furthermore, a common factor which has been described to affect aesthetic outcome is radiotherapy [52].

Optimizing Aesthetic Outcomes in Breast Conservation

By maintaining oncological safety through breast conservation as the standard surgical procedure, the intention of optimizing individual aesthetic outcomes has been put into focus in the last years. In general, systematically generated data are lacking for the evaluation of oncological breast surgery [53]. Evidence-based data are available only for the simple comparison of breast-conserving surgery versus mastectomy breast surgery. This might result from the absence of standardization and classification of the wide differentiation of surgical procedures and techniques used in breast surgery worldwide. Also due to the high variability of tumor localization in compound with interindividual differences in breast size, breast shapes, and tissue factors, it was necessary to develop classifications that might be useful for patient selection and choice of optimal surgical procedure for breast cancer patients undergoing BCS. There are two fundamentally different approaches: first, volume-replacement procedures, which combine the resection with immediate reconstruction by using local flaps (glandular, fascio-cutaneous, and latissimus dorsi mini-flaps), and secondly, volume-displacement procedures, which combine resection with a variety of different breast reduction and reshaping techniques, according to the location of the tumor. Several proposals for a surgical classification have been made, for example, the first proposal of the Tuebingen classification from Hoffmann et al., which differs between simple breast-conserving cancer surgery without mobilization of glandular tissue or skin flaps and complex breast-conserving cancer surgery with mobilization of subcutaneous or epifascial glandular flaps and, if necessary, mobilization of the skin envelope for defect repair of ≤25% of the area of the breast. Likewise, oncoplastic surgery is differentiated with this classification into simple oncoplastic breast-conserving surgery and complex oncoplastic breast-conserving surgery as well as complex oncoplastic breast-conserving surgery with additional resection (reduction) of mammary gland tissue, i.e., tumor-adapted reduction mammoplasty. The highest complexity is represented in an additional group of complex oncoplastic breast-conserving surgery involving defect repair using distant pedicled flaps [54]. Following this initiative, several additional approaches of standardization of oncoplastic breast-conserving surgeries have been made, for example, the Basel classification by Weber et al. [55, 56] or the bi-level classification system by Clough et al. [57]. Figure 4.2 shows exemplarily a simplified representation of the "Tuebingen classification" [54].

In recent years especially these advanced oncoplastic surgery techniques have improved as an approach for extending possibilities of BCS, reducing both mastectomy and re-excision rates, while avoiding breast deformities. Several studies could proof that oncoplastic surgery was effective to broaden the indication for breast conservation toward larger tumors as alternative to mastectomy [58] without reducing oncological safety [59].

Careful patient selection and preoperative planning, including preoperative marking and selection of incision, are essential components for the success of any breast-conserving operation [60]. Accurate preoperative evaluation of the clinical and biological features of the tumor as well as of the morphological aspects of the breast allow the surgeon to make a decision if a conservative or radical approach is preferable and select the most effective oncoplastic surgical technique.

But even if a careful preoperative planning has been performed, around 20–30% of patients have a residual deformity that sometimes requires surgical correction. For these cases proposals for classifications with differentiation into different types have been developed in order to standardize following surgical correctional procedure, e.g., the classification from Clough et al. (type I, asymmetrical breasts with no deformity of the treated breast; type II, deformity of the treated breast, compatible with partial reconstruction and breast conservation; and type III, major deformity of the breast, requires mastectomy) [61, 62] or Munhoz et al. [63].

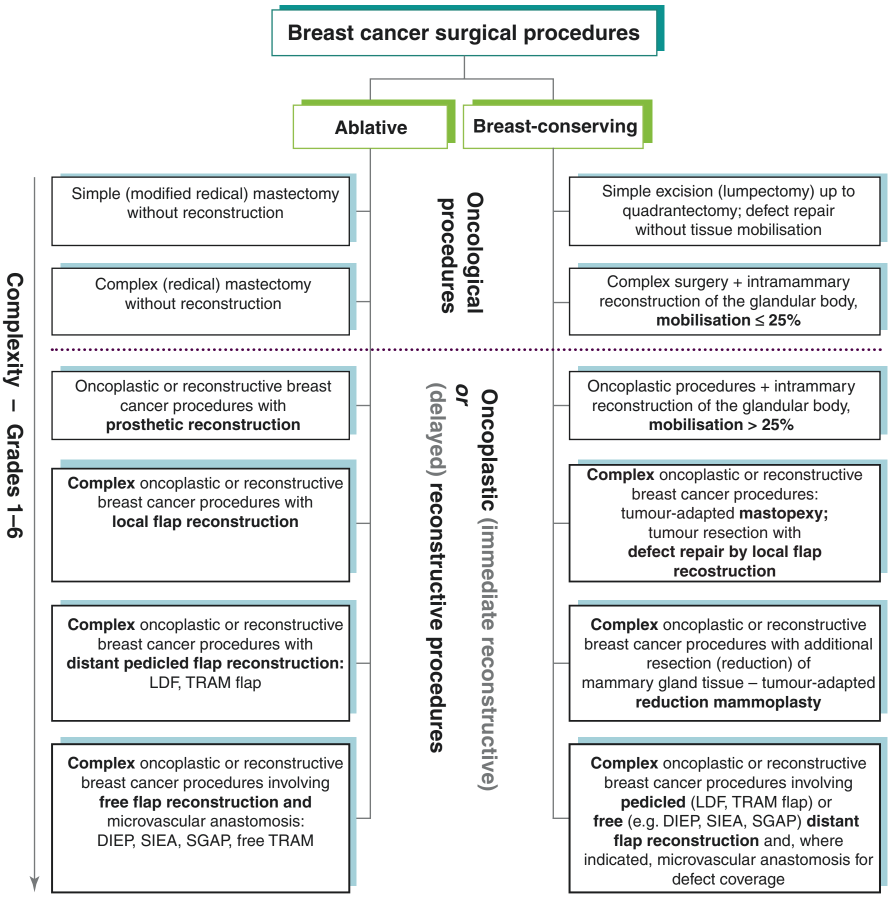


Fig. 4.2 Classification of ablative and breast-conserving surgical procedures for the treatment of breast cancer ("Tuebingen Classfication"). The system is based on six levels of complexity of oncological, oncoplastic and delayed reconstructive surgery (simplified representation) [54]

An alternative approach for treating small defects after BCS is the transfer of autologous fat tissue (lipotransfer). Recent studies could show adequate patients' satisfaction [64] and oncologic safety [65, 66] and not relevant affection of radiologic follow-up. The immediate approach of lipofilling in breast-conserving surgery seems to be feasible as well [67].

In cases of a breast-conserving approach in small breasts with relative large resection defects, heterologous implants as volume-replacement device can be considered as an alternative. Although the use of prosthetic device for volume replacement has advantages in the setting of breast conservation therapy, it has been marginalized based on results presenting high complication rates following implant placement and obligatory postoperative radiation therapy. Recent study results could show that with modern techniques (improved implant materials, targeted breast irradiation), the radiotherapy-induced side effects on implants (e.g., capsular contractions) declined, and good aesthetic results can be obtained for the majority of the patients in a medium-term follow-up [68]. Thus, this option could be offered to patients with small breasts and a relative large lumpectomy who decline immediate autologous reconstruction or mastectomy.

Conclusion

BCS has been established as the standard surgical procedure for primary breast cancer and fits to the preferences of most breast cancer patients concerning oncological safety and aesthetic outcome. When there is no specific contraindication against a breast-conserving approach, BCS is as safe an option as mastectomy concerning overall long-term survival. Concerning the aesthetic perspective, new oncoplastic techniques as well as the rising usage and effectiveness of NACT might enlarge the group of patients who can profit from BCS with a good aesthetic outcome. In preoperative planning BCS, the high variability of tumor localization in compound with interindividual differences in breast size, breast shapes, and tissue factors has to be taken into consideration. Nowadays a standardized classification of oncoplastic procedures should be used to find the optimal approach that suits to the individual surgical situation. Additional techniques like lipofilling could help to avoid sequelae of breast deformities after BCS. Different objective and patient-related tools like validated questionnaires help breast surgeons to evaluate the individual aesthetic outcome on a follow-up basis.

Literature

1. Hennigs A, Riedel F, Gondos A, Sinn P, Schirmacher P, Marmé F, et al. Prognosis of breast cancer molecular subtypes in routine clinical care: a large prospective cohort study. BMC Cancer. 2016;16(1):1–9.
2. Riedel F, Hennigs A, Hug S, Schaefgen B, Sohn C, Schuetz F, et al. Is mastectomy oncologically safer than breast-conserving treatment in early breast cancer? Breast Care. 2017;12(6):385–90.
3. Fisher B, Redmond C, Poisson R, Margolese R, Wolmark N, Wickerham L, et al. Eight-year results of a randomized clinical trial comparing total mastectomy and lumpectomy with or without irradiation in the treatment of breast cancer. N Engl J Med. 1989;320(13):822–8.
4. Fisher B, Bauer M, Margolese R, Poisson R, Pilch Y, Redmond C, et al. 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. 1985;312(11):665–73.
5. Veronesi U, Banfi A, Salvadori B, Luini A, Saccozzi R, Zucali R, et al. Breast conservation is the treatment of choice in small breast cancer: long-term results of a randomized trial. Eur J Cancer. 1990;26(6):668–70.
6. Veronesi U, Saccozzi R, Del Vecchio M, Banfi A, Clemente C, De Lena M, et al. Comparing radical mastectomy with quadrantectomy, axillary dissection, and radiotherapy in patients with small cancers of the breast. N Engl J Med. 1981;305(1):6–11.
7. Effects of radiotherapy and surgery in early breast cancer. An overview of the randomized trials. N Engl J Med. 1995;333(22):1444–55.

8. Morris AD, Morris RD, Wilson JF, White J, Steinberg S, Okunieff P, et al. Breast-conserving therapy vs mastectomy in early-stage breast cancer: a meta-analysis of 10-year survival. Cancer J Sci Am. 1997;3(1):6–12.
9. Veronesi U, Cascinelli N, Mariani L, Greco M, Saccozzi R, Luini A, et al. Twenty-year follow-up of a randomized study comparing breast-conserving surgery with radical mastectomy for early breast cancer. N Engl J Med. 2002;347(16):1227–32.
10. Fisher B, Anderson S, Bryant J, Margolese RG, Deutsch M, Fisher ER, et al. 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. 2002;347(16):1233–41.
11. Fortin A, Larochelle M, Laverdiere J, Lavertu S, Tremblay D. Local failure is responsible for the decrease in survival for patients with breast cancer treated with conservative surgery and postoperative radiotherapy. J Clin Oncol Off J Am Soc Clin Oncol. 1999;17(1):101–9.
12. Rutgers EJ. Quality control in the locoregional treatment of breast cancer. Eur J Cancer. 2001;37(4):447–53.
13. van Dongen JA, Voogd AC, Fentiman IS, Legrand C, Sylvester RJ, Tong D, et al. Long-term results of a randomized trial comparing breast-conserving therapy with mastectomy: European Organization for Research and Treatment of Cancer 10,801 trial. J Natl Cancer Inst. 2000;92(14):1143–50.
14. Litiere S, Werutsky G, Fentiman IS, Rutgers E, Christiaens MR, Van Limbergen E, et al. Breast conserving therapy versus mastectomy for stage I-II breast cancer: 20 year follow-up of the EORTC 10801 phase 3 randomised trial. Lancet Oncol. 2012;13(4):412–9.
15. Zumsteg ZS, Morrow M, Arnold B, Zheng J, Zhang Z, Robson M, et al. Breast-conserving therapy achieves locoregional outcomes comparable to mastectomy in women with T1-2N0 triple-negative breast cancer. Ann Surg Oncol. 2013;20(11):3469–76.
16. Mamtani A, Morrow M. Why are there so many mastectomies in the United States? Annu Rev Med. 2017;68:229–41.
17. Lowery AJ, Kell MR, Glynn RW, Kerin MJ, Sweeney KJ. Locoregional recurrence after breast cancer surgery: a systematic review by receptor phenotype. Breast Cancer Res Treat. 2012;133(3):831–41.
18. Cao JQ, Olson RA, Tyldesley SK. Comparison of recurrence and survival rates after breast-conserving therapy and mastectomy in young women with breast cancer. Curr Oncol. 2013;20(6):e593–601.
19. Houssami N, Macaskill P, Marinovich ML, Morrow M. The association of surgical margins and local recurrence in women with early-stage invasive breast cancer treated with breast-conserving therapy: a meta-analysis. Ann Surg Oncol. 2014;21(3):717–30.
20. Heil J, Breitkreuz K, Golatta M, Czink E, Dahlkamp J, Rom J, et al. Do reexcisions impair aesthetic outcome in breast conservation surgery? Exploratory analysis of a prospective cohort study. Ann Surg Oncol. 2012;19(2):541–7.
21. Aziz D, Rawlinson E, Narod SA, Sun P, Lickley HL, McCready DR, et al. The role of reexcision for positive margins in optimizing local disease control after breast-conserving surgery for cancer. Breast J. 2006;12(4):331–7.
22. Menes TS, Tartter PI, Bleiweiss I, Godbold JH, Estabrook A, Smith SR. The consequence of multiple re-excisions to obtain clear lumpectomy margins in breast cancer patients. Ann Surg Oncol. 2005;12(11):881–5.
23. Swanson GP, Rynearson K, Symmonds R. Significance of margins of excision on breast cancer recurrence. Am J Clin Oncol. 2002;25(5):438–41.
24. Smitt MC, Nowels K, Carlson RW, Jeffrey SS. Predictors of reexcision findings and recurrence after breast conservation. Int J Radiat Oncol Biol Phys. 2003;57(4):979–85.
25. Hennigs A, Fuchs V, Sinn HP, Riedel F, Rauch G, Smetanay K, et al. Do patients after reexcision due to involved or close margins have the same risk of local recurrence as those after one-step breast-conserving surgery? Ann Surg Oncol. 2016;23(6):1831–7.
26. Chagpar AB, Killelea BK, Tsangaris TN, Butler M, Stavris K, Li F, et al. A randomized, controlled trial of cavity shave margins in breast cancer. N Engl J Med. 2015;373(6):503–10.

27. Comprehensive molecular portraits of human breast tumours. Nature. 2012;490(7418):61–70.
28. Ellis MJ, Perou CM. The genomic landscape of breast cancer as a therapeutic roadmap. Cancer Discov. 2013;3(1):27–34.
29. Prat A, Perou CM. Deconstructing the molecular portraits of breast cancer. Mol Oncol. 2011;5(1):5–23.
30. Weigelt B, Baehner FL, Reis-Filho JS. The contribution of gene expression profiling to breast cancer classification, prognostication and prediction: a retrospective of the last decade. J Pathol. 2010;220(2):263–80.
31. von Minckwitz G, Untch M, Blohmer JU, Costa SD, Eidtmann H, Fasching PA, et al. Definition and impact of pathologic complete response on prognosis after neoadjuvant chemotherapy in various intrinsic breast cancer subtypes. J Clin Oncol Off J Am Soc Clin Oncol. 2012;30(15):1796–804.
32. Hennigs A, Riedel F, Marme F, Sinn P, Lindel K, Gondos A, et al. Changes in chemotherapy usage and outcome of early breast cancer patients in the last decade. Breast Cancer Res Treat. 2016;160(3):491–9.
33. Kuerer HM, Rauch GM, Krishnamurthy S, Adrada BE, Caudle AS, DeSnyder SM, et al. A clinical feasibility trial for identification of exceptional responders in whom breast cancer surgery can be eliminated following neoadjuvant systemic therapy. Ann Surg. 2018;267(5):946–51.
34. Heil J, Schaefgen B, Sinn P, Richter H, Harcos A, Gomez C, et al. Can a pathological complete response of breast cancer after neoadjuvant chemotherapy be diagnosed by minimal invasive biopsy? Eur J Cancer. 2016;69:142–50.
35. Manguso N, Gangi A, Giuliano AE. Neoadjuvant chemotherapy and surgical management of the axilla in breast cancer: a review of current data. Oncol. 2015;29(10):733–8.
36. Curran D, van Dongen JP, Aaronson NK, Kiebert G, Fentiman IS, Mignolet F, et al. Quality of life of early-stage breast cancer patients treated with radical mastectomy or breast-conserving procedures: results of EORTC Trial 10,801. The European Organization for Research and Treatment of Cancer (EORTC), Breast Cancer Co-operative Group (BCCG). Eur J Cancer. 1998;34(3):307–14.
37. Chen CM, Cano SJ, Klassen AF, King T, McCarthy C, Cordeiro PG, et al. Measuring quality of life in oncologic breast surgery: a systematic review of patient-reported outcome measures. Breast J. 2010;16(6):587–97.
38. Hennigs A, Biehl H, Rauch G, Golatta M, Tabatabai P, Domschke C, et al. Change of patient-reported aesthetic outcome over time and identification of factors characterizing poor aesthetic outcome after breast-conserving therapy: long-term results of a prospective cohort study. Ann Surg Oncol. 2016;23(5):1744–51.
39. Amichetti M, Busana L, Caffo O. Long-term cosmetic outcome and toxicity in patients treated with quadrantectomy and radiation therapy for early-stage breast cancer. Oncology. 1995;52(3):177–81.
40. Hennigs A, Hartmann B, Rauch G, Golatta M, Tabatabai P, Domschke C, et al. Long-term objective esthetic outcome after breast-conserving therapy. Breast Cancer Res Treat. 2015;153(2):345–51.
41. Arenas M, Sabater S, Hernandez V, Henriquez I, Ameijide A, Anglada L, et al. Cosmetic outcome of breast conservative treatment for early stage breast cancer. Clin Transl Oncol. 2006;8(5):334–8.
42. Hennigs A, Heil J, Wagner A, Rath M, Moosbrugger H, Kelava A, et al. Development and psychometric validation of a shorter version of the Breast Cancer Treatment Outcome Scale (BCTOS-12). Breast. 2017;38:58–65.
43. Pusic AL, Klassen AF, Scott AM, Klok JA, Cordeiro PG, Cano SJ. Development of a new patient-reported outcome measure for breast surgery: the BREAST-Q. Plast Reconstr Surg. 2009;124(2):345–53.
44. O'Connell RL, DiMicco R, Khabra K, O'Flynn EA, deSouza N, Roche N, et al. Initial experience of the BREAST-Q breast-conserving therapy module. Breast Cancer Res Treat. 2016;160(1):79–89.

45. Fitzal F, Krois W, Trischler H, Wutzel L, Riedl O, Kuhbelbock U, et al. The use of a breast symmetry index for objective evaluation of breast cosmesis. Breast. 2007;16(4):429–35.
46. Heil J, Carolus A, Dahlkamp J, Golatta M, Domschke C, Schuetz F, et al. Objective assessment of aesthetic outcome after breast conserving therapy: subjective third party panel rating and objective BCCT. core software evaluation. Breast. 2012;21(1):61–5.
47. Santos G, Urban C, Edelweiss MI, Zucca-Matthes G, de Oliveira VM, Arana GH, et al. Long-term comparison of aesthetical outcomes after oncoplastic surgery and lumpectomy in breast cancer patients. Ann Surg Oncol. 2015;22(8):2500–8.
48. Kelly DA, Wood BC, Knoll GM, Chang SC, Crantford JC, Bharti GD, et al. Outcome analysis of 541 women undergoing breast conservation therapy. Ann Plast Surg. 2012;68(5):435–7.
49. Foersterling E, Golatta M, Hennigs A, Schulz S, Rauch G, Schott S, et al. Predictors of early poor aesthetic outcome after breast-conserving surgery in patients with breast cancer: initial results of a prospective cohort study at a single institution. J Surg Oncol. 2014;110(7):801–6.
50. Wazer DE, DiPetrillo T, Schmidt-Ullrich R, Weld L, Smith TJ, Marchant DJ, et al. Factors influencing cosmetic outcome and complication risk after conservative surgery and radiotherapy for early-stage breast carcinoma. J Clin Oncol. 1992;10(3):356–63.
51. Waljee JF, Hu ES, Newman LA, Alderman AK. Predictors of breast asymmetry after breast-conserving operation for breast cancer. J Am Coll Surg. 2008;206(2):274–80.
52. Shaitelman SF, Schlembach PJ, Arzu I, Ballo M, Bloom ES, Buchholz D, et al. Acute and short-term toxic effects of conventionally fractionated vs hypofractionated whole-breast irradiation: a randomized clinical trial. JAMA Oncol. 2015;1(7):931–41.
53. Haloua MH, Krekel NM, Winters HA, Rietveld DH, Meijer S, Bloemers FW, et al. A systematic review of oncoplastic breast-conserving surgery: current weaknesses and future prospects. Ann Surg. 2013;257(4):609–20.
54. Hoffmann J, Wallwiener D. Classifying breast cancer surgery: a novel, complexity-based system for oncological, oncoplastic and reconstructive procedures, and proof of principle by analysis of 1225 operations in 1166 patients. BMC Cancer. 2009;9:108.
55. Weber WP, Soysal SD, Zeindler J, Kappos EA, Babst D, Schwab F, et al. Current standards in oncoplastic breast conserving surgery. Breast. 2017;34(Suppl 1):S78–s81.
56. Weber WP, Soysal SD, El-Tamer M, Sacchini V, Knauer M, Tausch C, et al. First international consensus conference on standardization of oncoplastic breast conserving surgery. Breast Cancer Res Treat. 2017;165(1):139–49.
57. Clough KB, Kaufman GJ, Nos C, Buccimazza I, Sarfati IM. Improving breast cancer surgery: a classification and quadrant per quadrant atlas for oncoplastic surgery. Ann Surg Oncol. 2010;17(5):1375–91.
58. Chang EI, Peled AW, Foster RD, Lin C, Zeidler KR, Ewing CA, et al. Evaluating the feasibility of extended partial mastectomy and immediate reduction mammoplasty reconstruction as an alternative to mastectomy. Ann Surg. 2012;255(6):1151–7.
59. De La Cruz L, Blankenship SA, Chatterjee A, Geha R, Nocera N, Czerniecki BJ, et al. Outcomes after oncoplastic breast-conserving surgery in breast cancer patients: a systematic literature review. Ann Surg Oncol. 2016;23(10):3247–58.
60. Shrotria S. Techniques for improving the cosmetic outcome of breast conservation surgery. Eur J Surg Oncol. 2001;27(1):109–12.
61. Clough KB, Cuminet J, Fitoussi A, Nos C, Mosseri V. Cosmetic sequelae after conservative treatment for breast cancer: classification and results of surgical correction. Ann Plast Surg. 1998;41(5):471–81.
62. Clough KB, Thomas SS, Fitoussi AD, Couturaud B, Reyal F, Falcou MC. Reconstruction after conservative treatment for breast cancer: cosmetic sequelae classification revisited. Plast Reconstr Surg. 2004;114(7):1743–53.
63. Munhoz AM, Montag E, Arruda E, Pellarin L, Filassi JR, Piato JR, et al. Assessment of immediate conservative breast surgery reconstruction: a classification system of defects revisited and an algorithm for selecting the appropriate technique. Plast Reconstr Surg. 2008;121(3):716–27.

64. Brown AWW, Kabir M, Sherman KA, Meybodi F, French JR, Elder EB. Patient reported outcomes of autologous fat grafting after breast cancer surgery. Breast. 2017;35:14–20.
65. Waked K, Colle J, Doornaert M, Cocquyt V, Blondeel P. Systematic review: the oncological safety of adipose fat transfer after breast cancer surgery. Breast. 2017;31:128–36.
66. Wazir U, El Hage Chehade H, Headon H, Oteifa M, Kasem A, Mokbel K. Oncological safety of lipofilling in patients with breast cancer: a meta-analysis and update on clinical practice. Anticancer Res. 2016;36(9):4521–8.
67. Khan LR, Raine CR, Dixon JM. Immediate lipofilling in breast conserving surgery. Eur J Surg Oncol. 2017;43(8):1402–8.
68. Barnea Y, Friedman O, Arad E, Barsuk D, Menes T, Zaretski A, et al. An oncoplastic breast augmentation technique for immediate partial breast reconstruction following breast conservation. Plast Reconstr Surg. 2017;139(2):348e–57e.
69. Cardoso MJ, Cardoso J, Amaral N, Azevedo I, Barreau L, Bernardo M, et al. Turning subjective into objective: the BCCT.core software for evaluation of cosmetic results in breast cancer conservative treatment. Breast. 2007;16(5):456–61.

5 Quadrant by Quadrant Preoperative Planning for Oncoplastic Resections

Walter P. Weber, Christian Kurzeder, and Martin Haug

Introduction

The first oncoplastic breast conserving surgery (OPS) techniques have been described almost 30 years ago [1–3]. Over the last decade, several authors have published algorithms that they use in their clinical practice to indicate a specific procedure and individualize partial breast reconstruction [4–10]. Several OPS pioneers described the selection of the appropriate technique based on tumor location either by quadrant or by the poles of the breast [4, 8]. Others described the specific procedure in detail and then outlined to what clinical situations it could be applied [6, 7]. Another approach is to base the classification on the detailed documentation of the extent and complexity of the procedure [5]. Personally, we favor to focus on the size and shape of the breast when starting the treatment planning process [9, 10]. However, all surgeons use a combination of all of these criteria when finalizing their individualized oncoplastic treatment plan.

Indications

The round block mammoplasty was initially performed by circular incision at the border of the areola and then further developed to a circumareolar mastopexy technique, also known as donut mastopexy, which has been first described by Benelli et al. almost 30 years ago [1]. It works well for tumors in all locations except the

W. P. Weber (✉)
University Hospital Basel and University of Basel, Basel, Switzerland
e-mail: walter.weber@usb.ch

C. Kurzeder · M. Haug
Breast Center, University Hospital Basel, Basel, Switzerland
e-mail: christian.kurzeder@usb.ch; Martin.Haug@usb.ch

V. S. Klimberg et al. (eds.), *Oncoplastic Breast Surgery Techniques for the General Surgeon*, https://doi.org/10.1007/978-3-030-40196-2_5

ones that are close to the submammary fold or peripheral in large ptotic breasts. Due to the limited exposure through the outer incision circle, partial breast reconstruction and complete removal of the tumor with clear margins can become challenging in these two situations. Prerequisite for this technique is a minimum distance between tumor and skin of a few mm to allow surgical dissection in this plane with clear anterior margin. We prefer this technique in women with small- or medium-sized breasts and no major ptosis, but it is feasible in most situations with decent results.

The second group of procedures that can be used for tumors in all quadrants are the various forms of oncoplastic reduction mammoplasty. Originally, this technique has been described for use in lower quadrant tumors [2]. In the meantime, several modifications have been proposed that allow partial breast reconstruction for tumors in all quadrants [8–10]. Several series demonstrated good local, regional, and distant control with extended follow-up [11, 12]. Pre-requisite for this group of techniques are breasts with high volume and preferably some degree of ptosis.

Besides these two groups of procedures that can be used for tumors in most quadrants, other techniques have been designed for use in more specific situations [3, 7, 8, 13, 14]. For tumors near the submammary fold, the triangle excision or its modification V-mammoplasty can be used as technically not very demanding procedures to avoid an asymmetry called the bird's beak deformity [4, 8]. A small thoraco-epigastric flap is the alternative for tumors at this location [7]. The hemi-batwing mammoplasty, also known as racquet technique, has been developed for tumors in the outer quadrants [4, 8]. It works best in medium- to large-sized breasts with some degree of ptosis. For supraareolar tumors with close distance to the skin, the crescent or batwing mammoplasties are straight-forward approaches to en bloc resections with good aesthetic results [8]. Since these techniques result in lifting of the NAC, a contralateral procedure for symmetry is often performed. For retroareolar tumors that require central tumorectomy with removal of the nipple-areola-complex (NAC), the Grisotti mammoplasty, also known as the B-technique, allows immediate reconstruction of the areola with adequate reshaping of the breast in most situations [3, 13].

Preoperative Evaluation and Planning

In our practice, every patient is presented at an oncoplastic board before surgery to discuss and finalize the treatment plan. In preparation, the surgical resident takes pictures of both breasts from the front, oblique, and lateral view. At the board meeting, the pictures and the radiological findings are presented along with the clinical baseline data. We select the basic technique according to our local indication and partial breast reconstruction algorithms and discuss predictable needs for adjustment to tailor the procedure to each patient [9]. While our own algorithms work well in our hands, several other classification systems are available [4, 6, 8]. In fact, an independent panel of experts concluded that other systems may perform better than ours in clinical practice and research [15]. Hence, we believe that it is a critical step for all surgeons to find the clinical algorithms that work best for themselves and their units.

In any case, preoperative marking of the patient is the basis for a successful performance of advanced oncoplastic surgery procedures. The goal is to take measurements and establishing landmarks in the upright position that are used during surgery when the patient is supine. We draw a line from the top of the mid-sternum to the xiphoid process and then mark the submammary folds full-length on both sides, followed by the clavicles. Next, we draw the breast meridian lines, starting at the midclavicular line about 5 cm laterally from the midline down through the nipples to the abdomen, which divide each hemithorax into two halves with equal widths. Occasionally, the line has to be adjusted medially or laterally to the nipple to ensure that it leads to the midline of the hemithorax. To mark the optimal new position of the nipple, the fingers are placed behind the breast with the fingertips pushing at the submammary fold toward the investigator. The point of maximum pressure can be felt by the other hand; it corresponds with the position of the submammary fold. This point marks the optimal position for the nipple in a younger and the new border of the areola in an older patient when bilateral procedures are planned. In case of unilateral surgery, the nipple is generally recentralized into the direction that is opposite to the tumorectomy cavity. All these lines are used to plan the incisions that vary widely between different techniques, as described in the next chapter.

Surgical Techniques by Quadrants

Upper Quadrants

Our default approach to a tumor in the upper quadrants in a small- to medium-sized breast is the *round block* or *donut mastopexy*. Please see Fig. 5.1 for the procedure at a glance.

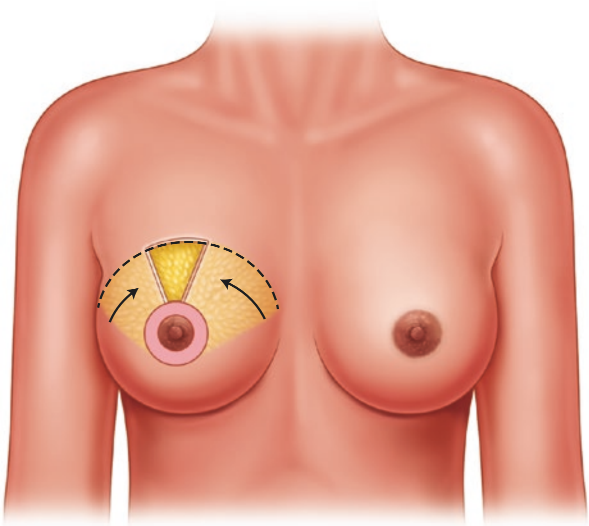


Fig. 5.1 Round block mastopexy for tumors in the upper quadrants

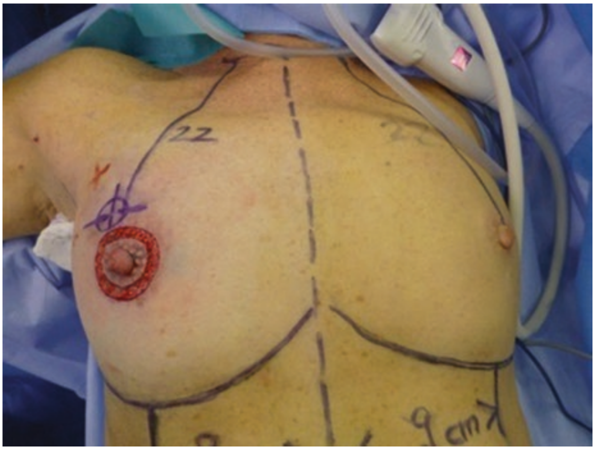


Fig. 5.2 Round block mastopexy by circumareolar de-epithelialization of skin between inner and outer circle

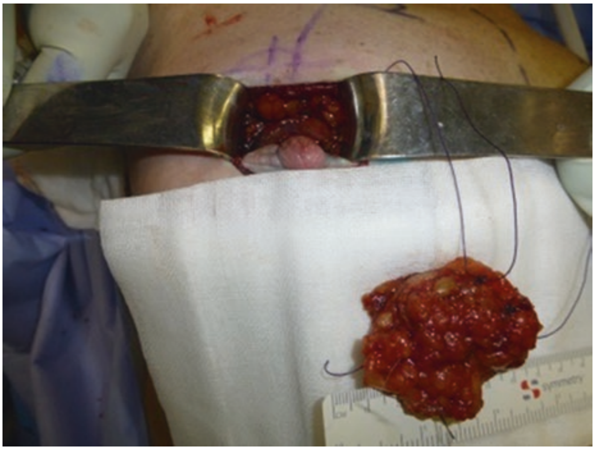


Fig. 5.3 Tumorectomy cavity and specimen

It starts by de-epithelialization between the inner and outer circumareolar lines with a distance in between the two circles of about 1 cm. The wider the distance between the inner and outer circle, the more flattening of the breast will occur, since the technique does not allow formal reshaping of the breast to promote its projection. As you can see in Fig. 5.2, the access to the subcutaneous mastectomy plane when using the outer circle is both closer to the tumor and longer compared to the traditional periareolar incision. Therefore, it gives wider access to the tumor. Hence, this technique offers advantages for the oncological part of the oncoplastic procedure as well. A crucial step of that specific procedure is wide mobilization in that plane to the border of the gland whenever possible. In general, this allows safe tumorectomy (Fig. 5.3). The round block mammoplasty reliably prevents severe deformities in most situations and good to excellent results in patients selected by small- to medium-sized breasts, as you can see in this patient 3 years after surgery (Fig. 5.4).

Fig. 5.4 Patient 3 years after round block mastopexy

Fig. 5.5 Patient before surgery

If the tumor is located directly under the skin in the supraareolar region, part of the skin between the outer and inner incisional circle can be left attached en bloc to the tumorectomy specimen to secure the anterior margin. Alternative procedures in this situation are the *hemi-batwing* and *crescent mastopexies* [8]. For the crescent mastopexy, the distance between the inner and outer circle increases toward the upper pole of the breast (Figs. 5.5 and 5.6). This allows great access to these tumors with a wide skin island left attached to the specimen (Fig. 5.7). Due to the lifting of the nipple-areola complex, however, a contralateral procedure for symmetry is commonly recommended (patient 2 years after surgery in Fig. 5.8). In addition, even though the procedure is feasible also in large breasts with advanced ptosis, the lack of reshaping clearly limits the projection of the breast and accordingly, the final aesthetic results in these patients.

To increase the projection of the breast, glandular reshaping by the use of an oncoplastic *reduction mammoplasty* with inferior pedicle can be used for tumors in the supraareolar region (Fig. 5.9).

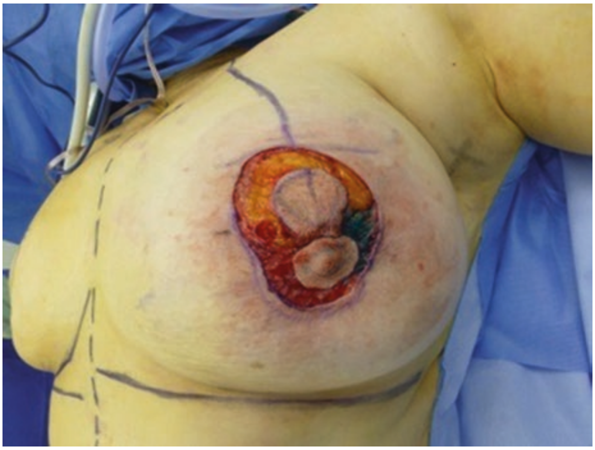


Fig. 5.6 Crescent mastopexy with de-epithelialization of skin crescent along the breast meridian

Fig. 5.7 En bloc tumorectomy cavity and specimen

Fig. 5.8 Patient 2 years after left oncoplastic crescent mastopexy and right crescent mastopexy for symmetry

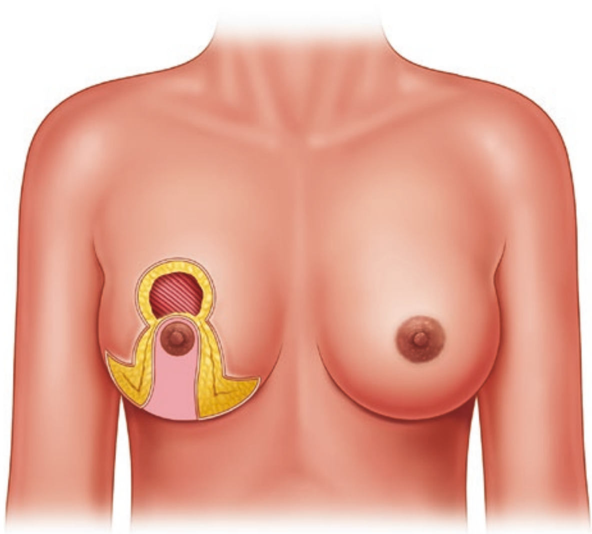


Fig. 5.9 Oncoplastic reduction mammoplasty with inferior pedicle for supraareolar tumors

Finally, if the skin has to be removed due to proximity to the tumor at very high positions in the breast not amenable to any of these techniques, we recommend the use of radial incisions in the form of an ellipse for better exposure during partial breast reconstruction and less risk of nipple distortion after radiotherapy. The removal of a wide skin island helps avoid wrinkling of the residual skin in large volume resections.

Outer Quadrants

Our default operation for tumors in the outer quadrants in large breasts is oncoplastic *reduction mammoplasty*. Prerequisite is a distance of a few mm between the tumor and the skin to allow access from the incision lines for the reduction mammoplasty. After performing the standard markings as described above, the lines for the inferior part of the reduction are drawn from the nipple – by gentle rotation of the breast to the lateral and medial side – on to the landmark on the middle of the hemithorax. The superior border of the areola is marked 2 cm above the nipple, from where the new border of the areola is drawn in a dome-shaped form over a distance of 6 cm until it crosses the inferior reduction line. Another 6 cm are measured down that line to mark the new inframammary fold, from where the incision lines deviate to the medial and lateral sides according to the Wise pattern. With this technique, large volume resections are possible with good access (Fig. 5.10). The NAC is repositioned on a superomedial pedicle, and the volume is displaced into the defect by the de-epithelialized inferomedial glandular flap (Fig. 5.11). The flap is rotated into the defect (Fig. 5.12). Three years after surgery, the aesthetic result is good and the patient is satisfied (Fig. 5.13); however, due to higher than anticipated

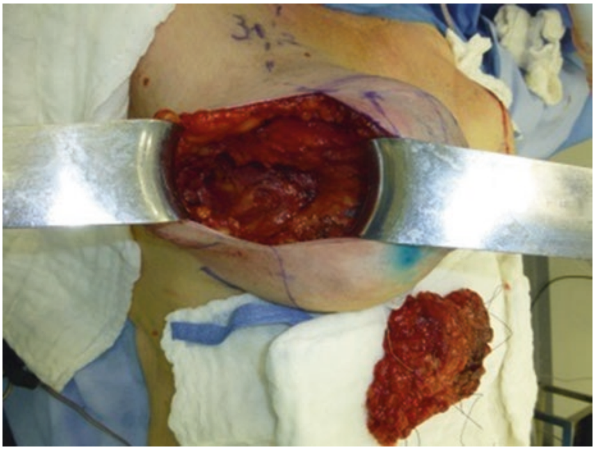


Fig. 5.10 Large volume tumorectomy cavity and specimen in the outer quadrants during oncoplastic reduction mammoplasty

Fig. 5.11 Superomedial nipple areola complex pedicle and de-epithelialized inferomedial glandular flap for partial breast reconstruction

Fig. 5.12 Volume displacement by rotation of inferomedial glandular flap into defect in outer quadrants

Fig. 5.13 Patient 3 years after surgery

shrinkage of the right breast after radiotherapy, it turned out to be smaller. We generally reduce the contralateral side by an additional 20% to adjust for the anticipated radiation-induced volume loss during long-term follow-up. Symmetry can be optimized by performing the contralateral procedure as a second step at least 6 months after the end of radiotherapy, when shrinkage has already occurred for the most part. In some countries, this is still standard of care. It also allows enough time to request coverage of costs by the insurance companies on an individual basis before performing the procedure if it is not generally granted. In Switzerland, for example, coverage of contralateral symmetrizing reduction mammoplasty by general insurance has been introduced in December 2014. This allowed us to offer immediate symmetrization to all patients from that time on to spare them the disadvantages of major asymmetry, although temporary, and the morbidity of a second surgical procedure.

A procedure specifically designed for use in the outer quadrants is the hemibatwing mammoplasty or racquet technique [4, 8]. It basically consists of a radial ellipse and a crescent excision (Fig. 5.14). The radial ellipse allows en bloc tumorectomy that resembles the form of a quadrantectomy. Thereafter, almost the entire residual gland is mobilized from the thoracic wall to allow rotation of the superolateral and inferolateral dermoglandular flaps into the defect. In case of very large volume resections, additional tissue can be displaced into the defect from the lateral part of the M. latissimus dorsi, a technique called lateral thoracic wall advancement [7]. Fixation of the reconstruction with several stitches using fully absorbable suture material is recommended to prevent deviation of the nipple toward the axilla after radiation. The second measure to prevent asymmetry is the crescent mastopexy part of the procedure, which works best in patients with some degree of ptosis (Fig. 5.15).

Finally, the round block mastopexy works well for tumors in the outer quadrants as well.

Fig. 5.14 Hemi-batwing mammoplasty (racquet technique)

Fig. 5.15 Patient 1 year after surgery

Inner Quadrants

Whenever possible, a scar in the décolleté should be avoided. As so often, this depends on the distance between tumor and skin. Our favorite approach is the *round block mammoplasty* in smaller to medium sized breasts and *reduction mammoplasty* in larger breasts. If the distance between tumor and skin requires skin excision, the V-mammoplasty is a safe option (Fig. 5.16) [4]. This technique allows en bloc resection of the skin, tumor, and pectoral fascia. Reconstruction consists of rotation of an inferolateral dermoglandular flap into the defect, which requires extensive opening of the submammary fold toward the axilla. Recentralization of the NAC in the form of a small crescent mastopexy is commonly recommended.

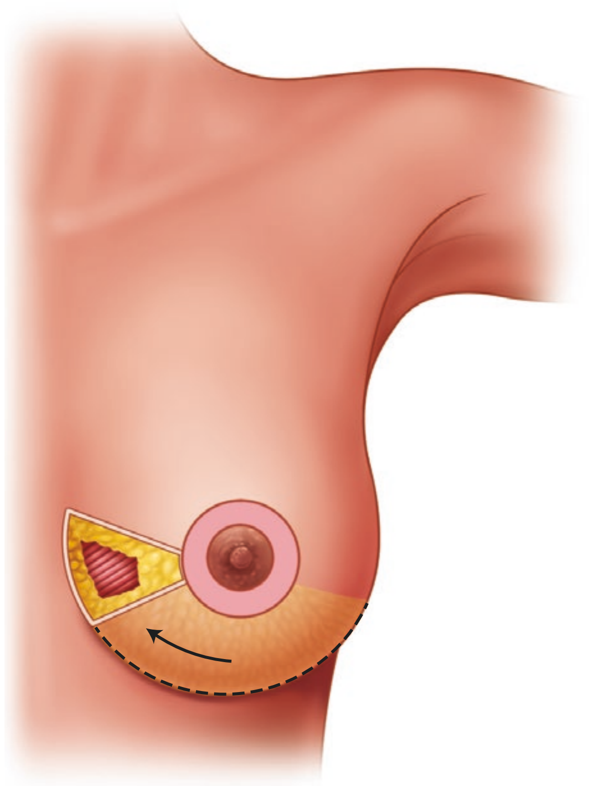


Fig. 5.16 V-mammoplasty with partial breast reconstruction by rotation of an inferolateral dermoglandular flap

Lower Quadrants

For tumors close to the submammary fold, one safe approach is *reduction mammoplasty* in larger breasts. The first oncoplastic reduction mammoplasties have been performed and described for tumors in this location, since it requires minimal adjustment of the standard reduction techniques with superior pedicles and Wise or vertical incision patterns, and virtually no tailored glandular flaps [2]. An even simpler technique that works in all sizes and forms of breasts is the *triangle excision* [8]. It consists of en bloc resection of the skin, tumor, and pectoral fascia in the form of a triangle (Fig. 5.17) and opening of the submammary fold in both directions until the dermoglandular flaps can be mobilized and rotated into the defect without tension (Fig. 5.18). Minor recentralization of the NAC by use of a small crescent or circumareolar mastopexy helps prevent bird's beak deformity (Fig. 5.19).

Fig. 5.17 Large volume en bloc tumorectomy and cavity

Fig. 5.18 Reconstruction with two dermoglandular flaps after broad incision of submammary fold

Fig. 5.19 Patient 1 year after surgery

Round block mastopexy is only recommended for tumors in the lower central portion of the breast due to the limited exposure for tumorectomy and partial breast reconstruction. To prevent the bird's beak deformity, the entire gland has to be mobilized on both sides of the tumorectomy to allow safe parenchymal support of the NAC.

Central Tumors

Our default approach for central tumors that require removal of the NAC in large breasts is oncoplastic *reduction mammoplasty*. However, the *Grissotti mastopexy* or *B-technique* allows immediate reconstruction of the areola and reshaping of the breast to restore projection in most situations [3]. The technique consists of central tumorectomy and immediate partial breast reconstruction by use of an inferolateral dermoglandular flap, which is de-epithelialized except for the skin island used to reconstruct the areola (Fig. 5.20). The flap is dissected along the medial line and

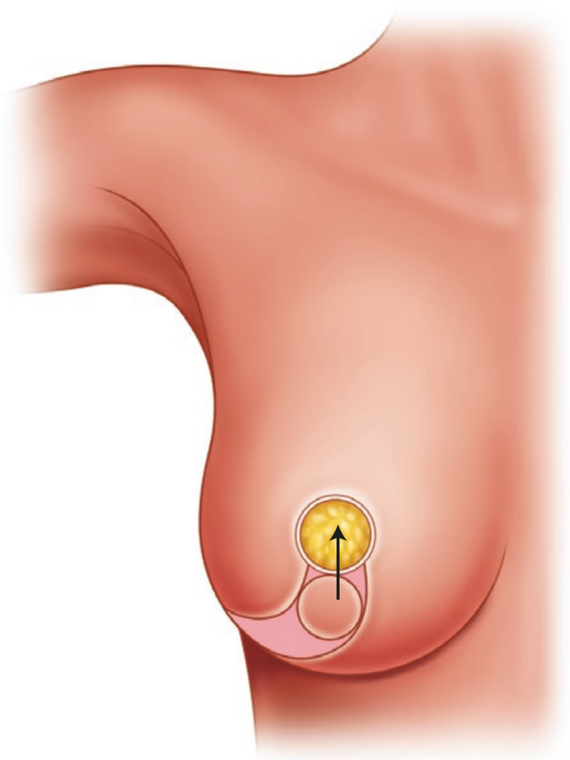


Fig. 5.20 Grissotti mastopexy, also known as B-technique, consists of central tumorectomy and immediate partial breast reconstruction by use of an inferolateral dermoglandular flap, which is de-epithelialized except for the skin island used to reconstruct the areola

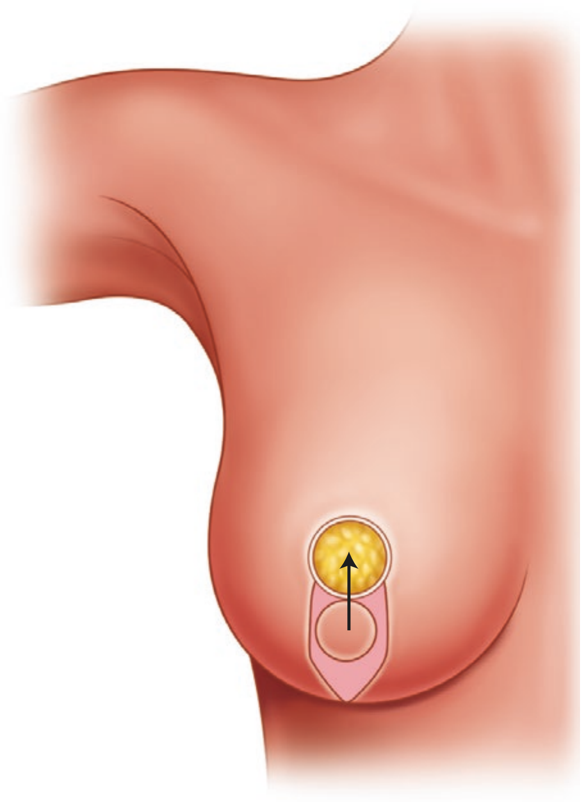


Fig. 5.21 The Grissotti mastopexy can be modified in small breasts by mobilizing the middle flap toward the chest wall from both incision lines to allow adequate mobility

rotated into the defect. In small breasts, the distance between NAC and submammary fold may be too short to allow sufficient advancement of the flap into the defect. In these situations, we propose to modify the technique by mobilizing the middle flap toward the chest wall from both incision lines to allow adequate mobility (Figs. 5.21 and 5.22).

Surgical Complications

As in all surgical disciplines, the risk of complications increases with the extent of surgery. For major oncoplastic procedures, the common complications include hematoma, seroma, wound healing disorders, and infection, which occur in approximately 20% of patients [16]. Since these complications can be severe and may delay adjuvant therapy, close follow-up of these patients and prompt initiation of treatment of such complications is recommended [17].

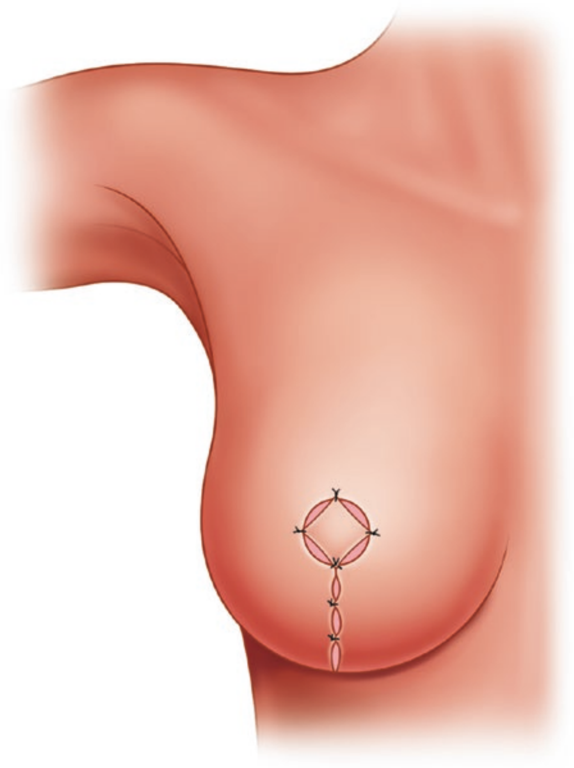


Fig. 5.22 Modified Grissotti mastopexy allows the reconstruction of the areola and the preservation of breast shape and projection by mobilizing the skin island on the middle flap from below in small breasts

However, several studies, while recognizing the high rate of complications, concluded that these did not delay adjuvant therapy in the majority of patients [18, 19].

Conclusions

In summary, OPS has a 25-year-old tradition and has now entered routine clinical breast surgery practice. Several clinical algorithms and classification systems have been published over the last decade that differ in many aspects. However, all of them offer the selection of techniques based on the size of the tumor and its location, as well as the size and shape of the breast. The Basel indication algorithm recommends to decide between the use of oncoplastic mastopexy, oncoplastic tumorectomy, or oncoplastic reduction mammoplasty based on these parameters. Once the basic approach has been selected, the Basel partial breast reconstruction algorithm recommends the use of specific nipple-areola complex pedicles and tailored glandular flaps. In most situations, more than one option is available, which requires an informed decision by the patient after a thorough discussion of the options and their risks and benefits with the surgeon. Oncoplastic surgery allows excellent aesthetic results in many situations even in the case of larger tumors. However, the basic rules of oncologic breast conserving surgery apply: clear margins must be obtained, the general need of radiation recognized, and the risk of complications minimized.

References

1. Benelli L. A new periareolar mammaplasty: the "round block" technique. Aesthet Plast Surg. 1990;14(2):93–100.
2. Clough KB, Nos C, Salmon RJ, Soussaline M, Durand JC. Conservative treatment of breast cancers by mammaplasty and irradiation: a new approach to lower quadrant tumors. Plast Reconstr Surg. 1995;96(2):363–70.
3. Galimberti V, Zurrida S, Zanini V, Callegari M, Veronesi P, Catania S, Luini A, Greco M, Grisotti A. Central small size breast cancer: how to overcome the problem of nipple and areola involvement. Eur J Cancer. 1993;29A(8):1093–6.
4. Clough KB, Kaufman GJ, Nos C, Buccimazza I, Sarfati IM. Improving breast cancer surgery: a classification and quadrant per quadrant atlas for oncoplastic surgery. Ann Surg Oncol. 2010;17(5):1375–91.
5. Hoffmann J, Wallwiener D. Classifying breast cancer surgery: a novel, complexity-based system for oncological, oncoplastic and reconstructive procedures, and proof of principle by analysis of 1225 operations in 1166 patients. BMC Cancer. 2009;9:108.
6. Piper M, Peled AW, Sbitany H. Oncoplastic breast surgery: current strategies. Gland Surg. 2015;4(2):154–63.
7. Rezai M, Kraemer S, Kimmig R, Kern P. Breast conservative surgery and local recurrence. Breast. 2015;24(Suppl 2):S100–7.
8. Silverstein MJ, Mai T, Savalia N, Vaince F, Guerra L. Oncoplastic breast conservation surgery: the new paradigm. J Surg Oncol. 2014;110(1):82–9.
9. Weber WP, Soysal SD, Fulco I, Barandun M, Babst D, Kalbermatten D, Schaefer DJ, Oertli D, Kappos EA, Haug M. Standardization of oncoplastic breast conserving surgery. Eur J Surg Oncol. 2017;43:1236.
10. Weber WP, Soysal SD, Zeindler J, Kappos EA, Babst D, Schwab F, Kurzeder C, Haug M. Current standards in oncoplastic breast conserving surgery. Breast. 2017;34(Suppl 1):S78–81.
11. Chang EI, Peled AW, Foster RD, Lin C, Zeidler KR, Ewing CA, Alvarado M, Hwang ES, Esserman LJ. Evaluating the feasibility of extended partial mastectomy and immediate reduction mammoplasty reconstruction as an alternative to mastectomy. Ann Surg. 2012;255(6):1151–7.
12. Clough KB, van la Parra RFD, Thygesen HH, Levy E, Russ E, Halabi NM, Sarfati I, Nos C. Long-term results after oncoplastic surgery for breast cancer: a 10-year follow-up. Ann Surg. 2017;268(1):165–71.
13. Eggemann H, Ignatov A, Elling D, Lampe D, Lantzsch T, Weise M, Costa SD. Efficacy and patient satisfaction of breast conserving therapy for central breast cancer by the B technique. Ann Surg Oncol. 2013;20(11):3438–45.
14. Rageth CJ, Tausch C. Intramammarian flap reconstruction (IFR) technique in breast conserving surgery. Breast. 2009;18(6):387–92.
15. Weber WP, Soysal SD, El-Tamer M, Sacchini V, Knauer M, Tausch C, Hauser N, Gunthert A, Harder Y, Kappos EA, Schwab F, Fitzal F, Dubsky P, Bjelic-Radisic V, Reitsamer R, Koller R, Heil J, Hahn M, Blohmer JU, Hoffmann J, Solbach C, Heitmann C, Gerber B, Haug M, Kurzeder C. First international consensus conference on standardization of oncoplastic breast conserving surgery. Breast Cancer Res Treat. 2017;165(1):139–49.

16. Haloua MH, Krekel NM, Winters HA, Rietveld DH, Meijer S, Bloemers FW, van den Tol MP. A systematic review of oncoplastic breast-conserving surgery: current weaknesses and future prospects. Ann Surg. 2013;257(4):609–20.
17. Eaton BR, Losken A, Okwan-Duodu D, Schuster DM, Switchenko JM, Mister D, Godette K, Torres MA. Local recurrence patterns in breast cancer patients treated with oncoplastic reduction mammaplasty and radiotherapy. Ann Surg Oncol. 2014;21(1):93–9.
18. Khan J, Barrett S, Forte C, Stallard S, Weiler-Mithoff E, Doughty JC, Romics L Jr. Oncoplastic breast conservation does not lead to a delay in the commencement of adjuvant chemotherapy in breast cancer patients. Eur J Surg Oncol. 2013;39(8):887–91.
19. Tenofsky PL, Dowell P, Topalovski T, Helmer SD. Surgical, oncologic, and cosmetic differences between oncoplastic and nononcoplastic breast conserving surgery in breast cancer patients. Am J Surg. 2014;207(3):398–402.

6 Oncoplastic Surgery

Yoav Barnea and Moshe Papa

Introduction

Breast cancer is the most common cancer in females, affecting about one in eight women (13%). Surgery is the major tool in the treatment of breast cancer along with chemo-/biological therapy and radiation. Surgical interventions and outcomes intimately affect the lives of patients. Over the years, surgical treatment changed toward less radical, less mutilating surgical treatment of the breast. Breast-conserving surgery (BCS), followed by postoperative radiotherapy, replaced the radical and modified-radical procedures as the standard of care for early-stage breast cancer. Experience and time proved that the overall and disease-free survival rates of BCS were equivalent to those of mastectomy [1, 2].

Now that breast preservation has become the operation of choice that effectively achieved tumor-free resection margins and good local control, patients expect the treatment to result not only in long-term survival but also to have good aesthetic outcomes. This important secondary goal has in turn been shown to affect quality of life and psychological outcome [3–5].

The primary goal of BCS is the removal of cancer along with a tumor-free margin. The optimal extent of this margin has recently been agreed upon as no

Y. Barnea
Tel Aviv University Medical School, Tel Aviv-Yafo, Israel

Department of Plastic and Reconstructive Surgery, 'Sourasky' Tel Aviv Medical Center, Tel Aviv-Yafo, Israel

Department of Breast Surgery "Assuta" Medical Center, Tel Aviv-Yafo, Israel

Peres Academic Center, Rehovot, Israel

M. Papa (✉)
Tel Aviv University Medical School, Tel Aviv-Yafo, Israel

Department of Breast Surgery "Assuta" Medical Center, Tel Aviv-Yafo, Israel

Peres Academic Center, Rehovot, Israel

V. S. Klimberg et al. (eds.), *Oncoplastic Breast Surgery Techniques for the General Surgeon*, https://doi.org/10.1007/978-3-030-40196-2_6

tumor on ink for invasive cancer and a 2 mm negative microscopic margin for in situ cancer [6, 7].

Breast-conserving surgery involves lumpectomy, usually after image-guided or needle localization, along with sentinel node identification and removal and radiotherapy. The role of axillary dissection is also diminishing and preserved for special indications.

Breast-conserving surgery indications have broadened, and currently it is mainly used for early-stage ductal or lobular cancer, localized ductal carcinoma in situ (DCIS), as well as locally advanced tumors treated and responsive to neoadjuvant chemotherapy. It can also be used for certain multifocal or multicentric tumors.

One current major limit for a lumpectomy is the skin and tissue deformity influencing the ultimate cosmetic outcome. This may result from many factors including host factors, adjuvant therapy administered, tumor location in the breast, and surgical technique. However, the percentage of breast volume excised is the single most important factor influencing cosmetic outcome. Following the removal of a significant amount of breast tissue, the deformity may be worsened by the radiation effect and subsequent fibrosis [8, 9].

Aesthetic outcomes lagged behind securing improved local control and overall survival. Following standard BCS, up to 40% complain of unsatisfactory cosmetic changes. Among them are deficiency in the context of the breast tissue, overlying skin retraction, changes in the breast size and symmetry, retraction/displacement of the nipple-areola complex, reduction of mammary ptosis, and skin discoloration [10].

As mentioned before, tumor-to-breast ratio is the strongest predictive factor for poor outcomes. This is especially important since the indications for local resection became broader. Previous studies have demonstrated that excision of >20% of breast tissue (parenchymal tissue greater than 70–100 cm^2 or a tumor-to-breast weight ratio exceeding 10:1) will result in unfavorable outcomes [11–13].

The location of the tumor in the breast is another significant issue that may also affect the cosmetic outcome. Those arising within the lower and central have the worst cosmetic impact, whereas a medial location due to the lack of tissue limits significantly the amount of breast tissue that can be removed without adverse effect.

Breast size and shape – large breasts with various grades of breast ptosis – may also adversely impact the results of breast-conserving surgery. This is partially due to the higher incidence of complications and radiation-induced fibrosis secondary to the higher dosage of radiation required for patients with large breasts [14].

Patient-related risk factors for bad cosmetic outcome include diabetes mellitus, tobacco use, and collagen diseases.

There are also factors that are related to treatment complications such as re-excision, fat necrosis, seroma formation, infection, and radiotherapy [15].

Due to the broadening indications for BCS, there was a need for surgical technique that will reduce the risk of late deformities and asymmetry. Oncoplastic breast surgery (OPS) combines oncologic with plastic surgery principles and allows safe removal of tumors that are up to 30% of the breast volume and then treated with postoperative radiotherapy with good cosmetic results. The increased utilization of neoadjuvant chemotherapy allows the application of breast preservation with the use of OPS even for larger cancers [9, 16].

A recent study demonstrated that OPS had a nearly fourfold increase in the percentage of all breast cancer surgeries performed. In 2014, OPS accounted for over 33% of all breast-conserving surgeries [17].

Another benefit is that it allows ample margins due to the specimen size excised by OPS, which translates to a lower incidence of positive margins and fewer reoperations [18, 19]. This may add to the cost-effectiveness of the procedure. In addition, filling the gap, caused by tissue volume excision, with OPS prior to radiotherapy will minimize breast deformities.

Definition of Oncoplastic Surgery

OPS uses strategies for adequate oncologic outcome during partial mastectomy that addresses the aesthetic outcomes of the tissue defect at the time of surgical resection. However, the lack of a consistent definition of OPS causes confusion among surgical trainees, practicing surgeons, and educators. Equally important, the lack of a consistent definition may be confusing to patients seeking breast cancer treatment. Therefore, a formal consensus definition and classification of OPS was needed. The American Society of Breast Surgeons (ASBrS) consensus definition of oncoplastic surgery implies that "OPS is a form of BCS that includes oncologic resection with a partial mastectomy, ipsilateral reconstruction using volume displacement or volume replacement techniques with possible contralateral symmetry surgery when appropriate." OPS was further classified according to the percent of breast tissue removed: Level 1, < 20% breast tissue removed; Level 2, 20–50% of breast tissue removed; and > 50% of breast tissue removed [20].

The Europeans created a consensus classification for oncoplastic surgery that is similar to the ASBrS classification; however, the difference between their consensus and the ASBrS consensus definition is the added description of volume replacement [21, 22].

Another major importance for a uniform definition of OPS is for standardized outcomes, clinical research, uniform billing, and communication between the surgeon and patients as well as colleagues.

Many different kinds of OPS techniques have been introduced to minimize deformities and to obtain the best possible aesthetic satisfaction [16, 23]. These techniques can be divided into those that *displace* volume of surrounding breast tissue and techniques where autologous tissue from an extramammary site is used to *replace* the lost breast tissue. Some techniques are appropriate for small-sized tumors and breasts and others for multifocal and large tumors or for large breasts. The cutoff point of 20% is delineating between Levels 1 and 2 volume displacement methods used for oncoplastic surgery.

Level 1 oncoplastic technique usually does not require a specialist plastic surgeon. This technique is used to prevent deformities for tumor excisions that are

<20% of the breast volume and includes simple reshaping without skin excision and may require limited nipple recentralizing.

Level 2 oncoplastic techniques should be considered when major volume loss is anticipated and require either volume displacement or volume replacement techniques. The majority of OPS Level 2 techniques utilize volume displacement techniques, which comprise tumor excision followed by reshaping of the breast parenchyma as well as reduction of the breast skin envelope (Figs. 6.1, 6.2, 6.3, and 6.4).

Often, especially in Level 2 volume displacement oncoplastic surgery, a symmetrization contralateral operation is performed by the use of either mastopexy or breast reduction techniques to allow for symmetric breasts and nipple position. Rarely, when preforming the adjustment of the contralateral breast, an incidental malignant or a high-risk lesion is identified and should be treated accordingly. The timing of contralateral procedures is variable. It can be done either simultaneously or delayed. Advocates of the delayed adjustment procedure argue that the possible adverse cosmetic effects of radiotherapy can then be taken into account.

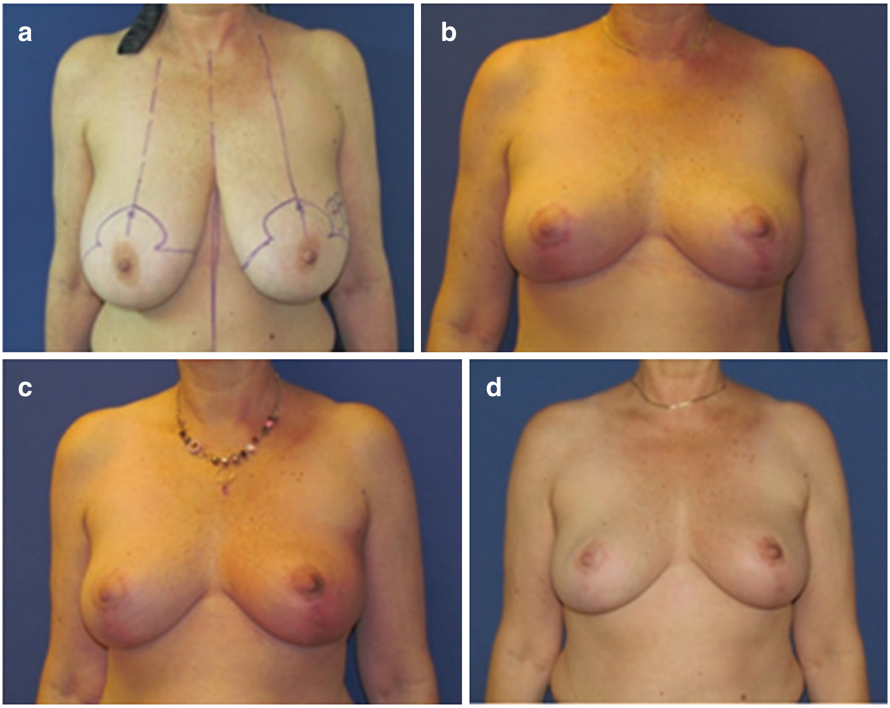


Fig. 6.1 A 47-year-old patient with bilateral breast hypertrophy. She was diagnosed with multifoci IDC of the left breast in the upper-lateral quadrant (**a**). She underwent left breast quadrantectomy and oncoplastic reduction-pattern reconstruction, rotating inferior pole breast tissue laterally, based on the superior-medial pedicle, and right breast reduction (**b**). She received radiotherapy to the left breast (**c**). The patient 1 year after radiation therapy (**d**)

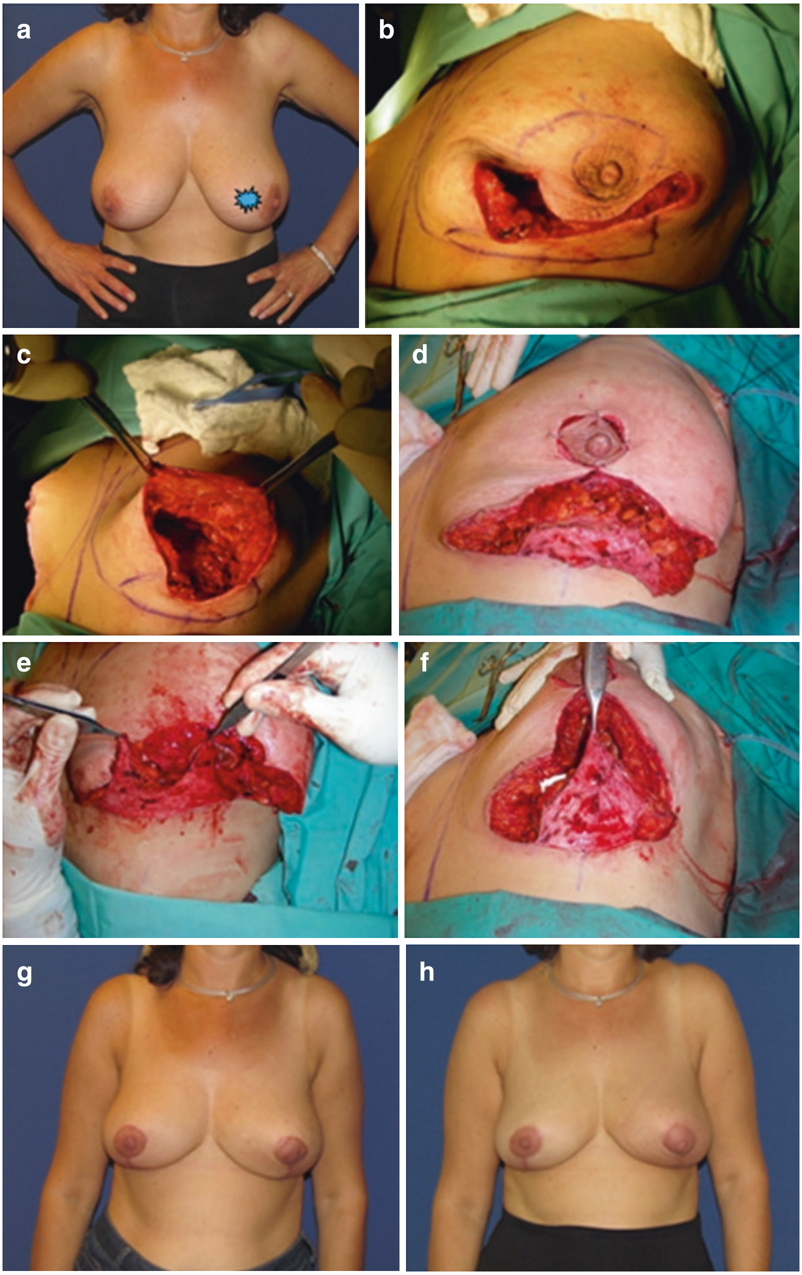


Fig. 6.2 A 35-year-old patient with a left breast central DCIS, close to the nipple-areolar complex (NAC) (**a**). She underwent left breast central lumpectomy, sparing the NAC (**b**, **c**). The NAC was lifted based on a superior pedicle (**d**), and the lower breast tissue was deepithelized and advanced to the central breast area (**e**, **f**). The right breast was reduced. The patient 1 month after surgery (**g**) and 6 months after the completion of radiotherapy to the left breast (**h**)

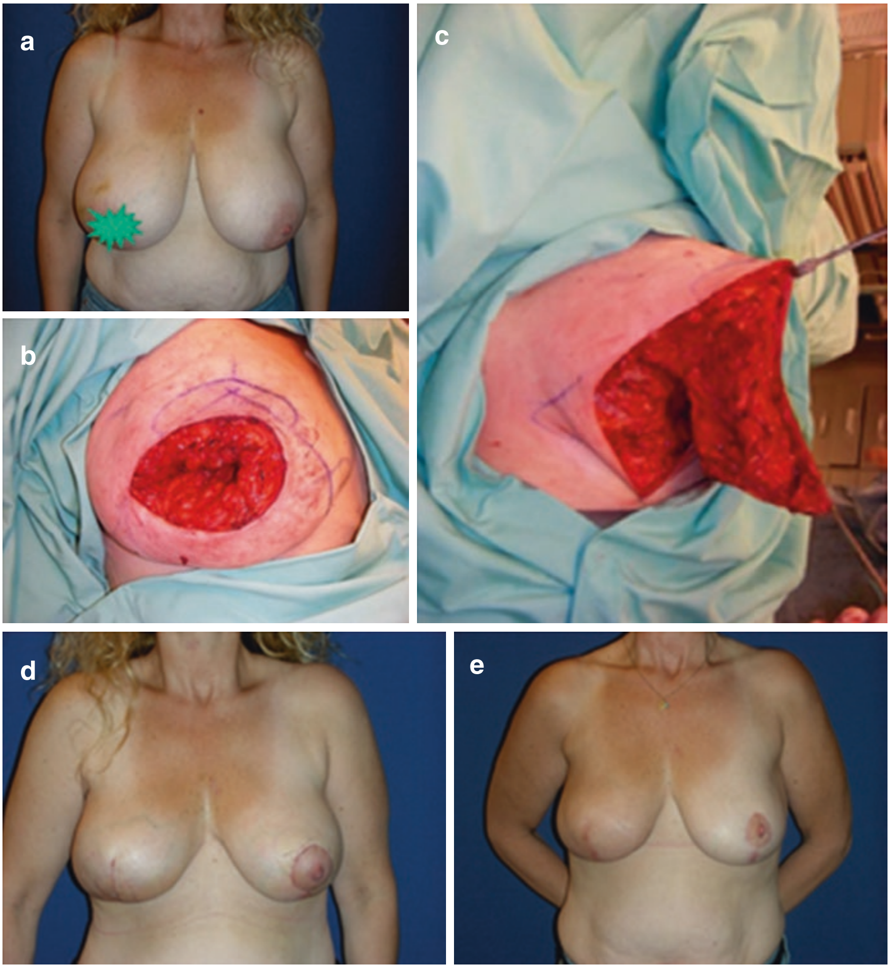


Fig. 6.3 A 53-year-old patient with a central IDC and DCIS involving the nipple-areolar complex (NAC) (**a**). She underwent right breast central lumpectomy including the NAC (**b**). She underwent right breast oncoplastic reconstruction by rotating a medially based dermo-glandular flap (**c**) and left breast reduction. The patient 1 month after surgery (**d**) and 1 year after the completion of radiotherapy to the right breast (**e**)

If more than 50% of the breast needs excision, then a volume replacement option with implant-based reconstruction or local/regional flap reconstruction may be preferred as the residual tissue volume is frequently inadequate, except in extremely large breasts [24].

Oncologic Safety and Benefits

Despite the widespread adoption of OPS, there is limited high-quality evidence to support the benefits of this approach. The rationale for OPS is based on prospective

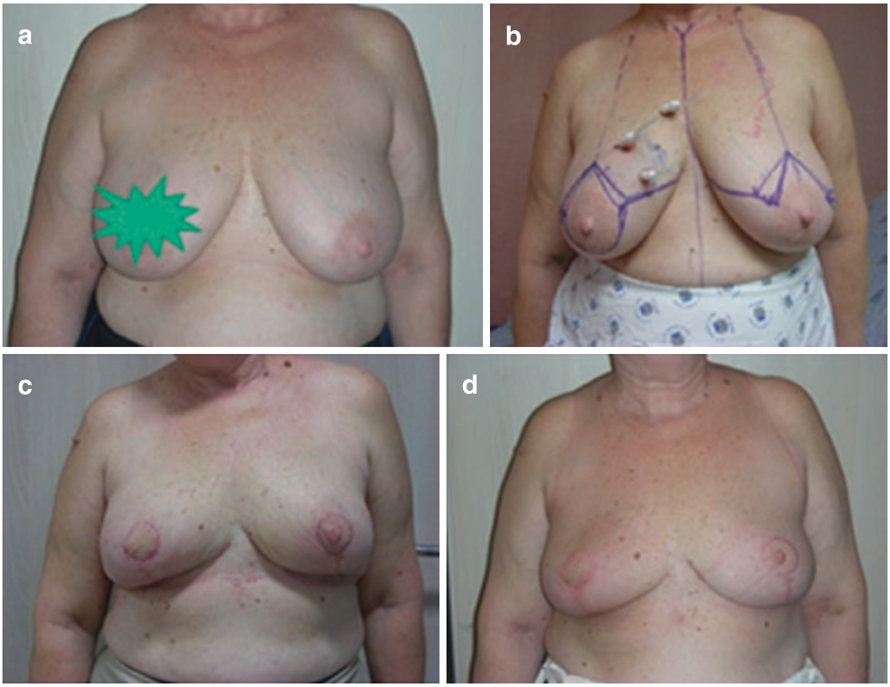


Fig. 6.4 A 60-year-old patient with right breast upper-pole multifoci IDC and DCIS involving the nipple-areolar complex (NAC) (**a**, **b**). She underwent right upper-pole extensive quadrantectomy including the NAC. She underwent right breast oncoplastic reconstruction by advancing an inferiorly based dermo-glandular flap that includes a skin island for areolar reconstruction and left breast reduction. The patient 1 month after surgery (**c**) and 1 year after the completion of radiotherapy to the right breast (**d**)

randomized trials that established the safety and efficacy of BCT that were performed on patients with mostly small tumors. Oncoplastic techniques, however, are used for larger, multifocal and more aggressive tumors. The evidence that cancers of these sizes can be safely treated with breast conservation cannot be directly extrapolated from the classic prospective randomized trials.

Adequate surgical margins are an important factor in reducing the risk of local recurrence (LR) [25]. Positive surgical margins necessitate a reoperation, either a re-excision or a mastectomy [26]. This causes discomfort and stress to the patient, leads to an increased risk of surgical complications and to poor aesthetic outcome, delays adjuvant therapy, and increases healthcare costs. Furthermore, re-excision may increase the risk of developing a LR, compared to patients with only one operation [27, 28].

Involved surgical margins occur in 20%–40% of all standard BCS, and one in five BCS patients undergo a reoperation. The guidelines for surgical margins are continuously evolving, and there was no universal consensus on what defines a positive margin. Recently, the Society of Surgical Oncology, the American Society for Radiation Oncology, and the American Society of Clinical Oncology published a consensus statement on margins that recommends a 2 mm excision margin for DCIS and no tumor on ink for invasive cancer [6, 29].

OPS allows wider oncological resections, and advocates of OPS argue that wider resections reduce positive margin rate and result in less reoperations compared with standard BCS [24, 30]. Our group uses additional technologies during OPS to ensue negative margins during surgery. These include specimen radiography along with the use of the handheld MarginProbe or the ClearSight specimen MRI device.

Reviewing the literature reveals that, of the studies published, only a minority report the positive margin rate (at a time where there was no consensus regarding the definition of a positive margin). Only a few of these comparative studies report a statistically significant benefit in terms of negative margins and/or reoperation rate. A study by Meretoja et al. demonstrated that with OPS, reoperation rate was 9.2% [31]. Tumor size, multifocal disease, and extensive intraductal component proved to be predictors of inadequate margins. This was consistent with several other previous studies [22, 32, 33]. A trend toward a higher risk of reoperation in the DCIS group (15.1%) and in the invasive lobular carcinoma group (12.3%) was observed, yet this did not reach statistical significance ($p = 0.007$). A recent systematic review [24] demonstrated that the tumor-positive margin rate was significantly lower after OPS (12% vs. 21%) and the re-excision was more common when BCT without OPS was performed (14.6% vs. 4%) and completion mastectomy was more common after OPS than after BCT (6.5% vs. 3.7%). Another study extracted data from 55 studies and collectively evaluated over 6000 with OPS and reported an average positive margin rate of 9.8%, a re-excision rate of a 6.0%, and conversion rate to mastectomy of 6.2% [33]. The diversity of OPS procedures as well as margin definition explains the variation in the frequency of margin involvement ranging between 0% and 36% [24, 30]. Even though there are studies that failed to show a free margin benefit for OPS, review of the literature suggests that the positive margin rate and reoperation is lower with OPS than with simple BCS. One should also take into consideration the different tumor characteristics operated when using OPS. Additionally, in patients with positive margins, the subsequent reoperation management varied. Reoperation following OPS seemed to be more often mastectomy (8%–100%) compared to when conventional BCS was used (11%–75%), but the difference was not statistically significant ($p = 0.102$). The volume excised by OPS can result in a significant reduction in the amount of mammary tissue and thus hamper subsequent re-excision opportunities of the tumor bed, necessitating conversion to mastectomy to ensure oncologic safety as well as cosmetic results. This was probably the reason why mastectomy was performed more often as the second procedure following OPS. However, this was not our group's experience, and we managed to perform an adequate oncological as well as esthetic re-excision on most of our patients. The reoperation was always performed as a joint team with the breast surgeon and the plastic surgeon.

Local Recurrence – local recurrence is dependent on local tumor characteristics such as size and tumor biology; surgery combined with radiotherapy and systemic therapy has a major influence on its reoccurrence. Most studies examining the oncological safety of OPS lack high level evidence in terms of local recurrence, patient disease-free survival (DFS) and breast cancer-specific survival. Campbell et al. state that the current best available evidence is from observational studies with inadequate control groups. To date, eight comparative studies have been published that report on recurrence rates and survival, the ultimate measures of oncologic safety. Only three studies include local recurrence rates and survival compared with mastectomy patients, and most studies are limited in terms of follow-up [14]. Chakravorty [34] and Niinkoski [31] et al. reported equivalent safety in a retrospective comparative study that compared OPS with BCS. It should be noted that the OPS group included significantly larger, higher-grade tumors, and more patients had received neoadjuvant chemotherapy. On the other hand, the OPS also included a significant greater number of patients with noninvasive breast cancer. There was no difference in the adjuvant treatment therapy given. No significant difference in local relapse rates (OPS 2.7% vs. BCS 2.2%) or distant relapse (1.3% OBS vs. 7.5% BCS) at median follow-up of 28 months was noted. Mazouni et al. compared BCS with OPS after neoadjuvant chemotherapy in a retrospective study with median follow-up of 46 months [35]. They reported that OPS outcomes results were similar to those of standard BCS. No significant difference in 5-year overall survival (OS; 96.2% OPS vs. 94.2% BCS) or relapse-free survival (92.7% OPS vs. 92% BCS). The groups were equivalent in terms of tumor size, grade, and nodal disease; however, the OPS had significantly less HER2-positive patients, and more ER+, suggesting better breast cancer subtypes. The largest comparative study is a retrospective single-institution study by Carter et al. that included 9861 consecutive patients diagnosed between 2007 and 2014 with a median follow-up of 3.4 years [17]. The aim of the study was determine the operative and oncologic outcomes of OPS (BCS with oncoplastic reconstruction) compared with other breast surgical procedures for breast cancer. Four groups were included: 34% had BCS (n = 3559), and 11% underwent OPS (BCR + R) (n = 1177), mastectomy only (TM) (n = 3263), and mastectomy plus immediate reconstruction (TM+ IR) (n = 2608). Compared with BCS, patients undergoing OPS had more aggressive diseases. There was no difference in the proportion of hormone receptor-positive or triple-negative patients in the OPS group; however, they were significantly younger in age and had larger tumors, more advanced disease stages, higher tumor grade, higher incidence of multifocality, node positivity, LVI, more HER2 positivity, more adjuvant chemotherapy administered, and surprisingly less adjuvant hormonal therapy and adjuvant radiotherapy. Despite the marked differences in the clinical and pathological features between BCS and OPS groups, there was no difference during the 3.4 years of median follow-up in OS (95.8% OPS vs. 96.8% BCS) and recurrence-free survival (94.6% OPS vs. 96.1% BCS). The study concluded that OPS is an oncologically safe procedure with complication rates that are equivalent to or less frequent than BCS or TM + R. However, the mean follow-up period of 3.4 years was relatively short, which may make the oncologic safety difficult to interpret. It is of note that The Oxford overview demonstrates that 75% of local recurrences occur within 5 years of surgery [15]. In a collective review of 40 studies including 2830 patients by Yiannakopoulou and Mathelin, the majority were observational studies of low quality, and the length of follow-up was relatively short (21 studies investigated volume displacement techniques; 14 studies investigated volume replacement techniques; 4 studies presented data on various oncoplastic techniques). Local recurrence was observed in 0–10.8% (0–10.8% for volume displacement and 0–8% for volume replacement). Distant metastasis ranged between 0 and 14.6% and death between 0 and 8.1% [30]. Other studies have shown that OPS is a safe approach regarding oncologic results compared to conservative BCS [14–16, 34, 38–40]. The main weakness of the above comparative studies is that the control groups were not matched; the different tumor pathology and the oncoplastic procedures described in these studies were heterogeneous. Therefore, it was difficult to make definite conclusions about oncologic safety and patient outcome. Unfortunately, prospective randomized trials are unlikely to be undertaken, given the complex logistical and ethical considerations.

Postoperative Complications

OPS includes a few surgical techniques such as volume displacement and replacement. These differ in volume excised, materials used, and length of procedure which may impact the postoperative complication rates. Only a few studies focus on the postoperative complications in OPS and the different techniques of reconstruction that are used; most of them reported no difference in surgical complications between the groups [17, 19]. Although radiotherapy is an integral and important component of breast preservation surgery, the influence of postoperative radiotherapy on the complication rate of OPS is rarely analyzed [14, 39, 40] . Immediate OPS complications include infection, bleeding, seroma formation, and wound problems. OPS does not appear to significantly increase the risk of postoperative complications [13]; however, complication rate with volume replacement OPS is slightly higher [24]. A study by Hillberg and van Mulken [41] found that most complications occurred before the start of the adjuvant radiotherapy and the risk factor for developing postoperative complications was older age at operation. Other variables such as increased BMI, smoking, hypertension, use of anticoagulants, and the weight of the lumpectomy were not significant when examined by multivariable regression analysis.

Hillberg and van Mulken also noted that there was no delay in start of adjuvant chemotherapy in those patients due to complications. However, the start of adjuvant radiotherapy was delayed for more than 8 weeks in 3.7% of patients who suffered from postoperative problems.

It is our experience as well as seen in the literature that OPS does not delay the time to adjuvant chemotherapy treatment [14, 42]. Campbell and Romics examined the time to the first cycle delivery and found no significant difference between the groups, and the median time to adjuvant therapy for OBCS was 29 days, concluding that OBCS seems safe in terms of adjuvant chemotherapy delivery [14]. Radiotherapy (RT) has oncological benefits as well as side effects, both short term and long term. Early toxicity is directly proportional to the duration of RT and relatively insensitive to dose variations per fraction. Early toxicity results in erythema or, in extreme cases, sunburn effect that may later develop into hyperpigmentation and telangiectasia. Late toxicity in contrast is more sensitive to dose variations and less to the duration. Long-term effects include delayed global shrinkage, contraction, and firmness of the breast, often permanent. This happens due to the fibrosis of the breast parenchyma resulting in reduction in volume and asymmetry with the contralateral breast in BCS. The fibrosis can also lead to deviation of the nipple. The UK Standardization of Breast Radiotherapy Trial (START) and Patient Reported Outcome Measures (PROMS) and clinical assessment reported a breast shrinkage rate of 53% and 47% and 78% and 86%, respectively, at 2 and 5 years. Fat necrosis as well as oil cyst is another common side effect of RT though reported to be between15% and 31.1% and was associated with worse cosmetic outcome [43].

The immediate effect of RT after OPS remains the same as in simple BCS, i.e., erythema, epidermolysis, etc. As mentioned before, there is no evidence that OPS significantly delays institution of adjuvant therapy [14, 42, 44] or increases the difficulty of whole-breast RT. Large-volume parenchymal displacement may lead to a higher incidence of fat necrosis especially in fatty breasts and a consequent deformity due to the combination of ischemia and radiation effect if not performed expertly by a suitably trained oncoplastic surgeon [45, 46]. RT effect on replacement autologous tissue flaps may cause some sequelae of fibrosis/scarring following RT effect on muscle though without major clinical concerns. Recently, we have used the combination of OPS with intraoperative RT in appropriately selected patients with excellent cosmetic results. A study by Cracco et al. [47] demonstrated that esthetic postoperative results between IORT and EBRT were not statistically significant and disease recurrence rates between the two groups were also not significantly different.

One of the major advantages of neoadjuvant chemotherapy is the downstaging of the tumor, making lumpectomy and OPS also an option for these patients with larger tumors. A study by Peled et al. demonstrated that offering OPS to patients with locally advanced disease in order to minimize postoperative complications can play an important role in minimizing unnecessary surgical procedures and improving patient quality of life [48]. It is therefore very important to mark the tumor area by a clip prior to the administration of neoadjuvant chemotherapy; this will enable the surgeon to identify the area that needs removal in case of a complete clinical response.

Oncoplastic Surgery in the Elderly

OPS can also be a reconstructive option for the elderly. One-third of all breast cancers occur in women aged 70 years or more. Essentially, the same surgical options should be offered to patients aged over 70 years as are offered to younger women. Despite this recommendation, a woman's age remains the single most important factor in determining whether or not she will be offered breast reconstruction with rates declining after the age of 55 years. Many issues potentially influence the uptake of oncoplastic and reconstructive surgery in fit elderly patients. These include comorbidities, lack of standard pathways of care, concerns about higher operative risk, lack of evidence regarding outcomes, preconceptions regarding body image, and lack of engagement with the decision-making process. The lack of evidence in the literature with regard to reconstruction and oncoplastic breast-conserving surgery in the elderly reflects the underuse of these techniques in this group. The few studies published suffer from selection bias and are based on small numbers; however, they suggest that complication rates in the elderly following reconstruction are comparable to those among younger groups and that length of stay and recovery time are not significantly different.

Oncoplastic breast-conserving surgery in the elderly may offer oncological advantages as a result of the wider area of tissue excised, and, importantly, margins are more likely to be clear with a reduction in the number of second operations required. The wider excision margins achieved by OCS may eliminate the need for RT in this group especially in those with hormone receptor-positive tumors [49].

One-Stage or Two-Stage Operation: Timing of Contralateral Symmetry

Resection and breast reconstruction can be carried out simultaneously in a one-stage or in two-stage approach. The second stage usually involves esthetic repair, post radiotherapy, of the tumor-bearing breast along with the ipsilateral breast adjustment. One benefit for two-stage approach is insuring satisfactory surgical as well as oncological control of the resected primary tumor margins. If one-stage approach is used and resection of margins is needed, it can be done by re-excision or by mastectomy. Some have advocated using frozen section analysis of the margins or of tumor bed biopsies [50–52]. We use a modified approach; when clinical examination, intraoperative radiography, or any other specimen-examining devices (such as MarginProbe or ClearSight) point to a suspicious margin, a frozen section of that aspect of tumor bed excision is performed. Another benefit of a delayed approach is the ability to repair the cosmetic adverse results of radiotherapy [14].

Since patients prefer a one-stage operation, they should be informed about the possibility of a second surgery due to margin involvement sometimes necessitating mastectomy. There is no evidence that immediate OPS is worse from the point of view of local recurrence or survival than delayed OPS [50, 53].

The timing for a second procedure depends on the technique of OPS reconstruction. For some OPS methods, mainly Level 1 volume displacement, the best results are when carried out within 1 week to 10 days following the resection of the primary tumor. This is to avoid resection cavity contraction. For Level 2 OPS, the timing can be either immediate, within 7–10 days, or planned delayed.

Operative Time

Operative time of OPS is longer than lumpectomy alone. This is also dependent on whether displacement or replacement procedures are used. Clough reported a mean operative time of 120 min for immediate OPS with contralateral adjustment [16]. Time should be taken into consideration when planning OPS.

Neoadjuvant Chemotherapy (NAC) and OPS

Preoperative chemotherapy, known as NAC, was introduced and has become standard of care for locally advanced and inoperable tumors, thus enabling breast conservation depending on the tumor response. The indication for NAC has been broadened to include HER2 positive or triple negative early stage breast cancer, in order to assess tumor response and plan further postoperative oncological treatment.

In the past, NAC was considered as a possible risk factor for increased postoperative complication rate and margin positivity. The ideal interval between NAC and surgery was 4–8 weeks. In our experience, NAC did not increase the complication rate of OPS relative to patients who were operated without previous chemotherapeutic treatment. A recent publication examined the effect of NAC timing on the rate of complications in breast surgery. No increase in complications was found for patients with an interval shorter than 4 weeks between completion of NAC and surgery compared with an interval of 4 weeks or longer [71].

Indications for OPS

- Resection of parenchymal tissue greater than 70–100 cm^2 or a tumor-to-breast weight ratio exceeding 10%
- Need to resect over 20% of the breast volume (Cochrane et al. claim that aesthetically limit for BCT is approximately 10% volume excision.) [9, 13]
- Tumor located in the central, medial, or inferior quadrant, where only a 5% reduction in breast volume will cause deformity due to paucity of breast tissue
- Large breasts with ptosis
- Need for large skin resections
- Cancers located close to the skin

Contraindications for OPS

- Small breasts without ptosis and conical breasts
- Previous plastic surgery of the breast
- Widespread DCIS

Relative Contraindications for OPS

- Multifocal tumors
- Recurrence
- Minimal clinical response to neoadjuvant chemotherapy
- Exaggerated patient’s expectations of aesthetic results

- Previously irradiated breast
- Very young age as well as old age
- Associated clinical conditions, such as uncontrolled vascular diabetes, tobacco use, and collagen vascular diseases

Preoperative Planning

This is the most important phase for optimizing the adequate surgical resection technique without compromising cosmesis [9, 30, 32, 54–56]. This is a multidisciplinary phase. The multidisciplinary breast team should bear in mind that the primary aim of OPS is oncologic safety; therefore, a clear understanding of the location and spread of the cancer is required for optimal tumor removal. Review of all imaging information with the assistance of the breast radiologist, combined with the tumor biology information along with the breast and plastic surgeon's experience, is extremely important in the decision-making. Since the primary aim of OPS is oncologic safety, a clear understanding of the location and spread of the cancer is crucial for optimal tumor resection. The extent of ductal carcinoma in situ (DCIS) dissemination cannot be reliably predicted by mammography combined with ultrasound. DCIS may present with micro-calcifications. However, the calcifications do not represent the full extent of DCIS spread and are absent in low-grade DCIS, so they may not be reliable for predicting the entire resection needed to remove the lesion. Contrast-enhanced magnetic resonance imaging (MRI) has the lowest false-negative rate and highest accuracy [57]. However, the rate of false-positive results is high, and it is not always possible to determine the extent of noninvasive cancers. Therefore, MRI cannot be considered as the standard for surgery planning, and its use should be limited to restricted indications. Preoperative planning should be reassessed during the operation using specimen radiography and other devices such as the MarginProbe [58, 59], the ClearSight [60], or any other available technology for intraoperative tumor margin assessment.

The contralateral breast adjustment is part of OPS since symmetry is part of the overall outcome. With time, there is a natural sagging of the breast and ptosis of the nipple. They lay progressively infero-laterally with age. Symmetric considerations of the breasts by lifting or reducing the adjacent breast will add benefit to the aesthetic improvement by oncoplastic techniques [9, 30, 54–56].

Oncoplastic Breast Surgery Techniques

Tissue Displacement/Rearrangement (Figs. 6.1 and 6.2)

Small- to medium-sized breasts are best suited for limited tissue rearrangement when the defect does not lead to significant volume alteration and asymmetry. Dermoglandular advancement and rotation and transposition flap placement are the main procedures used for filling the dead space with the surrounding remaining breast tissue.

The mammary gland is usually dissected from the underlying pectoralis muscle, and a full-thickness fibro-glandular breast flap is advanced into the defect (Fig. 6.2). However, the extensive dual-plane undermining of the breast gland may harness blood supply and should be performed cautiously, especially in low-density breasts with a high fatty composition. In an optimal procedure, the location of the nipple-areolar complex (NAC) is anticipated and it is relocated accordingly, as its position progresses in the infero-lateral direction with age, particularly in young patients [61–66].

The ideal technique for medium to large breasts with ptosis is probably mastopexy or reduction [61–66]. The tumor is included within the breast resection pattern, while the remaining breast parenchyma is used for mound reshaping. The oncoplastic approach has been described by Masetti et al. [67] as a four-step procedure where skin incisions and parenchymal excisions are first planned according to reduction/mastopexy templates. This is followed by parenchymal reshaping, repositioning of the NAC, and, finally, correction of the contralateral breast to achieve symmetry. When the tumor lies beyond the resection region of the mammoplasty, breast reshaping can be combined with complete tumor removal (Fig. 6.1).

The key step is the preoperative decision-making process: designing the pedicle, creating the skin/parenchymal resection pattern so as to preserve the viability of the NAC, reshaping the breast mound, and reducing the dead space.

If the expected volume of the breast to be removed is <20%, the remaining breast mound can be satisfactorily reshaped with simple skin and glandular undermining. Skin undermining follows the mastectomy plane, and the target can be increased from 20% to 60% of overlying skin. The nipple-areolar complex (NAC) can also be undermined by complete transection of the terminal ducts with a 0.5 to 1 cm glandular tissue left attached. NAC sensitivity may be reduced, but arterial supply and venous drainage are usually maintained. Furthermore, NAC displacement can be prevented by deepithelization of the periareolar skin in the shape of a crescent opposed to the defect site. Immediate recentralization guarantees a better cosmetic outcome than repositioning of the NAC after radiotherapy.

If the volume of the breast to be removed exceeds 20–50%, more complex OPS procedures are required, which ensure a wider resection margin while preserving the final breast shape from contour deformities and asymmetry. In addition, corrective surgery for the contralateral breast to achieve symmetry should be discussed with the patient in the preoperative setting, as after OPS the operated cancer-bearing breast usually appears smaller, higher, and rounder.

OPS is suitable for lower pole tumors, since the use of BCT in these areas usually results in the “bird’s-beak” deformity with a downward deviation of the NAC, which can also worsen as a consequence of postirradiation fibrosis.

Superior or superomedial pedicle inverted T- or vertical scar mammoplasty allows for tumor removal within the Wise pattern [61–66]. The resulting cosmetic outcome is excellent in women with medium-to-large breasts.

A V-mammoplasty improves the aesthetic outcome of superior pedicle mammoplasty when the tumor is located in the lower-inner quadrant. The tumor is excised en bloc with a pyramidal section of the gland, with its apex at the border of the areola and its base in the inframammary fold (IMF). The incision is made laterally to the anterior axillary line in order to medially rotate a skin-glandular flap to fill the defect and reshape the breast. The resulting scar has a V-shape and is mainly hidden in the IMF.

Tumor located in the upper inner quadrant needs to be treated with extra caution in the preoperative setting [62]. It is the most visible part of the breast and therefore an aesthetically relevant region. Therefore, the scars are particularly difficult to hide and may distort the décolleté. An inferior medial pedicle mammoplasty provides satisfactory results and allows for safe tumor excision in the upper half of the breast while preserving the viability of the NAC. Donut or round-block mastopexy also allows for removal of segmentally distributed tumor of the upper inner quadrant through a periareolar access point. Furthermore, Clough et al. [9] described the use of a rotation glandular flap for upper inner quadrant tumors, which can be also applied to all quadrants. However, their technique requires extensive undermining of the gland and, therefore, should be reserved for glandular and not fatty breasts. According to Clough's technique, the NAC and the gland are extensively undermined through a semicircular periareolar incision. Once the tumor is completely resected, a wide V-shaped glandular flap is rotated medially toward the defect site via a full-thickness glandular incision created laterally from the lumpectomy cavity. Such remodeling techniques are not feasible if the skin in the upper half of the breast needs to be resected. In such cases, Silverstein's batwing mastopexy technique may be a solution [32, 55]. According to this method, two similar half-circle incisions with angled "bat" wings are marked on either side of the NAC; the tumor is located within this resection pattern and is excised at full thickness. The remaining fibro-glandular tissue is advanced to close the defect; this results in the upward lift of the breast and nipple. This is a simple procedure that does not need extensive dual-plane undermining and also corrects breast ptosis. A similar procedure is occasionally performed on the contralateral breast to achieve symmetry. When performing the batwing mastopexy, surgeons should not excessively reduce the sternal notch to nipple (SN-N) distance, as this could result in pseudo-ptosis. Indeed, undue upward displacement of the NAC would make the breast appear highly unnatural, and, therefore, the SN-N distance should never be less than 16 cm. Both batwing and donut mastopexy also provide outstanding results for tumors located in the upper and lateral quadrants.

Round-block mastopexy can easily be performed on tumors in any location; however, it is most suitable for upper-pole tumors that are close to the areola and mildly ptotic breasts that can be aesthetically improved after a mastopexy. Indeed, once the two concentric periareolar incisions are made and the intervening skin is deepithelized, the skin envelope can be undermined starting from the outer incision line in any direction, in the same fashion as a subcutaneous mastectomy. The tumor and the surrounding tissue are excised from the subcutaneous plane to the pectoralis fascia, while the glandular flap from both sides is mobilized and advanced into the defect. The viability of the NAC is ensured as it is derived from the posterior glandular base. Moreover, the resulting periareolar scar stretching is lessened by a dual-layer closure with absorbable sutures, thus eliminating the need for a purse-string closure.

Tumors of the upper outer quadrant are associated with the best cosmetic outcome, since this is the most forgiving location; fortunately, up to 60% of tumors occur in this region. Racquet mammoplasty can be used to resect large sections of tumors with a quadrantectomy-type incision made over the tumor from the NAC toward the axilla. The periareolar skin is deepithelized, and the NAC is extensively undermined to relocate it to the center of the breast mound.

Tumor of the lower outer pole can be resected using a J-type mammoplasty that avoids lateral retraction of the breast and deviation of the NAC, which are usually associated with an inverted-T mammoplasty. Similar to the V-mammoplasty, the J-type method uses a lateral and central glandular flap that is rotated toward the defect to redistribute the remaining tissue. The NAC is repositioned with a deepithelialized superior pedicle. The final scar is in the shape of the letter J from the periareolar down to the inframammary crease.

Centrally located and subareolar tumors can be contraindications for BCS, since the NAC is involved in 50% of the cases. Retro-areolar tumors or those closer than 2 cm to the nipple do not allow for preservation of the NAC that are usually removed en bloc with the tumor. However, an inverted T, a modified Lejour, or a J-closure pattern, similar to breast amputation reduction techniques, can all provide good aesthetic outcomes. The NAC is eventually reconstructed using a local flap of choice and subsequently tattooed. When the cancer is located superiorly or laterally, an elliptical skin excision centered on the NAC can also be performed, and similar surgery may be required for the contralateral breast. However, the inverted-T Wise pattern mastectomy tends to have better cosmetic outcomes as some amount of breast projection is retained; in contrast, the purse-string and transverse-scar techniques tend to flatten the breast mound (Figs. 6.3 and 6.4).

Tissue Replacement

Large tumors, high tumor/breast volume ratio, and small breasts are often associated with defects that are difficult to reconstruct with tissue displacement techniques [50, 68–70]. Indeed, the residual breast tissue is usually insufficient for proper rearrangement after a partial mastectomy, and the patient may require reconstruction using autologous local or distant flaps. As a result, tissue-replacement techniques are opted for the reconstruction of relatively small breasts with a large resection volume. Furthermore, with the tissue-replacement technique, remodeling of the contralateral breast is usually not required to achieve symmetry. The use of fasciocutaneous flaps, myo-cutaneous local flaps, pedicled perforator flaps, and even free flaps has been described for partial breast reconstruction. Local fascio-cutaneous flaps can be employed in the case of small lateral defects (<10% of the breast size). The use of transposition flaps from the subaxillary area was first reported by Clough et al. [9]. Munhoz et al. [63] have described the placement of the lateral thoracodorsal flap (LTDF), which is ideal for lateral defects, especially in obese patients. These are essentially fascio-cutaneous flaps that rotate or transfer the skin and the subcutaneous fat of the subaxillary area to fill the breast parenchyma into the defect.

Lower-quadrant resection near the IMF in small- to moderate-sized breasts can be filled with a fascio-cutaneous flap harvested from below the IMF and then rotated to fill the defect created by the segmental excision. Flap survival and aesthetic outcome are ensured by a careful flap design.

When the defect ranges from 10% to 30% of the breast volume, a pedicled musculocutaneous flap can be harvested. The latissimus dorsi (LD) musculocutaneous flap represents a common local option. This flap uses the LD muscle and overlying skin to fill lateral, central, inferior, and even medial defects. The LD is separated from its insertions and pivoted under the axilla while preserving excellent blood supply via its vascular pedicle. An LD myo-subcutaneous flap can be harvested with the help of an endoscope when the skin overlying the tumor needs to be preserved in order to avoid a scar on the back. An LD musculocutaneous flap should have larger dimensions than the defect it is used to fill. Indeed, the LD muscle usually undergoes postoperative atrophy as a consequence of the surgical de-innervation and radiotherapy. Therefore, a much larger flap than needed must be harvested in order to avoid unsatisfactory results caused by the expected loss of muscle volume.

The pedicled perforator flap technique has an advantage over other methods of autologous breast reconstruction, as it uses well-vascularized tissues and spares the underlying muscles, which results in lower donor site morbidity in terms of muscle function and seroma formation. According to the pedicle length, perforator flaps can be used to manage defects in almost every quadrant. Intercostal, thoracodorsal, and superior epigastric arteries are the main pedicles upon which the perforator flaps can be based. The fascio-cutaneous skin paddle of the classical LD musculocutaneous flap can be raised as a pedicled perforator flap from either the thoracodorsal or intercostal vessels and used to cover lateral, central, and inferior defects. The thoracodorsal artery perforator (TDAP) flap is based on the vertical branch of the thoracodorsal artery; it can be easily used for filling in lateral, superolateral, and central defects of the breast. If no suitable perforators are found, the flap can be easily converted to a muscle-sparing TDAP or muscle-sparing LD flap. Either the anterior or the lateral branches of the intercostal arteries are suitable for harvesting local perforator flaps. Lateral and inferior defects of the breast can be reconstructed with the lateral intercostal artery perforator (LICAP) flap, while inferior or medial defects can be reconstructed with the anterior intercostal artery perforator (AICAP) flap. Perforators of the LICAP flap are usually found 2.7–3.5 cm from the anterior border of the LD muscle, while those of the AICAP flap pierce through the rectus abdominis or the external oblique muscles.

The superior epigastric artery perforator (SEAP) flap can be harvested as an alternative to the AICAP flap since both share the same indications. However, the SEAP flap can cover more remote defects in the breast since it has a longer pedicle provided by perforators arising from the superior epigastric artery or its superficial branch.

If the defect is large and medially located or if the residual breast tissue after a partial mastectomy is minimal, mastectomy and subsequent autologous free-flap breast reconstruction may have the best cosmetic and oncologic outcomes.

Other less common volume replacement techniques are adipo-fascial flap placement, omental flap placement, and an autologous fat graft (AFG). Autologous fat grafting (AFG) is also a secondary procedure that can ameliorate any residual contour deformities and asymmetry with the contralateral breast. Due to the presence of the so-called adipose-derived stem cells (ASCs), an AFG displays regenerative and therapeutic properties. ASCs can differentiate into multiple cell lineages and secrete paracrine factors. Thus, angiogenesis and wound healing are strongly enhanced, leading to higher fat graft survival as well as dermal and subcutaneous tissue regeneration. Moreover, AFG can improve radio-induced soft tissue damage in reconstructed breasts. Indeed, ASCs can thicken the subcutaneous tissue and improve the texture of the irradiated skin by enhancing its vascular supply through the ASCs' regenerative potential.

Postoperative Follow-Up

One of the main concerns with OPS is that postsurgical major tissue rearrangements, scar tissue, and fat necrosis may have an impact on the ability to adequately screen for local recurrence. Concerns about this issue have been raised in the literature; however, current radiologic imaging combined with ultrasonography and MRI may assist in identifying suspicious recurrent cancer that can be then finally diagnosed by tissue sampling. As the tissue-healing process advances, mammographic sensitivity does not seem to be less affected, and the qualitative changes observed are similar to those observed after lumpectomy [24]. The time required to achieve radiologic stability that will be considered as the new baseline after OBS tends to be longer (25.6 months vs. 21.2 months) [72]. As mentioned previously, ultrasound and MRI can be integrated in the diagnostic process. The frequency of follow-up examinations should be the same for OPS than for any other breast-conserving surgery.

References

1. Veronesi U, Cascinelli N, Mariani L, Greco M, Saccozzi R, Luini A, Agullar M, Marubini E. Twenty-year follow-up of a randomized study comparing breast-conserving surgery with radical mastectomy for early breast cancer. N Engl J Med. 2002;347:1227–32.
2. Fisher B, Anderson S, Bryant J, Margolese RG, Deutsch M, Fisher ER, Jeong JH, Wolmark N. 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. 2002;347:1233–41.
3. Al-Ghazal K, Fallowfield L, Blamey RW. Does cosmetic outcome from treatment of primary breast cancer influence psychosocial morbidity. Eur J Surg Oncol. 1999;25:571–7.
4. Bajaj AK, Kon PS, Oberg KC, Miles DA. Aesthetic outcomes in patients undergoing breast conservation therapy for the treatment of localized breast cancer. Plast Reconstr Surg. 2004;114:1442–8.
5. Amichetti M, Caffo O. Quality of life in patients with early stage breast carcinoma treated with conservation surgery and radiotherapy. An Italian monoinstitutional study. Tumori. 2001;87:78–83.

6. Moran MS, Schnitt SJ, Giuliano AE. Society of Surgical Oncology–American Society for Radiation Oncology consensus guideline on margins for breast-conserving surgery with whole-breast irradiation in stages I and II invasive breast cancer. Int J Radiat Oncol Biol Phys. 2014;88:553–64.
7. Morrow M, van Zee KJ, Solin LJ, Houssami N, Chavez-MacGregor M, Harris JR, Horton J, Hwang S, Johnson PL, Marinovich ML, Schnitt SJ, Wapnir I, Moran MS. Society of Surgical Oncology–American Society for Radiation Oncology–American Society of Clinical Oncology consensus guideline on margins for breast-conserving surgery with whole-breast irradiation in ductal carcinoma in situ. Ann Surg Oncol. 2016;23:3801–10.
8. Clough KB, Cuminet J, Fitoussi A, Nos C, Mosseri V. Cosmetic sequelae after conservative treatment for breast cancer: classification and results of surgical correction. Ann Plast Surg. 1998;41:471–81.
9. Clough KB, Benyahi D, Nos C, Charles C, Sarfati I. Oncoplastic surgery: pushing the limits of breast-conserving surgery. Breast J. 2015;21:140–6.
10. Hill-Kayser CE, Vachani C, Hampshire MK, Di Lullo GA, Metz JM. Cosmetic outcomes and complications reported by patients having undergone breast-conserving treatment. Int J Radiat Oncol Biol Phys. 2012;83(3):839–44.
11. Ozmen T, Polat AV, Polat AK. Factors affecting cosmesis after breast conserving surgery without oncoplastic techniques in an experienced comprehensive breast center. Surgeon. 2015;13:139–44.
12. Negenborn VL, Volders JH, Krekel NMA, Haloua MH, Bouman MB, Buncamper ME, Niessen FB, Winters HAH, Terwee CB, Meijer S, van den Tol MP. Breast-conserving therapy for breast cancer: cosmetic results and options for delayed reconstruction. J Plast Reconstr Aesthet Surg. 2017;70:1336–44.
13. Cochrane RA, Valasiadou P, Wilson AR, Al-Ghazal SK, Macmillan RD. Cosmesis and satisfaction after breast-conserving surgery correlates with the percentage of breast volume excised. Br J Surg. 2003;90:1505–9.
14. Campbell EJ, Romics L. Oncological safety and cosmetic outcomes in oncoplastic breast conservation surgery, a review of the best level of evidence literature. Breast Cancer. 2017;9:521–30.
15. Darby S, McGale P, Correa C, et al. Effect of radiotherapy after breast-conserving surgery on 10-year recurrence and 15-year breast cancer death: meta-analysis of individual patient data for 10801 women in 17 randomized trials. Lancet. 2011;378:1707–16.
16. Clough KB, Lewis JS, Couturaud B, Fitoussi A, Nos C, Falcou MC. Oncoplastic techniques allow extensive resections for breast-conserving therapy of breast carcinomas. Ann Surg. 2003;237:26–34.
17. Carter SA, Lyons GR, Kuerer HM, Bassett RL Jr, Oates S, Thompson A, Caudle AS, Mittendorf EA, Bedrosian I, Lucci A, DeSnyder SM, Babiera G, Yi M, Baumann DP, Clemens MW, Garvey PB, Hunt KK, Hwang RF. Operative and oncologic outcomes in 9861 patients with operable breast cancer: single-institution analysis of breast conservation with oncoplastic reconstruction. Ann Surg Oncol. 2016;23(10):3190–8.
18. Kaur N, Petit JY, Rietjens M, et al. Comparative study of surgical margins in oncoplastic surgery and quadrantectomy in breast cancer. Ann Surg Oncol. 2005;12:539–45.
19. Down SK, Jha PK, Burger A, Hussien MI. Oncological advantages of oncoplastic breast-conserving surgery in treatment of early breast cancer. Breast J. 2013;19(1):56–63.
20. Clough KB, Kaufman GJ, Nos C, Buccimazza I, Sarfati IM. Improving breast cancer surgery: a classification and quadrant per quadrant atlas for oncoplastic surgery. Ann Surg Oncol. 2010 May;17:1375–91.
21. Weber WP, Soysal SD, Fulco I, Barandun M, Babst D, Kalbermatten D, Schaefer DJ, Oertli D, Kappos EA, Haug M. Standardization of oncoplastic breast conserving surgery. Eur J Surg Oncol. 2017;43:1236–43.
22. Weber WP, Soysal SD, El-Tamer M, Sacchini V, Knauer M, Tausch C, Hauser N, Gunthert A, Harder Y, Kappos A, Schwab F, Fitzal F, Dubsky P, Bjelic-Radisic V, Reitsamer R, Koller R, Heil J, Hahn M, Blohmer J, Hoffmann J, Solbach C, Heitmann C, Gerber B, Haug M,

Kurzeder C. First international consensus conference on standardization of oncoplastic breast conserving surgery. Breast Cancer Res Treat. 2017;165:139–49.
23. Haloua M, Krekel N, Winters H, Rietveld D, Meijer S, Bloemers F, van den Tol M. A systematic review of oncoplastic breast-conserving surgery: current weaknesses and future prospects. Ann Surg. 2013;257:609–20.
24. Bertozzi N, Pesce M, Santi P, Raposio L. Oncoplastic breast surgery: comprehensive review. Eur Rev Med Pharmacol Sci. 2017;21:2572–85.
25. Pilewskie M, Morrow M. Margins in breast cancer: how much is enough. Cancer. 2018;124:1335–41.
26. McCahill LE, Single RM, Aiello Bowles EJ. Variability in reexcision following breast conservation surgery. JAMA. 2012;307:467–75.
27. Houssami N, Macaskill P, Marinovich ML. Meta-analysis of the impact of surgical margins on local recurrence in women with early-stage invasive breast cancer treated with breast-conserving therapy. Eur J Cancer. 2010;46:3219–32.
28. Schnitt SJ, Abner A, Gelman R, Connelly JL. The relationship between microscopic margins of resection and the risk of local recurrence in patients treated with breast conserving surgery and radiation therapy. Cancer. 1994;74:1746–51.
29. Moran MS, Schnitt SJ, Giuliano AE, et al. Society of Surgical Oncology-American Society for Radiation Oncology consensus guideline on margins for breast-conserving surgery with whole-breast irradiation in stages I and II invasive breast cancer. J Clin Oncol. 2014;32(14):1507–15.
30. Yiannakopouloua EC, Mathelin C. Oncoplastic breast conserving surgery and oncological outcome: systematic review. Eur J Surg Oncol. 2016;42:625–30.
31. Niinikoski L, Leidenius MHK, Vaara P, Voynov A, Heikkilä P, Mattson J, Meretoja TJ. Resection margins and local recurrences in breast cancer: comparison between conventional and oncoplastic breast conserving surgery. Eur J Surg Oncol. 2019 Jun;45:976–82.
32. Silverstein MJ, Mai T, Savalia N, Vaince F, Guerra L. Oncoplastic breast conservation surgery: the new paradigm. J Surg Oncol. 2014;110:82–9.
33. De LaCruz L, Blankenship SA, Chatterjee A. Outcomes after oncoplastic breast-conserving surgery in breast cancer patients: a systematic literature review. Ann Surg Oncol. 2016;23(10):3247–58.
34. Chakravorty A, Shrestha AK, Sanmugalingam N, Rapisarda F, Roche N, Querci Della Rovere G, Macneill FA. How safe is oncoplastic breast conservation? Comparative analysis with standard breast conserving surgery. Eur J Surg Oncol. 2012 May;38(5):395–8.
35. Mazouni C, Naveau A, Kane A, Dunant A, Garbay JR, Leymarie N, Sarfati B, Delaloge S, Rimareix F. The role of oncoplastic breast surgery in the management of breast cancer treated with primary chemotherapy. Breast. 2013;22:1189–93.
36. Chang EI, Peled AW, Foster RD. Evaluating the feasibility of extended partial mastectomy and immediate reduction mammoplasty reconstruction as an alternative to mastectomy. Ann Surg. 2012;255:1151–7.
37. Kaviani A, Safavi A, Mohammadzadeh N, Jamei K, Ansari-Damavandi M, Salmon RJ. Oncoplastic surgery in breast conservation: a prospective evaluation of the patients, techniques, and oncologic outcomes. Am J Surg. 2014;208:727–34.
38. Gulcelik MA, Dogan L, Yuksel M, Camlibel M, Ozaslan C, Reis E. Comparison of outcomes of standard and oncoplastic breast-conserving surgery. J Breast Cancer. 2013 Jun;16:193–7.
39. Koppiker CB, Noor AU, Dixit S, Busheri L, Sharan G, Dhar U, Allampati HK, Nare S. Extreme oncoplastic surgery for multifocal/multicentric and locally advanced breast cancer. Int J Breast Cancer. 2019;2019:1–8.
40. Calì Cassi L, Vanni G, Petrella G, Orsaria P, Pistolese C, Lo Russo G, Innocenti M, Buonomo O. Comparative study of oncoplastic versus non-oncoplastic breast conserving surgery in a group of 211 breast cancer patients. Eur Rev Med Pharmacol Sci. 2016;20:2950–4.
41. Hillberg NS, van Mulken TJM, Meesters-Caberg MAJ, Piatkowski A, XAH K, Hommes J, van der Hulst RRW. Autologous breast reconstruction with a delay procedure of the deep inferior epigastric artery perforator flap because of venous congestion of the flap on pedicle: a case series. Ann Plast Surg. 2019;82:537–40.

42. Tenofsky PL, Dowell P, Topalovski T, Helmer SD. Surgical, oncologic, and cosmetic differences between oncoplastic and nononcoplastic breast conserving surgery in breast cancer patients. Am J Surg. 2014;207:398–402.
43. START Trialists' Group, Bentzen SM, Agrawal RK, Aird EG, Barrett JM, Barrett-Lee PJ, Bliss JM, Brown J, Dewar JA, Dobbs HJ, Haviland JS, Hoskin PJ, Hopwood P, Lawton PA, Magee BJ, Mills J, Morgan DA, Owen JR, Simmons S, Sumo G, Sydenham MA, Venables K, Yarnold JR. The UK Standardisation of Breast Radiotherapy (START) Trial A of radiotherapy hypofractionation for treatment of early breast cancer: a randomised trial. Lancet Oncol. 2008;9:331–41.
44. Kelemen P, Pukancsik D, Újhelyi M, Sávolt Á, Kovács E, Ivády G, Kenessey I, Kovács T, Stamatiou A, Smanykó V, Mátrai Z. Comparison of clinicopathologic, cosmetic and quality of life outcomes in 700 oncoplastic and conventional breast-conserving surgery cases: a single-centre retrospective study. Eur J Surg Oncol. 2019;45:118–24.
45. James R, McCormick B, Cox L, Yahalom Y. Primary breast irradiation in large-breasted or heavy women: analysis of cosmetic outcom. Int J Radiat Oncol Biol Phys. 1991;21:347–54.
46. Macmillan RD, McCulley SJ. Oncoplastic breast surgery: what, when and for whom? oncoplastic breast surgery: what, when and for whom? Curr Breast Cancer Rep. 2016;8:112–7.
47. Cracco S, Semprini G, Cattin F, Gregoraci G, Zeppieri M, Isola M, Ceschia T, Cedolini C, Parodi PC. Impact of intraoperative radiotherapy on cosmetic outcome and complications after oncoplastic breast surgery. Breast J. 2015;21:285–90.
48. Peled AW, Sbitany H, Foster RD, Esserman LJ. Oncoplastic mammoplasty as a strategy for reducing reconstructive complications associated with postmastectomy radiation therapy. Breast J. 2014;20:302–7.
49. James R, McCulley SJ, Macmillan RD. Oncoplastic and reconstructive breast surgery in the elderly. Br J Surg. 2015;102:480–8.
50. Noguchi M, Yokoi-Noguchi M, Ohno Y, Morioka E, Nakano Y, Kosaka T, Kurita T. Oncoplastic breast conserving surgery: volume replacement vs. volume displacement. Eur J Surg Oncol. 2016;42:926–34.
51. Raja MAK, Straker VF, Rainsbury RM. Extending the role of breast-conserving surgery by immediate volume replacement. Br J Surg. 1997;84:101–5.
52. Rainsbury RM. Breast-sparing reconstruction with latissimus dorsi miniflaps. Eur J Surg Oncol. 2002;28:891–5.
53. Noone R, Frazier T, Noone G, Blanchet N, Murphy J, Rose D. Recurrence of breast carcinoma following immediate reconstruction: a 13-year review. Plast Reconstr Surg. 1994;93:96–106.
54. Berry MG, Fitoussi AD, Curnier A, Couturaud B, Salmon RJ. Oncoplastic breast surgery: a review and systematic approach. J Plast Reconstr Aesthet Surg. 2010;63:1233–43.
55. Savalia NB, Silverstein MJ. Oncoplastic breast reconstruction: patient selection and surgical techniques. J Surg Oncol. 2016;113:875–82.
56. Kopkash K, Clark P. Basic Oncoplastic surgery for breast conservation: tips and techniques. Ann Surg Oncol. 2018;25:2823–8.
57. Houssami N, Turner RM, Morrow M. Meta-analysis of pre-operative magnetic resonance imaging (MRI) and surgical treatment for breast cancer. Breast Cancer Res Treat. 2017;165:273–83.
58. Thill M. MarginProbe: intraoperative margin assessment during breast conserving surgery by using radiofrequency spectroscopy. Expert Rev Med Devices. 2013;10:301–15.
59. Schnabel F, Boolbol SK, Gittleman M, Karni T, Tafra L, Feldman S, Police A, Friedman NB, Karlan S, Holmes D, Willey SC, Carmon M, Fernandez K, Akbari S, Harness J, Guerra L, Frazier T, Lane K, Simmons RM, Estabrook A, Allweis T. A randomized prospective study of lumpectomy margin assessment with use of MarginProbe in patients with nonpalpable breast malignancies. Ann Surg Oncol. 2014;21:1589–95.
60. Papa M, Allweis T, Karni T, Sandbank J, Konichezky M, Diment J, Guterman A, Shapiro M, Peles Z, Maishar R, Gur A, Kolka E, Brem R. An intraoperative MRI system for margin assessment in breast conserving surgery: initial results from a novel technique. J Surg Oncol. 2016;114:22–6.

61. Grubnik A, Benn C, Edwards G. Therapeutic mammaplasty for breast cancer: oncological and aesthetic outcomes. World J Surg. 2013;37:72–83.
62. Cutress RI, Simoes T, Gill J, Hurren JS. Modification of the wise pattern breast reduction for oncological mammaplasty of upper outer and upper inner quadrant breast tumours: a technical note and case series. J Plast Reconstr Aesthet Surg. 2013;66:31–6.
63. Munhoz AM, Montag E, Gemperli R. Current aspects of therapeutic reduction mammaplasty for immediate early breast cancer management: an update. World J Clin Oncol. 2014;5(1):1–18.
64. Macmillan RD, James R, Gale KL, McCulley SJ. Therapeutic mammaplasty. J Surg Oncol. 2014;110:90–5.
65. Losken A, Pinell-White X, Hart AM, Freitas AM, Carlson GW, Styblo TM. The oncoplastic reduction approach to breast conservation therapy: benefits for margin control. Aesthet Surg J. 2014;34:1185–91.
66. Egro FM, Pinell-White X, Hart AM, Losken A. The use of reduction mammaplasty with breast conservation therapy: an analysis of timing and outcomes. Plast Reconstr Surg. 2015;135(6):963e–71e.
67. Masetti R, Di Leone A, Franceschini G, Magno S, Terribile D, Fabbri MC, Chiesa F. Oncoplastic techniques in the conservative surgical treatment of breast cancer: an overview. Breast J. 2006;12:S174–80.
68. Liu LQ, Branford OA, Mehigan S. BREAST-Q measurement of the patient perspective in oncoplastic breast surgery: a systematic review. Plast Reconstr Surg Glob Open. 2018;6(8):e1904.
69. Hu J, Rainsbury RM, Segaran A, Predescu O, Roy PG. Objective assessment of clinical, oncological and cosmetic outcomes following volume replacement in patients undergoing oncoplastic breast-conserving surgery: protocol for a systematic review. BMJ Open. 2018;19(8):e020859.
70. Pasta V, D'Orazi V, Merola R, Frusone F, Amabile MI, De Luca A, Buè R, Monti M. Oncoplastic central quadrantectomies. Gland Surg. 2016;5:422–6.
71. Adamson K, Chavez-MacGregor M, Caudle A, Benjamin S, Baumann D, Liu J, Schaverien M. Neoadjuvant chemotherapy does not increase complications in oncoplastic breast-conserving surgery. Ann Surg Oncol. 2019;26(9):2730–7.
72. Mendelson EB. Evaluation of the postoperative breast. Radiol Clin N Am. 1992;30:107–38.

Crescent Mastopexy

7

Michael Knauer

Introduction

As described in Chap. 1 BEFORE, oncoplastic breast-conserving surgery has several goals by combining breast cancer surgery adhering to oncologic principles with techniques from plastic surgery [1]. One of these goals always has to be best possible patient satisfaction as measured by patient reported outcome measures (PROMs). In a relevant percentage of cases, assessment by patient differs substantially from the surgeon's perspective and assessment is often not well reproducible [2, 3]. Frequently the patients rate cosmetic outcome better than we surgeons do. In order to better standardize quality of life assessments, several instruments like the BREAST-Q questionnaire among some others have been developed [4, 5]. We have to keep in mind that the patient's perception of a very good cosmetic result may differ from the surgeon's judgment.

Having said that, many women with naturally shaped and aged breasts with considerable ptosis do not want to undergo a complete reduction mammoplasty for cancer surgery, since wound complication rates are higher [6, 7]. Patients also frequently deny contralateral procedures in the healthy breast for symmetrization purposes. A second more sad and barely acceptable reason for women not undergoing contralateral symmetrization surgery is the lack of education and training of many breast surgical oncologists [8]. In a survey among 708 members of the American Society of Breast Surgeons from 2017, only 19% reported independently performing breast reductions, and only 10% performed contralateral symmetrization. In many settings and centers, plastic breast surgeons are not available every day for simultaneous surgery, and therefore many patients may end up with asymmetry and no correction thereof because they do not want to return to the operation theater.

M. Knauer (✉)
Breast Center Eastern Switzerland, St. Gallen, Switzerland
e-mail: michael.knauer@bz-ost.ch

V. S. Klimberg et al. (eds.), *Oncoplastic Breast Surgery Techniques for the General Surgeon*, https://doi.org/10.1007/978-3-030-40196-2_7

As a consequence, breast surgeons have to be enabled to develop a skill set of oncoplastic procedures and offer these techniques to their patients.

A relatively simple and easy to learn technique to achieve this is the "crescent mastopexy," either for correction of some degree of ptosis of the breast harboring the cancer or for contralateral symmetrization. There is no doubt that more complex breast reduction techniques offer better possibilities to reduce hypertrophic breasts when performing cancer surgery with more durable correction of higher-grade ptosis according to Regnault [9]. The first time the term "crescent mastopexy" appears in Medline was in 1985 by Puckett et al. when the authors used this technique in 26 patients with a lesser degree of ptosis in combination with augmentation [10]. In 2006 Gruber et al. described an "extended crescent mastopexy with augmentation" in three patients where in addition to the skin crescent also parenchyma below the skin and two small triangles of breast tissue on either side of the areola were resected [11]. The reason to resect tissue and then do an implant augmentation was to prevent areola spreading, hypertrophic scars, and recurrence of the ptosis because of the tension on the skin closure. These tips and tricks can also be adopted by breast surgeons for breast-conserving cancer surgery.

Indications

The crescent mastopexy can be used as independent technique for breast-conserving oncoplastic surgery, or it can be combined with several other techniques like the triangle resection or V-mammoplasty to change and modify size, contour, and elevation of the breasts [12]. It can also be used for correction of (anticipated) nipple deviation in larger segmentectomies or quadrantectomies.

Breast Shape and Size

In patients with small breasts without any ptosis, the crescent mastopexy technique is contraindicated if the nipple-areola complex (NAC) would end up too high, i.e., the distance from the midclavicle to the nipple would be less than 18–19 cm. The resulting high-riding nipple is very hard to correct and should be avoided in any case [13]. Alternatively a round block mastopexy or a periareolar incision without skin excision can be used – if necessary with a lateral extension to obtain sufficient access to the gland.

In patients with moderate ptosis, the crescent mastopexy is an ideal technique to lift the NAC for about up to 4–5 cm.

For patients with severe ptosis, the crescent mastopexy is not suited if complete correction of the ptosis is desired. An exception could be a patient who does not want to undergo contralateral surgery, since the more adequate technique of a reduction mammoplasty will result in considerable asymmetry.

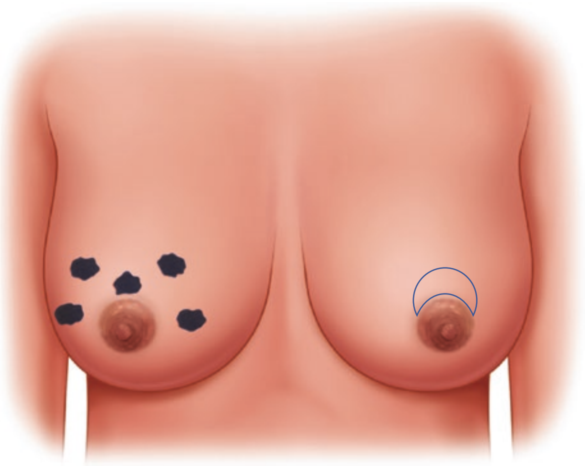


Fig. 7.1 By using the hemicrescent incision, a variety of tumor locations can be approached in both upper quadrants. As a side effect, some degree of breast ptosis can be corrected

Tumor Position

Any location of the tumor between the 9 and 3 o'clock position in the upper quadrants is suitable for the crescent mastopexy (possibly extended to a hemi-batwing operation), especially when correction of ptosis is the goal (see above) or when the skin above the nipple is infiltrated (Fig. 7.1). Alternatively, if the skin left or right of the areola is involved, a batwing or hemi-batwing procedure is more adequate for prevention of local recurrence. Especially in the 12 o'clock position, if the lesion is further away from the NAC, the tissue below the excised skin can be used for closing the cranial defect (Fig. 7.2).

Contralateral Symmetrization and Nipple Centralization

A crescent mastopexy of the skin with or without underlying tissue can be used for contralateral lifting of the NAC to achieve symmetry or also in combination with other oncoplastic procedures like the V-mammoplasty for tumors in the lower inner quadrant or the J-mammoplasty for lesions in the lower outer quadrant [1].

Surgical Technique

1. Incisions

The incision of the crescent mastopexy is marked as usual in a standing or sitting position. It provides a relatively simple means of lifting the NAC to the desired

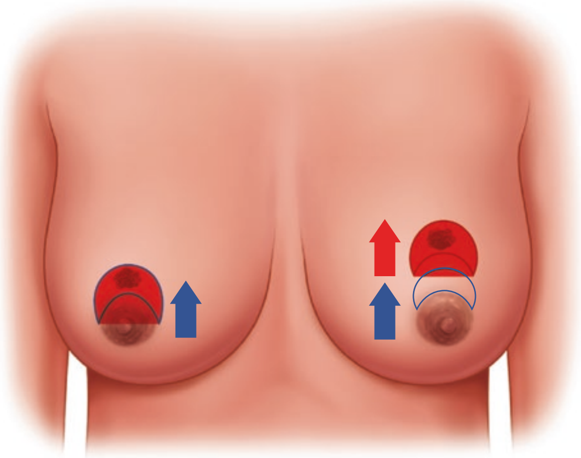


Fig. 7.2 The hemicrescent technique may be used in two different ways. On the right breast, the tumor position is just below the skin of the hemicrescent – the whole skin with the underlying tumor segment is removed – and in a second step, the nipple-areola complex including the tissue below is moved upward into the defect. On the left breast, a variation for tumors higher up in the 12 o'clock position is depicted: After only epidermal incision of the hemicrescent (in blue), the dermal layer is cut along the outer epidermal incision. In this case, the tumor-containing segment is above the skin incision. It will be removed and the deepithelialized tissue segment will be moved upward to fill the defect, including the nipple-areola complex. Wide tissue mobilization is often necessary for this step. Finally the skin incision is closed again

position corresponding to the height of the inframammary fold (Figs. 7.3, 7.4, 7.5, 7.6, 7.7 and 7.8). The first inferior C-shaped line runs along the cranial areolar border from 9 to 3 o'clock, and the second parallel C-shaped incision is marked further cranially. The two lines are then connected at the sides to complete the crescent-shaped skin incision. If only a contralateral lifting of the NAC is planned or the tumor is far away from the NAC at 12 o'clock, it is sufficient to only deepithelialize the crescent pattern. Alternatively, also full skin resection can be done and is even necessary if the skin is tumor-infiltrated. In these cases, sensation of the NAC might be impaired postoperatively.

2. Skin Undermining

Compared to the round block technique, the crescent mastopexy does not need as much skin undermining, and the nipple-areola complex is not to be detached from the underlying tissue. Undermining of the skin may extend laterally to excise spare tissue triangles at the end of the operation.

3. Tumor Resection

If the tumor is close to the NAC below the skin island, an en bloc resection down to the chest wall is performed (Fig. 7.2 right breast). If the tumor is located further

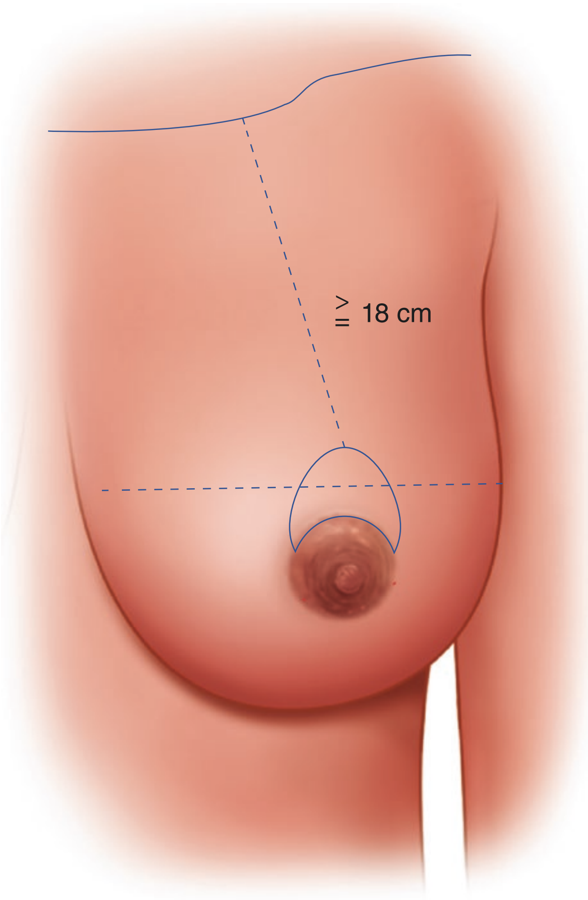


Fig. 7.3 In a not too ptotic breast, the hemicrescent technique can be used to achieve some degree of ptosis correction. By putting the finger into the IMF, the surgeon can determine the height of new position of the NAC. The distance between the midclavicle and the NAC position must not be below 18cm in most cases to avoid cranial malpositioning of the NAC

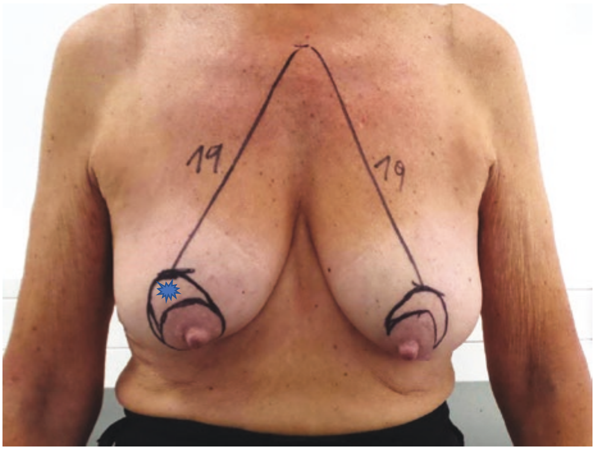


Fig. 7.4 Planning of incisions to correct for ptosis and for contralateral symmetrization: frontal view

Fig. 7.5 45° view of the right breast with tumor located just above the nipple-areola complex

Fig. 7.6 Preoperative skin markings for bilateral hemicrescent mastopexy. The tumor location is not visible at the 6 o'clock position

cranially, the skin island (Fig. 7.2, left breast, blue crescent) can be resected or deepithelialized. In the next step, the tumor-containing segment is resected without overlying skin (left breast, red segment).

4. Glandular Reapproximation

Finally, after clip markings of the cavity, the tissue from underneath the skin crescent is elevated off the chest wall and advanced upward to fill the defect that has been created by the lumpectomy (left breast, red arrow), or the NAC with underlying tissue is moved directly into the cavity (right breast, blue arrow). Glandular absorbable 2–0 sutures are used to close the defect and avoid seroma formation. Fixation sutures to the chest wall are not advised. If there is too much tension in this

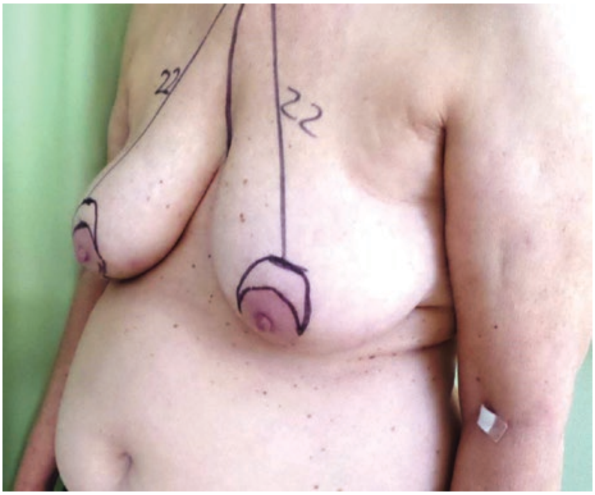


Fig. 7.7 45° view from the left in the same patient – a moderate correction on the contralateral side is desired

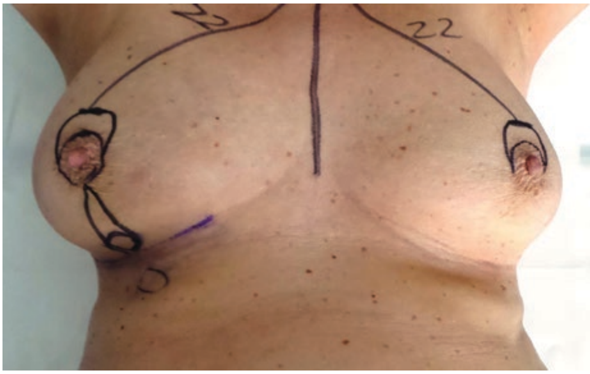


Fig. 7.8 View from below: The tumor is located at the 6 o'clock position near the inframammary fold. A V-mammoplasty is combined with the hemicrescent mastopexy

area or if tissue parts laterally from the cavity tend to bulge ventrally, small triangles of the tissue can be resected to facilitate the NAC lift.

5. Wound Closure

Wound closure is done with a two-layer suture by approximating the superior and inferior edge. An interrupted suture in the dermal layer is done first to carefully approximate the corresponding points of the skin edges, and then a 4–0 or 5–0 absorbable monofilament running suture is used to close the skin. Because of the frequently significant difference in length of the two incisions, there is a limitation

Fig. 7.9 Short-term postoperative image – the ptosis was moderately corrected. Some wrinkling of the scar is visible

to this technique which can only partly be overcome by taking larger bites along the superior C-shape and smaller ones along the inferior margin (see clinical case 2, Fig. 7.9). The wavelike appearance of the closed wound will disappear after some weeks.

Surgical Complications and Solutions

In general, the crescent mastopexy has a low risk of complications compared to other, especially level II oncoplastic procedures like tumor-adapted reduction mammoplasty. Although no large case series or randomized trials for the crescent mastopexy are available, general complications of breast-conserving surgery like bleeding, relevant seroma formation, and wound infection are low in our experience. Complication rates are not higher than in conventional lumpectomy or segmentectomy although this technique is not very frequently performed as an oncoplastic procedure in our practice – far more often a crescent skin or epidermal resection is done for contralateral symmetry or to raise the NAC in combination with other oncoplastic techniques (see clinical case 2). Nipple necrosis – a quite frequent and dreaded complication in nipple-sparing mastectomy – has also never occurred in my experience, when precautions have been taken like leaving the NAC on the tissue below and limiting the periareolar incision to 180° maximum for better blood supply and nipple sensation.

Next to these general complications, the following specific complications or rather cosmetic conditions have to be discussed with the patient beforehand.

1. Impairment of nipple sensation

   Either temporarily or permanently, the sensation of the nipple can be reduced. This cannot be avoided if the whole segment including the skin island has to be removed. However, in contralateral symmetrization procedures, it is advised only to remove the epidermis and leave the dermal plexus to avoid reduced sensation.

2. Recurrence or undercorrection of ptosis

   Since the degree of ptosis that can be corrected is limited to a few centimeters, the patient has to know that a complete correction in grade III ptosis cannot be achieved. Reduction mammoplasty techniques are better suited for these situations. Secondly, it is not rare that ptosis recurs after a year or two, especially in large and pendulous breasts.

3. Redundant skinfolds at wound edges

   If there are still skinfolds at the edges that are unlikely to settle, it might be necessary to reopen the wound and excise lateral skin wings like in the batwing procedure. This results in a different and additionally extended scar.

Conclusion

For cancers in the upper quadrants in breasts with mild to moderate ptosis, this combination of breast-conserving surgery with a moderate breast lift can achieve satisfying cosmetic results. The crescent mastopexy can be used as stand-alone oncoplastic technique as well as in combination with other oncoplastic techniques for correction of the NAC position or for contralateral symmetrization. For complete correction of relevant ptosis, this technique is not appropriate since the degree of correction is limited and recurrent ptosis can occur.

Clinical Cases

Case 1: Correction of Moderate Ptosis and Nipple Deviation

In this 74-year-old patient, an 8 mm lobular cancer is located in the right breast at 11 o’clock adjacent to the nipple-areola complex. The tumor position is delineated in blue. To achieve the best possible cosmetic result, a distance of 19 cm from the sternal notch to the new position of the areola has been chosen. Furthermore because of the natural medial deviation of the NAC, the crescent on both sides was chosen to extend more laterally instead of directly upward.

Case 2: Pre- and Postoperative Image

A 79-year-old patient with a 24 mm cancer NST in the 6 o’clock position of the right breast. In order to avoid the “bird’s-beak deformity,” it was decided to combine a V-mammoplasty for tumor resection with a bilateral crescent mastopexy for a moderate breast lift (distance from sternal notch to new areola position of 22 cm). The patient did not want to undergo a reduction mammoplasty with superior pedicle, also because of multiple comorbidities and an indication for prompt start of adjuvant chemotherapy.

The tumor position is delineated as black circle at the 6 o'clock position near the inframammary fold – only visible in a lying position.

One week postoperatively, compared to the preoperative image, some degree of ptosis correction has been achieved. The inferior scar on the right breast is hardly visible in a standing position. As a consequence of different incision lengths of the upper and lower incision, the wavelike scar is still prominent.

Reference Video

- https://youtu.be/YdzSyljOfRo

References

1. Clough KB, Kaufman GJ, Nos C, Buccimazza I, Sarfati IM. Improving breast cancer surgery: a classification and quadrant per quadrant atlas for oncoplastic surgery. Ann Surg Oncol. 2010;17:1375. https://doi.org/10.1245/s10434-009-0792-y.
2. Chen CM, Cano SJ, Klassen AF, et al. Measuring quality of life in oncologic breast surgery: a systematic review of patient-reported outcome measures. Breast J. 2010;16:587. https://doi.org/10.1111/j.1524-4741.2010.00983.x.
3. Cardoso MJ, Oliveira H, Cardoso J. Assessing cosmetic results after breast conserving surgery. J Surg Oncol. 2014;110:37. https://doi.org/10.1002/jso.23596.
4. Pusic AL, Klassen AF, Scott AM, Klok JA, Cordeiro PG, Cano SJ. Development of a new patient-reported outcome measure for breast surgery: the BREAST-Q. Plast Reconstr Surg. 2009;124:345. https://doi.org/10.1097/PRS.0b013e3181aee807.
5. Kanatas A, Velikova G, Roe B, et al. Patient-reported outcomes in breast oncology: a review of validated outcome instruments. Tumori. 2012;98:678. https://doi.org/10.1700/1217.13489.
6. Losken A, Hart AM, Broecker JS, Styblo TM, Carlson GW. Oncoplastic breast reduction technique and outcomes: an evolution over 20 years. Plast Reconstr Surg. 2017;139:824e. https://doi.org/10.1097/PRS.0000000000003226.
7. De La Cruz L, Blankenship SA, Chatterjee A, et al. Outcomes after oncoplastic breast-conserving surgery in breast cancer patients: a systematic literature review. Ann Surg Oncol. 2016;23:3247. https://doi.org/10.1245/s10434-016-5313-1.
8. Chatterjee A, Gass J, Burke MB, et al. Results from the American Society of Breast Surgeons Oncoplastic Surgery Committee 2017 survey: current practice and future directions. Ann Surg Oncol. 2018;25:2790. https://doi.org/10.1245/s10434-018-6586-3.
9. Regnault P. Others. Breast ptosis. Definition and treatment. Clin Plast Surg. 1976;3(2):193–203.
10. Puckett CL, Meyer VH, Reinisch JF. Crescent mastopexy and augmentation. Plast Reconstr Surg. 1985;75:533. https://doi.org/10.1097/00006534-198504000-00015.
11. Gruber R, Denkler K, Hvistendahl Y. Extended crescent mastopexy with augmentation. Aesthet Plast Surg. 2006;30:269. https://doi.org/10.1007/s00266-005-0138-5.
12. Holmes DR, Silverstein MJ. Triangle resection with crescent mastopexy: an oncoplastic breast surgical technique for managing inferior pole lesions. Ann Surg Oncol. 2012;19:3289. https://doi.org/10.1245/s10434-012-2532-y.
13. Spear SL, Albino FP. Management of the high-riding nipple after breast reduction. Clin Plast Surg. 2016;43:395. https://doi.org/10.1016/j.cps.2015.12.008.

Round Block or Donut Mastopexy

8

Michael Knauer

Introduction

Oncoplastic breast-conserving surgery has several goals and indications. Next to the "oncologic goals" like reducing reoperations, mastectomy rates, and recurrence rates for positive margins, we also want to improve quality of life and esthetic outcomes. These goals have been endorsed by the first multidisciplinary international consensus conference on standardization of oncoplastic breast-conserving surgery in 2017 in Basel, Switzerland [1].

Several classification systems for breast-conserving oncoplastic procedures have been published in an attempt to facilitate research and make scientific results more comparable. One of the most widely used and user-friendly classification systems is the bi-level classification by Clough et al. [2], providing a simple and reproducible system to differentiate between the so-called level I and level II procedures. The allocation of the respective oncoplastic procedure to level I or II is based on excision volume, the requirement of skin excision and mammoplasty, as well as glandular characteristics (Table 8.1).

The donut or round block mastopexy belongs to level I oncoplastic techniques, where less than 20% of breast tissue is resected. It does not require excessive skin resection or volume reduction to achieve very good cosmetic outcomes.

The first description of the periareolar incision for cosmetic reduction mammoplasty and correction of ptosis in certain cases was published already more than 40 years ago [3]. The term "donut mastopexy" has first been published by Gruber et al. in 1980 in 13 patients [4]. The authors used the technique to minimize the scar to the periareolar area with a complete preservation of the nipple sensation by using an easy and short type of operation. Also, the disadvantages of the technique have already been described in this chapter: ptosis may recur even in small breasts and areolar

M. Knauer (✉)
Breast Center Eastern Switzerland, St. Gallen, Switzerland
e-mail: michael.knauer@bz-ost.ch

V. S. Klimberg et al. (eds.), *Oncoplastic Breast Surgery Techniques for the General Surgeon*, https://doi.org/10.1007/978-3-030-40196-2_8

Table 8.1 Oncoplastic decision guide

Criteria	Level I	Level II
Maximum excision volume to breast volume ratio	20%	20–50%
Requirement of skin excision for reshaping	No	Yes
Mammoplasty	No	Yes
Glandular characteristics	Dense	Dense or fatty

Adapted from Clough et al. [2]

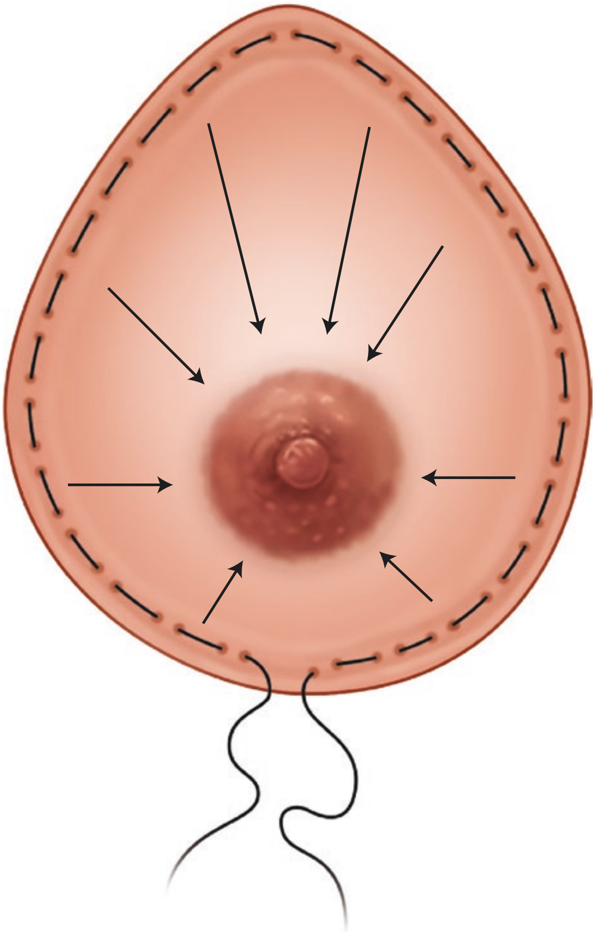


Fig. 8.1 Image of first publication of the round block or Benelli mastopexy (figure redrawn) [5]

spreading occurs in most patients to some extent. Therefore, the recommendation of the authors was to limit this breast reduction technique to very small breasts – something which obviously is not a very common scenario in clinical routine.

The term "round block" was first described in English by Louis Benelli from Paris in 1990 after he had presented the technique in French 3 years earlier (Fig. 8.1) [5].

Indications for the round block technique included ptosis, breast hypertrophy, and the alternative incision location for implant insertion in breast augmentation. For the first time, the possibility to excise a tumor via this incision was mentioned too – one of the reasons why this nearly 30-year-old oncoplastic technique is also frequently referred to as “Benelli mastopexy”. In this chapter, the “donut” or “round block” or “Benelli” mastopexy is described in detail. This simple and fast technique is one of the cornerstones of oncoplastic surgery and should therefore be part of the repertoire of every modern breast surgeon.

Indications

Breast Shape and Size

In esthetic plastic surgery, the round block technique is being used for patients with small-to-medium-sized breasts, if minor ptosis or pseudoptosis correction is requested. The advantages of this simple technique are a good or very good cosmetic result with minimal scarring. The same prerequisites apply to the field of surgical oncology.

Another major consideration for patient selection is the density of the breast tissue. In rather glandular breasts, full thickness resection and re-approximation has a low risk of wound healing complications. In rather fatty breasts (especially in the upper inner quadrant), the risk of fat necrosis due to thin tissue flaps and consecutively impaired cosmetic outcome with a dent in the cleavage poses a higher risk.

Tumor Location

When it comes to cancer surgery, the round block technique is perfectly suitable for tumors at the following positions of the breast (Fig. 8.2):

- Central tumors – without NAC involvement
- Upper outer quadrant – 9–12 o’clock position (right breast)
- Upper inner quadrant – 12–3 o’clock position (right breast)

In the lower quadrants, the round block can theoretically be used too; however, one should be cautious, and personally I would prefer alternative techniques like the V-mammoplasty in smaller breasts or reduction mammoplasty techniques in large ptotic breasts.

Tumor-to-Breast Volume Ratio

Centrally located tumors and tumors in the upper outer quadrant can be larger in size or volume as compared to the breast volume than tumors in the upper inner quadrant – especially when located far from the nipple-areola complex (NAC).

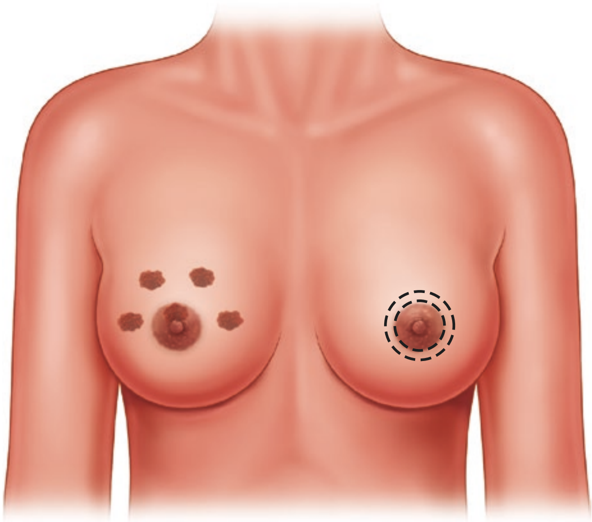


Fig. 8.2 Suitable tumor locations for the round block technique

Lesions far away from the NAC can be a challenge to reach in patients with small breasts and a small NAC. The difference in diameter of the two incisions and therefore the extent of mastopexy have to be carefully planned in advance in these patients.

Surgical Technique

Incisions

The term "donut" describes the epidermal incisions very well. The first concentric incision is placed on the border between the pigmented areola and the breast skin. Areola cutters can be used – alternatively the natural shape of the areola can be used as inner incision line (Figs. 8.6 and 8.9). The external incision should be planned according to the following factors:

1. Degree of the desired mastopexy: The further apart the two incisions are placed, the higher the degree of mastopexy (Fig. 8.3).
2. Degree of ptosis and desired correction thereof: If correction of ptosis is planned, the external incision has to be planned in a more oval than round shape with the larger diameter between both incisions toward the 12 o'clock position (Fig. 8.3b – right breast).
3. Tumor location: When the resection of the tumor containing segment is performed, the NAC – if not detached from the underlying tissue – will tend to move

a

b

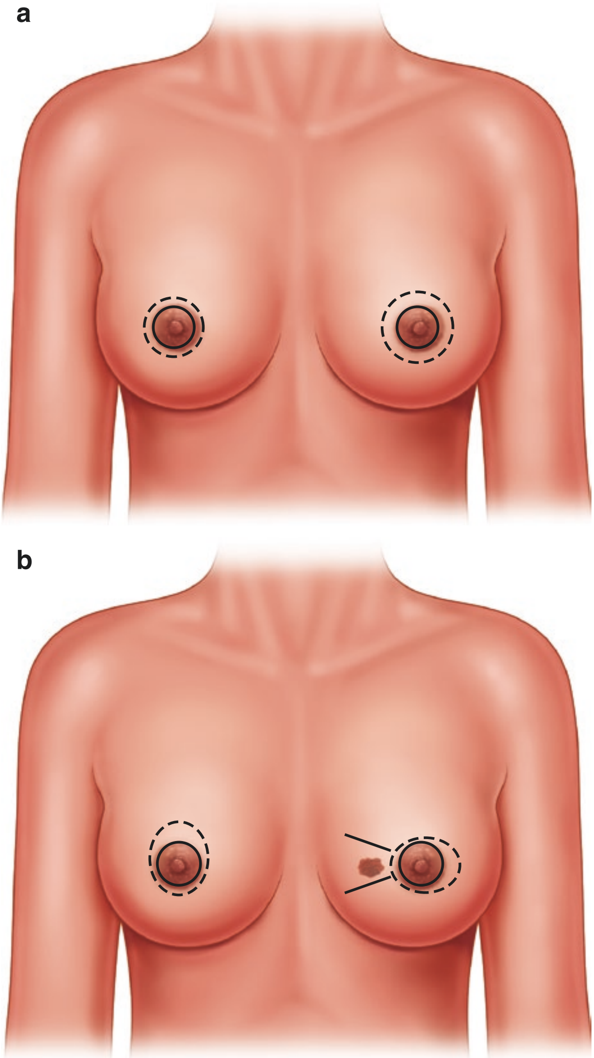


Fig. 8.3 (**a**) Different options of incision diameter depending of the desired degree of mastopexy. The maximum diameter of the "donut" may reach up to 5 cm. (**b**) Right breast: oval scar placement in cases when minor degree of ptosis should be corrected. Left breast: when movement of the NAC toward the segmentectomy region is anticipated, the outer oval-shaped incision might be placed toward the contralateral side

in the same direction. This can be anticipated and counter-steered by placing the outer incision a little toward the opposite direction (Fig. 8.3b – left breast).

4. Size of the NAC: If the diameter of the areola is quite small, the donut diameter has to be larger to achieve appropriate visibility for tumor resection.

After deepithelization of the epidermal ring, the dermal incision is placed near the outer ring to gain wide access to the gland. The length of this deep incision should not exceed 30–50% of the circumference in order not to compromise blood supply and sensitivity.

Skin Undermining

In the next step, the skin overlying the tumor is undermined (Fig. 8.7). The extent of this step varies according to the respective situation. In general, detachment of about one quadrant of the breast from the skin will be necessary to sufficiently mobilize the gland for reshaping after the lumpectomy or segmentectomy (Fig. 8.4). The nipple-areola complex may also be undermined, as long as the dermal connection to blood supply remains intact. If these precautionary measures are undertaken, there

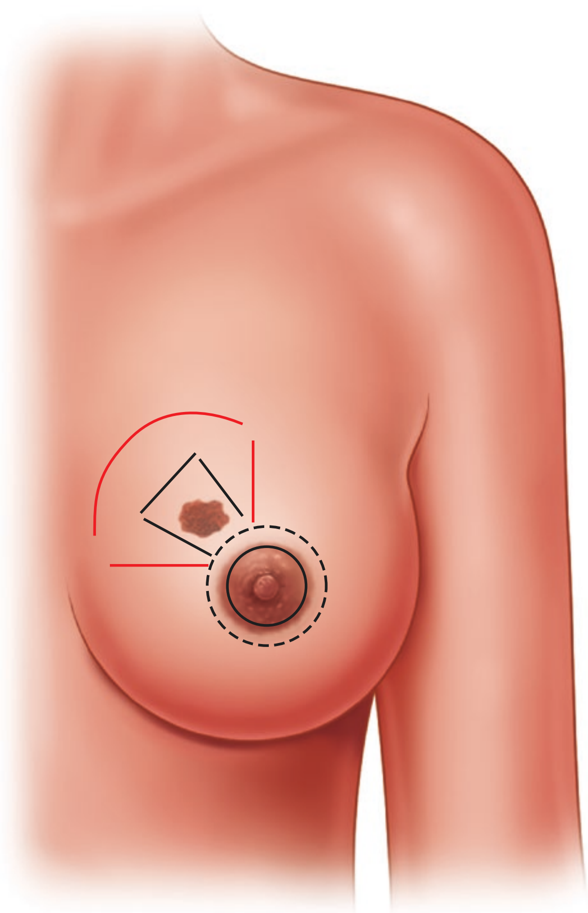


Fig. 8.4 Area of tumor resection (black lines) and approximate area of skin undermining (red lines)

will be no substantial risk for even partial nipple necrosis. A modified technique has been described by Zaha in 2013, where the NAC is completely detached from the surrounding skin flap and blood supply comes from the gland below only [6]. In this series of 40 patients without deepithelization, the NAC was pushed into the cavity, and after lumpectomy it was repositioned into its original place with less risk of consecutive areolar spreading.

Tumor Resection

If the thickness of the gland is not excessive – which it normally isn't when using this technique – standard full-thickness resection including the pectoralis fascia is recommended. One reason is to avoid posterior or anterior margin involvement and the second reason is that the internal wound healing of the gland is better, if the resected margins are closely adapted over the whole surface in order to try to avoid seroma formation and consecutive dents after radiotherapy.

Every center or even every surgeon has his or her own technique for tumor localization: either palpation or guide wire placement is still the most commonly used methods despite obvious disadvantages of this modus operandi. Several case series and also randomized trials have shown that palpation-guided and wire-guided surgery lead to more re-excisions and also higher resection volumes – two things that obviously should be avoided also in oncoplastic surgery – especially in small-to-medium-sized breasts. Re-excision rates of 30–60% have been published after wire-guided surgery [7–9]. In earlier publications, it was mentioned that oncoplastic surgery has the advantage of achieving wider margins [10]. Nowadays, since it has been accepted in several consensus conferences that no tumor on the inked resection margin is sufficient, this goal of oncoplastic surgery does no longer exist [11, 12]. Several alternatives to these outdated localization techniques have been published in the last two decades like radio-guided or clip-guided localization as most common ones [13–16].

A fast and reliable alternative that can be used by breast surgeons is intraoperative ultrasound (IOUS) to lower excision volumes and R1-resection rates. Next to publication of several case series, three randomized controlled trials have also been performed with significant reduction of positive margins and resection volume and consecutively better cosmesis [17–21]. There is a variety of advantages of using intraoperative ultrasound over other techniques: no need of a radiology or nuclear medicine department and therefore more flexibility in operation planning, no radiation protection issues, and most of all direct visibility of the tumor intraoperatively to plan the resection margins. One of the disadvantages of IOUS is that tumors might be underestimated regarding extent, especially of surrounding DCIS. Therefore, a planned margin of about 5 mm and a segmental kind of resection are crucial for this procedure for oncologic reasons on one hand and better cosmetic results on the other hand (Fig. 8.5).

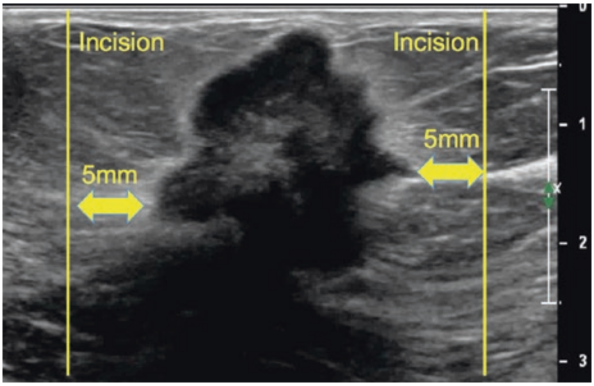


Fig. 8.5 Planning of adequate but sufficient resections margins by intraoperative ultrasound to reduce the extent of resected healthy tissue. The centrally located tumor is clearly visible – planned full thickness incision lines shown in yellow with 5 mm margin

Fig. 8.6 Planning of round block incisions

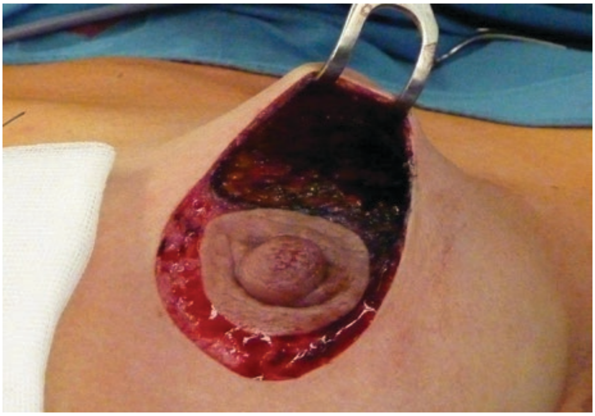


Fig. 8.7 Deepithelization and skin-undermining before resection of the tumor

Glandular Reapproximation

After resection of the tumor-containing segment and confirmation that the tumor has been removed entirely – either by specimen radiography, ultrasound, or frozen section – undermining of the skin can be completed to avoid dimpling. On the fascia level, the glandular tissue is also detached to facilitate rotation and adaption. Clip markings for radiation planning are placed and the glandular tissue is sutured. Suction drainage is usually not necessary, as any seroma will generally be reabsorbed or disappears after a single aspiration in symptomatic patients. In cases of extensive volume displacement, 1 or 2 days of drain placement helps to reduce the amount of seroma fluid.

Wound Closure

The wound is closed with two layers of sutures (Fig. 8.8). Several authors recommend a nonabsorbable dermal purse-string suture to avoid consecutive extensions of the NAC; however, this can also be achieved by interrupted inverted 3–0 absorbable sutures [6]. Alternatively, the size of the neo-areola may be planned a little smaller than the contralateral areola to compensate stretching of the skin. A running subcuticular suture is used to close the skin. By having chosen the right size and shape of the outer epidermal incision in the beginning – which can still be adapted at the end of the procedure – the nipple-areola complex can be centralized or lifted. This is easier to do at the first operation before radiotherapy will be given than afterward.

Surgical Complications and Solutions

In general, the round block mastopexy has a very low risk of complications compared to especially level II oncoplastic procedures like tumor-adapted reduction mammoplasty. Although no large case series or randomized trials regarding this

Fig. 8.8 Wound closure after tissue rearrangement and suturing

Fig. 8.9 Incision planning of the round block technique

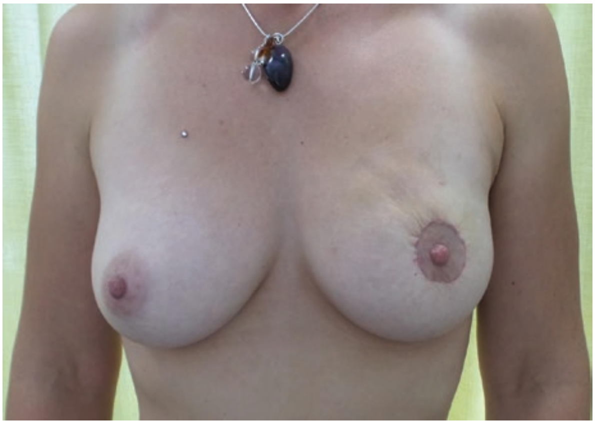


Fig. 8.10 Early postoperative result at 2 weeks after surgery

specific technique are available, general complications of breast-conserving surgery like bleeding, relevant seroma formation, and wound infection are in the range of 1–3% in our experience. These rates are not higher than in conventional lumpectomy or segmentectomy. Nipple necrosis – a quite frequent and dreaded complication in nipple-sparing mastectomy – has never occurred in my experience, when the precautions mentioned above have been taken and full devascularization of the areolar skin is avoided. However, if after a round block oncoplastic procedure a nipple-sparing mastectomy has to be done because of positive margins or early recurrence, the risk of nipple necrosis is substantial.

Next to these general complications, more specifically two complications or rather cosmetic conditions have to be discussed with the patient beforehand:

1. Possible denting:

   Even after wide mobilization of the gland and meticulous reapproximation, some denting may occur (Fig. 8.10). Especially in patients with more fatty than glandular parenchyma, fat necrosis can occur if the glandular flaps are too thin or the gland is moved too far from its original position, especially in the periphery.

To avoid this situation, one should not remove more tissue than absolutely necessary, especially in the upper inner quadrant. This can be achieved by accurate planning of the width of the resected segment for example by intraoperative ultrasound as described above. If denting still happens in the course of time, lipofilling of the defect is a suitable method to overcome this cosmetic complication and volume loss.

2. Increase of areola diameter:

   The larger the diameter of the donut has to be planned and the higher the degree of mastopexy, the more likely an increase of the areola diameter will occur after time because of tension (Figs. 8.11a, b and 8.12). One possibility to

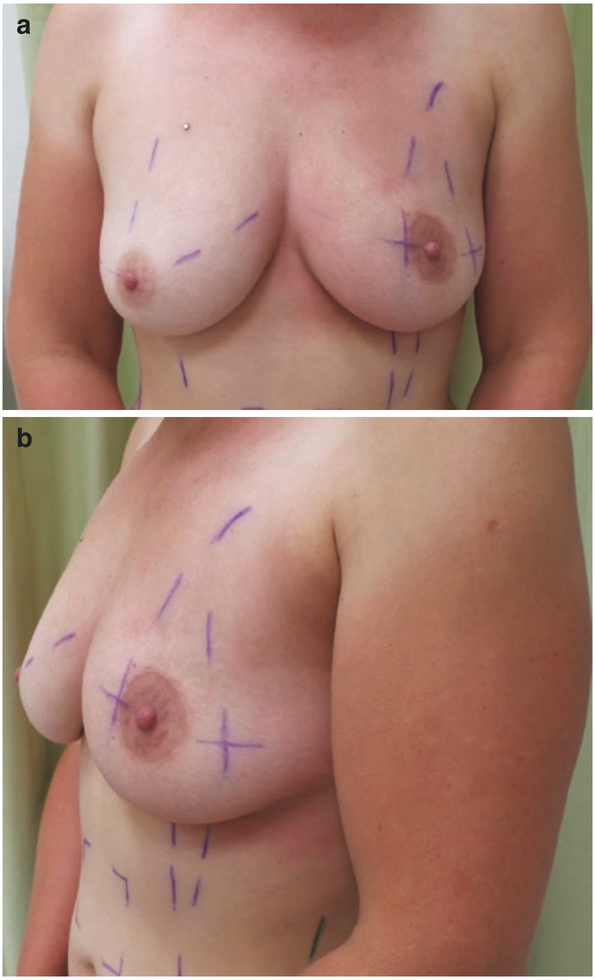


Fig. 8.11 (**a**, **b**) Frontal and oblique view of the patient 6 months after surgery

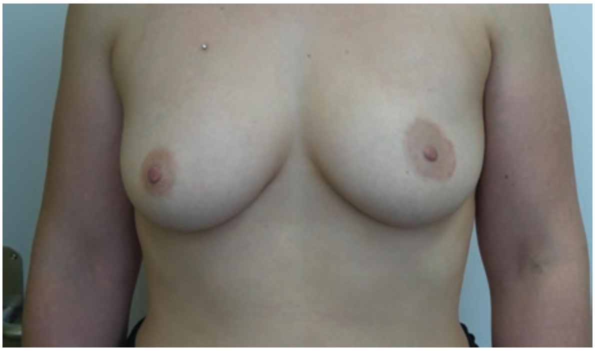


Fig. 8.12 Final result 12 months after surgery and after completion of radiotherapy 6 months before

prevent this is the use of nonabsorbable or slowly resorbable suture material for the deep dermal approximation of the two incisions and the second possibility is to plan the diameter of the new areola somewhat smaller than the contralateral side. Even after having performed more than 150 cases of this operation, I personally still find it challenging to exactly foresee the future development of the areola diameter in the individual patient, since it depends on many factors like administration of radiotherapy, degree of ptosis and mastopexy, and individual skin condition of the patient.

Conclusion

The donut or round block mastopexy technique is a simple and easy to learn level I oncoplastic procedure for up to 20% of resected breast volume. It definitely has to be part of the repertoire of every modern breast surgeon, since with 15–20 minutes of extra spent time, inferior cosmetic results with scars or dents in the cleavage can be avoided. By placing a periareolar scar only, the donut mastopexy can be utilized best for cancers in the upper and especially upper inner quadrants, depending on the planned resection volume and breast size. In small-to-medium-sized breasts with no or minimal to moderate ptosis, this technique is the most frequently used oncoplastic procedure by far.

Clinical Cases

Case 1: Intraoperative Steps

1. Planning of the incisions:
   The 7 mm breast cancer NST is located in the 11 o'clock position of the left breast, approximately 6 cm away from the nipple-areola complex. Delineation of

the tumor position and size increases precision of the segmental resection. In this nonpalpable tumor, no guide wires have been placed – intraoperative ultrasound was used to guide the resection instead. Because of the small size of the breast (Cup A), not even a 1 cm diameter of the donut mastopexy is planned to avoid overcorrection. The drawings have to be done in a standing or sitting position before induction of general anesthesia. Sentinel node biopsy has already been performed.

2. Deepithelization and skin undermining:

   After deepithelization of the "donut," the dermal incision is made from 10 to 1 o'clock at the outer border of deepithelialized skin. The skin of the quadrant is detached from the glandular tissue to facilitate exposure of the tumor containing segment.

3. Wound closure:

   Circular closure of the wound by two layers of sutures. The deep suture was done as interrupted inverted 3–0 sutures to position the NAC. For closure of the skin, a 5–0 absorbable monofilament running suture was used. To compensate for the different circumferences of the incisions, the outer intradermal stiches are longer than the inner ones. The wave-like appearance of the closed suture will disappear after a few months.

Case 2: Development of Periareolar Scar

1. Planning of incisions:

   The 15 mm cancer is located in the upper inner quadrant 8 cm from the nipple in this 33-year-old patient with medium-sized breasts (Cup C). Preoperatively, the left NAC is already 1 cm higher and no relevant ptosis is present. The right breast has minimal ptosis grade I.

2. Two weeks postoperatively:

   Some denting in the cleavage and the wavelike scar are still prominent. The preexisting asymmetry is now slightly more pronounced.

3. Six months postoperatively after completion of chemotherapy during radiotherapy. The wavelike scar has subsided.
4. Final result after 12 months: The areola has enlarged in diameter unfortunately. A correction and lifting of the contralateral areola by a crescent mastopexy were not desired by the patient.

Reference Video

- https://youtu.be/jznq1UFG1G8
- https://youtu.be/sMRpxaeFnug

References

1. Weber WP, Soysal SD, El-Tamer M, et al. First international consensus conference on standardization of oncoplastic breast conserving surgery. Breast Cancer Res Treat. 2017;165(1):139. https://doi.org/10.1007/s10549-017-4314-5.
2. Clough KB, Kaufman GJ, Nos C, Buccimazza I, Sarfati IM. Improving breast cancer surgery: a classification and quadrant per quadrant atlas for oncoplastic surgery. Ann Surg Oncol. 2010;17:1375. https://doi.org/10.1245/s10434-009-0792-y.
3. Andrews JM, Yshizuki MMA, Martins DMSF, Ramos RR. An areolar approach to reduction mammaplasty. Br J Plast Surg. 1975;28:166. https://doi.org/10.1016/0007-1226(75)90122-8.
4. Gruber RP, Jones HW. The "donut" mastopexy: indications and complications. Plast Reconstr Surg. 1980;65:34. https://doi.org/10.1097/00006534-198001000-00007.
5. Benelli L. A new periareolar mammaplasty: the "round block" technique. Aesthet Plast Surg. 1990;14:93. https://doi.org/10.1007/BF01578332.
6. Zaha H, Onomura M, Unesoko M. A new scarless oncoplastic breast-conserving surgery: modified round block technique. Breast. 2013;22:1184. https://doi.org/10.1016/j.breast.2013.07.056.
7. Papa MZ, Zippel D, Koller M, Klein E, Chetrit A, Ben AG. Positive margins of breast biopsy: is reexcision always necessary? J Surg Oncol. 1999; https://doi.org/10.1002/(SICI)1096-9098(199903)70:3<167::AID-JSO4>3.0.CO;2–7.
8. Mullenix PS, Cuadrado DG, Steele SR, et al. Secondary operations are frequently required to complete the surgical phase of therapy in the era of breast conservation and sentinel lymph node biopsy. Am J Surg. 2004;187:643. https://doi.org/10.1016/j.amjsurg.2004.01.003.
9. McLaughlin SA, Ochoa-Frongia LM, Patil SM, Cody HS, Sclafani LM. Influence of frozen-section analysis of sentinel lymph node and lumpectomy margin status on reoperation rates in patients undergoing breast-conservation therapy. J Am Coll Surg. 2008;206:76. https://doi.org/10.1016/j.jamcollsurg.2007.07.021.
10. Nahabedian MY. Oncoplastic surgery of the breast with DVD. 2009; https://doi.org/10.1016/B978-0-7020-3181-6.X0001–8.
11. Moran MS, Schnitt SJ, Giuliano AE, et al. Society of Surgical Oncology-American Society for Radiation Oncology consensus guideline on margins for breast-conserving surgery with whole-breast irradiation in stages I and II invasive breast cancer. J Clin Oncol. 2014;32:1507. https://doi.org/10.1200/JCO.2013.53.3935.
12. Coates AS, Winer EP, Goldhirsch A, et al. Tailoring therapies-improving the management of early breast cancer: St Gallen International Expert Consensus on the primary therapy of early breast cancer 2015. Ann Oncol. 2015;26:1533. https://doi.org/10.1093/annonc/mdv221.
13. Feggi L, Basaglia E, Corcione S, et al. An original approach in the diagnosis of early breast cancer: use of the same radiopharmaceutical for both non-palpable lesions and sentinel node localisation. Eur J Nucl Med. 2001;28:1589. https://doi.org/10.1007/s002590100601.
14. DeCicco C, Pizzamiglio M, Trifiro G, et al. Radioguided occult lesion localisation (ROLL) and surgical biopsy in breast cancer - technical aspects. Q J Nucl Med. 2002;46(2):145–51.
15. Gray RJ, Salud C, Nguyen K, et al. Randomized prospective evaluation of a novel technique for biopsy or lumpectomy of nonpalpable breast lesions: radioactive seed versus wire localization. Ann Surg Oncol. 2001;8:711.
16. Harvey JR, Lim Y, Murphy J, et al. Safety and feasibility of breast lesion localization using magnetic seeds (Magseed): a multi-centre, open-label cohort study. Breast Cancer Res Treat. 2018;169:531. https://doi.org/10.1007/s10549-018-4709-y.
17. Haid A, Knauer M, Dunzinger S, et al. Intra-operative sonography: a valuable aid during breast-conserving surgery for occult breast cancer. Ann Surg Oncol. 2007;14(11):3090. https://doi.org/10.1245/s10434-007-9490-9.
18. Harlow SP, Krag DN, Ames SE, Weaver DL. Intraoperative ultrasound localization to guide surgical excision of nonpalpable breast carcinoma. J Am Coll Surg. 1999;189:241. https://doi.org/10.1016/S1072-7515(99)00156-8.

19. Moore MM, Whitney LA, Cerilli L, et al. Intraoperative ultrasound is associated with clear lumpectomy margins for palpable infiltrating ductal breast cancer. Ann Surg. 2001;233:761. https://doi.org/10.1097/00000658-200106000-00005.
20. Rahusen FD, Bremers AJ, Fabry HF, et al. Ultrasound-guided lumpectomy of nonpalpable breast cancer versus wire-guided resection: a randomized clinical trial. Ann Surg Oncol. 2002;9(10):994–8.
21. Volders JH, Haloua MH, Krekel NMA, et al. Intraoperative ultrasound guidance in breast-conserving surgery shows superiority in oncological outcome, long-term cosmetic and patient-reported outcomes: final outcomes of a randomized controlled trial (COBALT). Eur J Surg Oncol. 2017;43:649. https://doi.org/10.1016/j.ejso.2016.11.004.

Batwing and Hemibatwing Mammoplasty

9

Dennis Ricky Holmes

Introduction

When a woman is diagnosed with breast cancer, many aspects of her physical, emotional, and sexual wholeness are threatened. The quickly expanding field of oncoplastic breast surgery aims to enhance the physician's commitment to preserving or restoring the patient's image and self-assurance. Successful results in the eyes of the patient and physician are more likely to be achieved when combined with the multidisciplinary approach to diagnosis and treatment.

The majority of breast malignancies present in the central and upper quadrants of the breast. Surgeons involved in the management of breast cancer should have a range of surgical options for resecting central and upper pole lesions that preserve or enhance the aesthetic appearance or minimize defects following breast cancer surgery [2, 11]. For surgeons lacking intermediate or advanced training in oncoplastic surgery (OPS), the batwing and hemibatwing mammoplasty incisions may be utilized to achieve complete resection of upper pole, medial, or lateral tumors with acceptable cosmetic results and considerably less complexity than formal mammoplasty procedures.

Batwing and hemibatwing procedures are level I oncoplastic volume displacement procedures well suited for relatively large volume glandular resection of tumors in the central or upper pole of the breast between the 8:00 and 4:00 positions [19, 1, 11, 21]. The batwing mammoplasty combines resection of a crescent-shaped area of skin and gland above the nipple-areolar complex plus two adjoining triangle or winglike areas of the skin and breast parenchyma extending from both sides of the areola. As the name suggests, the hemibatwing mammoplasty is similar to the batwing mammoplasty except that only one triangle or "wing" of the skin and parenchyma is excised along with the supra-areolar crescent. Following wound

D. R. Holmes (✉)
Department of Surgery, John Wayne Cancer Institute, Santa Monica, CA, USA

V. S. Klimberg et al. (eds.), *Oncoplastic Breast Surgery Techniques for the General Surgeon*, https://doi.org/10.1007/978-3-030-40196-2_9

closure, the resulting skin incision consists of a circumareolar incision along the upper half of the areola as well as a radial component extending from the edge of the areola in the medial or lateral direction (hemibatwing) or in both directions (batwing). The radial components help to prevent dog-ears that result from closure of the crescent component. The batwing procedure is also referred to as “omega-plasty” or “inverted V mammoplasty” due to the “omega” or inverted “V”-shaped incision formed by the union of the superior circumareolar incision and the two adjoining radial incisions [9, 15].

The length of the radial wing(s) of the batwing or hemibatwing mammoplasty is directly proportional to the vertical height of the central skin crescent as well as the vertical height of the adjacent triangle. In addition to those factors, the length of each radial wing may also be adjusted to further minimize dog-ear formation at the apex of each triangle. Radial incisions of insufficient length may produce a boxy, flattened breast shape. Increasing the radial incision length facilitates contouring of the breast to maintain a round shape. Radial incisions extending into the cleavage can produce an inferior aesthetic result and are best avoided unless proximity of the malignancy to the skin necessitates resection of the skin in the upper inner quadrant.

Indications

The batwing mammoplasty is better suited for resection of larger tumors in the central, superior periareolar, or subareolar location of the breast, especially in patients who would benefit from mastopexy; reduction of redundant, inelastic skin; or moderate breast volume reduction. Using the batwing approach, resection of excess glandular tissue can be balanced between the medial and lateral glandular triangles. In contrast, the hemibatwing mammoplasty is more appropriate for tumors located in the upper inner/medial or upper outer/lateral breast, particularly in patients that do not require significant volume reduction. The batwing or hemibatwing mammoplasty procedures are particularly useful for resection of tumors located within 5–10 mm of the overlying skin where excision of the adjacent skin might be needed to ensure a histologically clear anterior or superficial margin.

Mastopexy for correction of ptosis is a key benefit of the batwing and hemibatwing mammoplasty procedures. In contrast with the crescent mastopexy, which is only useful for correcting mild (grade I) ptosis, the batwing and hemibatwing mammoplasty procedures are capable of correcting both mild and moderate ptosis (grade I–II) by allowing removal of a larger area of the skin from the upper half of the breast. The degree of ptosis correction by the batwing and hemibatwing mammoplasty procedures is determined foremost by the size and location of the malignancy and its proximity to the overlying skin. However, the degree of ptosis should also take into account the surgeon’s skillset, the patient’s wishes, and whether or not an immediate or delayed contralateral symmetrization procedure is planned. Mastopexy may also be accomplished by de-epithelization of the skin above the nipple-areolar complex when full-thickness skin resection is not required.

Use of the batwing and hemibatwing mammoplasty has fallen as they are cosmetically inferior to the Wise pattern reduction mammoplasty and other intermediate and level II mammoplasty procedures that achieve better breast projection, correction of ptosis, and breast symmetry [8]. Nonetheless, the batwing and hemibatwing mammoplasty procedures are sometimes favored by patients wishing to avoid long breast incisions and also by surgeons aiming to avoid extensive tissue mobilization and reduce operative time for patients at higher risk of wound complications.

Circumareolar incisions are commonly utilized for breast resection because they produce a scar that is camouflaged by contrasting pigment at the edge of the areola. Despite this advantage, use of circumareolar incisions is more challenging in women with relatively small areolar diameters since an incision limited to the upper edge of the areola may not provide sufficient access for dissection and removal of a lumpectomy specimen. This limitation may be overcome partially by the batwing and hemibatwing, which can provide relatively wide access to the central breast and upper quadrants while incorporating a segment of the incision along the areolar margin where it would be less apparent.

Preoperative Evaluation and Planning

A successful oncoplastic procedure begins with selecting the appropriate operation for a given patient, which takes into account a patient's unique breast anatomy (e.g., breast shape and degree of ptosis), an understanding of tumor location and extent, as well as appreciation of the patient's goals. Batwing and hemibatwing mammoplasty are best suited for tumors in the central, upper inner, and upper outer quadrants, particularly in breasts that may benefit from volume reduction and/or ptosis correction. Batwing mammoplasty is better suited for central upper outer or upper inner tumors within a few centimeters of the nipple-areolar complex, with or without a radially oriented intraductal extension. On the other hand, the hemibatwing mammoplasty is better suited for resection of tumors in the upper inner and upper outer quadrant, particularly when proximity to the skin necessitates resection of the overlying skin. Both mammoplasty procedures achieve optimal results (i.e., breast contour and nipple projection) in patients with larger breast volume and a mild to moderate degree of breast ptosis (grades I and II). On the other hand, flattening of the breast may occur if either procedure is performed in women with smaller (i.e., A or B cup) breasts [16]. Patients with upper inner quadrant tumors may experience inferior results if a radial skin incision extends into the cleavage area. For patients with invasive breast cancer, neoadjuvant systemic therapy may facilitate skin preservation if a significant clinical response is obtained.Evaluation of extent of disease is facilitated by full-field digital mammography, selective use of breast and axillary ultrasound, and contrast-enhanced breast magnetic resonance imaging. Breast MRI may be particularly helpful for evaluation of extent of disease for mammographically occult cancers, infiltrating lobular carcinoma, assessment of proximity of the malignancy to the adjacent skin or chest wall, and evaluation of response to neoadjuvant systemic therapy.

Wire- or non-wire-based localization procedures are required to guide resection of a non-palpable lesion. Larger non-palpable lesions may benefit from bracketing using multiple wires or localization devices [3, 13]. Intraoperative ultrasound can also be used in place of or as an adjunct to wire or non-wire localization to aid surgical resection and assessment of gross surgical margins.

Photographic documentation of the preoperative appearance and postoperative results will help the surgeon evaluate and improve his or her results over time. In addition, the confidential sharing of these photos with prospective patients will give them a clearer understanding of what they can expect from oncoplastic surgery. Initial skin markings are performed in the preoperative holding area using an indelible marker. Skin marking is best performed with the patient in standing position with arms at her side and the surgeon seated. Upon arriving in the operating room, patients are maintained in the supine position following induction of anesthesia. Securement of both arms to the arm boards allows the patient to be brought to the upright seated position for evaluation of nipple position, breast shape, symmetry, and skin tethering prior to definitive wound closure. Temporary skin closure with staples (i.e., tailor tacking) permits adjustment of the skin flaps and breast contour prior to definitive wound closure.

Surgical Technique

Batwing

Planning the batwing mammoplasty begins with designing the central crescent skin incision using two parallel curved convex incisions centered above the nipple-areolar complex (Fig. 9.1). Both incisions should be of equal length and span the diameter of the native areola. The first incision is drawn along the superior border of the areola from the 3:00 to 9:00 positions to include 50% of the upper half of the areolar margin. The second incision is drawn superior and parallel to the circumareolar incision. The distance between the two incisions and hence the elevation of the nipple-areolar complex (NAC) are assessed by determining the ideal position of the nipple, which is the point where the inframammary fold (IMF) projects forward onto the surface of the breast (Pitanguy's point). However, a lesser degree of ptosis correction may be performed if preferred by the patient. The final position of the NAC should also be centered on the breast meridian, an invisible line extending from the midclavicular point through the nipple, which typically shifts the NAC in a slight medial direction when elevated to a higher position.

To create the batwing, two isosceles or scalene triangles are drawn at the medial and lateral edges of the central crescent with the base of each triangle in alignment with the medial and lateral edges of the areola (Fig. 9.2). With this orientation, the apex of each triangle should project to the medial and lateral borders of the breast. The vertical height of each triangle (i.e., the width of the triangle base) and the length of each leg are determined by the proximity of the malignancy to the skin of

Fig. 9.1 Preoperative (image A) and postoperative (images B and C) photos of right batwing mammoplasty for infiltrating lobular carcinoma in a patient with marked breast asymmetry following previous left breast-conserving therapy

the triangle, the area of the skin to be resected, the degree of NAC elevation, and/or the volume of the glandular resection required.

After injection of local anesthetic as a field block, the corresponding oncoplastic resection is performed with the breast centered on the pectoralis muscle. The skin and glandular tissue surrounding the breast malignancy are incised, and dissection is extended posterior to the breast malignancy. Although resections are generally full-thickness dermoglandular procedures, the need for full-thickness dermoglandular resection is influenced by the proximity of the lesion to the skin and/or chest wall. Depending on the tumor location, the surgeon may bias the glandular resection in one direction or another to gain greater clearance around the malignancy and to preserve glandular tissue where it may be advantageous to do so. The plane of glandular resection can also be extended beyond the borders of the skin incision by undermining the skin and subcutaneous flap for excision of the underlying tissue. If skin resection is not required, the surgeon can use the de-epithelized dermoglandular flap to fill the partial mastectomy cavity (Fig. 9.3).

Fiducial markers or hemoclips are placed along the surgical margins prior to guide radiation therapy delivery. A mild pressure dressing obviates the need for surgical drains in most patients, but surgical drains may be placed selectively. Full-thickness wound closure is accomplished by approximating the superior and inferior parenchymal surgical margins using layered interrupted absorbable

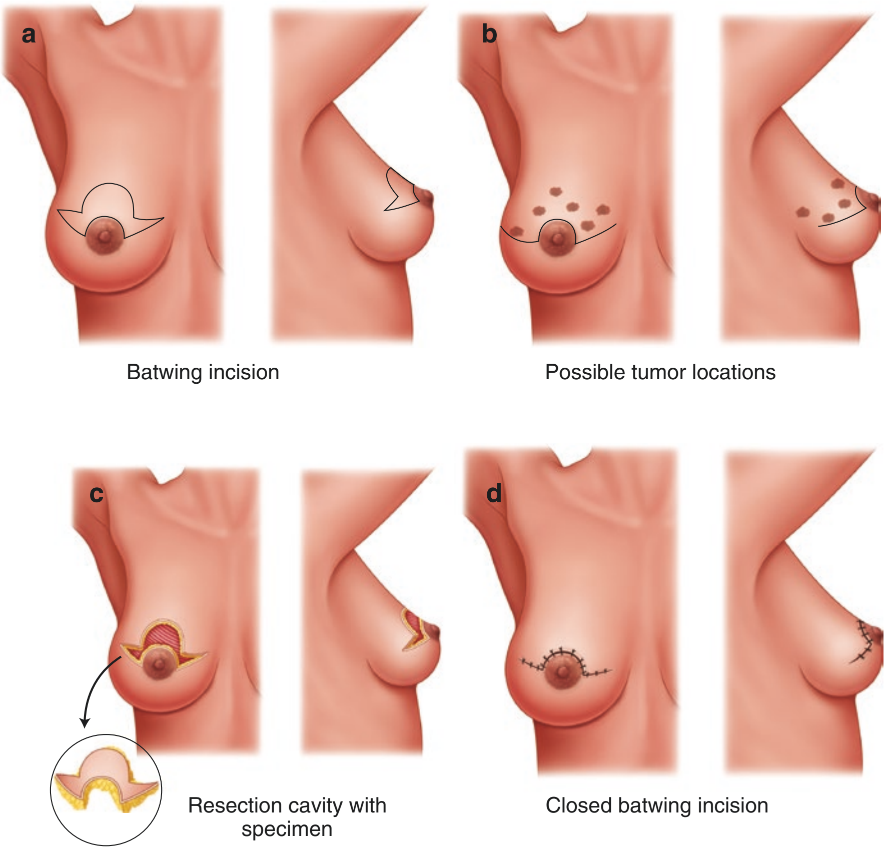


Fig. 9.2 Batwing mammoplasty. (**a**) Location of batwing skin incision, (**b**) multiple "stars" indicating possible tumor locations, (**c**) resection cavity with excised specimen (inset), (**d**) breast following closure of batwing incision

sutures. Layered purse-string sutures may also be utilized to close a spherical cavity in the central breast. In performing glandular wound closure, the surgeon should anticipate encountering a discrepancy between the glandular tissue thickness of the upper (thinner) and lower (thicker) poles of the breast. This discrepancy may be managed by suturing a full-thickness layer of the superior margin to the anterior half of the inferior margin. This maneuver will avoid a step-off or contour deformity of the breast that might result in a prominent ridge and/or an inferior cosmetic result.

Accurate orientation of the surgical specimen is particularly important in oncoplastic surgery where failure to orient the surgical margins may necessitate more intensive breast irradiation or conversion to mastectomy [17, 12]. Selective use of intraoperative pathology consultation, e.g., gross sectioning, frozen section, or touch prep, or use of intraoperative margin assessment devices (e.g., MarginProbe), may help to optimize margin clearance [5, 20, 14].

Fig. 9.3 Intraoperative skin marking (image A) of batwing and planned partial mastectomy (image A, circle), surgical cavity after resection of an 8.8 × 7.0 × 4.5 cm, 148 gram specimen from upper inner quadrant with de-epithelization of upper pole skin that did not require resection (image B), initial wound closure after displacement of periareolar dermoglandular flap (image C), and final wound closure (Image D)

Hemibatwing

Similar in design to the batwing mammoplasty, the hemibatwing mammoplasty consists of a central crescent incision adjoined by a single isosceles or scalene triangle at either the medial or lateral edge of the crescent (Fig. 9.4). However, instead of forming the crescent using two parallel curved lines of equal length, the hemibatwing utilizes two semi-parallel convex incisions that converge at the medial and lateral edges of the areola (Fig. 9.5). Similar to the batwing mammoplasty, the final position of the NAC is determined by the ideal location of the nipple at the IMF (Pitanguy's point) and the breast meridian.

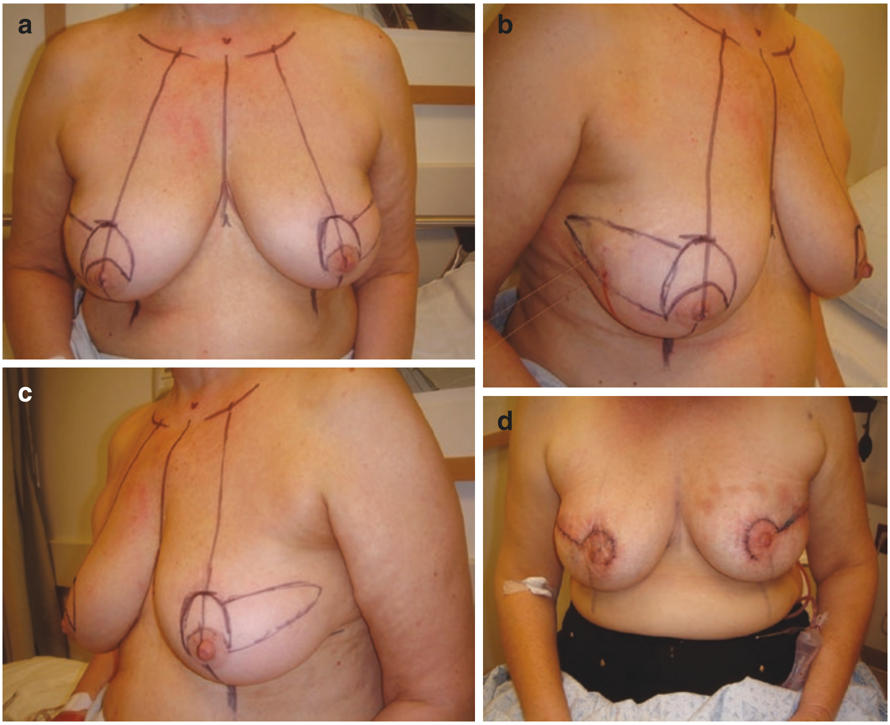


Fig. 9.4 Images A, B, and C show preoperative markings (image A, B, and C) and postoperative photos of bilateral hemibatwing mammoplasties (image D). (Images courtesy of Melvin J. Silverstein)

In planning the hemibatwing mammoplasty incision, the first skin marking is drawn along the superior border of areola from the 3:00 to 9:00 positions to encircle the upper half of the areolar circumference (Fig. 9.5). This is then followed by a second, more superior semi-parallel incision which will form the final superior areolar margin of the new NAC. To complete the hemibatwing, a single isosceles or scalene triangle is drawn on the skin at the medial or lateral edge of the central crescent, depending on the tumor location. The upper leg of the triangle should begin at the edge of the crescent, and the lower leg should join the end of the circumareolar incision at the edge of the areola. As with the batwing mammoplasty, the vertical height of the triangle and the length of each leg are determined by the proximity of the malignancy to the skin of the triangle, by the amount of skin to be resected, the degree of ptosis correction, and/or the volume of the glandular resection. However, since the single triangle of the hemibatwing is not offset by a similar triangle on the opposite site of the areola, the hemibatwing procedure is associated with a greater degree of lateral or medial distortion of the areola, which from a cosmetic perspective limits the amount of skin than may be excised using the hemibatwing procedure. On the other hand, patients with central/upper outer quadrant

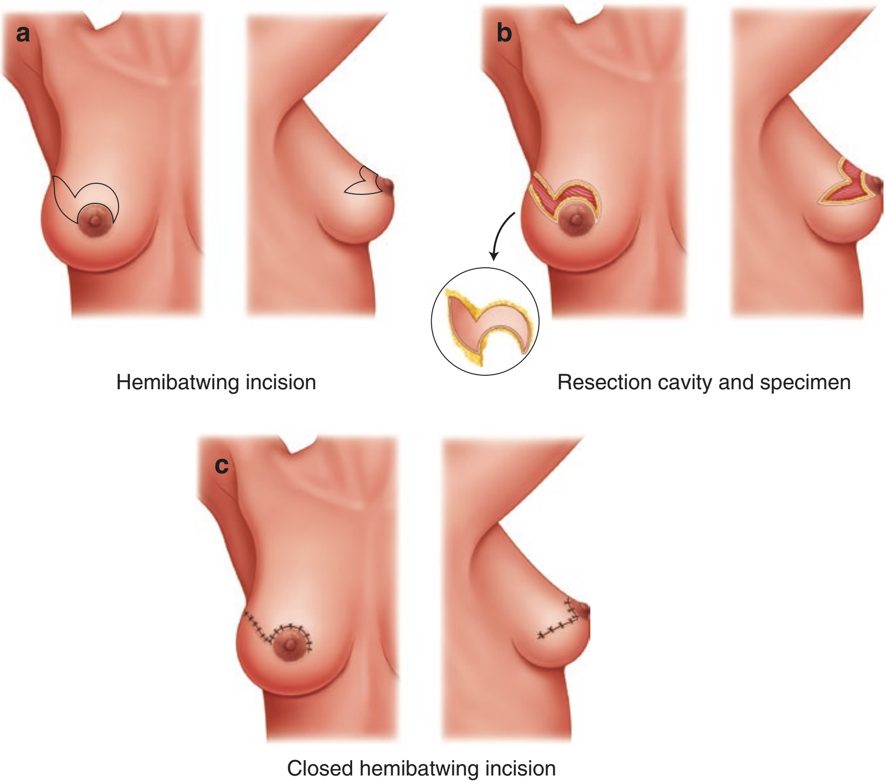


Fig. 9.5 Hemibatwing mammoplasty. (**a**) Location of hemibatwing skin incision, (**b**) resection cavity and hemibatwing resection with excised specimen (inset), (**c**) breast following closure of the hemibatwing incision

tumors may prefer the hemibatwing approach over the batwing approach to eliminate the upper inner quadrant extension of the batwing incision. Apart from these important distinctions, the remaining aspects of the hemibatwing resection are essentially identical to the batwing resection.

Management of the Contralateral Breast

Mastopexy, breast reduction, or a mirror batwing or hemibatwing procedure of the opposite breast may be performed to reduce or correct breast asymmetry resulting from oncoplastic breast-conserving surgery. Symmetrization surgery can be performed at the time of the oncoplastic resection, at a second operation after assessment of surgical margins, or it may be deferred indefinitely depending on the clinical setting, patient's wishes, surgeon's skill set, and availability of plastic surgery expertise [7].

Surgical Complications and Solutions

There are no complications that are unique to the batwing or hemibatwing mammoplasty.

Smoking, diabetes, obesity, COPD, longer operative time, and bleeding disorder are independent predictors of 30-day morbidity following oncoplastic surgery and increase the risk of infection and wound dehiscence [6]. Although the batwing or hemibatwing requires considerably less dissection than level II mammoplasty procedure, the fact that the batwing and hemibatwing are more commonly performed in less healthy patients underscores the importance of careful tissue handling. Extensive undermining of the fatty breast may increases the risk of fat necrosis and seroma formation. Excessive undermining of the NAC may increase the risk of NAC ischemia or necrosis.

Results

There is a paucity of published literature on the safety and efficacy of the batwing mammoplasty and essentially no published series on the hemibatwing mammoplasty. The largest published series of batwing mammoplasty was a retrospective analysis of 62 women treated with bilateral batwing mammoplasty and 64 women managed with bilateral inferiorly based Wise pattern mammoplasty for superior pole tumors between the 3 and 9:00 axes of the breast [10]. Age, BMI, and pathology were comparable between the two groups. Mean operative time was approximately 50% lower in the batwing group (103 min vs. 220 min), and mean hospital stay was shorter (2 days vs. 3 days) in the batwing group. Surgical complications were significantly lower in the batwing group (19% vs. 36%, $p = 0.038$), primarily related to higher rates of wound dehiscence and delayed wound healing at the T-junction in the first 2 months of recovery, a commonly reported complication following Wise pattern mammoplasty [18]. Fat necrosis and scar hypertrophy were similar between both groups. Self-assessed cosmesis was comparable in breast shape, volume, and correction of ptosis. Patient undergoing Wise pattern mammoplasty reported significantly better breast projection, whereas scar visibility and overall satisfaction were significantly better in the batwing group. Objective cosmesis assessment using BCCT.core showed higher rates of excellent overall cosmesis related to breast asymmetry, scar visibility, and color match among patients treated with Wise pattern mammoplasty [10]. NAC numbness was reported in 6.25% of Wise pattern patients but was not reported in batwing patients.

The feasibility and cosmetic outcome of batwing mammoplasty and contralateral symmetrization were evaluated in a non-randomized prospective comparison of women with large/ptotic C, D, or DD cup breasts treated with bilateral superior pedicle reduction mammoplasty ($n = 10$) for lower pole lesions, bilateral inferior pedicle reduction mammoplasty ($n = 40$) for upper pole lesions, and bilateral batwing mastopexy ($n = 36$) for upper pole, periareolar lesions in proximity to the skin [8]. An identical procedure was performed in the contralateral breast at the same operation to achieve symmetry. Overall satisfactory was highest in the bilateral batwing mastopexy, whereas patients managed with bilateral inferior pedicle reduction mammoplasty reported better ptosis correction, projection, and symmetry.

Matkowski et al. [16] prospectively evaluated the early cosmetic results of 35 women (aged 33–75) that underwent batwing mammoplasty for invasive ductal carcinoma ($n = 28$) or DCIS ($n = 7$) in the upper inner ($n = 19$) and upper outer ($n = 16$) quadrants. Inclusion criteria were limited to periareolar tumors within 2 cm of the areola. Seventy-two percent of patients had breast cup size B or C. Mean pathological tumor size was 14.6 +/− 4.7 mm and skin triangles ranged from 3 to 8 cm. Closed suction surgical drains were utilized in all cases and mean operative time was 63 min. Tumor non-transection was achieved in all patient, including three patients that underwent re-excision for close margins. Self-assessed cosmesis on a three-point scale (good, medium, poor) reported good breast shape in 86%, good nipple-areolar complex position in 91%, and good scar arrangement in 74%. Inferior breast projection was more commonly observed in patients with A and B cup breasts. Adverse events were limited to symptomatic breast seromas requiring aspiration ($n = 2$). Skin/areola necrosis, hematomas, or surgical site infections were not observed.

Though not explicitly described in either publication, cosmetic limitations of the batwing or hemibatwing procedures included longer incisions on the anterior breast and possible distortion of the areola where radial incisions join the areola.

Conclusion

Batwing and hemibatwing mammoplasty are well suited for tumors in the central, upper inner, and upper outer quadrants of the breasts. An additional advantage of both procedures is the ability to achieve a modest mastopexy through resection of dermoglandular tissue above the NAC. Technical simplicity places both procedures within the skillset of most surgeons without a requirement for specialty training. The procedures may also be favored by patients and surgeons who wish to limit the operative time, extent of dissection, and potential surgical complications in higher-risk and/or elderly patients requiring large-volume resection of the skin and/or glandular tissue.

Reference Video

- https://youtu.be/cX7AEGD_MQE
- https://youtu.be/V7vkRKaUkn8

References

1. Anderson BO, Masetti R, Silverstein MJ. Oncoplastic approaches to partial mastectomy: an overview of volume-displacement techniques. Lancet Oncol. 2005;6:145–57.
2. Berry MG, Fitoussi AD, Curnier A, Couturaud RJ, Salmon RJ. Oncoplastic breast surgery: a review and systemic approach. J Plast Reconstr Aesthet Surg. 2010;63:1233–43.

3. Burkholder HC, Witherspoon LE, Burns RP, Horn JS, Biderman MD. Breast surgery techniques: preoperative bracketing wire localization by surgeons. Am Surg. 2007;73(6):574–8.
4. Cardoso JS, Cardoso MJ. Towards an intelligent medical system for the aesthetic evaluation of breast cancer conservative treatment. Artif Intell Med. 2007;40:115–26.
5. Caruso F, Ferrara M, Castiglione G, Cannata I, Marziani A, Polino C, Caruso M, Girlando A, Nuciforo G, Catanuto G. Therapeutic mammaplasties: full local control of breast cancer in one surgical stage with frozen section. Eur J Surg Oncol. 2011;37:871–5.
6. Cil TD, Cordeiro E. Complications of oncoplastic breast surgery involving soft tissue transfer versus breast-conserving surgery: an analysis of the NSQIP database. Ann Surg Oncol. 2016;23:3266–71.
7. Clough KB, Kaufman GJ, Nos C. Improving breast cancer surgery: a classification and quadrant per quadrant atlas for oncoplastic surgery. Ann Surg Oncol. 2010;17:1375–91.
8. Farahat AM, Attie AAM, El Shafei El Zawahry MAM, Zedan MH, Soliman HO. Therapeutic mammoplasty in management of breast cancer: a prospective clinical study. Adv Breast Cancer Res. 2017;6:107–16.
9. Fitoussi A, Berry MG, Couturaud B, Salmon RJ. Oncoplastic and reconstructive surgery of breast cancer. Berlin: Springer-Verlag Berlin and Heidelberg GmbH & Co; 2009.
10. Hashem T, Farahat A. Batwing versus wise pattern mammoplasty for upper pole breast tumors: a detailed comparison of cosmetic outcome. World J Surg Oncol. 2017;15(60):1–6.
11. Holmes DR, Schooler W, Smith R. Oncoplastic approaches to breast conservation. Int J Breast Cancer. 2011;2011:303879.
12. Iwuchukwu OC, Harvey JR, Dordea M, Critchley AC, Drew PJ. The role of oncoplastic therapeutic mammoplasty in breast cancer surgery—a review. Surg Oncol. 2012;21:133–41.
13. Kirstein LJ, Rafferty E, Specht MC. Outcome of multiple wire localization for larger breast cancers: when can mastectomy be avoided? J Am Coll Surg. 2008;207(3):342–6.
14. Landercasper J, Attai D, Atisha D, Beitsch P, Bosserman L, Bougher J. Toolbox to reduce lumpectomy reoperations and improve cosmetic outcome in breast cancer patients: the American Society of Breast Surgeons Consensus conference. Ann Surg Oncol. 2015;22:3174–83.
15. Malka I, Villet R, Fitoussi A, Salmon RJ. Oncoplastic conservative treatment for breast cancer (part 3): techniques for the upper quadrants. J Visc Surg. 2010;147(6):e365–72.
16. Matkowski R, Szynglarewicz B, Kasprzak P, Forgacz J, Skalik R, Zietek M, Kornafel D. Batwing mastopexy as oncoplastic surgical approach to periareolar tumors in upper quadrants. Tumori. 2012;98:421–7.
17. Molina MA, Snell S, Franceschi D, Jorda M, Gomez C, Moffat FL, Powell J, Avisar E. Breast specimen orientation. Ann Surg Oncol. 2009;16(2):285–8.
18. Piper M, Peled AW, Sbitany H. Oncoplastic breast surgery: current strategies. Gland Surg. 2015;4(2):154–63.
19. Silverstein MJ. An argument against routine use of radiotherapy for ductal carcinoma in situ. Oncology (Williston Park). 2003;17:1511–33.
20. Schnabel F, Boolbol SK, Gittleman M, Karni T, Tafra L, et al. A randomized prospective study of lumpectomy margin assessment with use of MarginProbe in patients with nonpalpable breast malignancies. Ann Surg Oncol. 2014;21:1589–95.
21. Yang JD, Lee JW, Cho YK, Kim WW, Hwang SO, Jung JH, Park HY. Surgical techniques for personalized oncoplastic surgery in breast cancer patients with small- to moderate-sized breasts (part 1): volume displacement. J Breast Cancer. 2012;15(1):1–6.

Grisotti Flap Mammoplasty

10

Abby Geletzke, Erik Hoy, and Jennifer S. Gass

Introduction

Randomized prospective trials with 25 years of follow-up published over a decade ago established the equivalence of breast-conserving surgery to mastectomy regarding survival outcomes [1]. Thus, breast conservation has become the preferred approach for the surgical management of breast malignancy limited to one region (quadrant) of the breast [2]. Survival from breast cancer continues to climb with 5-year overall survival now cited at 98.9% for the 62% of breast cancer presenting as disease localized to the breast and 85.2% for the 31% presenting as regional disease [3]. As survival improves, quality of life outcomes become increasingly relevant, including body image which ultimately is impacted by the cosmetic outcome of the ablative procedure. Oncoplastic surgery, initially described by Audretsch [4] in 1998, asserts that oncologically sound resection can be safely combined with surgical techniques that lead to acceptable cosmetic outcomes. To this end, oncoplastic approaches to tumorectomy specific to each region of the breast, taking into consideration the native size and shape of the breast, have blossomed, hallmarked by the classic quadrant by quadrant approach of Clough and colleagues [5] and others [6, 7]. In the era of the oncologic acceptance of nipple-sparing mastectomy,

A. Geletzke
University of Pittsburgh Medical Center, Pinnacle, Lancaster, PA, USA
e-mail: Abby.Geletzke@pinnaclehealth.org

E. Hoy
Division of Plastic Surgery, Women and Infants' Hospital, Providence, RI, USA
e-mail: ehoy@kentri.org

J. S. Gass (✉)
Women and Infants' Hospital, Providence, RI, USA

Alpert Medical School, Brown University, Providence, RI, USA
e-mail: JGass@Wihri.org

V. S. Klimberg et al. (eds.), *Oncoplastic Breast Surgery Techniques for the General Surgeon*, https://doi.org/10.1007/978-3-030-40196-2_10

which conserves the patient's own total skin envelope which is then filled with an idealized breast glandular substitute whether autologous or implant, cosmetic outcomes for breast-conserving surgery face a greater challenge to achieve equal cosmetic outcomes. However as breast cancer surgeons and patients weigh the relative aesthetic merits of a nipple-sparing mastectomy versus breast-conserving surgery, at least one report suggests that in survivorship, the conserved breast retains a greater role during intimacy when compared to mastectomy and reconstruction [8]. Furthermore, in our increasingly obese population in the USA, oncoplastic breast-conserving reconstruction has one-tenth the risk of major complication as compared to mastectomy paired with any type of reconstruction (autologous or implant) as well as 5% the risk of delaying adjuvant therapy [9]. Therefore, as breast cancer surgeons, we continue to strive to offer breast-conserving surgery to all those eligible.

Nevertheless, certain quadrants of the breast can present a greater challenge when striving for a good cosmetic outcome. Turning to the central "quadrant" of the breast, close proximity of the nipple-areolar complex to the malignancy in the past has led to the consideration of mastectomy given concerns of poor cosmetic outcome [9]. Furthermore, the NSABP B-06 did not evaluate patients with central lesions potentially involving the nipple-areolar complex [10] though subsequent small studies have supported equal outcomes when analyzing local recurrence and overall survival [11, 12, 13]. While remarkable progress has been made in nipple areola preservation in the setting of mastectomy [14, 15] in breast-conserving procedures, when attaining a clear margin precludes preservation of the nipple-areolar complex, the nipple-areolar complex (NAC) requires removal. Not only is the NAC described as the signature of the breast [16], but furthermore, the resultant loss of the mammary apex, or the most forwardly oriented region of the breast, diminishes the span of the skin envelope and distinctly alters the contour or profile of the breast (Fig. 10.1). Traditionally, a central mastectomy has been performed through a transverse incision, similar to the Stewart mastectomy approach. In a breast with upper

Fig. 10.1 Transverse scar orientation

Fig. 10.2 Vertical scar orientation

pole volume loss associated with ptosis, aging, or tubular breast deformity, the transversely oriented incision often leads to a flattening deformity of the desired curvature of the breast mound. A vertical incision can reduce the flattening effect but continues to narrow the breast, which may not be ideal for all breast sizes and shapes (Fig. 10.2).

The Grisotti mammoplasty, described by Andrea Grisotti in 1993 [17], uses an inferiorly based dermal-glandular pedicle to advance a skin island into the central mastectomy defect. This skin island is sized to fill the entirety of the skin loss centrally and harvested from the lower pole of the breast where those with ptosis have redundant skin. Tattooing or nipple reconstruction can be subsequently performed as a second stage procedure. Modifications have been described that aim to decrease postoperative complications [18]. Subsequent authors have described using the inferior pedicle of a Wise pattern mammoplasty to support the skin island with a resultant reverse T or anchor incision plan or a vertical Lejour mammoplasty [5, 19, 20]. The former will be reviewed below and the Wise pattern in Chap. 11.

Indications

The Grisotti mammoplasty specifically addresses lumpectomy associated with resection of the NAC, with retroareolar tumors or Paget's disease of the nipple being standard indications. Given the inferiorly based pedicle, a degree of ptosis is required to ensure that the recreated dermal graft is appropriately oriented on the breast mound. Another approach to the central breast cancer is the Wise pattern incision approach with delayed nipple reconstruction on the medial and lateral parenchymal skin flaps. Yet, in a narrower breast, the Grisotti flap may be superior since with the Wise pattern approach tends to diminish the width of the breast. The Grisotti technique is not the approach for those women who desire significant elevation of the NAC or significant reduction in breast volume. It is useful when little change in the native breast size and shape is desired and when surgery to the contralateral breast is not desired or should be avoided.

Preoperative Evaluation

Standard preoperative evaluation includes a comprehensive history and physical with attention to family history and presence of comorbidities such as diabetes mellitus, obesity, and history of tobacco use. While none of these are an absolute contraindication to mammoplasty, patients with a deleterious BRCA 1/2 mutation may want to consider more extensive surgery, and those with comorbidities need appropriate informed consent regarding risks. Regarding obesity specifically, Tong reported a significant tenfold increased risk of significant complications for mastectomy with either tissue-based or implant-based reconstruction as compared to oncoplastic breast reduction in this at-risk population [9]. A bilateral diagnostic mammogram, ipsilateral ultrasound, and image-guided core biopsy with clip placement are standard. This technique does not require different breast MRI indications from the usual for early breast cancer.

At examination, the patient's breast symmetry, anatomic dimensions, and degree of ptosis are quantified. The Grisotti mammoplasty is most successful in women with some degree of ptosis and those who are comfortable with their breast size. Larger volume reduction can be achieved with the Wise pattern. Since the movement of the NAC is not extensive with the Grisotti flap, those wishing greater correction of ptosis are better served with a different approach. If there is breast asymmetry, the decision should be made regarding immediate or delayed symmetrization. Delayed symmetrization increases the ability to match the treated breast's size and shape after radiation is complete. Immediate symmetrization allows the patient to achieve potentially reasonable symmetry in one procedure. A detailed discussion detailing the patient's priorities will clarify the best strategy.

Patient Selection

The first decision in all breast cancer surgeries is to determine if the patient is a candidate for breast-conserving surgery. First the disease needs to be centered in one region or, classically, quadrant of the breast. For this procedure, the disease will be retroareolar. Disease that extends well away from this region may not be well addressed by the Grisotti, and either a Wise pattern that allows more extensive glandular reshaping or a skin-sparing mastectomy with reconstruction may be a better choice. The decision for unicentric breast conservation therapy is routinely based on breast to tumor volume ratio. General guidelines suggest that when more than 10–20% of the breast volume requires resection, an oncoplastic procedure should be considered [21, 22]. Patients presenting with macromastia and ptosis are clear candidates to this type of approach. The Wise pattern or "keyhole" skin incision design is commonly used by plastic surgeons when performing either breast reduction or mastopexy. This creates both glandular flaps and skin flaps that result in an inverted "T"-shaped scar joined to the circumareolar scar. This approach also can refill the nipple-areolar complex with a dermal island that is most commonly based on an inferior or superior-medial parenchymal pedicle and leads to maximal reshaping. However, the inverted T juncture at the inframammary fold is well-known to be prone to delayed healing, and strategies to mitigate against wound failure have been described [23].

To avoid postoperative complications in those at increased risk due to comorbidities, tobacco use (active or recent), obesity, and metabolic- and age-associated risks, the Grisotti mammoplasty eliminates the "T" scar.

Nevertheless, in all cases, if there is not to be volume replacement, the surgeon needs to establish that the size and shape of the residual glandular tissue will leave an adequately sized breast, which will involve a clear conversation with the patient.

Given that mature trials show no overall survival disadvantage to primary systemic therapy [24, 25], another pathway to breast conservation therapy for larger tumors is to downstage with either neoadjuvant chemotherapy or endocrine therapy [26]. Uniformly, trials show a modest conversion rate from mastectomy to breast-conserving surgery of about 16–18%. However, the rate is highly dependent of tumor subtype with the greatest results in triple-negative and Her-2 neu-enriched invasive mammary carcinomas with the lowest rates for primary chemotherapy in the invasive lobular carcinomas [27]. See Chap. 32.

Women who cannot undergo radiation, such as those with recurrent breast cancer in a previously radiated breast or those with connective tissue disorders such as scleroderma, are likely better served with one of the types of mastectomy potentially paired reconstruction.

Surgical Technique

In the holding area, the patient is marked in the seated or standing position. The most essential mark is the height to which the Grisotti skin island can rise to be located ideally on the residual mound. (See Chap. 11.) Standard breast markings and measurements from the sternal notch, mid clavicle, and orientation to the mid-humerus should be reconciled. The procedure is reviewed with the patient.

The patient is positioned supine on the operating table with arms abducted at 90° and, if desired, secured with wrapped elastic gauze to permit elevating the patient's back into the seated position during the procedure. Prophylactic antibiotics are given and bilateral breasts are prepped and draped.

Fig. 10.3 Breast secured with gauze pad

1. Sentinel node biopsy for clinically node-negative patients should precede the breast resection. Lymphatic mapping with dermally injected radioisotope is favored over subareolar injection for subareolar tumors. Dual agent mapping with both blue dye and radioisotope eases node identification and marginally increases sentinel node accuracy [28].
2. A peri-areolar *partial-thickness* incision is made sharply. A 38–42 cm nipple-areolar sizer is useful in creating a perfectly circular incision. This device will simply mark the incision line on the skin either with an applied marker to its surface or by the imprint on the skin. Placing a laparotomy gauze pad around the base of the breast provides an evenly stretched skin surface (Fig. 10.3). Enlarging the perimeter of the resection by 2 cm outside of the areolar edge to encompass an eccentric lying lesion has been described with satisfactory results [29].
3. A second imprint is made immediately below the first. This delineates the skin island that is to move into the space left by the tumorectomy. The incision plan for the Grisotti flap is now drawn as two lines extending from the edge of the nipple-areolar complex down and laterally in concentric curves, J shaped in a right breast. The tips of these lines converge at the inframammary fold. Within these lines is where the second marked skin disc which ultimately refills the resected NAC lies. The lateral line should be 2–3 mm lateral to the skin island. How quickly these two lines narrow depends on the breast's shape (Fig. 10.4).
4. The tumorectomy is accomplished first by completing the incision of the skin around the NAC and then dissecting through the breast parenchyma to the pectoralis muscle. The specimen is checked for margin clearance, oriented, and weighed particularly if a contralateral procedure is anticipated. Hemostasis is ensured, and the tumor bed is irrigated and delineated with fiducial markers.
5. Having completed the tumorectomy, incisions are made along the two curved lines and the skin island to the *partial-thickness* depth.

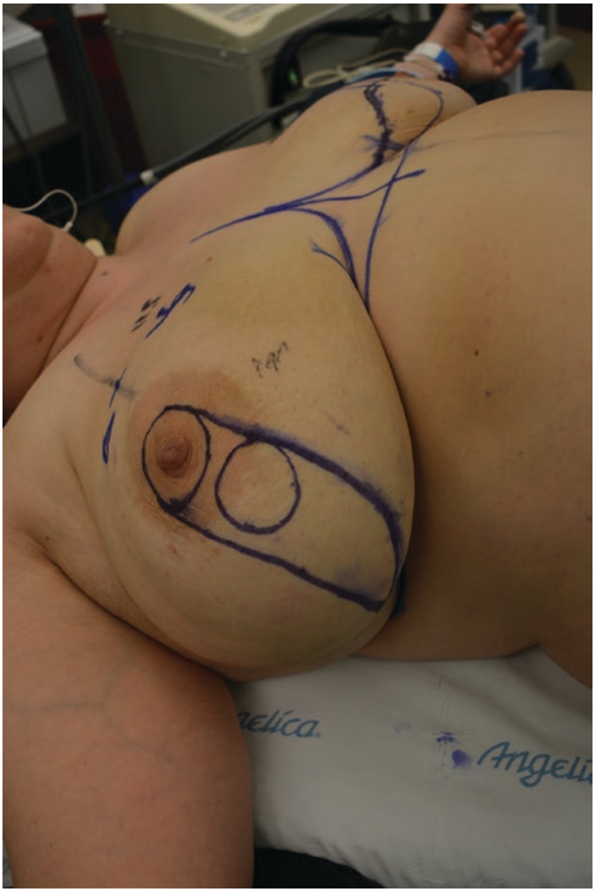


Fig. 10.4 Skin incision markings

6. The skin between the incisions, but not the skin island, is de-epithelialized completely. This step is easier without the full-thickness incision. A de-epithelialized border lateral to the skin island remarkably facilitates subsequent skin flap placement.
7. Once de-epithelialized, the flap is created by incising full thickness at the medial incision only, extending through the skin and the parenchyma to pectoralis fascia. Dissecting the flap from the pectoralis fascia will increase the mobility of the flap.
8. This flap is then rotated up into the tumorectomy cavity (Fig. 10.5). Rotation is facilitated freeing the skin island laterally; however, too extensive mobilization at either the skin level or the pectoralis level can lead to either arterial or venous ischemia [30]. Therefore, dissection is limited to the degree or extent necessary

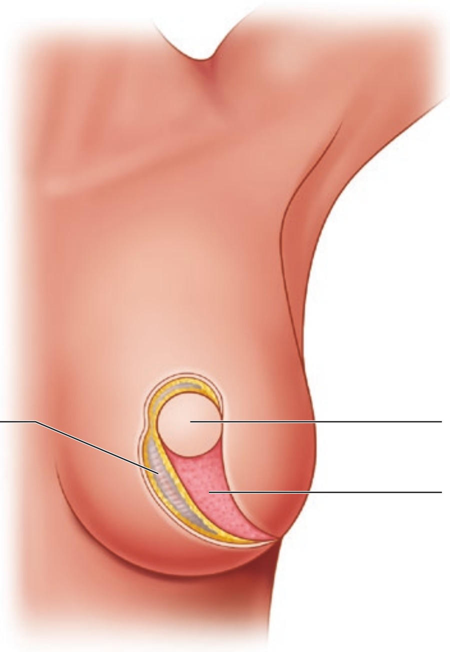


Fig. 10.5 De-epithelialized flap and medial full-thickness mastotomy

for flap rotation and a tension-free inset into the defect. The point of maximal tension for this closure is from the inferolateral aspect of the breast to the superomedial aspect of the flap's skin paddle. Sufficient undermining of the flap should allow this tension to be as little as possible, without unnecessarily disrupting vascularity at the base of the flap.

9. The wound is closed by placing subdermal dissolvable 3–0 sutures, securing the new skin island to the recipient defect at 90° intervals first and then along the length of the curved incision. Generally, the skin island rotates up and outward by 90°, such that in the left breast the superior midline point (12 o'clock[1]) of the skin island will approach the central lateral location (3 o'clock[1]) of the tumorectomy cavity. Similarly the central medial point (9 o'clock[1]) of the skin island point approaches superior midline position (12 o'clock[1]) in the tumorectomy defect, and inferior midline (6 o'clock[1]) point of the skin island reaches toward central medial aspect (9 o'clock[1]) of the tumorectomy cavity (Fig. 10.6).
10. Grisotti described suturing the glandular tissue in layers to ensure the deep glandular tissues are well aprroximated to adequately fill the central defect, though others have described leaving the parenchyma un-approximated. Suturing the parenchymal pillars serves to take lateral tension off the skin clo-

[1] Clock face descriptors are for a left breast procedure.

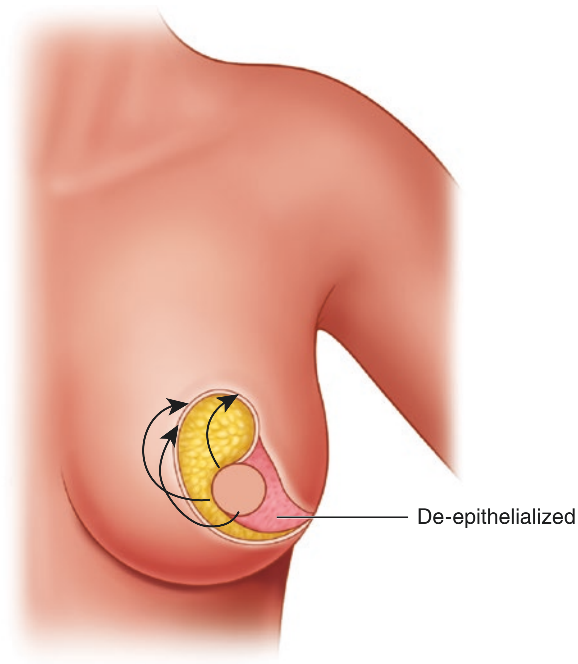


Fig. 10.6 Flap rotation into the tumorectomy defect

sure and helps prevent inferior retraction on the skin due to tethering from the ptotic glandular pedicle. The skin is closed with a subcuticular 5–0 dissolvable suture. Topical adhesive strips or surgical glue is applied and then a sterile gauze dressing. A surgical bra provides good support and is worn for at least 1 week. Drains are not routinely employed (Fig. 10.7).

Querci Della Rovere and colleagues described a modification designed to facilitate wound closure, and that reportedly may improve cosmetic outcomes [18]. Labeled an E3 modification, it preserves the epidermis superior and medial to the skin island. This may decrease tension at the time of closure of the inferior aspect of the skin island. Diagram (permission from publisher)

Surgical Complications and Solutions

Common to all breast cancer surgeries are the somewhat minor risks of hematoma and infection. Reports to date show no significantly reported increased risk of either in the limited series of the Grisotti flaps specifically [18] or in larger oncoplastic series [17, 20, 31, 32]. The oncologic safety of oncoplastic surgery as it relates to positive margin rate, time to adjuvant therapies, local recurrence, and overall survival have been repeatedly evaluated and show no difference when compared to breast-conserving surgery [33, 34].

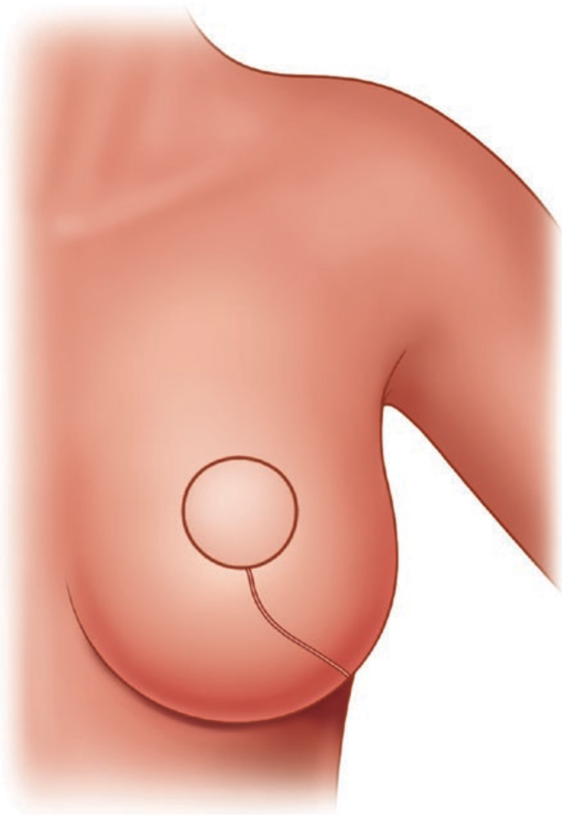


Fig. 10.7 Completed subcuticular closure

Fat Necrosis

Oncoplastic surgery does carry a greater risk of fat necrosis than in non-oncoplastic resections [35]. A review of oncoplastic reduction mammoplasty delineates a 4.3% risk of fat necrosis in 17 articles and 1324 cases with follow-up between 20 and 74 months [36]. While fat necrosis was not reported in the original Grisotti series [17], a single episode was reported in Petit's cohort [37]. Fat necrosis is associated with a higher rate of palpable breast masses and subsequent biopsies in surveillance [38] and can mimic breast malignancy on clinical or radiographic exam and in some cases can obscure malignant lesions [39]. Management of fat necrosis depends on the degree of associated symptoms. For many patients, establishing a benign diagnosis is adequate, while others may need treatment. Nonoperative treatments with topical antibacterial ointments, nonsteroidal anti-inflammatory medications, and warm compresses will alleviate symptoms for a proportion of those affected. Antibiotics can be started empirically to prevent suprainfection but are controversial. The imaging modality of choice for evaluation of fat necrosis is controversial. Whitman et al. recommend mammography as more specific than ultrasound for evaluation of fat necrosis in the breast [40]. However, postsurgical fat necrosis is often associated with a significant degree of pain and tenderness, making ultrasound or MRI a potentially more practical imaging modality. Successful resection of fat necrosis is straightforward in the absence of radiation. However, in the radiated breast, a nonoperative approach with analgesics and pentoxifylline [41] is the first line of therapy, and surgery is approached with trepidation as wound healing can be a challenge (personal communication).

Finally, it is worth noting that in the original Grisotti report, boost radiation was not delivered. Rather, radiation was delivered as two opposing tangent beams to a total dose of 60 gray in 2 gray daily fractions [17]. In the current era, boost irradiation has become standard [42] and may lead to early or delayed fat necrosis. Therefore, surgeons need to critically assess comorbidities such as smoking, obesity, and diabetes when selecting the best operative procedure for their patients [20].

Ischemic necrosis of the new NAC skin island was reported in a single patient by Galimberti et al. [17] in their group of 37 patients. In the Turkish series [43] of 42 women undergoing oncoplastic surgery including 5 Grisotti flaps, there were 7 complications including suture separation, superficial skin infection, seroma, and a single case of partial necrosis of the NAC. The rate of complication in both of these series is lower than described by Clough [44], in the study of several oncoplastic techniques. In NAC-sparing surgery, several intraoperative and postoperative maneuvers can be employed to prevent ischemia including, first and foremost, preserving not only the arterial but also the venous drainage to the NAC, limiting the dissection from the chest, and the degree to which the skin island is freed from the pedicle during sitting (step 9.) Flap ischemia is clinically diagnosed with the development of pallor or delayed capillary refill >3 seconds of the flaps skin island during dissection or inset. Alternatively, the SPY (Stryker, Kalamazoo, MI) indocyanine green intraoperative laser imaging system can be used to monitor flap perfusion in a noninvasive manner. Use of this imaging modality has been shown to lower mastectomy flap necrosis rates in skin-sparing mastectomy from 16% to nearly zero [45]. Avoiding compression or kinking or folding of the de-epithelialized pedicle and evacuating hematomas all have helped with preventing NAC necrosis by releasing tension or occlusion of the flap pedicle and increasing vascular inflow to the flap [34]. If ischemia is identified intraoperatively as the flap is inset, or in the immediate postoperative period, the easiest first step is to judiciously release the insetting sutures. A small wound dehiscence which heals secondarily is usually preferable to ischemic complications due to tight flap inset. This relatively simple maneuver may help the patient avoid secondary surgery to debride an ischemic area later.

Venous congestion of the flap is an insidious, but no less worrisome, complication than arterial ischemia. Signs of venous congestion may be seen as dark bleeding from the flap edges or rapid capillary refill of the flap. As with arterial ischemia, flap repositioning maneuvers are attempted first. Pharmacologic interventions with venodialators such as topical nitroglycerin paste and, experimentally, sildenafil/fibrin glue [46] have been shown to improve survival of venous-congested flaps. Topical nitropaste has been shown to decrease the necrosis of mastectomy flaps over placebo 15.3% vs. 33.8%, respectively [47], and is a low-risk intervention. If SPY angiography is used, reimaging the flap 20 minutes after initial ICG injection can verify washout of the contrast material and help to verify that no venous insufficiency in the flap exists [48].

Avoiding compression or kinking or folding of the de-epithelialized pedicle and evacuating hematomas all have helped with preventing NAC necrosis [49].

Aesthetic outcomes are critical when discussing oncoplastic surgery. In the original Galimberti and Grisotti cohort, patients were evaluated 3 months after radiotherapy. Form and symmetry were considered excellent or good in 91.9% and 75.7%, respectively. Most importantly, 70% of patients were satisfied with the results. It is worth noting that 10 of 37 women completed nipple reconstruction following completion of treatment. These cosmetic results were mirrored by others studying the technique [43, 50]. In particular, when Petit et al. evaluated the Grisotti flap compared to other reconstructive techniques, the results were scored as good in 100% based on photographic evaluation at a mean follow-up interval of 21 months using predefined cosmetic criteria. This was equivalent to the round block technique and better than inferior and superior pedicle, latissimus dorsi, and prosthetic implants with good scores ranging from 87% to 58% [37].

Results

Galimberti and Grisotti published their results on 37 patients with small, central breast cancers requiring central quadrantectomy with skin-glandular flap reconstruction in 1993, the first and largest study of this technique to date. They followed these patients for a mean 32 months. There were no positive margins, no local recurrences, and no distant metastases. Thirty-four patients underwent radiotherapy within 3–6 weeks of surgery [17].

Two other studies have been performed to evaluate outcomes of the Grisotti flap alone; however, the largest series included 25 patients followed for over 5 years for retroareolar cancers <20 mm who underwent a central mastectomy with either the classic Grisotti approach or the E3 modification, limiting the skin resection on the rotation flap (see technique section). Eight percent required mastectomy for margin involvement, and 8% underwent re-excision of margins successfully [18]. A retrospective series from Cairo University [29] described the Grisotti flap for 23 central mastectomies with extensive details of tumor histology (86% invasive ductal carcinoma with or without in situ disease), stage (70% T2–T4) occult nipple involvement (33.7%), surgical technique, operative time (mean: 195 minutes), blood loss (mean: 225 ml) patient and physician evaluated cosmetic outcome and complications. They did describe a volume discrepancy rate of 26% – yet no patient chose a contralateral symmetrization procedure – and also reported a 13% rate of shape distortion. Furthermore, though nipple reconstruction was offered with tattooing or banner flap, none proceeded.

Further studies included Grisotti reconstructions in conjunction with other central resection techniques. The Cairo University updated their treatment paradigm for centrally located tumors to recommend Grisotti for those with smaller tumors and moderate-sized breasts and a Wise pattern approach for those with "large or sagging breasts." Overall mean tumor size was 2.9 cm, 19 of 21 underwent adjuvant radiotherapy, and the group was followed for a mean of 15 months. There were no local recurrences or distant metastases in this group [50]. From Austria, another collective series on centrally located breast cancers reported on 31 patients, 9 of whom underwent repair with a modified Grisotti flap [20]. Two from the entire cohort required return to the operating room for positive margins. Radiotherapy was delivered 89% of the Grisotti flap recipients. For the entire cohort, there were no local recurrences and two systemic recurrences at mean follow-up of 34 months. Turning to locally advanced cancers treated with primary systemic therapy, Emiroglu reported on 42 patients with a median size of 27 mm post neoadjuvant therapy and followed for a median 61 months, including 5 resected with a Grisotti flap. The algorithm for procedure selection is not delineated; however, there were five centrally located tumors and five Grisotti flaps. Detailed outcome by procedure was not provided, yet this is the singular study reporting whole-breast radiation with boost. Complications described are limited to skin separation, partial NAC necrosis, skin surface infection, and seroma occurring in 17%. The entire cohort had a positive margin rate of 7.1% and a local and distant recurrence rate of 14.6% and 43%, respectively, in this locally advanced breast cancer group with mean 5-year surveillance [43]. Mansoura University of Egypt reported their approach to 30 women with centrally located breast tumors creating an algorithm guiding women with large and ptotic breasts to Grisotti, those with small or non-ptotic breasts to skin-sparing mastectomy with reconstruction, and those with large/ptotic and inability to clear margins to skin-reducing mastectomy with reconstruction [51]. As in the Cairo series, no symmetrization was elected by patients, and nipple tattooing/reconstruction was uniformly declined. Results are reported for the entire group with a 3% rate of surgical site infection and 13% rate of wound dehiscence (Table 10.1).

None of these studies vary significantly from [44] Clough's 2003 report of 101 patients undergoing oncoplastic resection, followed for an average of 3.8 years. In that report which advocated for oncoplastic technique and concomitant symmetrization when appropriate, there was a local recurrence rate of 9.4% and favorable cosmesis in 82% [44]. The findings are also comparable to those found by De La Cruz in the 2016 review of 55 articles including 6011 patients followed for a mean 50.5 months. In that study, there was a positive margin rate of 9.8%, an overall survival rate of 95%, and a local recurrence rate of 6.0% at 5 years [33]. The Grisotti technique adds an oncoplastic approach specific to patients with small central tumors in moderate sized ptotic breasts.

Table 10.1 Published series of Grisotti mammoplasty

Author, year	N = total	Grisotti	Mean f/u: months	RT/boost	LR[a]/DR[b]	Complications	Cosmetic outcome
Galimberti, Grisotti 1993 [17]	37	37	32	Whole Breast/no boost	0/0	3% ischemia of skin covering central defect	Excellent in 41%, good in 51%
Querci Della Rovere 2007 [18]	25	25	18	NA	0/NA	No sepsis or necrosis	100% excellent
Naguib 2006 [29]	23	23	17.5	Whole Breast/no boost	1/1	8% epidermolysis 4% Eschar<1 cm	Good to excellent: 60% Poor: 8%
Farouk 2015 [51]	30	8	24	RT planned No details	0/0	13% wound dehis. 3% infection	Excellent/good: 90%(all patients at 6 m)
Moustafa 2014 [50]	21	3	15	95% received no details	0/0	Limited to non Grisotti patients	Excellent/good: 85%
Emiroglu 2016 [43]	42	5	61	All Whole Breast + boost	15/60%	5% suture separation, 5% skin infection, 2% partial necrosis of the NAC, 2% donor-site seroma, 2% breast hypertrophy	Excellent/good: 79%
Heumer 2007 [20]	31	9	33.8	RT in 8/9; no details	0/2	6% delayed wound healing, fat necrosis	Excellent: 81% Good: 19%

[a]Local recurrence
[b]Distant recurrence

Conclusion

The Grisotti rotation flap is a valuable resource for central tumors requiring resection of the NAC. Replacing the resected NAC with a new skin island preserves the contour of the breast. The Grisotti flap finds its greatest advantage for women with a narrower chest and moderate ptosis where the more standard Wise pattern might result in undesirable narrowing of the breast mound. Furthermore, for those women wishing to avoid contralateral breast surgery, the Grisotti flap can more easily match the opposite breast. The published results mirror those of the oncoplastic plastic approach in other quadrants, with a comparable rate of margin involvement, local recurrence, and overall survival. A distinction for the Grisotti flap is the mobilization of a parenchyma flap into the tumorectomy defect, potentially exposing parenchyma outside of a traditional boost field to boost irradiation. This consequence is also seen with the Clough Crescent [52] and may be part of a Wise reduction mammoplasty, particularly when the target lesion is located superior to the areola. The consequences have not been reported, and strategies to address tailoring radiation have not been developed beyond the critical step of marking the tumorectomy cavity with fiducial markers to distinguish the tumor bed from the mobilizing and dissection cavities. The Grisotti flap technique is well recognized, particularly in Europe and the Middle East, and is a straightforward addition to the breast surgeon's repertoire with a low risk for postoperative complications. For women with symptomatic macromastia, or smaller breasts, the oncoplastic surgeon should turn to alternative operative interventions.

Reference Video

- https://youtu.be/CtR9HEWYGlw
- https://youtu.be/Y0_xyfmdGH0

References

1. Veronesi U, et al. Twenty-year follow-up of a randomized study comparing breast-conserving surgery with radical mastectomy for early breast cancer. N Engl J Med. 2002;347(16):1227–32.
2. NCCN, NCCN Clinical Practice Guidelines in Oncology Breast Cancer 2017. 3.
3. (SEER), N.C.I. Cancer stat facts: female Breast Cancer 2013; Available from: https://seer.cancer.gov/statfacts/html/breast.html.
4. Werner P, Audretsch MR, Kolotas C, Zamboglou N, Schnabel T, Bojar H. Tumor-specific immediate reconstruction in breast cancer patients. Semin Plast Surg. 1998;11(1):71–100.
5. Clough KB, et al. Improving breast cancer surgery: a classification and quadrant per quadrant atlas for oncoplastic surgery. Ann Surg Oncol. 2010;17(5):1375–91.
6. Wechselberger G, et al. Extending the role of breast-conserving surgery by immediate volume replacement. Br J Surg. 1997;84(8):1172–3.
7. Spear SL, Bulan EJ, Venturi ML. Breast augmentation. Plast Reconstr Surg. 2006;118(7 Suppl):188S–96S; discussion 197S–198S.

8. Gass JS, et al. Breast-specific sensuality and sexual function in cancer survivorship: does surgical modality matter? Ann Surg Oncol. 2017;24(11):3133–40.
9. Tong WM, et al. Obese women experience fewer complications after oncoplastic breast repair following partial mastectomy than after immediate total breast reconstruction. Plast Reconstr Surg. 2016;137(3):777–91.
10. Fisher B, et al. A randomized clinical trial evaluating sequential methotrexate and fluorouracil in the treatment of patients with node-negative breast cancer who have estrogen-receptor-negative tumors. N Engl J Med. 1989;320(8):473–8.
11. Pezzi CM, et al. Breast conservation surgery using nipple-areolar resection for central breast cancers. Arch Surg. 2004;139(1):32–7; discussion 38.
12. Fowble B, et al. Breast recurrence and survival related to primary tumor location in patients undergoing conservative surgery and radiation for early-stage breast cancer. Int J Radiat Oncol Biol Phys. 1992;23(5):933–9.
13. Dale PS, Giuliano AE. Nipple-areolar preservation during breast-conserving therapy for subareolar breast carcinomas. Arch Surg. 1996;131(4):430–3.
14. Li M, et al. Nipple sparing mastectomy in breast cancer patients and long-term survival outcomes: an analysis of the SEER database. PLoS One. 2017;12(8):e0183448.
15. Bailey CR, et al. Quality-of-life outcomes improve with nipple-sparing mastectomy and breast reconstruction. Plast Reconstr Surg. 2017;140(2):219–26.
16. Didier F, et al. Does nipple preservation in mastectomy improve satisfaction with cosmetic results, psychological adjustment, body image and sexuality? Breast Cancer Res Treat. 2009;118(3):623–33.
17. Galimberti V, et al. Central small size breast cancer: how to overcome the problem of nipple and areola involvement. Eur J Cancer. 1993;29A(8):1093–6.
18. Querci Della Rovere G, et al. Oncoplastic surgery for retro areolar breast cancer - a technical modification of the Grisotti flap. Indian J Surg. 2007;69(4):160–2.
19. McCulley SJ, Durani P, Macmillan RD. Therapeutic mammaplasty for centrally located breast tumors. Plast Reconstr Surg. 2006;117(2):366–73.
20. Huemer GM, et al. Oncoplastic techniques allow breast-conserving treatment in centrally located breast cancers. Plast Reconstr Surg. 2007;120(2):390–8.
21. Bulstrode N, Bellamy E, Shrotria S. Breast volume assessment: comparing five different techniques. Breast. 2001;10(2):117–23.
22. Cochrane RA, et al. Cosmesis and satisfaction after breast-conserving surgery correlates with the percentage of breast volume excised. Br J Surg. 2003;90(12):1505–9.
23. Bostwick J. Prophylactic (risk-reducing) mastectomy and reconstruction. In: Plastic and reconstructive breast surgery, vol. II: St. Louis Quality Medical Publishing; 1990. p. 1369–73.
24. Wolmark N, et al. Preoperative chemotherapy in patients with operable breast cancer: nine-year results from National Surgical Adjuvant Breast and Bowel Project B-18. J Natl Cancer Inst Monogr. 2001;30:96–102.
25. Bear HD, et al. Sequential preoperative or postoperative docetaxel added to preoperative doxorubicin plus cyclophosphamide for operable breast cancer:National Surgical Adjuvant Breast and Bowel Project Protocol B-27. J Clin Oncol. 2006;24(13):2019–27.
26. Olsen A, Egeberg R, Tjonneland A. Re: calcium plus vitamin D supplementation and the risk of breast cancer. J Natl Cancer Inst. 2009;101(9):690; author reply 690-1.
27. Gentile LF, et al. Tumor biology predicts pathologic complete response to neoadjuvant chemotherapy in patients presenting with locally advanced breast cancer. Ann Surg Oncol. 2017;24(13):3896–902.
28. Povoski SP, et al. Prospective randomized clinical trial comparing intradermal, intraparenchymal, and subareolar injection routes for sentinel lymph node mapping and biopsy in breast cancer. Ann Surg Oncol. 2006;13(11):1412–21.
29. Naguib SF. Expanding the role of breast conservation surgery by immediate volume replacement with the latissimus dorsi flap. J Egypt Natl Canc Inst. 2006;18(3):216–26.
30. Acea Nebril B, Cereijo Garea C, Garcia Novoa A. Cosmetic sequelae after oncoplastic surgery of the breast. Classification and factors for prevention. Cir Esp. 2015;93(2):75–83.

31. Clough KB, et al. Positive margins after oncoplastic surgery for breast cancer. Ann Surg Oncol. 2015;22(13):4247–53.
32. Imahiyerobo TA, et al. A comparative retrospective analysis of complications after oncoplastic breast reduction and breast reduction for benign macromastia: are these procedures equally safe? Ann Plast Surg. 2015;75(4):370–5.
33. De La Cruz L, et al. Outcomes after oncoplastic breast-conserving surgery in breast cancer patients: a systematic literature review. Ann Surg Oncol. 2016;23(10):3247–58.
34. De Lorenzi F, et al. Oncological results of oncoplastic breast-conserving surgery: long term follow-up of a large series at a single institution: a matched-cohort analysis. Eur J Surg Oncol. 2016;42(1):71–7.
35. Tenofsky PL, et al. Surgical, oncologic, and cosmetic differences between oncoplastic and non-oncoplastic breast conserving surgery in breast cancer patients. Am J Surg. 2014;207(3):398–402; discussion 402.
36. Peled AW, et al. Expanding the indications for total skin-sparing mastectomy: is it safe for patients with locally advanced disease? Ann Surg Oncol. 2016;23(1):87–91.
37. Petit JY, et al. One hundred and eleven cases of breast conservation treatment with simultaneous reconstruction at the European Institute of Oncology (Milan). Tumori. 2002;88(1):41–7.
38. Amitai Y, et al. What is the yield of breast MRI in the assessment of palpable breast findings? Clin Radiol. 2017;72(11):930–5.
39. Tan PH, et al. Fat necrosis of the breast--a review. Breast. 2006;15(3):313–8.
40. Taboada JL, et al. The many faces of fat necrosis in the breast. AJR Am J Roentgenol. 2009;192(3):815–25.
41. Dion MW, et al. Preliminary results of a pilot study of pentoxifylline in the treatment of late radiation soft tissue necrosis. Int J Radiat Oncol Biol Phys. 1990;19(2):401–7.
42. Kindts I, et al. Tumour bed boost radiotherapy for women after breast-conserving surgery. Cochrane Database Syst Rev. 2017;11:CD011987.
43. Emiroglu M, et al. The effectiveness of simultaneous oncoplastic breast surgery in patients with locally advanced breast cancer. Breast Cancer. 2016;23(3):463–70.
44. Clough KB, et al. Oncoplastic techniques allow extensive resections for breast-conserving therapy of breast carcinomas. Ann Surg. 2003;237(1):26–34.
45. Murray JD, et al. Fluorescent intraoperative tissue angiography with indocyanine green: evaluation of nipple-areola vascularity during breast reduction surgery. Plast Reconstr Surg. 2010;126(1):33e–4e.
46. Ulusoy MG, et al. Improved flap viability with site-specific delivery of sildenafil citrate using fibrin glue. Ann Plast Surg. 2005;55(3):292–6.
47. Gdalevitch P, et al. Effects of nitroglycerin ointment on mastectomy flap necrosis in immediate breast reconstruction: a randomized controlled trial. Plast Reconstr Surg. 2015;135(6):1530–9.
48. Gurtner GC, et al. Intraoperative laser angiography using the SPY system: review of the literature and recommendations for use. Ann Surg Innov Res. 2013;7(1):1.
49. Rancati A, Irigo M, Angrigiani C. Management of the Ischemic Nipple-Areola Complex after breast reduction. Clin Plast Surg. 2016;43(2):403–14.
50. Moustafa A, Fakhr I. Outcome of different oncoplastic surgical (OPs) techniques for centrally located breast cancer (CLBC). J Egypt Natl Canc Inst. 2014;26(4):203–9.
51. Farouk O, et al. The outcome of oncoplastic techniques in defect reconstruction after resection of central breast tumors. World J Surg Oncol. 2015;13:285.
52. Clough KB, et al. Oncoplastic surgery for breast cancer based on tumour location and a quadrant-per-quadrant atlas. Br J Surg. 2012;99(10):1389–95.

11 Reduction Mammoplasty Marking

Paul Thiruchelvam and Shadi Ghali

Introduction

Both reduction mammaplasty and mastopexy aim to lift the nipple-areolar complex, reduce the skin envelope and improve the shape of the breast. Whilst the primary goal of a reduction mammaplasty is to reduce the volume of the breast, a mastopexy is intended to lift and reshape the breast with little/no volume reduction. Volume reduction and correction of the shape of the breast can be undertaken by a number of techniques, many of which have come to be known simply on the basis of the name of the physician who first described the procedure.

Indications

Breast reduction can be performed for either cosmetic or functional reasons. Macromastia may cause significant emotional and physical distress for those women affected and is associated with a constellation of symptoms including neck pain, back pain, shoulder pain, breast pain, headaches, shoulder grooving and intertrigo. Reduction mammaplasty is associated with significant improvement in patient quality of life and patient satisfaction [1–6]. According to the American Society for Aesthetic Plastic Surgery, more than 103,077 women in the USA underwent breast reduction in 2015 [7].

P. Thiruchelvam (✉)
Imperial College Healthcare, London, UK

Imperial College, London, London, UK
e-mail: Paul.thiruchelvam@imperial.ac.uk

S. Ghali
University College London, University of London, The Royal Free Hospital Foundation Trust, London, UK

V. S. Klimberg et al. (eds.), *Oncoplastic Breast Surgery Techniques for the General Surgeon*, https://doi.org/10.1007/978-3-030-40196-2_11

Preoperative Evaluation and Planning

A thorough breast history and examination must be obtained prior to surgery, with emphasis on previous breast surgery, biopsies and breast imaging. Whilst there are no guidelines for imaging before elective breast reduction surgery [8], many advocate mammogram for patients >40 years of age. A recent survey of members of the American Society of Plastic Surgeons (ASPS) highlighted that 62% would routinely request preoperative radiography screening and 93% requesting mammography [9]. Early detection of breast cancer is the principal indication for preoperative breast imaging; however, baseline imaging has other benefits. These include documentation and appropriate investigation of pre-existing parenchymal abnormalities in the breast so as to aid radiological assessment in the setting of future breast cancer screening.

Information regarding a patient's desire to breast feed in the future is important to determine as breast reduction surgery can impact the patient's ability to do so [10, 11]. Information regarding previous or current smoking history must be determined, as active smoking more than doubles the risk of post-operative complications [12].

Managing patient expectations is key to determine preoperatively. Unreasonable expectations are best managed before surgery, as dealing with them post-operatively can be difficult. By examining the patient preoperatively, assessment of breast asymmetry, the level of the inframammary fold, nipple position and ptosis can be determined. Measurements of the suprasternal notch-to-nipple (SSND) distance and the distance of the nipple to the inframammary fold to the nipple should be recorded. The SSND will guide the distance needed to elevate the nipple to the new nipple position and enable selection of the safest technique for the nipple pedicle. Palpation of potential masses, assessment of the density of the breast parenchyma and 'stiffness' of the breast may also be determined. Quality of the skin is extremely important, as patients with good-quality elastic skin will have more durable results than those with poor-quality. Additionally, good-quality skin will redrape over the new breast parenchyma shape, enabling a better aesthetic than poor-quality skin. Risk of breast asymmetry, altered sensation, nipple-areolar necrosis and abnormal scarring must be explained to the patient.

Preoperative photography is a crucial part of the preoperative record and may be helpful in addressing any future concerns. Three views documenting the appearance of the breast from the front and both sides are sufficient. Further views including a hands-over-the-head view may be useful. It is critical that the patient's face is not included in any photography and items of personal jewellery removed.

The Surgical Technique of a Mammaplasty

Both reduction mammaplasty and mastopexy elevate the nipple-areolar complex and reduce the skin envelope, improving the shape of the breast. Whilst the reduction mammaplasty reduces the volume of the breast, a mastopexy results in very

Table 11.1 Regnault classification of ptosis

Grades of ptosis: Regnault classification	
Grade I, minor ptosis	Nipple at level of the inframammary fold, above lower contour of the gland
Grade II, moderate ptosis	Nipple below the level of inframammary fold, above the lower contour of the gland
Grade III, major ptosis	Nipple below the level of inframammary fold, at lower contour of the gland

little or no volume reduction but lifts and reshapes the breast. When assessing the breast, ptosis is usually graded according to the Regnault classification (Table 11.1) [13].

Several techniques for reducing the breast have been described, and many of these incorporate overlapping techniques. A successful breast reduction requires the following four components:

1. Maintenance of the viability and reposition of the nipple-areolar complex (NAC)
2. Excision of excess parenchyma
3. Excision of the excess skin
4. Reshaping the breast (redraping of the skin over the parenchyma)

Planning the Nipple Pedicle

A breast reduction centres around the ability to preserve the blood supply to the NAC. The overlapping vascularity to the NAC means that many variations can be utilised including an inferior pedicle, lateral pedicle, superomedial pedicle, central pedicle, vertical pedicle (McKissock) and horizontal bipedicle (Strombeck). A recent review of plastic surgeons in the USA highlighted that 56% reported preferentially using an inferior pedicle and an inverted-T skin pattern [14].

Excision of Excess Parenchyma

Orientation of the pedicle aims to maximise both the vascularity and sensation to the nipple, whilst optimising the aesthetic. Each operation requires excision of the excess parenchyma, whilst preserving the blood supply to the NAC. The inferior pedicle relies on a superior parenchymal reduction and a strong skin brassiere to hold the remaining breast in position. Medial and superomedial pedicles are less reliant on the skin as a brassiere [15]. Once the pedicle has been planned, the excess breast parenchyma is excised often around the perimeter of the pedicle.

Skin Excision Patterns

The type of cutaneous scar has come to define the operation – inverted-T (anchor, Wise pattern) and vertical 'short' scar – limiting the scar to the periareolar area and down to the inframammary fold. It is important to appreciate the pros and cons of each skin excision strategy in patient selection.

(a) *The Wise pattern*

This is the most commonly utilised skin excision pattern and is often combined with an inferior pedicle, but any pedicle may be used [8, 16] (Fig. 11.1). It is an excellent option for large reductions especially when large skin resections are required, in exchange for the greatest scar burden among available breast reduction techniques. This pattern enables a wide exposure that facilitates nipple elevation and parenchymal redistribution. Many surgeons find this

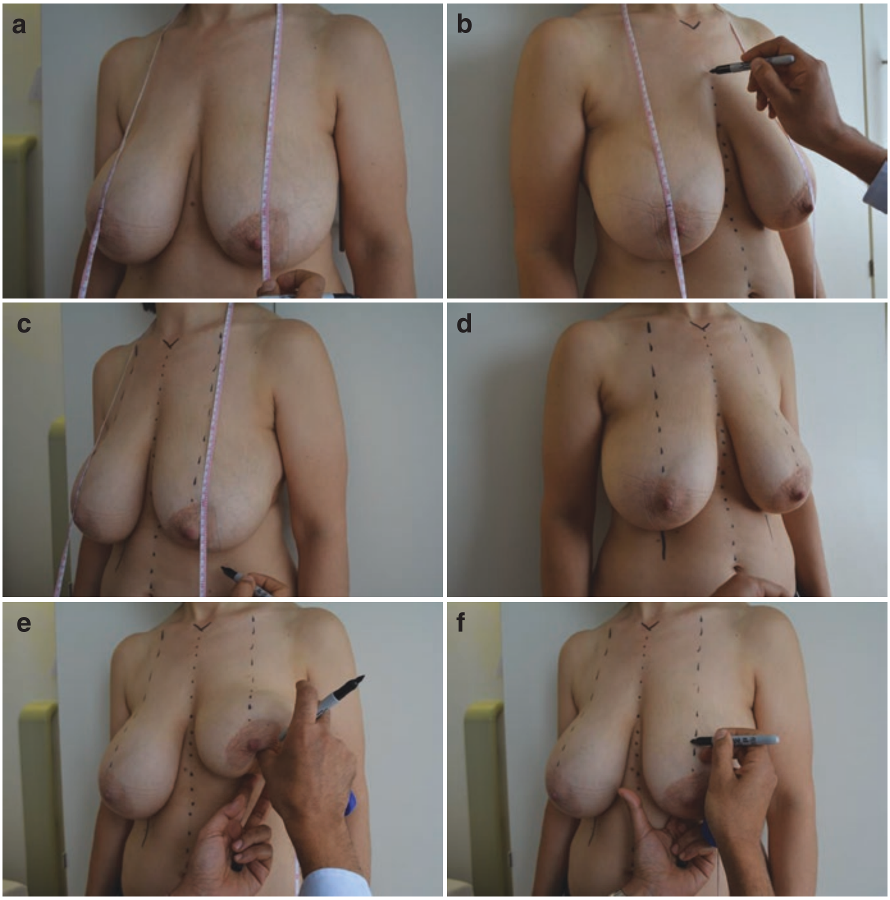


Fig. 11.1 Mark up for a "Wise-pattern" reduction mammoplasty (superiomedial pedicle)

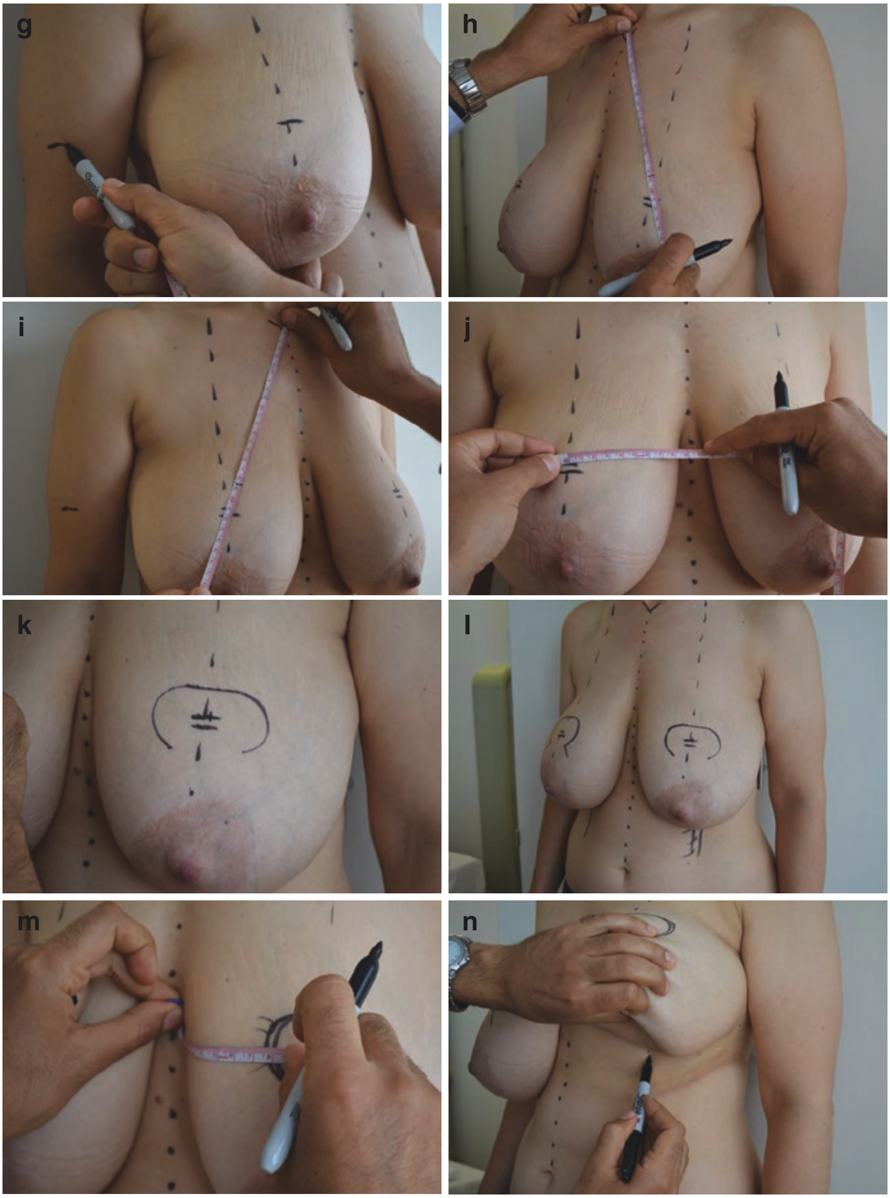


Fig. 11.1 (continued)

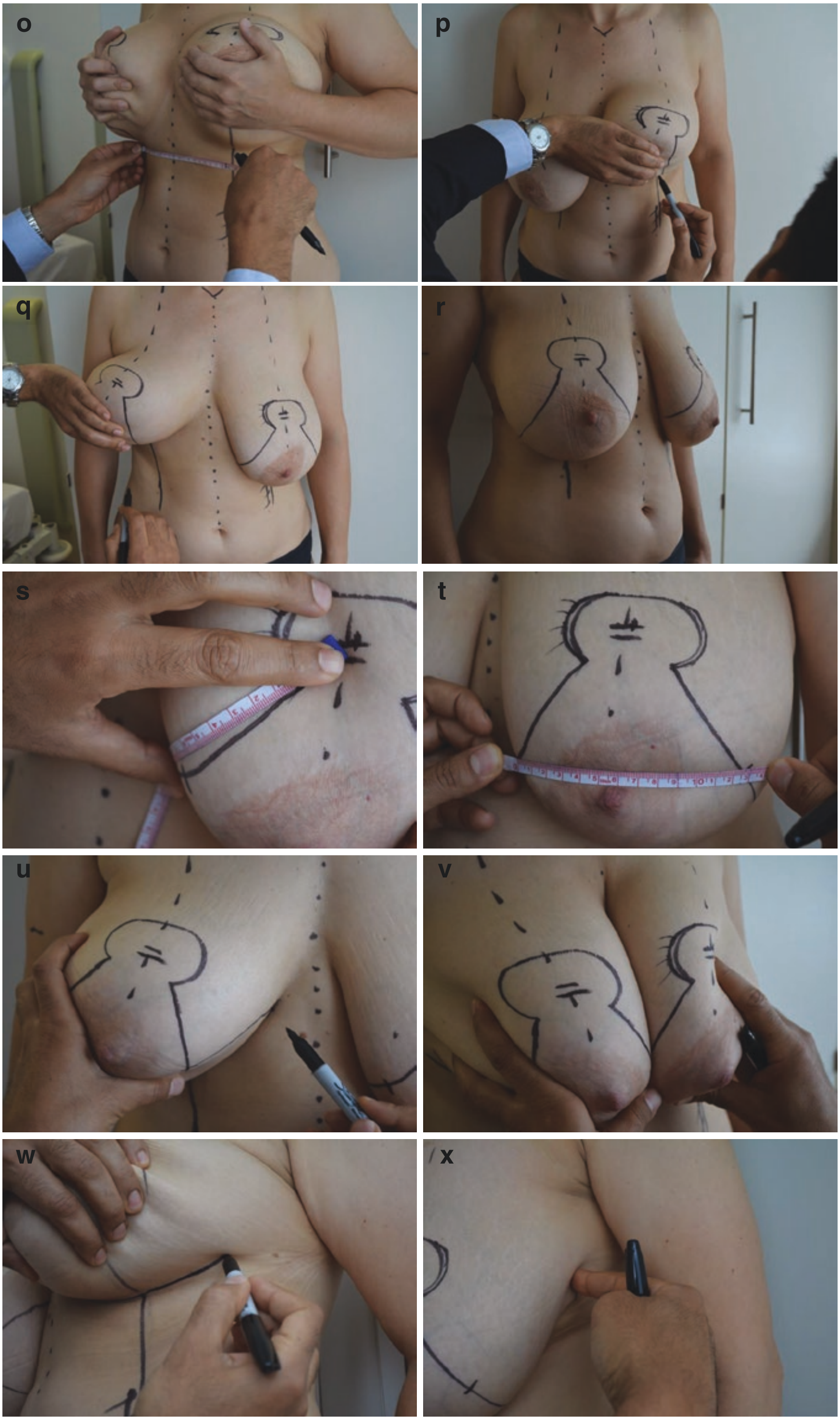


Fig. 11.1 (continued)

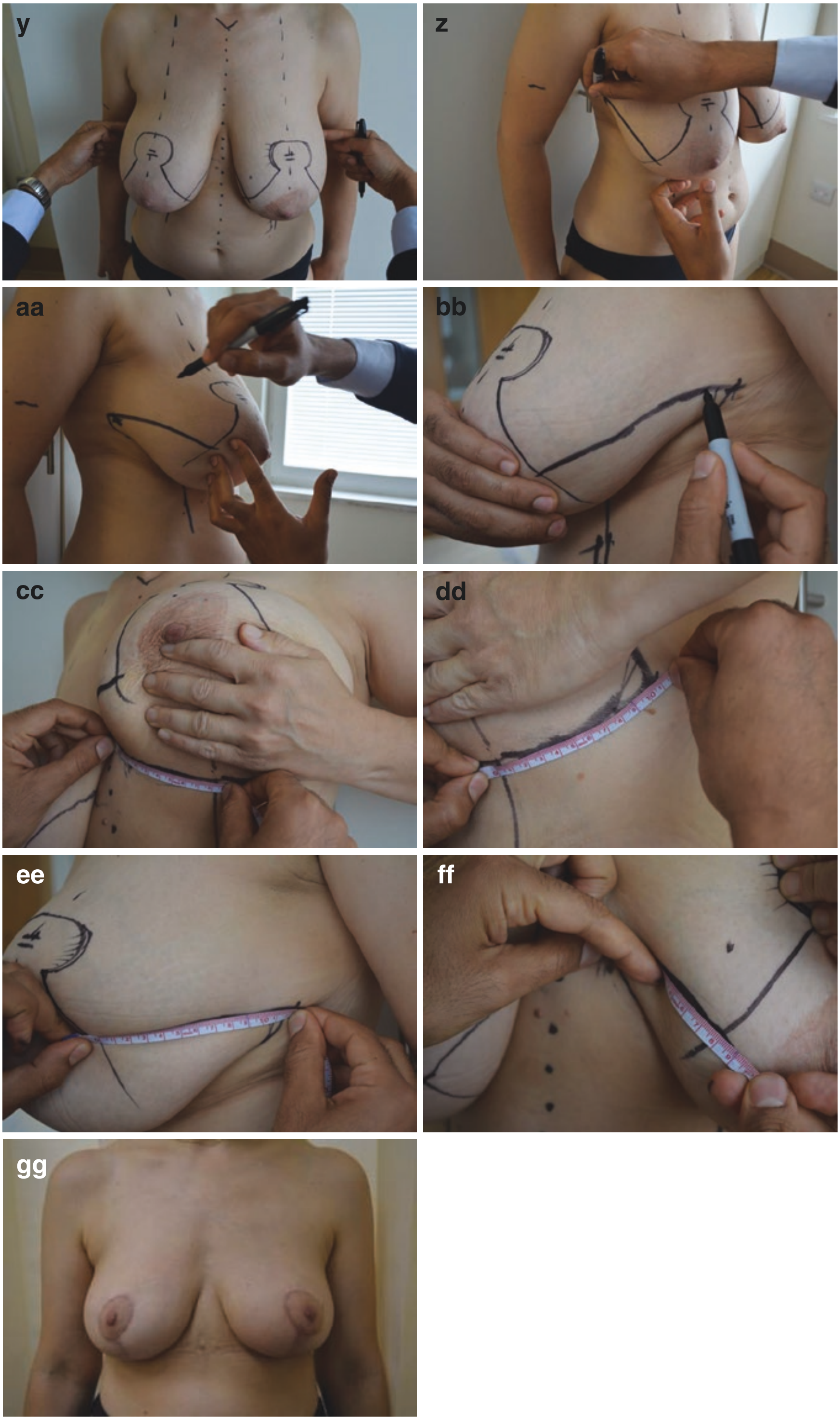


Fig. 11.1 (continued)

technique to be more predictable than other skin excisions, but disadvantages include the risk of a boxy breast and ‘bottoming out’ [17].

(b) *The vertical scar*

The vertical scar mammaplasty was first described by Passot and further refined by Lassus, Lejour and Hall-Findlay [18–20]. Vertical scar patterns are more commonly undertaken for smaller reductions and management of mild/moderate ptosis and are usually associated with superior, medial or superomedial pedicles [19] (Fig. 11.1). This technique raises the nipple position and reduces circumareolar skin tension. It is associated with improved projection over time, as a result of the glandular remodelling. The scar burden is less than for a Wise pattern. The problems associated with the lower end of the vertical scar are proportional to the size of the breast reduction and body mass index [21]. Initially the breast appears ‘upside down’ and ‘bunched up’ [22, 23].

With this technique, the vertical scar and lower breast skin may intially show wrinkling, but this will settle over time. The time needed for the wrinkling to settle is shorter (up to 2 months), when the breasts are small and the skin is elastic, but may be longer (5–6 months) in large breasts with stretched skin. It is important to inform the patient that it may take 2–3 months for the breasts to settle and achieve the desired appearance [21, 24].

(c) *Periareolar pattern*

The periareolar (concentric/donut) pattern limits the scar to the outline of the nipple-areolar complex [25, 26]. It is useful for mastopexy, raising the nipple modestly (<2 cm) in small-to-moderate reductions (up to 500 gm) as a reduction mastopexy with or without a mesh [27, 28]. Benneli described criss-crossing pillars in his mastopexy technique and using a purse string of non-absorbable suture around the areola [27]. The ratio of outside diameter to areolar diameter should ideally not exceed 2:1 to avoid pleating and wide scars [29, 30]. Issues including areola distortion, scar widening and flattening of the breast are described [30].

(d) *L-shaped pattern*

This is a variant of the Wise pattern (inverted-T), but eliminating the medial limb and shortening the lateral limb, and is used in patients with minimal-to-moderate ptosis. The two best described techniques are the Regnault B and Chiari patterns [31–34].

(e) *The J-pattern (short scar periareolar inferior pedicle reduction [SPAIR])*

This was first described by Hammond and may be used in simple mastopexies and reductions up to 2000 g, avoiding having to overcorrect and having to allow time for ‘settling in’ [35, 36]. In smaller reductions (<500 g), a vertical scar may be used, and in larger reductions >500 g, a J-shaped incision may be utilised.

The Mark Up

There is no 'set' breast reduction marking for patients, and it is important that this dogma be challenged. Marking will vary, dependent upon the size and the laxity of the breast, with planning of the breast reduction dictating the success of wound healing and subsequent complications. Patients with elastic skin will have better, more durable results. Good-quality elastic skin will redrape to the newly formed breast shape faster than poor-quality skin.

Excessive skin tension or overly thin flap dissection will lead to a greater risk of post-operative complications, and the notion that the tissue needs to be "pulled-together" is incorrect.

General Points

1. Plan your incision depending upon the skin needs and safety.
2. Pedicles and skin patterns are independent of each other.
3. Tailor the skin excision to the morphology of the breast.
4. When excising >500–600 g, a Wise pattern may be more appropriate.
5. When there is not much skin laxity or the reduction is smaller, use a vertical pattern.

- Mark the patient standing using landmarks and **do not** use devices created to 'facilitate' marking such as templates, keyhole patterns and goniometers [37–39].
- **Do not** routinely place the nipple at 21.5 cm (8.5 in) for all patients – this 'historical' measurement was based on the measurements taken from 150 "healthy" volunteers aged between 18 and 39 years [40].
- The nipple height in most older women generally lies between 23 and 26 cm.
- It is important to avoid tension on skin closure as most scarring will settle with time, although some may become hypertrophic; this is exaccerbated by excess skin tension.

The patient is marked standing up with the arms by the side (see patient pictures in Fig. 11.1):

1. Mark the midline of the chest.
2. Mark the sternal notch.
3. Mark the breast meridian – the central axis of the breast is drawn by draping a tape around the shoulders, asking the patient to hold the tape measure and drawing a straight line through the nipple intersecting with the inframammary crease. The breast meridian may be marked from the midclavicular point (~ 7.5 cm from the sternal notch) to the nipple-areolar complex. It is important to be aware of the more laterally or medially placed preoperative nipple. Compare both sides.

4. Mark the inframammary fold (IMF) under each breast. It is useful to identify any discrepancy in IMF position, which can be corrected by adjusting the vertical limb length in future markings.
5. Mark the new nipple position – the ‘ideal nipple plane’ is a concept first described by Maliniac and adopted by Pitanguy (Pitanguy’s point) which proposed that the ideal level for the nipple in women is a point on the mid-breast meridian at the level of the mid-humeral point (the midpoint between the acromion and the lateral epicondyle) [40]. The breast meridian may not necessarily be drawn through the preoperative nipple position, but it should be drawn through the ideal post-operative nipple position. The nipple is optimally placed, when it points slightly outward and downward. The inverted-T breast will have a wider horizontal base, and the new nipple position should be placed farther lateral than a vertical breast reduction which results in a narrower breast base.

   Gillies and McIndoe advised that the inter-nipple distance should rarely be less than 9 in (23 cm) and that the distance from sternal notch to nipple should be 6–7.5 in. The concept of the Penn triangle describes an 8–8.5 in (20–21.5 cm) equilateral from sternal notch to nipple [40]. These fixed, ‘ideal’ measurements have limitations as nipple height varies with trunk height, width and proportions as well as the breast footprint. Objective evaluation has revealed that the optimal nipple position is placed with 40% of the breast volume lateral of the nipple and 60% of the breast medial to the nipple (40:60x) and with half of the breast above the nipple and half under the nipple (50:50y) [41]. Studies have shown that the final post-operative position of the nipple is often higher on the parenchyma than the preoperative marking suggested [42]. This cranialisation of the nipple position post-operatively may be explained by the effect of gravity and the natural descent of the breast parenchyma and elongation of the inframammary fold-nipple distance and must be planned for in the mark up.

   Positioning the nipple at the level of the inframammary fold irrespective of distance from the suprasternal notch is commonly utilised. There are other options for marking the new nipple position including:
   (a) Placing a hand behind the breast at the level of the IMF and marking the new nipple position on the breast meridian; however, this may place the nipple too high.
   (b) By placing a tape measure under the breast crease and marking the level of the IMF on the medial aspect of the chest and extrapolating the nipple position on the breast.
   (c) Marking the nipple at the mid-humeral point.
6. The neo-areola is marked approximately 7–8 cm × 4–5 cm (transverse × vertical) with the superior border of the areola lying approximately 2–2.5 cm above the new nipple position.
7. The angle of divergence of the breast is the greatest determinant of the tension on the mammaplasty and will depend on the size of the breasts. These markings are made by rotating the breast laterally and medially (like a pendulum) and drawing a line from the lower border of the neo-areola to the meridian line marked on the abdominal wall (do not pull the breast too much; otherwise, the

angle created will be too wide, therefore putting too much tension on skin closure). There is no 'fixed angle' for the vertical limbs; this is determined by the patient's breast, and it may be different to the opposite breast. A useful technique is to pinch the vertical limbs together to ensure that the closure can be achieved with tension. If not, make the angle narrower as excess skin can always be excised at a later stage.

8. The vertical limbs are marked at 5.5–7 cm but may be left longer if there are concerns about tension. If left longer this may impact the cosmesis of the breast by stretching out the lower pole. In larger breasts, the vertical limb length should be 6–7 cm, and in smaller breasts, it should be 5.5–6 cm. It is important to consider what the patient's breast needs in terms of closure rather than what you predetermine.
9. Marking the nipple 'dome', the areolar opening is ideally planned to be between 4 and 5 cm. The circumference of a 5-cm-diameter areola is 16 m and a 4.5-cm-diameter areola is 14 cm. A mosque dome pattern is marked onto the breast – approximately 7–8 cm × 4–5 cm (transverse × vertical). The roof is drawn so that when the medial and lateral limbs are brought together, it will form a circle.
10. For the horizontal limbs, a line is drawn from the bottom of the vertical limb to the IMF. If a straight line, then one risks closure being too tight; therefore, one needs to lengthen the distance to the IMF by adding a gentle curve (thereby avoiding a straight line) and therefore adding length. If unsure cut inside your lines to leave the breast skin closure loose rather than too tight. It is important to pay attention that the resection lines do not reach the visible decolletée.

Alternatively, the reduction mammaplasty can be undertaken *without* a pre-drawn nipple dome, and the nipple inset (with a 38 mm/42 mm cookie cutter) *after* the reduction has been performed and the skin closed. This enables the final nipple position to be inset at a later stage and if needs be adjusted to ensure symmetry, preventing the nipple from being inset too high. With this approach, the vertical limb is drawn from the proposed nipple position marked on the breast meridian measuring between 8 and 10 cm depending on the final desired breast size. Marking of the horizontal limbs can continue as per the previously described technique.

Technical Tips

One may leave a 3 cm triangle of skin at the inferior aspect of the meridian if the final skin closure is too tight, thereby preventing T-junction breakdown.

The Vertical Scar Mammaplasty

This involves the same markings as a Wise pattern reduction with the exception of the horizontal markings and an alteration in vertical limb which extends down to a point marked 2–4 cm above the inframammary crease. Depending on the size of the reduction, the distance above the crease is shorter in smaller reductions and longer in larger reductions. The inframammary crease will move up in a vertical

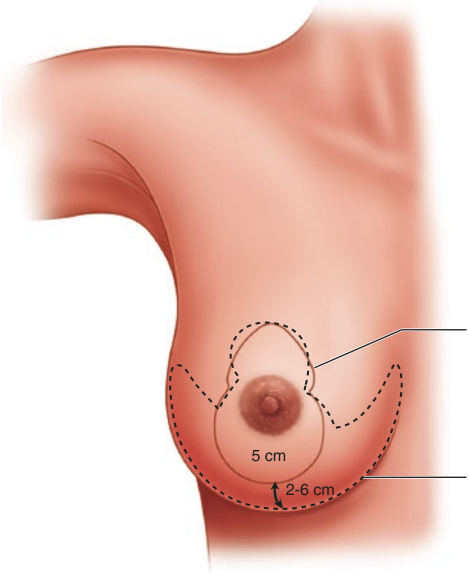


Fig. 11.2 Design of the vertical skin resection pattern compared with the inverted-T resection pattern. The Wise pattern is outline in dotted lines; the vertical pattern is outlined in solid lines

scar reduction, and this phenomenon accounts for the vertical scar extending onto the chest wall in earlier vertical scar techniques. Limiting the inferior point of the vertical scar to a position above the inframammary crease will prevent this. We choose to draw the inferior end of the vertical incision to form an angle similar to the end of an elliptical incision. This is in contrast to the technique described by Hall-Findlay, where a more rounded inferior end of the vertical incision is used (Fig. 11.2).

Overview

Vertical (short scar)	Inverted-T (Wise pattern)
Young patients	Old and young patients
May narrow the breast and raise the crease	Predictable and possibly easier technically
Perky breast	Broader and flatter breast
Shorter scars	Tendency to a boxy outcome
Longer time to 'settle'	Longer scars
Possibly greater longevity	Crease tends to remain in position
Normal-quality elastic skin	Can bottom out especially if inferior pedicle is used

Reference Video

- https://youtu.be/QIbIbNYcQ0Q
- https://youtu.be/2clwif1aTl4

References

1. Cohen WA, Homel P, Patel NP. Does time affect patient satisfaction and health-related quality of life after reduction mammoplasty? Eplasty. 2016;16:e7.
2. Cogliandro A, Barone M, Persichetti P. Prospective analysis of satisfaction by means of BREASTQ in 156 patients who underwent breast reduction. Plast Reconstr Surg. 2017;140(5):752e–3e.
3. Blomqvist L, Eriksson A, Brandberg Y. Reduction mammaplasty provides long-term improvement in health status and quality of life. Plast Reconstr Surg. 2000;106(5):991–7.
4. Menderes A, Mola F, Vayvada H, Barutcu A. Evaluation of results from reduction mammaplasty: relief of symptoms and patient satisfaction. Aesthet Plast Surg. 2005;29(2):83–7.
5. Woodman R, Radzyminski S. Women's perception of life following breast reduction: a phenomenological study. Plast Surg Nurs. 2007;27(2):85–92.
6. Faria FS, Guthrie E, Bradbury E, Brain AN. Psychosocial outcome and patient satisfaction following breast reduction surgery. Br J Plast Surg. 1999;52(6):448–52.
7. (ASAPS) TASFAPS. https://www.smartbeautyguide.com/procedures/breast/breast-reduction/. Accessed 30 May 2018.
8. Kerrigan CL, Slezak SS. Evidence-based medicine: reduction mammaplasty. Plast Reconstr Surg. 2013;132(6):1670–83.
9. Shah A, Sun A, Sumpio B, et al. Oncologic imaging in patients undergoing breast reduction. Plast Reconstr Surg Glob Open. 2016;4(6):e756.
10. Harris L, Morris SF, Freiberg A. Is breast feeding possible after reduction mammaplasty? Plast Reconstr Surg. 1992;89(5):836–9.
11. Souto GC, Giugliani ER, Giugliani C, Schneider MA. The impact of breast reduction surgery on breastfeeding performance. J Hum Lact. 2003;19(1):43–9. quiz 66–9, 120
12. Bartsch RH, Weiss G, Kastenbauer T, et al. Crucial aspects of smoking in wound healing after breast reduction surgery. J Plast Reconstr Aesthet Surg. 2007;60(9):1045–9.
13. Regnault P. Breast ptosis. Definition and treatment. Clin Plast Surg. 1976;3(2):193–203.
14. Rohrich RJ, Gosman AA, Brown SA, Tonadapu P, Foster B. Current preferences for breast reduction techniques: a survey of board-certified plastic surgeons 2002. Plast Reconstr Surg. 2004;114(7):1724–33; discussion 34–6.
15. Davison SP, Mesbahi AN, Ducic I, Sarcia M, Dayan J, Spear SL. The versatility of the superomedial pedicle with various skin reduction patterns. Plast Reconstr Surg. 2007;120(6):1466–76.
16. Wise RJ. A preliminary report on a method of planning the mammaplasty. Plast Reconstr Surg (1946). 1956;17(5):367–75.
17. Hidalgo DA. Improving safety and aesthetic results in inverted T scar breast reduction. Plast Reconstr Surg. 1999;103(3):874–86; discussion 87–9.
18. Lassus C. A technique for breast reduction. Int Surg. 1970;53(1):69–72.
19. Lejour M. Vertical mammaplasty and liposuction of the breast. Plast Reconstr Surg. 1994;94(1):100–14.
20. Hall-Findlay EJ. A simplified vertical reduction mammaplasty: shortening the learning curve. Plast Reconstr Surg. 1999;104(3):748–59; discussion 60–3.
21. Berthe JV, Massaut J, Greuse M, Coessens B, De Mey A. The vertical mammaplasty: a reappraisal of the technique and its complications. Plast Reconstr Surg. 2003;111(7):2192–9; discussion 200–2.
22. Hall-Findlay EJ. Vertical breast reduction. Semin Plast Surg. 2004;18(3):211–24.
23. Hall-Findlay EJ. Pedicles in vertical breast reduction and mastopexy. Clin Plast Surg. 2002;29(3):379–91.
24. Azzam C, De Mey A. Vertical scar mammaplasty in gigantomastia: retrospective study of 115 patients treated using the modified lejour technique. Aesthet Plast Surg. 2007;31(3):294–8.
25. Gruber RP, Jones HW Jr. The "donut" mastopexy: indications and complications. Plast Reconstr Surg. 1980;65(1):34–8.
26. Bartels RJ, Strickland DM, Douglas WM. A new mastopexy operation for mild or moderate breast ptosis. Plast Reconstr Surg. 1976;57(6):687–91.

27. Benelli L. A new periareolar mammaplasty: the “round block” technique. Aesthet Plast Surg. 1990;14(2):93–100.
28. Goes JC. Periareolar mastopexy: double skin technique with mesh support. Aesthet Surg J. 2003;23(2):129–35.
29. Spear SL, Kassan M, Little JW. Guidelines in concentric mastopexy. Plast Reconstr Surg. 1990;85(6):961–6.
30. Spear SL, Giese SY, Ducic I. Concentric mastopexy revisited. Plast Reconstr Surg. 2001;107(5):1294–9; discussion 300.
31. Regnault P. Breast reduction: B technique. Plast Reconstr Surg. 1980;65(6):840–5.
32. Regnault P. Breast reduction and mastopexy, an old love story: B technique update. Aesthet Plast Surg. 1990;14(2):101–6.
33. Parenteau JM, Regnault P. The Regnault “B” technique in mastopexy and breast reduction: a 12-year review. Aesthet Plast Surg. 1989;13(2):75–9.
34. Chiari A Jr. The L short-scar mammaplasty. Clin Plast Surg. 2002;29(3):401–9. vi
35. Hammond DC. The short scar periareolar inferior pedicle reduction (SPAIR) mammaplasty. Semin Plast Surg. 2004;18(3):231–43.
36. Hammond DC. Short scar periareolar inferior pedicle reduction (SPAIR) mammaplasty. Plast Reconstr Surg. 1999;103(3):890–901; discussion 2.
37. Kavka S. A simple device for marking the areola in vertical mammaplasty. Plast Reconstr Surg. 1999;103(7):2087.
38. Mendez-Fernandez MA. An easy-to-make, easy-to-use device for preoperative marking for reduction mammoplasty and mastopexy. Ann Plast Surg. 1991;26(6):602–3.
39. Paloma V, Samper A, Sanz J. A simple device for marking the areola in Lejour’s mammaplasty. Plast Reconstr Surg. 1998;102(6):2134–5; discussion 6–8.
40. Penn J. Breast reduction. Br J Plast Surg. 1955;7(4):357–71.
41. Lewin R, Widmark-Jensen E, Plate N, Hansson E. Objective evaluation of nipple position after 336 breast reductions. J Plast Surg Hand Surg. 2018;52(4):198–203.
42. Altuntas ZK, Kamburoglu HO, Yavuz N, Dadaci M, Ince B. Long-term changes in nipple-areolar complex position and inferior pole length in superomedial pedicle inverted 't' scar reduction mammaplasty. Aesthet Plast Surg. 2015;39(3):325–30.

Superior Pedicle Oncoplasty

12

Fabien Reyal, Enora Laas, Gabrielle Aubry, Julie Labrosse, Apolline Bout-Roumazeilles, Anne Sabaila, Léa Rossi, Jean-Guillaume Feron, Jean-Philippe Binder, and Benoit Couturaud

Introduction and Indications

The superior pedicle oncoplastic technique is performed on tumors located in the lower breast quadrants (LOQ, LIQ, junction of the lower quadrants). It is indicated in hypertrophic and/or ptotic breasts, for which tumor to breast size ratio is unfavorable and exposes the patient to poor cosmetic outcomes in case of breast-conserving surgery.

Indeed, the association of surgery and radiotherapy in the treatment of breast cancer is potentially damaging in terms of aesthetic results, especially for tumors located in the lower quadrants. Deformations of the lower quadrants are usually very difficult to correct secondarily.

Tumor location (31%) and tumor size (28%) are the two major factors taken into account to decide between superior pedicle oncoplasty and a simple partial mastectomy [1]. Breast shape and breast volume are also important elements to consider. Moreover, applying radiation to smaller amounts of breast tissue may avoid many undesirable effects of radiation due to large breasts.

Oncoplastic techniques enable to obtain satisfying cosmetic results after breast-conserving surgery for large tumors that would have otherwise been treated by total mastectomy.

F. Reyal (✉)
Department of Surgery, Institut Curie, Paris, France

Translational Research Department, RT2Lab Team, Institut Curie, Paris, France
e-mail: fabien.reyal@curie.fr

E. Laas · G. Aubry · J. Labrosse · A. Bout-Roumazeilles · A. Sabaila · L. Rossi
J.-G. Feron · J.-P. Binder · B. Couturaud
Department of Surgery, Institut Curie, Paris, France
e-mail: enora.laas@curie.fr; gabrielle.aubry@curie.fr; apolline.boutroumazeilles@curie.fr; anne.sabaila@curie.fr; lea.rossi@curie.fr; jeanguillaume.feron@curie.fr; jeanphilippe.binder@curie.fr; benoit.couturaud@curie.fr

V. S. Klimberg et al. (eds.), *Oncoplastic Breast Surgery Techniques for the General Surgeon*, https://doi.org/10.1007/978-3-030-40196-2_12

Preoperative Evaluation

The two fundamental elements to analyze before surgery are (1) tumor location and (2) the probability of chemotherapy +/− monoclonal antibody treatment.

It is indeed essential to precisely locate the tumor to be removed with imaging techniques (mammography, ultrasound, and breast magnetic resonance imaging (MRI). Superior pedicle oncoplasty enables to remove tumors of large volume, as well as extensive multifocal lesions (if lesions and nipple are on the same radial axis). Wire localization is optional if the tumor is palpable. However, if the tumor is not palpable, one or several metal clips are placed to correctly locate the tumor and guide its resection. Wide excisions reduce the risk of having positive margins after surgery and thus the risk of secondary re-excision. Since it can be much greater than the tumor volume itself, it is important to inform the patient of the breast volume reduction to be expected.

Therapeutic sequence is the second key element to consider. Long wound healing (which is common in this type of surgery) and surgical complications can delay treatment. Therefore, we recommend neoadjuvant treatment for aggressive tumors (triple-negative tumors, *HER2*, luminal B, pleomorphic lobular tumors, or tumors with node involvement). Coils are placed within the tumor to locate it and remove it precisely after neoadjuvant treatment. Breast MRI is systematically performed before treatment and before surgery to assess response and in some institutions also during neoadjuvant treatment to assess tumor progression.

Technique

Precisely (used many times) defining the limits of the excision to be performed is crucial. Drawings are done on a standing patient.

The first step is to draw the midline and the axis of the breast. The axis of the breast corresponds to the imaginary line, starting 5 cm outside from the suprasternal notch (usually passing by the nipple), that equally divides the breast in two. Point A, which represents the top of the future areola, is placed on this axis, at a 17–19 cm distance from the sternal notch (Fig. 12.1). This distance is chosen according to breast volume, patient size, and skin elasticity. Indeed, it is important to anticipate the ascension of point A after glandular resection, remembering that it is not difficult to move upward an areola located too low, whereas an areola located too high will never be able to go down.

Secondly, contours of the periareolar deepithelialization are drawn (Fig. 12.2). For an areola 4.5 cm wide, it corresponds to a zone on the axis of the breast of 5 cm vertically and 8 cm horizontally. For an areola 6 cm wide, measures change to 6 cm vertically and 10 cm horizontally. These measures are chosen to ensure an optimal nipple-areola pedicle.

The vertical excision can either be estimated by assessing the amount of skin to be removed (by pinching the breast vertically on a standing patient) or by pushing

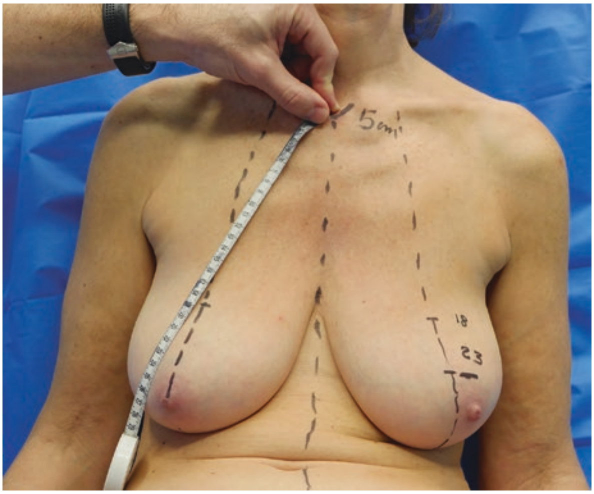


Fig. 12.1 Inverted T preoperative markings step 1

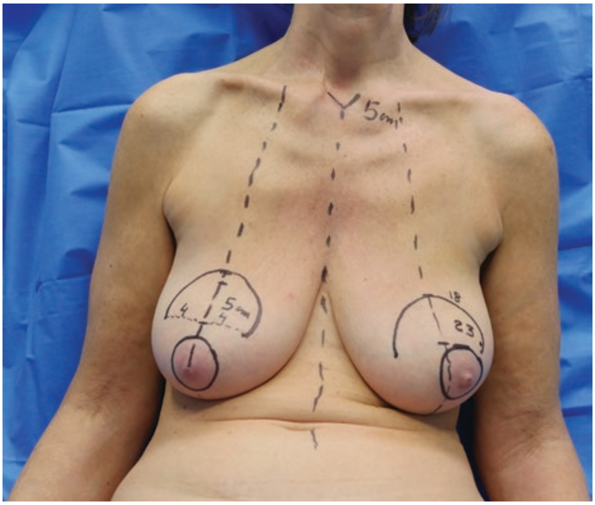


Fig. 12.2 Wise pattern markings step 2

the breast inside and outside to assess the amount of skin that will be preserved (on a patient lying down) (Figs. 12.3 and 12.4).

Finally, the inner and outer contours are defined by estimating the vertical scar between 4 and 6 cm (depending on breast morphology). These excisions can also be adjusted to the lumpectomy at the end of the intervention.

The objective is to make a wide excision that largely removes the tumor, while reshaping the breast to have an optimal cosmetic result (Fig. 12.5). The intervention begins with periareolar deepithelialization (Fig. 12.6). The breast is then incised vertically and horizontally (above the submammary fold). Breast tissue is detached, close to the pectoral muscle fascia. The nipple-areola pedicle is created, thin enough

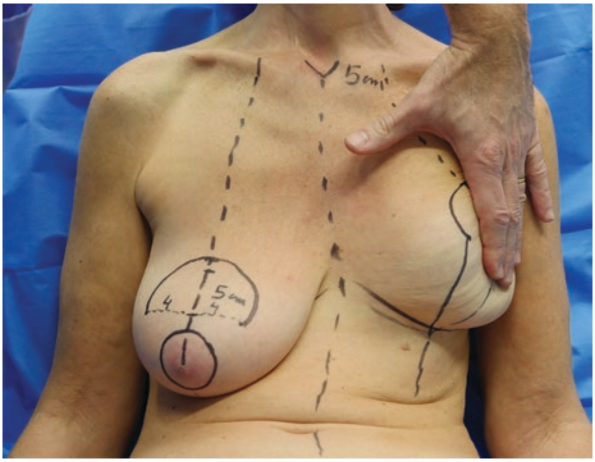


Fig. 12.3 Internal vertical markings step 3

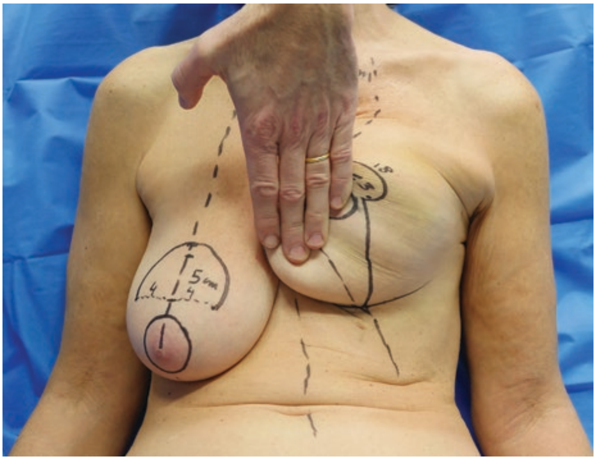


Fig. 12.4 Lateral vertical markings step 4

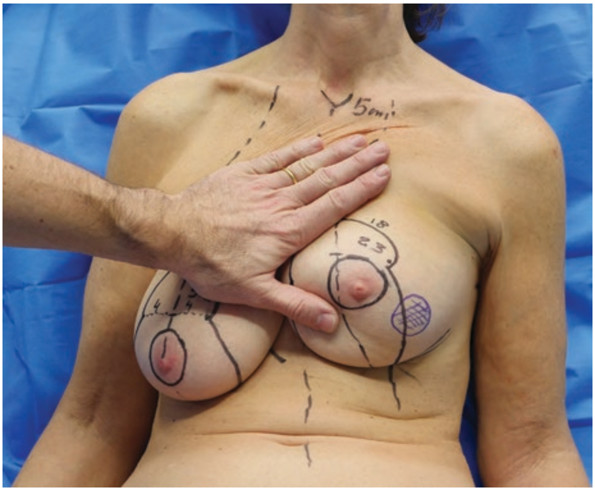


Fig. 12.5 25 mm diameter infero-lateral tumor

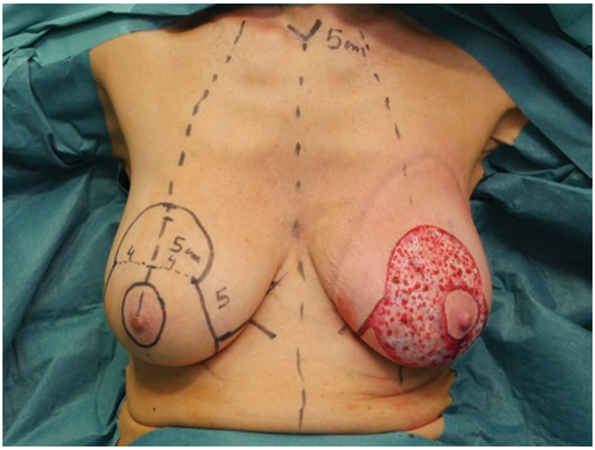


Fig. 12.6 Periareolar deepithelialization

Fig. 12.7 Harvesting the superior pedicled areolar flap

to avoid venous necrosis (Fig. 12.7). This dissection represents the excision's upper limit. Prepectoral detachment represents the dissection's deep limit. To finish the lumpectomy, the breast is incised laterally, which enables to reduce breast volume (Figs. 12.8 and 12.9).

The lumpectomy's operative bed is clipped to facilitate postoperative follow-up and orientate postoperative radiography (boost).

The intervention is completed by placing the nipple-areola complex. Inner and outer excisions are adjusted to tumor resection limits and breast reduction/modeling (Figs. 12.10 and 12.11).

If the lesion is located close to the described area, it is simple to center the resection on the tumor and use the adjacent gland to reshape the breast (e.g., resection in the inner corner and use of an outer glandular flap to reshape the breast).

There is no need to pad if no skin detachment or glandular flap is performed. Otherwise, it is essential to pad to avoid tissue retraction or depression.

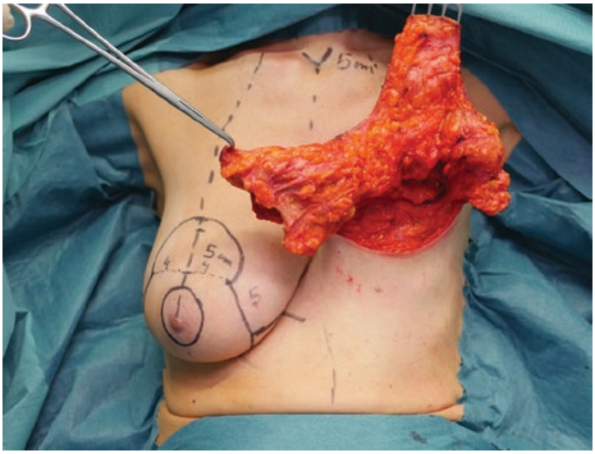


Fig. 12.8 Infero-lateral partial mastectomy

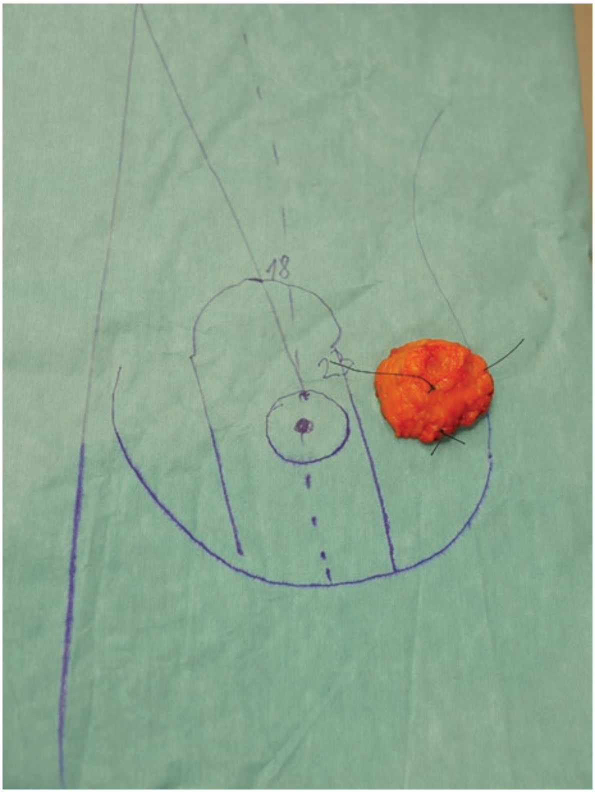


Fig. 12.9 Partial mastectomy specimen

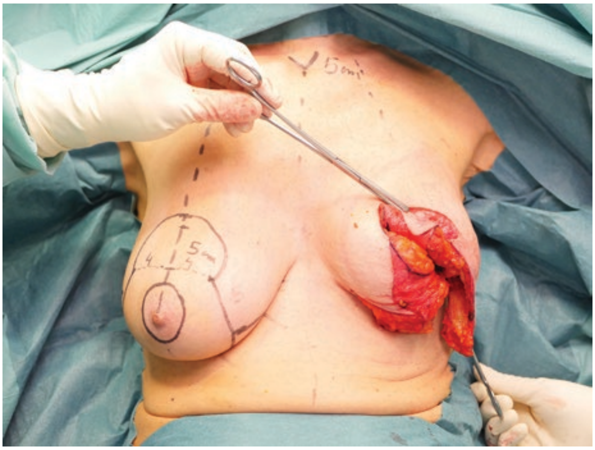


Fig. 12.10 Glandular modeling

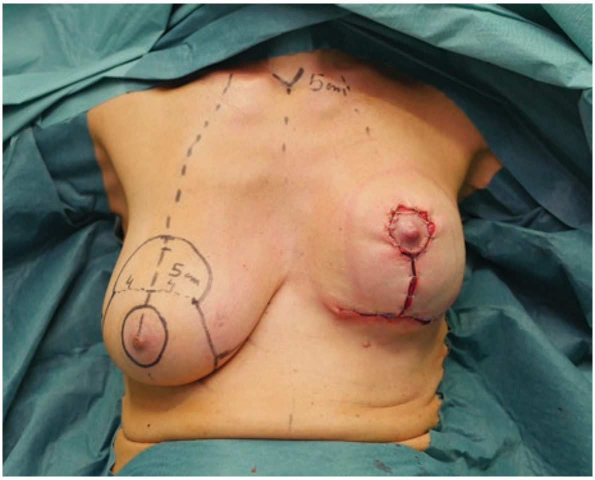


Fig. 12.11 Intraoperative results

Draining is optional. Symmetrization of the contralateral breast can be performed simultaneously. Figure 12.12 represents the postoperative image.

Complications

According to various series [1–5], complications occur in 16–20% of oncoplastic surgeries, which is comparable to that occurring after "classical" breast-conserving surgery [1, 6].

Fig. 12.12 Postoperative image

Complications are more frequent in case of "catch-up" oncoplasties compared to first-line oncoplasties. Risk factors for complications are active smoking, diabetes, overweight (voluminous breast), and history of locoregional radiotherapy [7, 8]. Neoadjuvant chemotherapy does not seem to be associated with an increased risk of complications.

Immediate Complications

Treatment of immediate complications must be fast to avoid delaying adjuvant treatment [9]. We consider that if adjuvant chemotherapy is indicated before surgery due to aggressive factors (triple-negative tumors, *HER2,* luminal B, pleomorphic lobular tumors, tumors with node involvement), it is preferable to begin the treatment by chemotherapy.

Minor Local Complications

Postoperative hematoma occurs in 1–5% of cases. The treatment is surgical, especially if the hematoma is diagnosed early, so that hemostasis of active bleeding (rare) can be done when necessary. The goal is to prevent subsequent infection. For hematomas diagnosed later on, a simple follow-up, possibly with short-term prophylactic antibiotic therapy, can be an option in case of good hemodynamic tolerance.

Seroma concerns 1–13% of superior pedicle oncoplasties. It is more frequent in plasties with important tissue detachment. Seroma can be punctured if it is associated to signs of local inflammation or causes discomfort for the patient.

Scar dehiscence is one of the most frequent postoperative complications, occurring in 0–16%, depending on series. It mostly concerns long scars or breasts with skin damage or tight tissues. The treatment depends on the importance of the dehiscence. In case of minor dehiscence, healing by secondary intention is effective. In case of major dehiscence, a negative pressure device (VAC therapy type) can be used if there are no signs of secondary infection. Revision surgery for closure and to remove necrotic tissue is also an option.

Major Local Complications

These complications are likely to affect the intervention’s cosmetic results.

Abscess is one of the most dreaded complications (2–4% of cases). Its treatment is surgical and consists in draining the abscess by a multi-tubular blade. A broad-spectrum antibiotic therapy (amoxicillin/clavulanic acid or fluoroquinolone in case of allergy) is initiated, which will secondarily be adapted to the antibiogram (done on per-operative bacteriological samples).

Skin necrosis is less frequent. Its treatment consists in removing necrotic tissues and healing by secondary intention with fatty substances (Jelonet type). In case of extensive necrosis, a skin graft (e.g., with skin obtained from the contralateral breast symmetry) can be performed.

Nipple-areola necrosis, occurring in 1% of cases, is specific to the superior pedicle technique. It is due both to the patient’s characteristics and to the technique itself since vascularized tissue is displaced. The superior nipple-areola pedicle can suffer from venous necrosis if it is too thick. Conversely, if the pedicle is too thin, necrosis is secondary to arterial insufficiency. Nipple-areola necrosis is more frequent in long pedicles. Several treatment options are possible, depending on the extent of the necrosis. In case of minor necrosis, necrotic tissues are removed, followed by healing by secondary intention with fatty substances. In case of complete necrosis, the nipple-areola complex is excised, followed by healing by secondary intention. A skin graft can be added secondarily.

General Complications

General complications such as thromboembolic complications or organ failure are rare [8]. Their prevention depends on the patient’s comorbidities, and their management will be defined according to the type of complication engendered.

Late Complications

Surgical radiotherapy sequence is potentially damaging for tissues; postoperative and post-radiotherapy pain can be important. It requires an appropriate treatment by a physiotherapist. Level I and II analgesics can be prescribed, as well as neuropathic analgesics (under appropriate medical supervision) when necessary.

Fat necrosis is not frequent (4.3% cases) and does not require special management in the absence of symptoms. Punctures may be necessary for oil cysts. In case of solid or painful fat necrotic zones, it is possible to fragment them with a thin cannula (under general anesthesia). Surgical excision may be considered at a distance from surgery and radiotherapy in case of persistent symptomatic fat necrosis. In rare cases of hyperalgesic fat necrosis, a total mastectomy (with or without reconstruction) is indicated.

Unaesthetic retractile scars cannot be prevented. They can be painful and require adapted analgesics. Their treatment can either be medical (physiotherapy massages and local care by corticoids or silicone bandages) or surgical (tenotomy and/or lipomodelling).

Breast asymmetry is a direct aesthetic consequence of breast-conserving surgery. Its treatment is surgical and is adapted to asymmetry grade and type. Since new asymmetries may appear due to variations of weight or post-radiotherapy sclerosis, surgery is performed at a distance from oncological treatments.

Results

Although several studies on oncoplastic surgery exist, few have compared oncoplastic surgery to “simple” partial mastectomies or total mastectomies [1, 10, 11]. Furthermore, so far, no study specifically focused on the superior pedicle oncoplasty, which represents 14–83% of the techniques performed. Oncoplastic surgery enables wide excisions on large tumors. Positive margins and local recurrence rates are similar to that of partial mastectomies.

Tumor Size

In 2016, in a review of 55 articles and 6011 procedures, De La Cruz found that average size of tumors removed by oncoplasty ranged from 15 to 43.8 mm [10].

In a series of 540 oncoplasties (of which 35% of superior pedicle plasties), Fitoussi et al. obtained an average removed tumor size of 29 mm [12].

Malhaire et al. compared oncoplasties performed on very extensive lesions (of which 20% of superior pedicle plasties) to simple partial mastectomies. Mean tumor size was significantly higher in the oncoplasty group (52 vs. 39 mm) [10]. Likewise, the Losken et al. meta-analysis of 2014 (including 3165 oncoplasties and 5494 partial mastectomies) also showed significantly greater tumor sizes in case of oncoplasty (27 mm vs. 12 mm for a simple partial mastectomy, respectively) [1].

Operative Specimen Average Weight

Oncoplasty enables wider tumor excisions, with mean tumor specimen weights ranging between 44 and 1085 g, depending on series [13].

In the Malhaire et al. series, average weight of a simple partial mastectomy was of 88 g, which was significantly lower than that of oncoplasties (246 g) [10]. Similarly, in the meta-analysis led by Losken et al., average weight of tumors with oncoplasty was four times bigger than that of simple partial mastectomies (249 g vs. 64 g, respectively).

The study led by Clough et al. on 101 patients (of which 83% of superior pedicle plasty) found an average tumor weight of 222 g [14].

Margins

In a study led by Carter et al. comparing oncoplasties to simple partial mastectomies, the rate of positive margins was significantly higher in the partial mastectomy group (8.3% vs. 5.8%, respectively). Similarly, Losken reported a positive margin rate of 21% for simple partial mastectomy vs. 12% for oncoplasty [1].

However, when analyzing extensive breast lesions requiring wire localization, Malhaire et al. did not find significantly different results in terms of disease-free margins for oncoplasty compared to simple partial mastectomy (60% vs. 62%, respectively) [10]. Similar results are found in the De Lorenzi series (12.7% for oncoplasty vs. 10% for simple partial mastectomies) [11].

In general, positive margin rates in the literature vary from 0% to 39.7% [13].

Surgical reoperation and secondary mastectomies

Surgical revisions occur in 0–26.7% of cases [13]. Although results of studies led on this subject are discordant, no significant difference seems to be observed between oncoplasty and simple partial mastectomies. Indeed, Malhaire et al. found similar revision rates between the two groups (40% vs. 42%, respectively) [10]. These rates are different in the Losken meta-analysis (4% vs. 14%, respectively) [1]. In 2015, Clough et al. found a secondary mastectomy rate of 9% [15]; this rate reaches up to 34.2% in certain series [13].

Local Recurrence and Survival

Local recurrence rates are low in case of oncoplasty (from 0% to 14.6% in the review of literature led by De La Cruz). Local recurrence rates seem similar between oncoplasty and simple partial mastectomy (4% vs. 7%, respectively) [1].

Average follow-up in the literature is 40 months. Overall survival is above 90% in most studies, which is not significantly different from survival rates obtained after partial mastectomy [13].

In Carter's study, total mastectomies had the poorest prognosis, certainly related to larger and more aggressive tumors.

With an average follow-up of 7.2 years, De Lorenzi et al. found equivalent overall survival rates between the two groups (91.4% in the oncoplasty group and 91.3% in the partial mastectomy group). Recurrence-free survival rates were slightly lower in the oncoplasty group, but results were not significant (69% vs.73.1%, respectively) [16].

Cosmetic Result

Only one study compared the cosmetic results of simple partial mastectomies versus oncoplasties, evaluated by a questionnaire. The oncoplasty group had a greater proportion of "excellent" results compared to the simple partial mastectomy group [17]. In every study led on oncoplastic techniques, authors judge cosmetic results to be from good to excellent [13].

Conclusion

The superior pedicle oncoplasty is a simple and safe surgical technique for breast conservative treatment. Obviously it requires a practical training but can significantly reduce the aesthetic sequels of conservative treatments and increase their indications.

Reference Video

- https://youtu.be/PxMMdV0c0Og

References

1. A meta-analysis comparing breast conservation therapy alone to the oncoplastic technique. PubMed – NCBI. Available at: https://www.ncbi.nlm.nih.gov/pubmed/23503430. Accessed 2nd Apr 2018.
2. Haloua MH, et al. A systematic review of oncoplastic breast-conserving surgery: current weaknesses and future prospects. Ann Surg. 2013;257:609–20.
3. Outcomes following oncoplastic reduction mammoplasty: a systematic review. PubMed – NCBI. Available at: https://www.ncbi.nlm.nih.gov/pubmed/26808743. Accessed 3rd Apr 2018.

4. Early complications of a reduction mammoplasty technique in the treatment of macromastia with or without breast cancer. PubMed – NCBI. Available at: https://www.ncbi.nlm.nih.gov/pubmed/21993009. Accessed 3rd Apr 2018.
5. Operative and oncologic outcomes in 9861 patients with operable breast cancer: single-institution analysis of breast conservation with oncoplastic ... PubMed – NCBI. Available at: https://www.ncbi.nlm.nih.gov/pubmed/27406093. Accessed: 3rd Apr 2018.
6. Surgical, oncologic, and cosmetic differences between oncoplastic and nononcoplastic breast conserving surgery in breast cancer patients. PubMed – NCBI. Available at: https://www.ncbi.nlm.nih.gov/pubmed/24581764. Accessed 3rd Apr 2018.
7. High body mass index and smoking predict morbidity in breast cancer surgery: a multivariate analysis of 26,988 patients from the national surgical … PubMed – NCBI. Available at: https://www.ncbi.nlm.nih.gov/pubmed/22330036. Accessed: 3rd Apr 2018.
8. Cil TD, Cordeiro E. Complications of oncoplastic breast surgery involving soft tissue transfer versus breast-conserving surgery: an analysis of the NSQIP database. Ann Surg Oncol. 2016;23:3266–71.
9. Therapeutic mammaplasty – a systematic review of the evidence. ScienceDirect. Available at: https://www.sciencedirect.com/science/article/pii/S0748798311007074. Accessed: 3rd Apr 2018.
10. Outcome of oncoplastic breast-conserving surgery following bracketing wire localization for large breast cancer. PubMed – NCBI. Available at: https://www.ncbi.nlm.nih.gov/pubmed/25913288. Accessed: 3rd Apr 2018.
11. Oncoplastic breast-conserving surgery for tumors larger than 2 centimeters: is it oncologically safe? A matched-cohort analysis. PubMed – NCBI. Available at: https://www.ncbi.nlm.nih.gov/pubmed/26842491. Accessed: 3rd Apr 2018.
12. Oncoplastic breast surgery for cancer: analysis of 540 consecutive cases [outcomes article]. PubMed – NCBI. Available at: https://www.ncbi.nlm.nih.gov/pubmed/20124831. Accessed: 3rd Apr 2018.
13. Outcomes after oncoplastic breast-conserving surgery in breast cancer patients: a systematic literature review. PubMed – NCBI. Available at: https://www.ncbi.nlm.nih.gov/pubmed/27357177. Accessed: 3rd Apr 2018.
14. Oncoplastic techniques allow extensive resections for breast-conserving therapy of breast carcinomas. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1513973/. Accessed: 3rd Apr 2018.
15. Positive margins after oncoplastic surgery for breast cancer. PubMednnn – NCBI. Available at: https://www.ncbi.nlm.nih.gov/pubmed/25893409. Accessed: 3rd Apr 2018.
16. De Lorenzi F, et al. Oncological results of oncoplastic breast-conserving surgery: long term follow-up of a large series at a single institution: a matched-cohort analysis. Eur J Surg Oncol. 2016;42:71–7.
17. Santos G, et al. Long-term comparison of aesthetical outcomes after oncoplastic surgery and lumpectomy in breast Cancer patients. Ann Surg Oncol. 2015;22:2500–8.

Check for updates

13 Inferior Pedicle Reduction Mammoplasty or Reconstruction of Tumor Defects Following Partial Breast Resection

Peter Schrenk and Florian Fitzal

Introduction

The technique uses an inferior-based pedicle carrying the nipple-areola complex (NAC) to reconstruct tissue defects following local breast cancer excision either immediately or delayed.

Indications

The inferior pedicle mammaplasty may be used in three different clinical situations:

1. Reconstruction of tumor defects when the tumor is located in either the upper quadrants, the lower inner or outer quadrants or behind the NAC (Fig. 13.1).
2. In case of central/retroareolar tumors after resection of the NAC to reconstruct the NAC with a de-epithelialized pedicle carrying a skin island for the areola (Fig. 13.2a) or just to add volume to the breast when the medial and lateral breast pillars are closed directly over the de-epithelialized inferior pedicle (Fig. 13.2b).
3. When a superior pedicle mammaplasty is done and the inferior pedicle (with or without a skin island) is used to reconstruct defects (auto-augmentation) in the same breast (Fig. 13.3a, b). In large and ptotic breasts, this inferior pedicle may even be transferred to the medial quadrants of the contralateral breast or thoracic wall.

P. Schrenk
Kepler University Clinic Surgery, Linz, Austria
e-mail: Peter.Schrenk@kepleruniklinikum.at

F. Fitzal (✉)
University Clinic for Surgery, Comprehensive Cancer Center Vienna, Medizinische Universität Wien 21A, Wien, Austria
e-mail: florian.fitzal@meduniwien.ac.at

V. S. Klimberg et al. (eds.), *Oncoplastic Breast Surgery Techniques for the General Surgeon*, https://doi.org/10.1007/978-3-030-40196-2_13

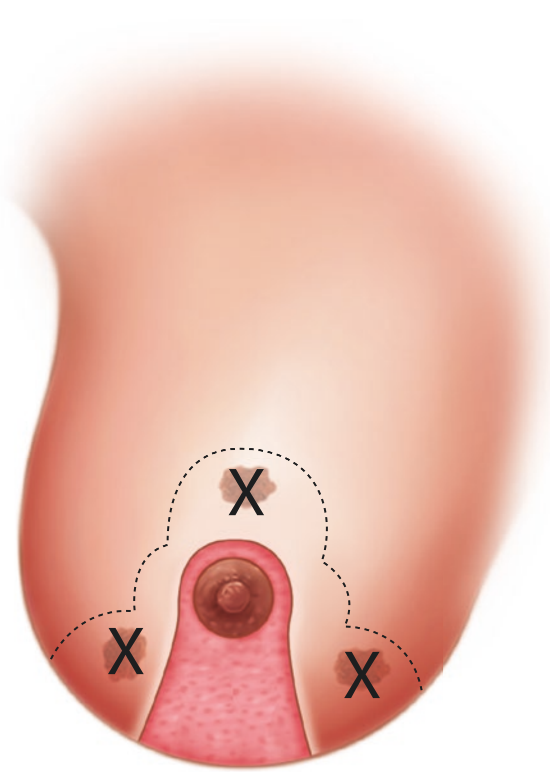


Fig. 13.1 Preoperative drawings for inferior pedicle reduction mammaplasty. The inferior pedicle may be used for reconstruction of tissue defects when the tumor is in the upper quadrants or the lower inner or outer quadrants

Preoperative Evaluation and Planning

The ideal patient for an inferior-based mammoplasty is a patient with moderate or large breast size and a moderate or pronounced ptosis.

Contraindications for surgery are tumors located in the inferior quadrant at the 6 o'clock position and patients with small, non-ptotic breasts. There may be an inferior cosmetic result when the tumor is in the very upper pole of the breast for in these patients the new NAC may be positioned too high on the vertical breast axis.

Patients with diabetes, smokers and those with obesity should be informed about the higher risk of complications such as wound healing problems and fatty tissue necrosis.

Previous breast surgery (excisional biopsy, tumor quadrantectomy, reduction mammoplasty) determines the planning of the incisions – scars should be included in the new incisions whenever possible – as well as the technique used for reduction mammoplasty in order not to compromise the blood supply of the NAC.

Drawings are done preoperatively with the patient in an upright standing position.

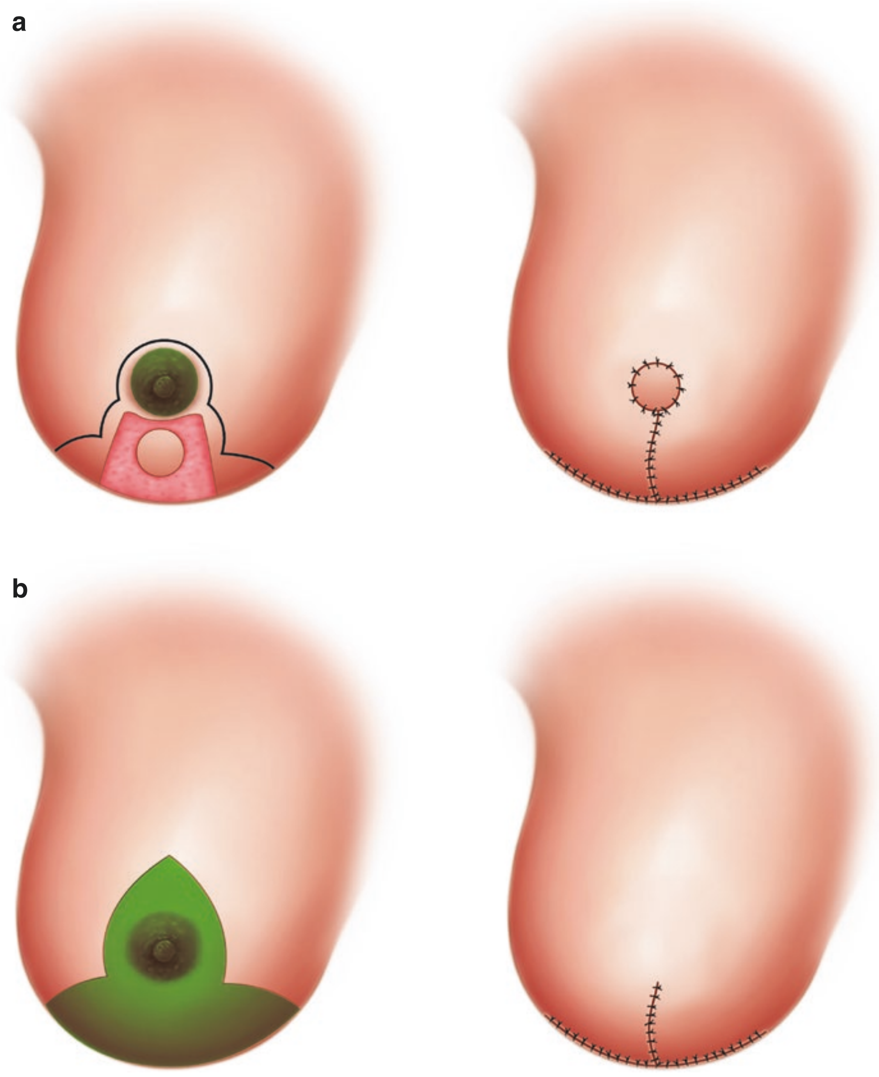


Fig. 13.2 (**a**, **b**) Following excision of the NAC, the defect is reconstructed with a skin island transferred into the defect on an inferior de-epithelialized pedicle (**a**), or the lateral and medial breast pillars are directly closed over the inferior pedicle (**b**)

A central midline is drawn from the sternal notch to the umbilicus. The size of the tumor and the area of breast tissue planned to be resected with the tumor are marked on the skin. A vertical line is drawn from the midclavicular point to the nipple, and this line is extended through the nipple to the inframammary fold and on the thoracic wall. The new position of the nipple is marked at the level of the original inframammary fold with the index finger pointing anteriorly on the midclavicular line.

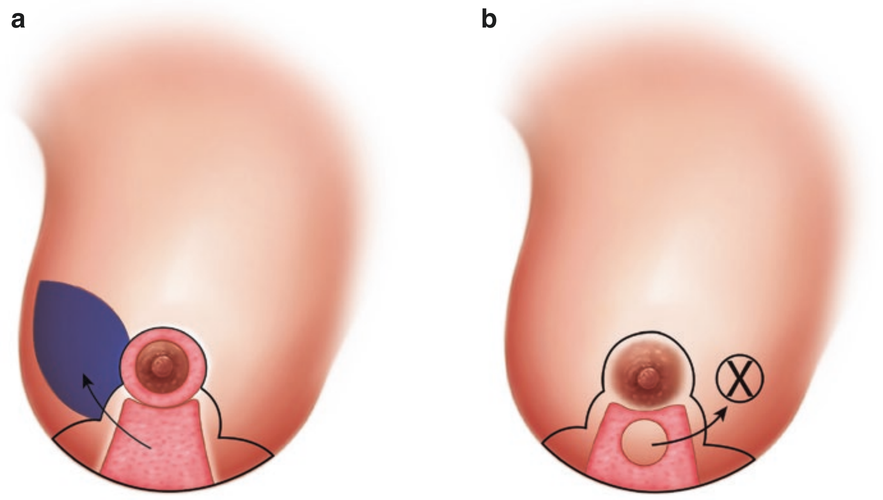


Fig. 13.3 (**a**, **b**) Superior-based pedicle reduction mammoplasty: the defect is reconstructed with a de-epithelialized inferior pedicle (which is otherwise discarded in reduction mammoplasty) (**a**) or in case skin overlying the tumor is excised with a de-epithelialized pedicle carrying a skin island to substitute for the defect (**b**)

The breast is pushed medially and laterally with an upwards rotation, and medial and lateral markings are drawn on the breast in continuity of the vertical axis line on the thoracic wall. An inverted V is drawn with the peak of the inverted V at the future nipple position. The two lines of the V are drawn by pinching the breast tissue between the thumb and middle finger and connecting these points to the peak of the V. The angle between these two lines determines the amount of breast tissue to be excised – the larger the angle, the more the breast tissue is resected.

Each of these lines is 8 cm in length. Horizontal lines are drawn from the end of both lines of the inverted V and connect to the inframammary fold medially and laterally with the breast moved laterally, respectively, and medially and folded down towards the inframammary fold at the same time. The inferior pedicle is outlined on the skin with a base width of 6–12 cm.

Special Considerations

- The drawings may be rotated laterally/medially when the tumor is in the lower outer or lower inner quadrant.
- In case of a retroareolar cancer which requires resection of the NAC, a skin island according to the size of the areola is outlined on the inferior pedicle and used for reconstruction of the areola (Fig. 13.2a).
- When the tumor is high in the upper breast pole, a vertical skin paddle to be resected with the tumor is drawn cranially from the future nipple (Fig. 13.4).

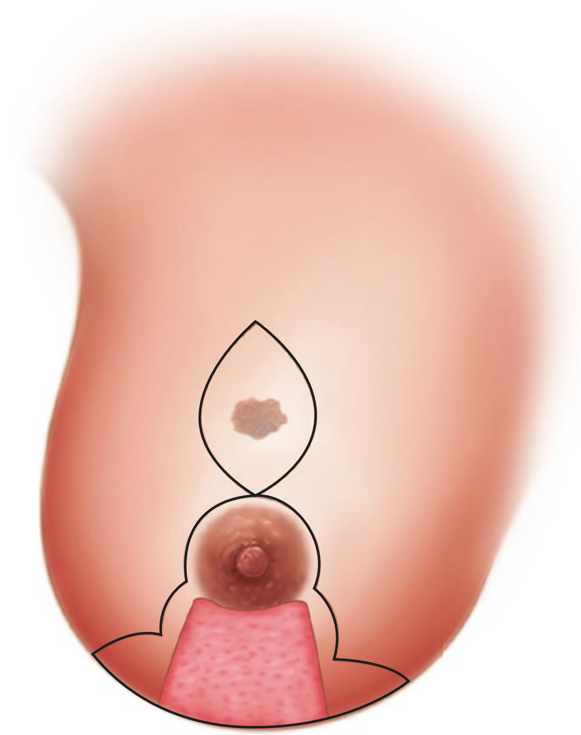


Fig. 13.4 The tumor is located high in the upper breast pole. The tumor is excised with an overlying skin paddle resulting in an additional vertical scar together with the reduction mammoplasty incisions

- When the tumor is in the upper inner or upper outer breast quadrant and involves the skin, resection of the skin is required. In these patients a superior-based pedicle reduction mammoplasty is done, and an inferior pedicle with a skin island is drawn to reconstruct the defect (Fig. 13.3a, b).
- Markings are drawn in the same way when a contralateral reduction mammaplasty is done for symmetrization but with the nipple placed 1–2 cm higher on the inframammary fold in order to compensate for the ptosis when no radiation is applied.

Surgical Technique

The patient is operated under general anaesthesia on a flexible adjustable operating table in a supine position with both arms extended 70°.

Tumor quadrantectomy is performed as part of the reduction mammoplasty by one (breast) surgeon with the tumor excised through the incision for reduction mammoplasty (Photo 1a). A circumareolar incision is performed around the new areola with about 40 mm in diameter, and an inferior pedicle is de-epithelialized (Photo 1b). Skin flaps of 1–2 cm in thickness – depending on how close the tumor is to the skin – are dissected superiorly, medially and laterally (Photo 1c). The tumor with surrounding tissue is dissected from the inferior pedicle including the pectoralis fascia (Photo 1d) and oriented for pathological examination. Sentinel lymph node biopsy is done through the same incision.

Multiple surgical clips are placed in the tumor bed (at the closest margin, around two to three clips) and the subcutaneous breast tissue beneath the skin flaps which in a reduction mammoplasty are transferred from the original tumor bed to a new location. These clips allow a more exact planning of the postoperative radiation therapy and help in the diagnosis of local recurrence.

The inferior pedicle is dissected with a basis of 6–12 cm in width and a thickness of 2–6 cm and transferred into the defect (Photo 1e). The skin is closed temporarily with skin staples and breast symmetry, and the new nipple position is assessed in the sitting position. A suction drain is used for 1–2 days. The wound is closed using inverted d 3–0 absorbable Vicryl sutures and intradermal 5–0 sutures. No antibiotics are used routinely (postoperatively)

Postoperative Care

A brassiere is given immediately after surgery and worn for 2–8 weeks. All sutures are removed 2 weeks after surgery.

Special Surgical Issues

- The tumor is very close to or infiltrates the skin: In these patients a superior-based pedicle reduction mammoplasty which provides the blood supply for the NAC is done. The tumor is excised through a separate incision and the defect reconstructed with a skin island transferred on a de-epithelialized inferior-based pedicle (Fig. 13.3b).
- Central tumor location with resection of the NAC: The defect is either reconstructed using a skin island on a de-epithelialized inferior pedicle (Fig. 13.2a) or the medial and lateral pedicles are directly closed over the inferior pedicle (Fig. 13.2b).
- Reconstruction of defects in the medial quadrants of the breast/thoracic wall: This technique may be used in patients with large and ptotic breasts. After excision of the tumor, a breast reduction using a superior-based pedicle is done on the contralateral breast, and the (de-epithelialized) inferior pedicle of this breast is transferred into the defect.

Reconstruction of the NAC or adaption reduction mammoplasty of the contralateral breast is performed 6 months after primary surgery or 6 months after finishing radiation therapy.

Surgical Complications and Solutions

- The most common complication is delayed wound healing or breakdown of the wound especially in the inverted T scar. In most instances it is related to too much tension on the scar due to wrong planning of the surgical incisions and may be avoided by leaving a small triangle of skin in the midline above the inframammary fold. Increased wound complications are also seen with smokers and after previous radiation therapy.
- Fatty tissue necrosis is most commonly seen at the top of the inferior pedicle. This is due to decreased blood supply and results in aseptic wound necrosis and abscess formation and later leads to firm nodules causing difficulties in distinguishing these nodules from cancer recurrence in the mammogram.
- The multiple scars with the remodelling of the breast after oncoplastic surgery may make it difficult for the radiotherapist to apply radiotherapy exactly to the tumor bed, as well as for the radiologist to assess the breast tissue in later mammograms.

Cases

Case 1 (Fig. 13.5a–e)
Intraoperative pictures showing oncoplastic reduction mammoplasty with an inferior-based pedicle: (a) preoperative drawings. Two tumors are located in the upper medial and upper outer quadrants. The inferior pedicle with the areola is outlined on the skin; (b) the inferior pedicle is de-epithelialized. The area to be resected shows a horseshoe-like figure; (c) the dissection has been carried cranially, and the inferior pedicle is partly dissected from the tumor area to be excised; (d) following horseshoe-like resection of the tumor area, the tumor bed is marked with surgical clips, and the inferior pedicle is transferred into the defect; (e) the NAC is reconstructed and the wound closed.

Case 2 (Fig. 13.6a, b)
A 44-year-old woman underwent oncoplastic reduction with an inferior pedicle for a tumor in the upper central quadrant (black circle) of the right breast and concomitant adaption reduction of the left breast. Preoperative picture (a) and postoperative result (b) following 2 years after radiation. Note that the scars are thickened in the non-radiated breast.

Case 3 (Fig. 13.7a, b)
A 27-year-old patient with a retroareolar cancer after preoperative chemotherapy for triple negative breast cancer. Prior to surgery the tumor was very close to the NAC. The patient had a partial remission. The NAC was excised and the defect filled with a de-epithelialized inferior pedicle carrying a skin island for the areola. (a) Preoperative picture and (b) postoperative result 3 years after radiation.

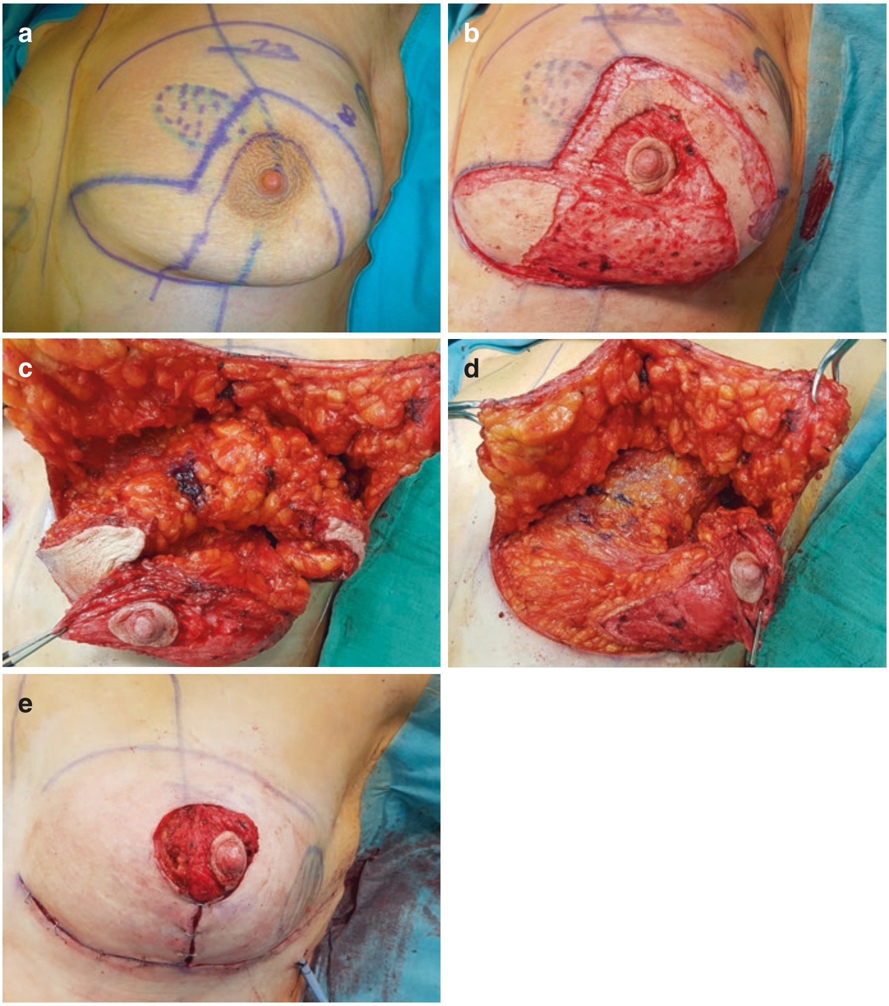


Fig. 13.5 (**a**) Preoperative drawing case 1, (**b**) after de-epithelialization around the nipple-areola complex, (**c**) complete detached skin from the breast parenchyma and presentation of the tumor infiltrated breast segment, (**d**) after resection of the breast cancer visualizing the pedicle for the nipple-areola complex coming from the thoracic wall as central and inferior pedicle and (**e**) closing of the skin

Case 4 (Fig. 13.8a, b)
A 53-year-old patient with an invasive cancer and large ductal carcinoma in situ in the upper outer quadrant of the right breast. The patient underwent a superior-based pedicle reduction mammoplasty with large tumor excision and reconstruction of the defect using a de-epithelialized inferior pedicle which was rotated into the defect. (a) Preoperative view and (b) postoperative result 2 years after radiation.

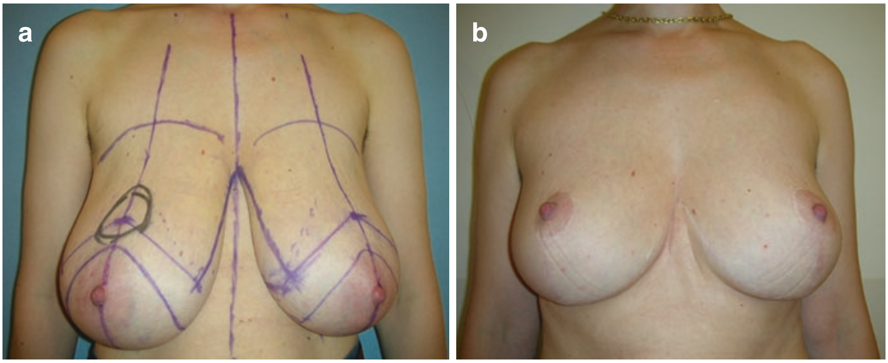


Fig. 13.6 Before and after pictures of case 2

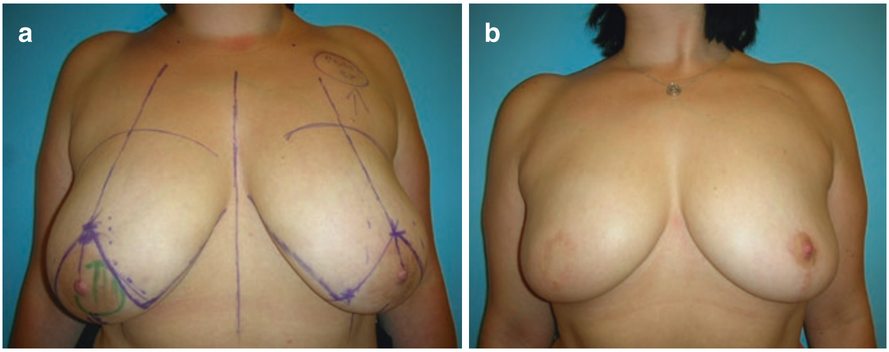


Fig. 13.7 Before and after pictures of case 3

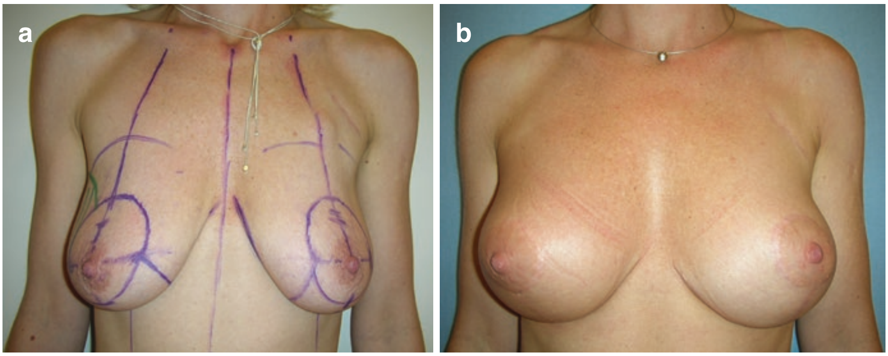


Fig. 13.8 Before and after pictures of case 4

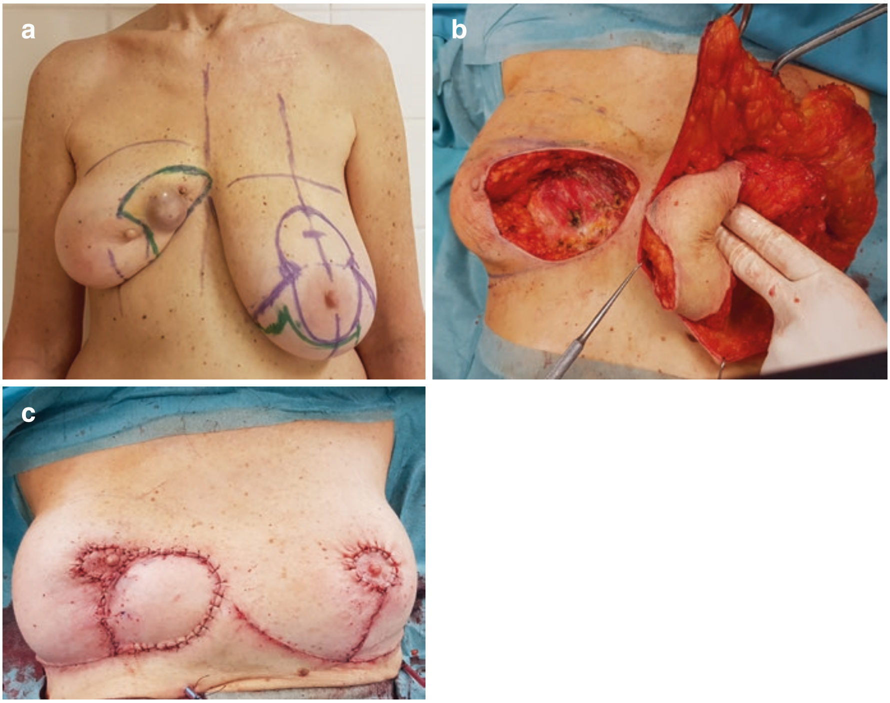


Fig. 13.9 Before, during and after surgery pictures of case 5. (**a**) Preoperative picture (**b**) Intraoperative picture resecting the tumor (**c**) After flap rotation and suturing

Case 5 (Fig. 13.9a–c)
A 56-year-old patient had a recurrent cancer in the right breast 8 years following quadrantectomy, axillary lymph node dissection, chemotherapy and radiation (Photo 5a). Preoperative staging revealed no metastatic disease. The tumor was excised with wide clear margins and the pectoralis major muscle. A superior-based pedicle reduction mammoplasty was done on the left breast, and the inferior pedicle with skin was transferred into the defect through a tunnel. Figure 13.5b, c shows the immediate post-operative result.

Case 6 (Figs. 13.10, 13.11 and 13.12)
A 49-year-old woman with left-sided breast cancer cT2 cN1 (sonographically and histologically proven) invasive ductal, her2-enriched non-luminal. After neoadjuvant chemotherapy with 6× docetaxel and 6× pertuzumab and trastuzumab the patient had a clinical complete remission. Microcalcification has the same size as before but no mass in MR. We performed oncoplastic breast conservation removing the whole microcalcification as data show that neither MR nor microcalcifications have any good predictive value regarding pathological complete remission [1]. Final histology demonstrated pathological complete remission ypT0 ypN0 (0/5) RCB 0. The other side will be symmetrized around 1 year after adjuvant radiotherapy. She

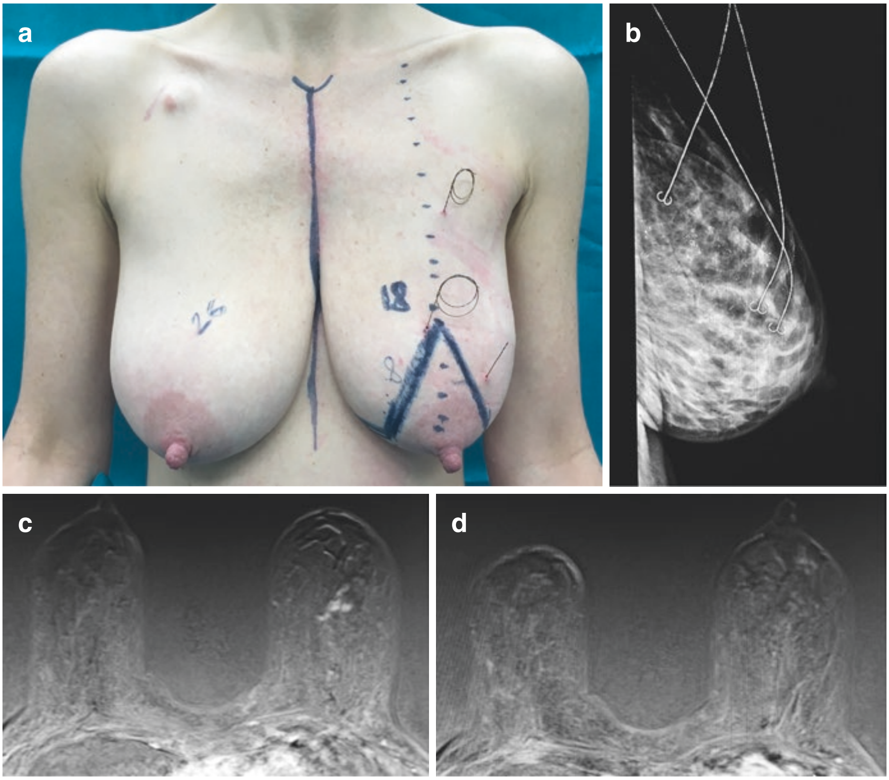


Fig. 13.10 Case 6 before surgery, (**a**) frontal picture of the patient after neoadjuvant therapy, (**b**) side view of the mammogram after neoadjuvant therapy with multiple microcalcifications, (**c**) MR view of the cancer lesion before neoadjuvant therapy and (**d**) MR view of the radiologic complete response after neoadjuvant therapy

received adjuvant trastuzumab up to 1 complete year and radiotherapy of the breast, a boost to the tumor bed as well as radiotherapy to the supraclavicular nodes due to cN1 before start of therapy.

A detailed description of further techniques may be found in our textbook [2].

Results: Data

We were able to prospectively analyze our oncoplastic patients (OPS) within the iTOP trial (NCT01396993) including 107 women with breast-conserving or oncoplastic breast-conserving therapy (Fig. 13.13), and we found a twofold increase in necrosis rate for OPS. Moreover OPS had less DCIS reresection rates and an improved BREAST-Q satisfaction with the breast. The data are not published and thus not ready to show as a figure or table.

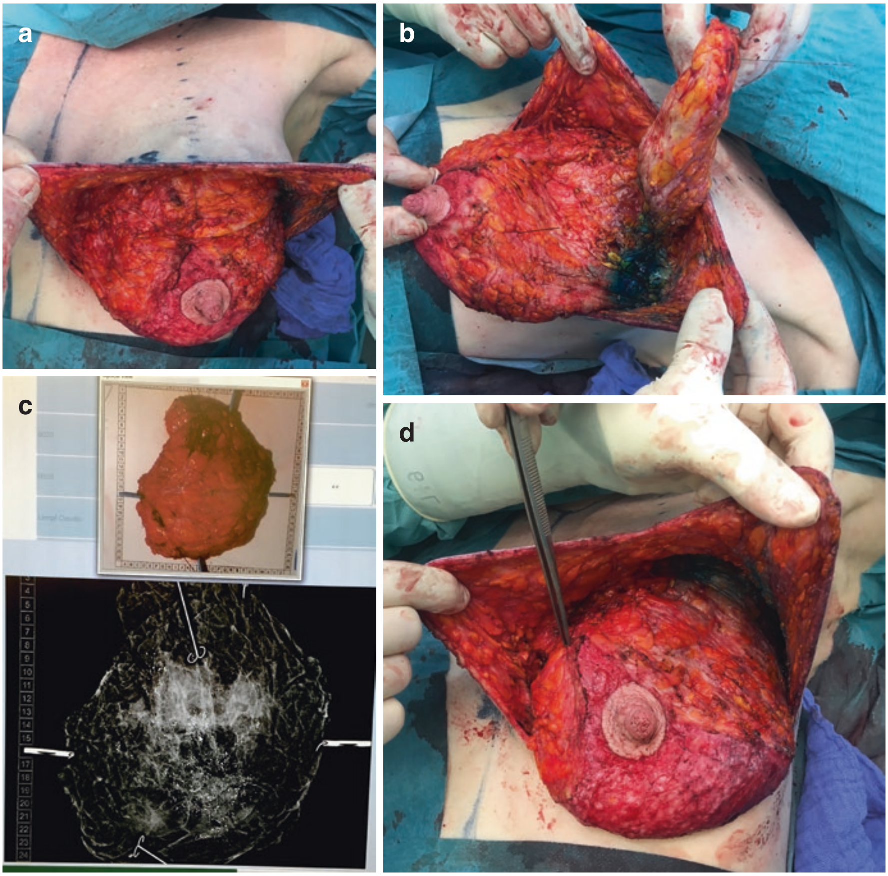


Fig. 13.11 Case 6 during surgery. (**a**) After elevation of the skin from the breast parenchyma. (**b**) Segment resection of the upper medial and lateral part of the breast including the guided wire-marked microcalcifications. (**c**) Resection specimen under the radiogram showing removal of the complete microcalcifications. (**d**) Closing the defect with parenchymal stiches after marking the tumor bed with clips

Fig. 13.12 Case 6 postoperative views. (**a**) On table after suturing, (**b**) 4 weeks after surgery frontal view and (**c**) 4 weeks after surgery side view

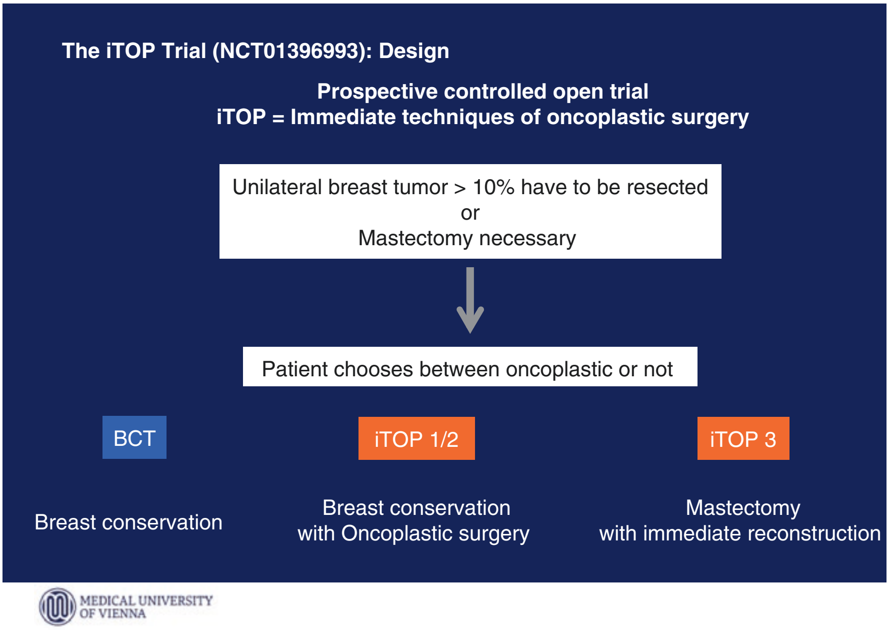


Fig. 13.13 The iTOP trial scheme

Conclusions

Oncoplastic surgery reduces reresection rates, improves quality of life and reduces mastectomy rates with the same oncologic result compared with conventional breast conservation or mastectomy. As classification we should use the Tübingen and the Clough classification, and we have to increase the knowledge of all stakeholders including patients and surgeons. This may only be achieved by performing prospective trials. For the latter we founded the oncoplastic breast consortium (oncoplasticbc.org) in order to increase the cooperation regarding research in this area led by Prof Weber (Basel), Prof Fitzal (Vienna), Prof De Boniface (Stockholm) and Prof Heil (Heidelberg). Please join this group to further develop oncoplastic surgery.

Reference Video

- https://youtu.be/PTtacLo7LVY

References

1. Feliciano Y, Mamtani A, Morrow M, et al. Do calcifications seen on mammography after neoadjuvant chemotherapy for breast cancer always need to be excised? Ann Surg Oncol. 2017;24(6):1492–8.
2. Fitzal F, Schrenk P, editors. Oncoplastic breast surgery: a guide to clinical practice. Wien: Springer; 2010.

V Mammoplasty

14

Peter A. Barry and Pooja Padmanabhan

Introduction

Cancers of the lower inner quadrant (LIQ) of the breast make up less than 6% of all cancers [1], making procedures on this area rare. Yet it is renowned for the significant deformity caused by simple breast conservation procedures.

For the smallest of cancers (<1 cm), simple wide local excision (WLE) may suffice; however, with increasing size, this quadrant requires special consideration regarding oncoplastic techniques given its small volume, depth, prominence in the décolletage as well as the lack of mobility of the medial parenchyma. The potential to cause significant noticeable deformity and volume loss with simple WLE oriented along the breast contour is well recognised and its impact heightened in the context of significant parenchymal ptosis. Evidence shows both cosmetic outcome and patient satisfaction are adversely affected by only 5% volume loss of the medial breast versus 15% in the lateral breast [2]. Experienced breast surgeons are all too familiar with the challenge the infero-medial breast produces, given that, with or without skin excision, volume loss in this area results – at best – in unsightly flattening of the otherwise gently convex outline of the breast in this quadrant.

Whilst larger volume resections in the LIQ can be solved with a standard Wise pattern, superior-pedicled mammoplasty [3], such procedures are more complex, time-consuming and likely to result in wound complications and the need for symmetrisation as a more significant reduction of breast volume is undertaken.

However, the V mammoplasty is more specifically geared towards dealing with resections involving the lower inner quadrant and should be considered the bespoke solution of choice for cancer limited to this quadrant.

LIQ-V mammoplasty is one of the oncoplastic surgical (OPS) techniques originally described by Clough et al. [4, 5] as part of the quadrant by quadrant atlas of

P. A. Barry (✉) · P. Padmanabhan
Breast Unit, Royal Marsden NHS Foundation Trust, London, UK
e-mail: Peter.Barry@icr.ac.uk

V. S. Klimberg et al. (eds.), *Oncoplastic Breast Surgery Techniques for the General Surgeon*, https://doi.org/10.1007/978-3-030-40196-2_14

OPS techniques for larger volume excision of carcinoma (invasive or DCIS) for tumours of the breast's lower inner quadrant.

Lower pole breast tumours are best dealt with using the generic inverted 'T' scar after triangular excision of the tumour. The 'V' mammoplasty is a natural extension of this technique when the tumour is located towards the medial extreme of the lower breast. The absence of mobility of the medial breast parenchyma converts the inverted 'T' scar into a 'V' by virtue of all the mobility coming from the lateral breast to close the triangular (pyramidal) defect which results from the cancer excision.

It is a technique which falls under the category of 'level 2' oncoplastic procedures, that is, those which require mammoplasty in the form of parenchymal displacement and mobilisation as a single unit with the overlying skin ('cutaneo-glandular' flap) to ensure adequate perfusion, here combined with re-centralisation of the nipple-areolar complex (NAC).

In essence, it is an example of a large rotation flap. The resultant defect from the resected volume is fashioned into a pyramid (with the infero-medial angle of the breast completing its base). Then the remainder of the inferior breast, extending supero-laterally, is rotated medially to fill this defect.

Indications

This technique is particularly suited to LIQ tumour resections which may be just beyond the reach of inverted 'T' (superior pedicle-based) mammoplasty techniques. The latter is better suited to patients with significant parenchymal and/or NAC ptosis.

Patients with broader breasts (wider base width) where minimal parenchymal and/or nipple-areolar complex (NAC) ptosis is present with a larger infero-medial invasive or in situ carcinoma larger than 5% of breast volume or greater than 50 g in weight are best suited to this form of OPS. Being a level 2 technique, it is also more suited to those breasts of low mammographic density (higher fat composition). Such fatty parenchyma is not well suited to mobilisation with respect to both the overlying skin and underlying muscle and under such conditions is liable to result in significant fat necrosis. Using this procedure, breast parenchyma and the overlying skin are mobilised as a single unit to ensure viability of the combined cutaneo-glandular rotation flap reinforced by the dermal plexus.

Whilst the triangular excision for tumours close to the infra-mammary fold is a feasible solution to tumours around the 6 o'clock (meridian) position, for those located nearer to the infero-medial angle of the breast, medial mobilisation is usually impossible. The V mammoplasty therefore depends solely on mobilisation of the lateral breast parenchyma with the overlying skin to achieve adequate volume displacement to fill the medial defect following tumour resection.

Preoperative Evaluation and Planning

Tumour Assessment

Estimates of the relative (tumour to breast) volume required for resection should be made. Medial tumours close to the infra-mammary fold may be challenging to assess clinically and radiologically. These tumours may be missed on screening mammography as they arise beyond or are excluded from the field of mammographic coverage. Such tumours may arise more deeply within the parenchyma, and involvement of the deep fascia (including the external oblique fascia or rectus sheath) should not be underestimated. Careful assessment by the specialist breast unit radiologist and surgeon will aid operative planning and preparation for *en bloc* resection of deep fascia and even underlying muscle to ensure adequate oncologic clearance of all margins. In such cases, clinical assessment of tumour extent can be misleading, and the use of bedside ultrasound may be useful to estimate true tumour dimensions. A tumour extending more superficially (or with clinical skin involvement) will necessitate overlying *en bloc* skin excision.

Breast Assessment

In selecting the most appropriate procedure, the breast is carefully assessed. The degree of ptosis – both parenchymal and nipple-areolar complex – should be visually assessed during physical examination. Objective recording of measurements including supra-sternal notch to nipple and nipple to infra-mammary fold distances is helpful. The base width of the breast relative to overall height of the footprint will also factor in decision-making. A more ptotic breast with narrower base may be more suited to superior pedicle (inverted T) mammoplasty-mastopexy or another technique such as a medial intercostal artery perforator flap (MICAP). It is more likely in the former case of inverted T mammoplasty that contralateral symmetrisation will be desired by the patient which may be planned as a synchronous procedure.

However, V mammoplasty is more ideally suited to patients with lesser degrees or minimal ptosis and a broader-based (greater base width) breast.

In considering the V mammoplasty, the degree of lateral flap advancement of the inferior breast available to cover the resultant defect is then gauged. Patients should be counselled about the narrower resultant breast base, the need for NAC re-centralisation as well as the lateral extent of the resultant scar. It is useful to demonstrate during examination with the use of a mirror the likely alterations in breast shape which may result. Explanation of the need for a longer scar (albeit in a hidden location) is aided by the patient's understanding of the rationale for such a procedure – i.e. the significant historic deformities which might otherwise result if a simple wide excision is undertaken. It is also useful to demonstrate the likely effect of radiotherapy (to pull the nipple-areolar complex in a downward or caudad direction) and the rationale for minimising this by lateral advancement of inferior breast parenchyma and re-centralisation (i.e. cranio-lateral displacement) of the NAC. Photographic illustration (see Fig. 14.1) of the classic deformity resulting from a non-OPS approach to breast conservation is likely to result in greater patient understanding and acceptance of the need for OPS in this situation.

Symmetrising mammoplasty is much less likely to be required following this procedure as the difference in final NAC height compared to the contralateral breast following radiotherapy will be generally less than 1–2 cm. Patients should be counselled regarding the location of the scar in the IMF and that discomfort in a standard underwire brassiere may result especially in the short to medium term.

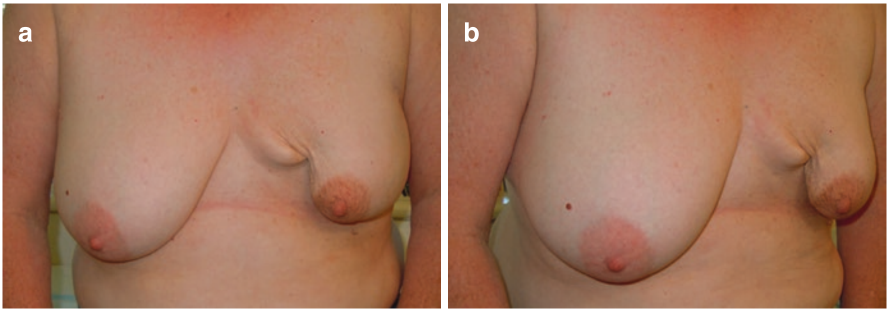


Fig. 14.1 (**a**, **b**) Long-term result of standard wide local excision breast conservation therapy for LIQ cancer causing the characteristic deformity associated with cancer surgery in this part of the breast

Preoperative Markings

As with any oncoplastic procedure, preoperative marking of the patient in the standing position is essential and arguably the most important aspect in achieving a good aesthetic outcome. If palpable, the cancer should be marked and outlined, although this may be easier with ultrasound guidance in the operating theatre (see below). The planned skin resection immediately overlying (or involved by) the cancer should be converted to a triangular shape (see Fig. 14.2a–d) with its base along the inferomedial angle of the breast or the IMF. The apex of the triangle should be directed towards the NAC margin. Importantly, the angle of divergence of the two limbs of the triangle from apex to the IMF should be estimated carefully. These limbs of the triangle are marked initially. Following this, the base of the triangle along the IMF can be marked accurately, extending it as far laterally as its definition allows.

The intended final height and lateral-most position of the areolar edge should then be estimated. This can be facilitated by gently pinching the skin on either side of the upper areola and elevating it to the desired level (depending on the degree of ptosis) to mark the new cephalad level of the superior areolar edge. If there is minimal or no ptosis, then the extent of lateral displacement alone should be estimated and marked accordingly. It may be helpful to displace the inferior breast skin with the flat of the surgeon's hand directed medially to assist in marking the lateral extent of the new NAC position (see Fig. 14.2b, c).

During this medial displacement of the breast, it is also useful to mark the anterior limit of any axillary incisions for planned sentinel (or axillary) lymphadenectomy. Since the axillary surgery is usually performed prior to the mammoplasty, this prevents undesirable movement of any axillary scars anterior to the lateral border of the pectoralis major which may occur during mammoplasty.

Surgical Technique

The area overlying the tumour is marked on the skin. Because, as outlined above, the extent of tumours in this location can be difficult to assess clinically, the authors prefer to use intraoperative ultrasound to map the tumour accurately. If this is not

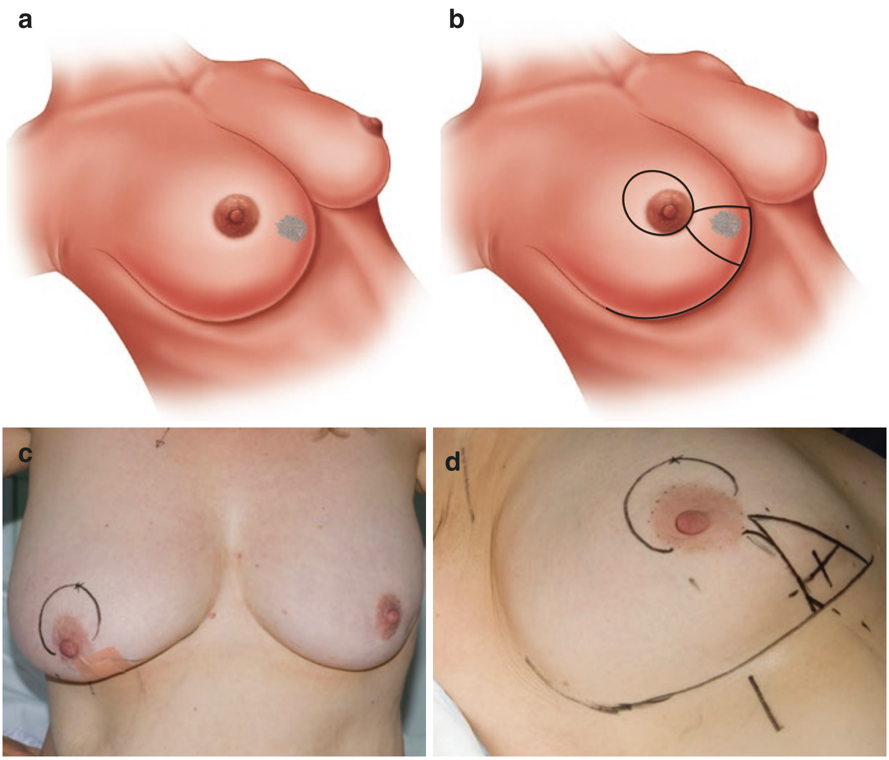


Fig. 14.2 Preoperative planning for V mammoplasty on the right breast. (**a**) Schematic showing right breast with LIQ cancer and (**b**) demonstrating planned incisions for V mammoplasty. (**c**) Demonstrates new NAC position for re-centralisation. Plaster indicates site of radioisotope injection. (**d**) Demonstrates triangular outline of breast resection with extension laterally along infra-mammary fold. The small cross within the triangle indicates the site of the cancer

available, the team radiologist can perform this with the patient in the surgical position preoperatively. For impalpable tumours a localisation procedure may be required.

The outline of the cancer is then converted to a triangular shape with the apex towards the areolar edge and the base at the breast periphery towards its infero-medial angle – the medial end of the infra-mammary fold (also an inverted 'V') – see Fig. 14.2b, c. The gently curved base of the triangle is completed by connecting the two open limbs at the level of the IMF and extending this laterally until 4 o'clock (infero-laterally) on the left or 8 o'clock on the right (refer to Fig. 14.2b, d).

The two-dimensional triangle is converted to a three-dimensional pyramid as breast parenchyma is resected down to pectoralis or external oblique fascia and the specimen orientated in standard fashion (Fig. 14.3a–e). As mentioned above, care should be taken with deeper tumours which may be infiltrating the deep fascia and even muscle. Further surrounding tissue (margin shaves) can be resected prior to fashioning the glandular-cutaneous flap either supero-medially or laterally, according to the intraoperative specimen X-ray findings and/or clinical concern. The cavity is then marked with radiopaque clips to facilitate radiotherapy planning as per local unit protocols.

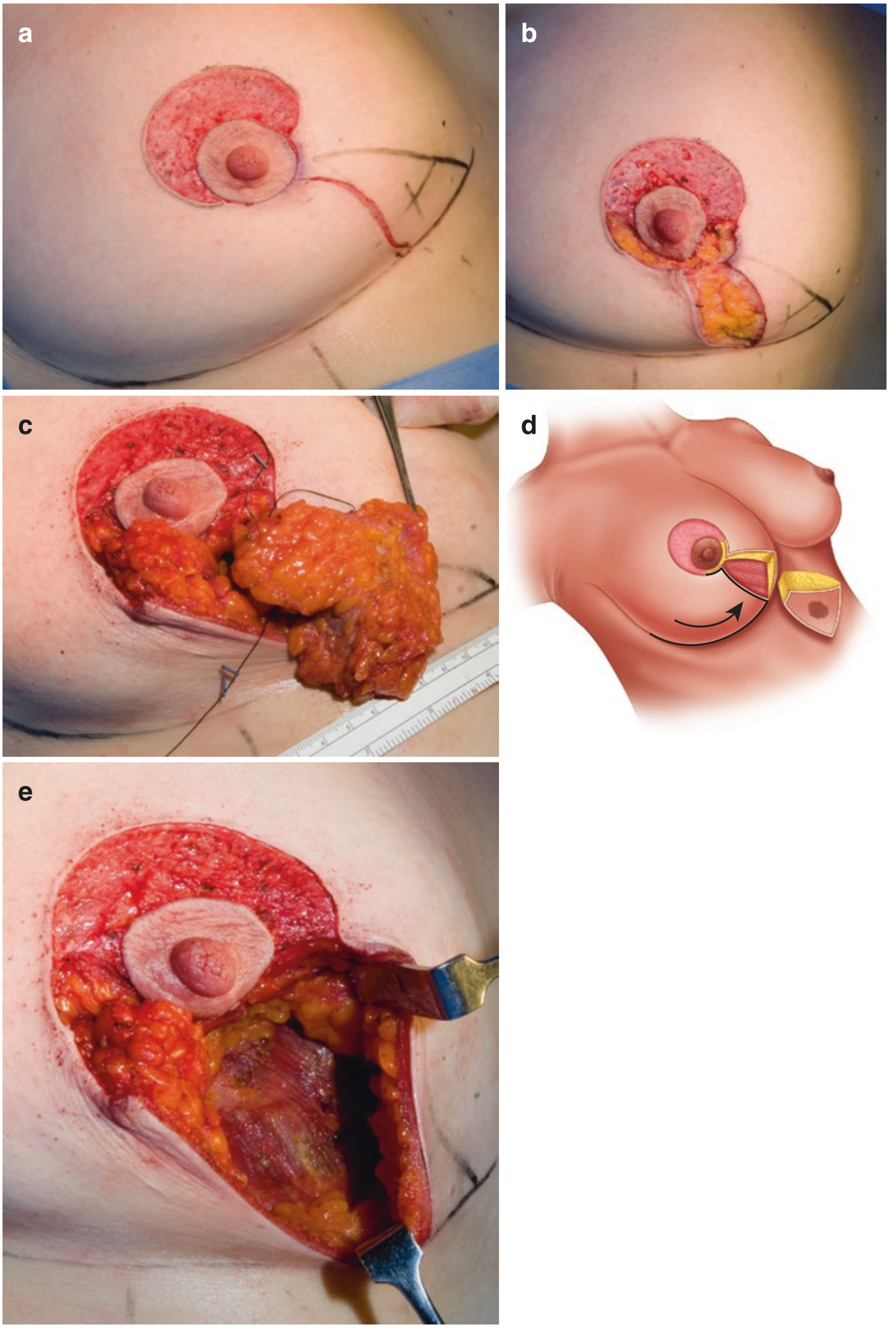


Fig. 14.3 Intraoperative photos of V mammoplasty: resection phase. (**a**) De-epithelialisation of new position of nipple-areolar complex and lateral incision of triangle. (**b**) Deepening of incision inferior to NAC and lateral to cancer. (**c**) Carcinoma resection from LIQ deep to marked triangle. Specimen orientation with marked sutures superiorly and laterally. (**d**) Schematic showing resection of cancer with defect in LIQ of breast and also de-epithelialisation of NAC. (**e**) Retraction of the site of cancer resection demonstrates pectoralis major muscle in the floor

The infra-mammary fold (IMF) incision is then extended laterally as described above (Fig. 14.4a–e), and the gland is mobilised off the underlying deep fascia. Any chest wall perforators (usually anterior and/or lateral intercostal vessels) encountered should if possible be preserved (Fig. 14.4c). At this stage, using skin staples (tailor tacking), the primary defect can be approximated and closed by advancing the lateral-based flap medially (Fig. 14.4e). If there is undue tension or distortion laterally, the IMF incision can be extended further laterally and/or superiorly along the edge of the new breast cone to as high as 3 (or 9) o'clock or even slightly higher. This will result in a narrower breast base. Such change in the proportions of the

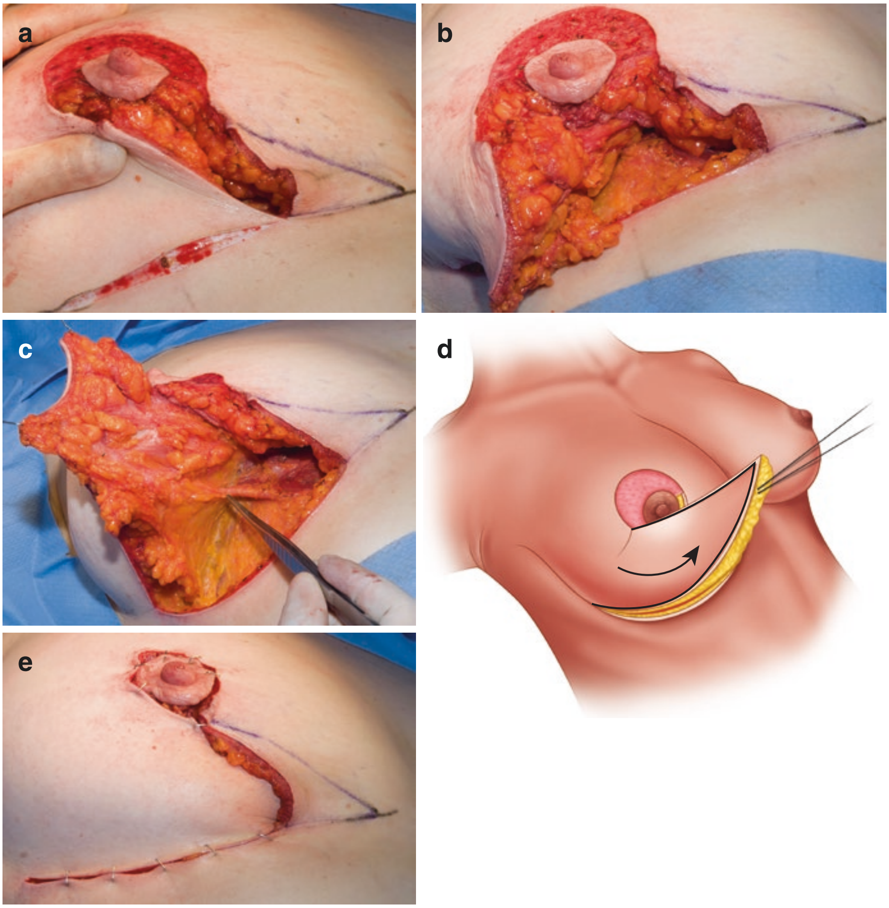


Fig. 14.4 Intraoperative V mammoplasty: reconstruction phase. (**a**) Commencement of infra-mammary fold incision laterally. (**b**) Mobilisation of infero-lateral breast parenchyma with the overlying skin following IMF incision. (**c**) Lateral retraction of cutaneo-glandular flap with forceps indicating an intact anterior intercostal perforator. (**d**) Schematic showing mobilisation of rotation flap and advancement to medial position over LIQ prior to being inset. (**e**) 'Tailor tacking' of lateral cutaneo-glandular flap into final position with skin staples. The flap tip is buried temporarily within the resection site medially

breast mound generally necessitates an accompanying re-centralisation of the NAC for aesthetic balance. Once the extent of flap advancement is satisfactorily achieved, the patient should be postured to be sat up on the operating table, and the new position of the NAC marked supero-lateral to its original position can be confirmed and fine-tuned if necessary. The infero-medial NAC is mobilised for the re-centralisation (Fig. 14.6a, b).

Insertion of a soft drain under the mobilised inferior breast flap is optional although is no substitute for meticulous haemostasis including the underlying muscle/fascia. In the authors' experience, significant oedema may occasionally develop within the flap in the first 24–36 h mimicking an acute haematoma. The latter should be excluded by US imaging if clinical doubt exists, and conservative management should then be employed with reassurance of the patient. Oedema can be reduced by taping of the breast or a mild to moderately compressive brassiere (without underwire) applied in the recovery suite.

Technical Variations/Modifications

The technique above is the original one described by Clough and colleagues [6]. Minor variations may include preservation of the overlying skin when the incision required would be so far medial and superior that impingement on the décolletage would be inevitable (refer to Figs. 14.5 and 14.6c, d). As long as clinical and imaging findings permit preservation of the skin overlying the carcinoma, the skin incision can be restricted to the lateral-most limb of the triangle alone. This also marks the lateral limit of the cancer resection. The entire pyramid of underlying parenchyma is then resected by undermining the infero-medial breast as outlined by the initial skin markings (Fig. 14.3c–e). To fill the defect, the flap is raised as described above, and once full advancement to fill the defect has been confirmed, tailor tacking can be used to maintain the advancement (Fig. 14.4e). The cutaneo-glandular flap is then marked where it meets the vertical skin incision at the lateral edge of the WLE defect (Fig. 14.5b, c). The flap is removed from the resection cavity, and its medial end is carefully de-epithelialised (Fig. 14.5d–f). In doing so, it will be unusual for the length to width ratio of the de-epithelialised flap to be greater than 1 and should resemble the original triangular outline of resected breast parenchyma.

The authors also recommend, where possible, during flap mobilisation that the infero-lateral (anterior and lateral intercostal) perforators be maintained where possible. This will minimise both venous congestion of the flap as well as sensory disturbance. Depending on the extent of medial advancement needed, maintenance of these perforators rarely constitutes a limiting factor.

Lipo-filling may also be used as an adjunct to fill any remaining contour deficits according to the technique described by Coleman [7] once the flap has been advanced and/or following adjuvant radiotherapy.

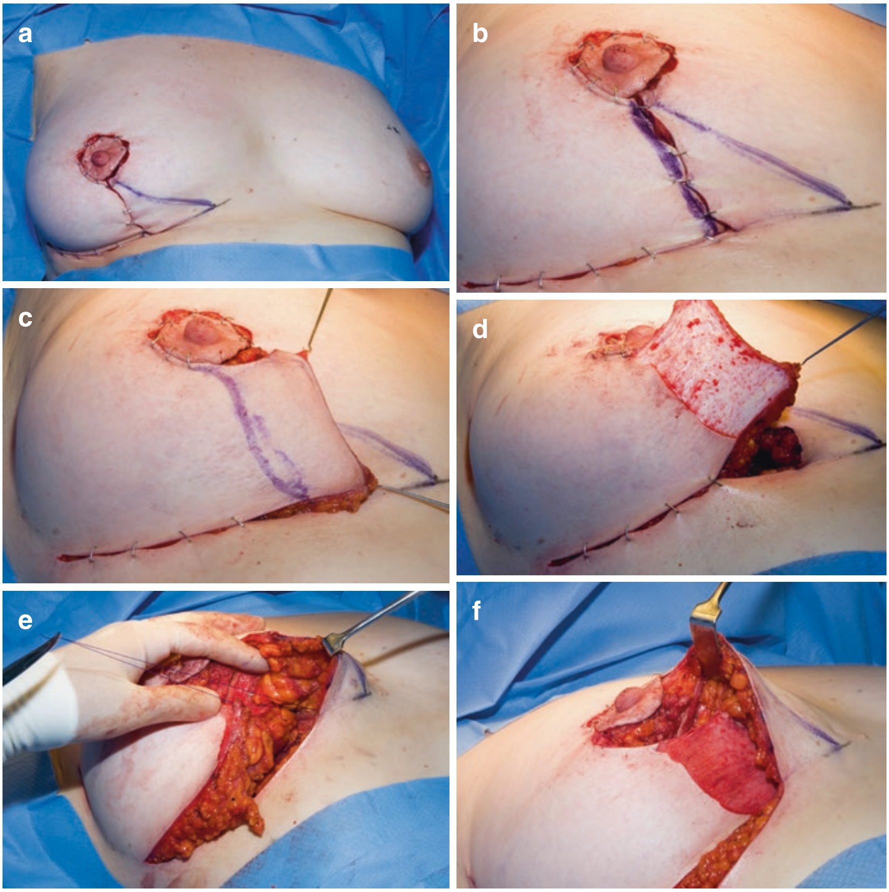


Fig. 14.5 Final series of intraoperative photos. (**a**) View of both breasts demonstrating inset position of flap right breast prior to definitive closure with the patient in a semi-recumbent (sitting) position. (**b**) Close-up of 14.5(**a**). (**c**) Medial retraction of tip of cutaneo-glandular flap in preparation for de-epithelialisation of medial end (see modification above). (**d**) Flap after de-epithelialisation of medial end prior to inset. (**e**) Insetting of flap with initial anchoring suture. (**f**) Flap anchored into final position to cover resection defect

Surgical Complications and Solutions

General

Bleeding – as mentioned above, flap oedema which usually peaks at 36–48 hours can mimic bleeding. Telltale signs of bleeding such as pain, flap tension, bruising and skin discoloration in the first 24 hours warrant early exploration beneath and around the flap. Any haematoma is evacuated and a soft drain placed after copious lavage and careful haemostasis with normotensive anaesthesia.

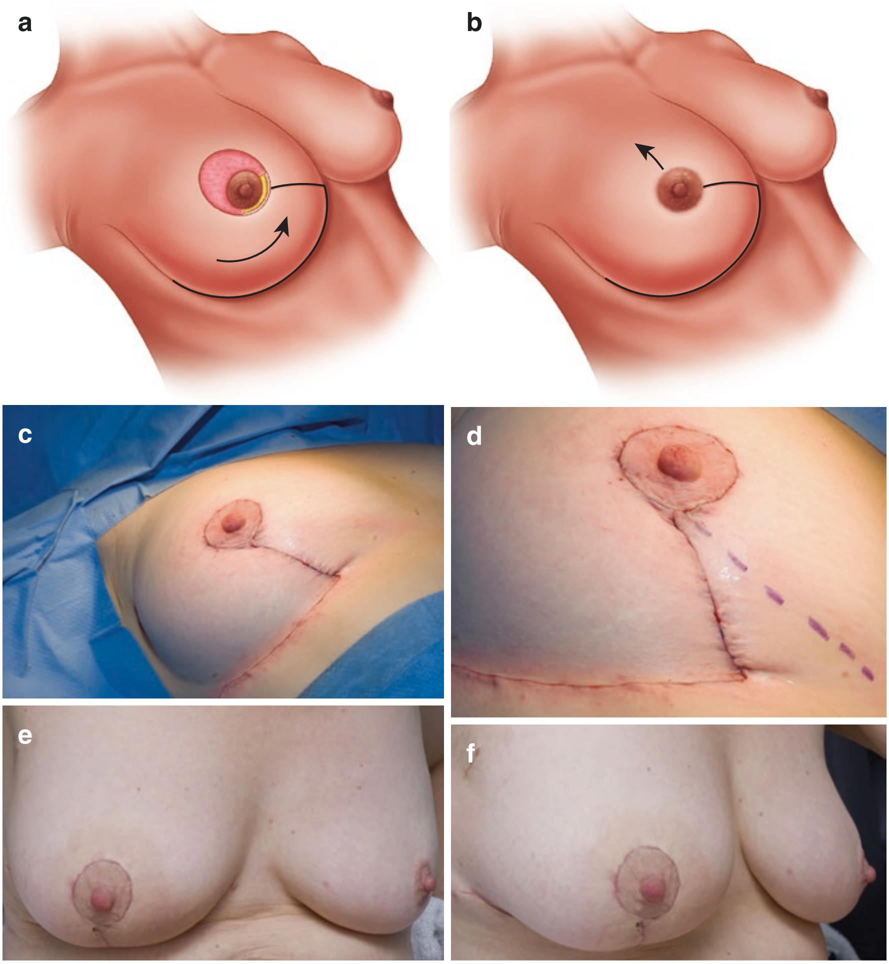


Fig. 14.6 (**a**) Showing schematic after flap inset into LIQ and (**b**) closure of NAC after re-centralisation. (**c**, **d**) Final views 'on table' following completion of V mammoplasty right breast. (**c**) Distant view right breast. (**d**) Close-up view demonstrating near-vertical scar medially after modification as described in the main text. (**e**, **f**) 3-month follow-up views

Specific

Loss of nipple/areolar sensation this is a predictable risk, and the patient should be warned about the likelihood of temporary and/or permanent numbness. Preservation of the lateral intercostal nerves (along with the vessels – see above) despite a high lateral incision may limit permanent loss of sensation.

Involvement of radial margin(s) re-excision may be required and the flap taken down and mobilised further to achieve this. Care should be taken at the time of initial surgery to remove all medial and inferior breast tissue (in the infero-medial angle). Involvement of the 'lateral margin' will necessitate trimming the end of the inset flap.

Fat necrosis the most vulnerable parenchyma is the medial end of the cutaneo-glandular flap. During initial surgery, the tip of the flap can be inspected for perfusion and venous congestion prior to and post-inset. The flap can be 'tailor-tacked' (with skin staples) into its final medial position and the medial end inspected. A thin sliver at the medial end can even be excised with scalpel or scissors to check for bleeding. Breast parenchyma which is deemed ischaemic can be excised until bleeding is observed. Such problems are rare in the authors' experience especially if care has been taken to ensure adequate width (height) of the flap proximally (i.e. laterally) and can be further minimised by maintenance of visible intercostal perforators.

Notably, any parenchyma at the medial end of the flap so resected should be orientated and sent for histopathology marked as a lateral margin shave.

Breast asymmetry this is more likely to occur when significant ptosis is pre-existent and a noticeable difference in the final lower pole and NAC height results. Such patients should be warned in advance and offered immediate symmetrisation although many patients choose delayed symmetrisation following the effects of radiation therapy to the index breast (Fig. 14.7).

Results

Whichever oncoplastic breast conservation classification system a surgeon subscribes to [4, 8], the V mammoplasty technique is universally agreed to satisfy requirements for the attainment of reproducible outcomes for tumours located in the LIQ. Historically, wide local excision of cancers in the lower breast – particularly at the medial extremity – caused loss of volume and vertical height of breast tissue resulting in the deformity known as the 'bird's beak' deformity, particularly after radiotherapy. The latter accentuates the extent of tissue and skin loss resulting in further fibrosis and scar retraction. Perhaps the medial equivalent of this deformity as seen from an anterior view could be described as a 'shark-bite' deformity as the entire convexly rounded contour of the infero-medial breast is removed resulting in a scalloped appearance (Fig. 14.1a, b).

By maintaining or possibly even enhancing the volume of tissue and the vertical height of that tissue as part of the resection (by recruiting the laterally based

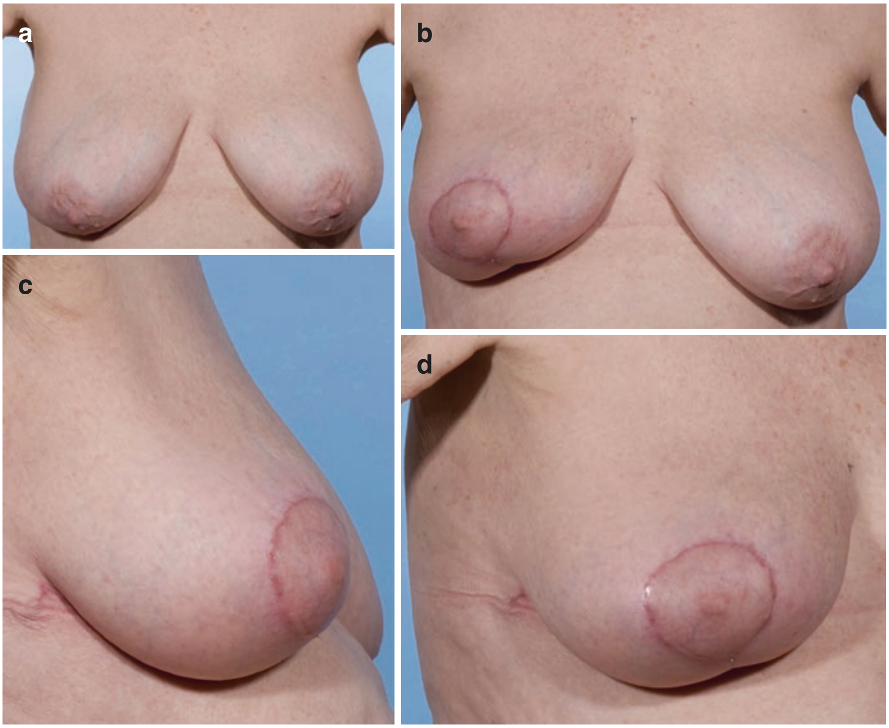


Fig. 14.7 Another patient who underwent standard LIQ-V mammoplasty for a 45-mm-diameter carcinoma hidden posteriorly in the LIQ. (**a**) Preoperative view. (**b**–**d**) Immediately following radiotherapy (after V mammoplasty on right) prior to left symmetrisation with (**b**) anterior view, (**c**) lateral view of right breast and (**d**) close-up of right breast showing slight notching of infero-medial breast at this time point

cutaneo-glandular flap), not only can such significant deformity be prevented, but an increased volume of parenchymal resection can be conveniently tolerated [9]. This technique of V mammoplasty despite being universally accepted has seen a paucity of publication of series or outcomes, possibly owing to the rarity of the LIQ as a location for primary cancers but possibly owing to some patients being treated by mastectomy for a variety of reasons. Clough et al. [6] published a series of 22 cases performed over 7 years, with 55-month median follow-up. Early wound-related complications (fat necrosis of the flap tip) occurred in two patients (9%), but only one case had delay in adjuvant radiotherapy. The mean tumour resection weight was 101 g and the maximal dimension ranged from 4 to 50 mm. The cosmetic outcome was judged by an independent panel as excellent in 68% of cases, and no patient required further ipsilateral or contralateral symmetrising surgery. A salient point made by Clough et al. is to re-centralise the NAC only after flap recruitment to ensure that its new position is not rendered too high, above the point of maximal projection after the enhancement of the inferior pole which results from this technique (flap advancement). The current authors do not recommend immediate symmetrisation of the contralateral breast with this technique. It is best left until after the effects of radiotherapy to the index breast are rendered and in particular the final height of the NAC is determined. In our experience, it is the difference in NAC height which ultimately drives the patient's decision to undergo symmetrisation (Figs. 14.6e, f and 14.7).

Another variation on the LIQ-V technique described by Lee et al. [10] involves a similar incision to create a broad cutaneo-glandular flap which rotates into the lower inner quadrant defect except that the flap incision is made several centimetres below the IMF, and by mobilisation and advancement of the upper abdominal wall skin, a neo-IMF is created. Re-centralisation of the NAC was optional. Lee et al. [10] claim that the above modification to create a neo-IMF prevents upward displacement of the breast contour and IMF. In our experience, upward migration of the IMF level has not been a problem, and the creation of a neo-IMF generally results in more post-operative pain. Additionally, in Lee's description, excess skin overlying tumour excision resulting from the flap rotation is de-epithelialised rather than excised. In their series, 21 patients with LIQ tumours underwent their so-called fish-hook incision rotation flap over a 5-year period with a mean resection weight of 130 g. NAC repositioning was undertaken in only 35% of patients. Good or excellent cosmesis was self-reported by 85% of patients.

Conclusions

Whilst lower inner quadrant cancers are rare, simple wide local excision of all but the smallest masses results in one of the most significant and well-recognised deformities following breast cancer surgery. The LIQ-V mammoplasty provides a reliable and safe solution for tumour including those which involve either the skin, the chest wall musculature or both. Excellent aesthetic results, clear cancer margins and avoidance of deformity following adjuvant radiotherapy can consistently be achieved by employing this readily reproducible technique.

References

1. Haagensen CD. Diseases of the breast, vol. 2. Philadelphia: WB Saunders; 1971. p. 13.
2. Cochrane RA, Valasiadou P, Wilson AR, Al-Ghazal SK, Macmillan RD. Cosmesis and satisfaction after breast-conserving surgery correlates with the percentage of breast volume excised. Br J Surg. 2003;90:1505–9.
3. Clough KB, Lewis JS, Couturaud B, Fitoussi A, Nos C, Falcou M-C. Oncoplastic techniques allow extensive resections for breast-conserving therapy of breast carcinomas. Ann Surg. 2003;237(1):26–34.
4. Clough KB, Kaufman GJ, Nos C, et al. Improving breast cancer surgery: a classification and quadrant per quadrant atlas for oncoplastic surgery. Ann Surg Oncol. 2010;17(5):1375–91.
5. Clough KB, Ihrai T, Oden S, et al. Oncoplastic surgery for breast cancer based on tumour location and a quadrant – per – quadrant atlas. Br J Surg. 2012;99(10):1389–95.
6. Clough KB, Oden S, Ihrai T, et al. Level 2 Oncoplastic surgery for lower inner quadrant breast cancers: the LIQ-V mammoplasty. Ann Surg Oncol. 2013;20:3847–54.

7. Coleman SR, Saboeiro AP. Fat grafting to the breast revisited: safety and efficacy. Plast Reconstr Surg. 2007;119:775–85.
8. Weber WP, et al. Standardization of oncoplastic breast conserving surgery. Eur J Surg Oncol. 2017;43(7):1236–43.
9. Clough KB, Gouveia PF, Benyahi D, et al. Positive margins after oncoplastic surgery for breast cancer. Ann Surg Oncol. 2015;22:4247–53.
10. Lee S, Lee J, Jung Y, Bae Y. Oncoplastic surgery for inner quadrant breast cancer: fish-hook incision rotation flap. ANZ J Surg. 2017;87(10):E129–33.

Thoraco-Epigastric Pedicled Flap for Partial Breast Reconstruction

15

Laszlo Romics, Eva Weiler-Mithoff, and Elizabeth Morrow

Introduction

Various oncoplastic techniques have been developed for volume replacement after tumour excision [1]. Selection of volume replacement techniques depends on tumour location and patient anatomy, as well as the preference of both patient and surgeon [2].

The thoraco-epigastric (TE) flap is a well-established flap to reconstruct the breast, which was first described by Kleinschmidt almost a century ago [3]. Originally, the flap was described to facilitate skin closure of large thoracic defects after breast cancer surgery, with a lower morbidity rate than distant flaps [4] (Table 15.1). However, the increased demand for reconstructive techniques for partial breast reconstruction, the relatively higher rate of flap survival and the fairly simple surgical technique all contributed to the renaissance of this flap. The TE flap is a loco-regional transposition flap, which is designed from the same anatomical region of the body as the defect. Typically, it is used for tumours located in the lower quadrants of the breast (Table 15.1). The concept of this flap is that it utilises local tissue in a rotation or advancement fashion [5].

Anatomically, the principal blood supply to this flap originates from the epigastric arcade, which connects the subclavian artery with the external iliac artery. The epigastric arcade projects perforating branches to the subcutaneous tissue of the

L. Romics (✉)
Department of Surgery, New Victoria Hospital, Glasgow, UK

Department of Academic Surgery, University of Glasgow, Glasgow, UK
e-mail: Laszlo.Romics@glasgow.ac.uk

E. Weiler-Mithoff
Canniesburn Plastic Surgical Unit, Glasgow Royal Infirmary, Glasgow, UK

E. Morrow
Department of Academic Surgery, University of Glasgow, Glasgow, UK
e-mail: elizabeth.morrow@nhs.net

V. S. Klimberg et al. (eds.), *Oncoplastic Breast Surgery Techniques for the General Surgeon*, https://doi.org/10.1007/978-3-030-40196-2_15

Table 15.1 Anatomy, mobilisation and common indications of the thoraco-epigastric and thoraco-abdominal flaps

Name of the flap	Blood supply	Base of the flap	Mobilisation	Common clinical applications
Thoraco-epigastric	Perforating branches of the superior epigastric artery	Medial (close to midline)	Superior rotation with medial advancement	Closure of large chest wall defects extending towards the sternum
Thoraco-abdominal	Lateral cutaneous branches of the posterior intercostal arteries	Lateral (at anterior axillary line)	Superior rotation with lateral advancement	Closure of large chest wall defects extending towards the axilla
Axial thoraco-epigastric	Sixth perforating branch of the internal thoracic artery	Medial (close to midline)	Supero-medial rotation above the inframammary fold	Volume replacement in the lower inner quadrant and lower pole of the breast
Axial thoraco-abdominal	Lateral cutaneous branch of one of the posterior intercostal arteries	Lateral (at anterior axillary line)	Supero-lateral rotation above the inframammary fold	Volume replacement in the lower outer quadrant and lower pole of the breast

thorax and abdomen along its entire length. The mid-part of the arcade, which is the superior epigastric artery in continuity with the internal thoracic (mammary) artery, provides blood supply for the TE flap from the underlying rectus abdominis muscle into the superficial fascia [6]. Depending on the skin surface mobilised, two types of TE flaps can be defined: the "classic" TE flap, which is classically described to facilitate skin closure after major chest wall defects, and the axial TE flap, which is used for partial breast reconstruction as a volume replacement oncoplastic technique for tumours located in the lower inner quadrant of the breast (Fig. 15.1). The former is a rotational advancement flap that allows for the skin situated in the lateral regions of the abdomen to be raised up to the thorax. The blood supply of the axial TE flap is dependent on the sixth perforating branch of the internal thoracic artery, which is a constant in clinical practice as it is invariably situated just lateral to the xiphoid process (Table 15.1).

The mirror flap of the TE flap is called a thoraco-abdominal (TA) flap. Anatomically, the blood supply to this flap originates from the intercostal arteries, which give off a perforating artery on the lateral side of the thorax that passes through the intercostal muscles to reach the subcutaneous tissue [7]. This branch is known as the lateral cutaneous branch of the posterior intercostal artery. The location of these perforating branches is constant and predictable, as they originate in the anterior edge of the serratus anterior muscle, at the termination of its insertion onto the rib, which usually is in the mid-axillary line. Similarly to the thoraco-epigastric flap, two types of thoraco-abdominal flaps can be described based on the extent of the abdominal surface mobilised (Table 15.1). The "classic" TA flap is used mainly to facilitate closure of large chest wall defects located in the medial aspect of the anterior chest wall. The axial TA flap can provide volume replacement after tumour excision from the lower outer quadrant of the breast (Fig. 15.2). As the

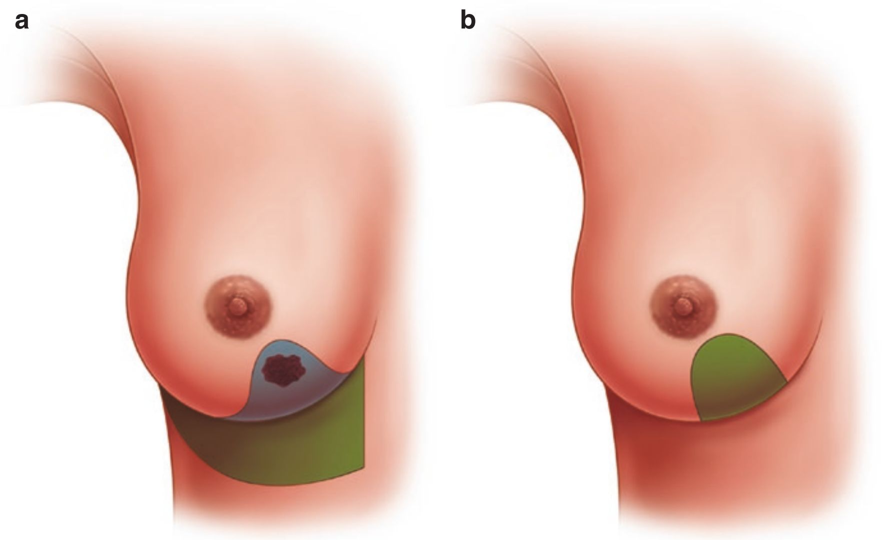


Fig. 15.1 Principles of axial thoraco-epigastric flap. (**a**) Preoperative marking of the flap under the inframammary fold. The base of the flap is located close to the midline. (**b**) Insertion of the flap into the excision cavity in the lower inner quadrant. Dotted line denotes flap base. Green, axial TE flap; red, tumour; blue, excised breast quadrant

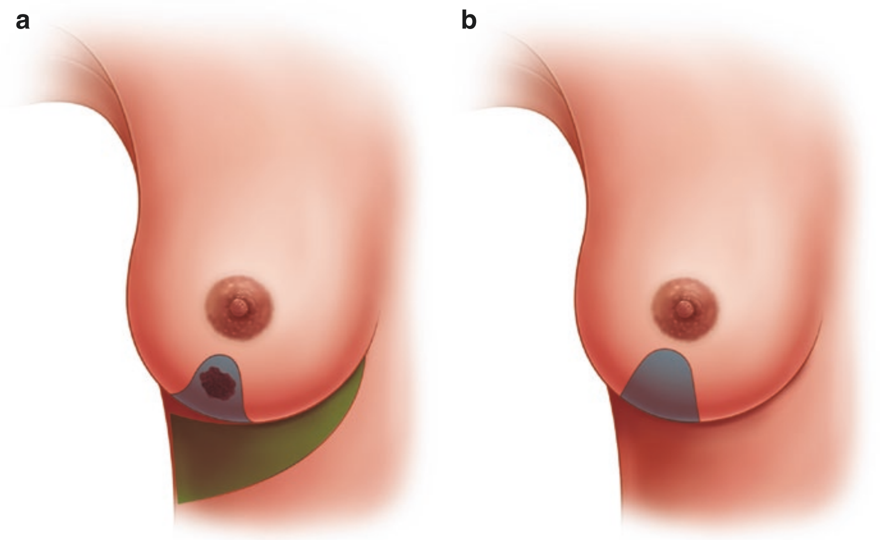


Fig. 15.2 Principles of axial thoraco-abdominal flap. (**a**) Preoperative marking of the flap under the inframammary fold. The base of the flap is located close to the anterior axillary line. (**b**) Insertion of the flap into the excision cavity in the lower outer quadrant. Dotted line denotes flap base. Green, axial TE flap; red, tumour; blue, excised breast quadrant

posterior intercostal perforator branches provide the blood supply for these flaps, the TA flap commonly has a relatively broader base and is rotated upwards into the defect of the breast.

While the reliability and the relative safety of these flaps are their primary advantage, it is obvious that their mobility is limited with this approach. An alternative would be to prepare the flap as a pedicled perforator flap, which greatly enhances mobility, insetting and donor site closure [8, 9]. The lateral intercostal artery perforator (LICAP) flap evolved from the TA flap. The intercostal vessels are dissected to their origin, the vascular pedicle is short (4–5 cm), and the LICAP flap is best utilised for small lateral defects [10]. The anterior intercostal artery perforator (AICAP) flap is based on perforators originating from the intercostal vessels through the rectus abdominis or the external oblique muscles. Since it has a short pedicle, the AICAP flap is suitable to cover close defects that extend over the inferior or medial quadrants of the breast [11]. The superior epigastric artery perforator (SEAP) flap evolved from the TE flap. The SEAP flap is based on perforators arising from the superior epigastric artery or its superficial branch [12]. It has the same indications as the AICAP flap; however, the SEAP flap has a longer pedicle and, therefore, it can cover more remote defects in the breast. These perforator flaps are detailed in Chap. 29.

As this chapter focuses on partial breast reconstruction, the application of TE and TA flaps primarily as volume replacement techniques is discussed here. However, as these flaps originate from their "classic" use to cover large chest wall defects after breast amputation, the original technique is briefly discussed too, with its relevant indications. The nomenclature in the relevant literature is somewhat inconsistent. The axial TA flap is commonly referred to as simply "thoraco-epigastric" or "laterally based thoraco-epigastric" flap, although there is a clear anatomical distinction between TE and TA flaps. Nevertheless, this chapter discusses both TE and TA flaps but uses the terms accurately throughout.

Indications

TE and TA flaps can be used for immediate partial breast reconstruction as a volume replacement oncoplastic technique [13]. It is usually offered for patients with small- or medium-sized breasts, when we would expect significant cosmetic deformity after breast-conserving surgery for tumours located in the lower quadrants if they were treated with wide local excision only (Table 15.2). These flaps can be offered to patients who are not candidates for reduction mammoplasty or glandular rotation flaps, which is called "j" or "v" mammoplasty as described by Clough et al. [14]. These flaps can be offered to patients who do not wish to have a smaller breast size after tumour excision with reduction mammoplasty, as well as to patients who refuse to have contralateral breast reduction, for whom preservation of their actual breast size would be desirable. Patients should have sufficient skin and subcutaneous tissue located under the breast to allow the primary suture to be performed at the

Table 15.2 Indications and preconditions for the use of axial thoraco-epigastric and thoraco-abdominal flaps

Flaps	Indications	Preconditions
Axial thoraco-epigastric Axial thoraco-abdominal	Volume replacement for the lower inner quadrant Volume replacement for the lower pole Volume replacement for the lower outer quadrant Rarely, volume replacement after central excision Rarely, volume replacement for the upper outer quadrant Correction of lower pole deformity after wide local excision (delayed) Skin replacement after extensive skin necrosis in the lower aspect in reduction mammoplasty	Small-, medium-sized breast Significant aesthetic deformity expected in the lower aspect after simple wide local excision Not suitable for reduction mammoplasty Not suitable for glandular rotation flap Perforator flaps are contraindicated or not obtainable Keep current breast size Sufficient laxity of the skin and subcutaneous tissue under the breast Sufficient laxity of the skin on abdomen for primary closure of the donor site Operating surgeon lacks microsurgical skills No previous scarring on ipsilateral upper abdomen No previous midline laparotomy if thoraco-epigastric flap planned No multiple risk factors present for delayed wound healing (smoking, diabetes, immunosuppression)

donor site, without additional dissection. As the TE and TA flaps are pedicled, they can also be used when the corresponding perforator flaps are not obtainable or are contraindicated. A relative advantage of these pedicled flaps over the perforator flaps is that raising them is relatively straightforward surgery, and they do not require specialised microsurgical training and microsurgical instruments. Contraindications include multiple risk factors for wound healing problems and previous scars in the ipsilateral upper abdomen (Table 15.2).

The flap may be either used as an adipo-cutaneous flap or completely de-epithelised to reconstruct defects in the lower quadrants of the breast, preferably the lower medial quadrant in the case of an axial TE flap or the lower outer quadrant if a laterally based mirror flap is raised, the axial TA flap. These flaps can be used for skin and volume replacement or when completely de-epithelised for volume replacement only. This depends on the necessity of partial replacement of the breast skin envelope in cases where skin resection is oncologically indicated. T4 tumours, tumours located close to the skin with or without skin dimpling and microcalcifications extending close to the skin are the usual indications for partial de-epithelisation or full-skin preservation on the flap. As these flaps are compositionally similar to the original breast skin, the patient experience is relatively good as there is no skin patch effect (Fig. 15.3).

Indications may be extended in carefully selected patients. Longer TE and TA flaps can reach up to the relevant upper quadrants; however, in these cases planning

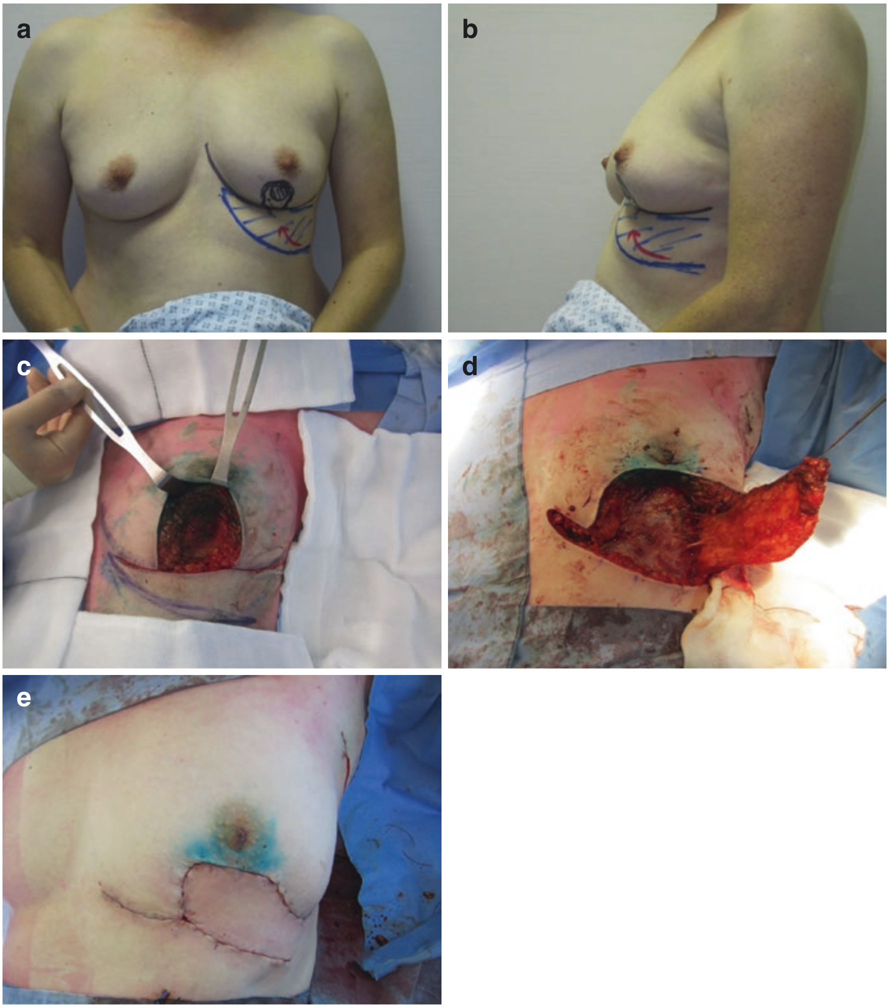


Fig. 15.3 Preoperative planning and surgical technique of non-de-epithelised axial thoraco-abdominal flap. (**a**) The base of the flap is located just anterior to the anterior axillary line and planned with a relatively broad base. The tip of the flap is 2–3 cm lateral to the midline. (**b**) Planning of the laterally based thoraco-abdominal flap around the lax skin and adipose tissue "roll" under the inframammary fold. The upper margin is in the inframammary fold of the breast. The skin overlying the tumour needs to be excised for oncological reasons as marked. (**c**) Large excision cavity requiring volume replacement. (**d**) Laterally based thoraco-abdominal flap is raised. Perforators providing blood supply to the flap are visible at the base. (**e**) Flap is rotated superiorly into the excision cavity providing volume and skin replacement for the excision cavity

a relatively broader-based flap is suggested. In some patients TE or TA flaps can be used to replace defects after central excision in the breast (Fig. 15.4) [15]. When TA or TE flaps are used for volume replacement with the above-mentioned extended indications, they can only be applied in highly selected patients. Nevertheless,

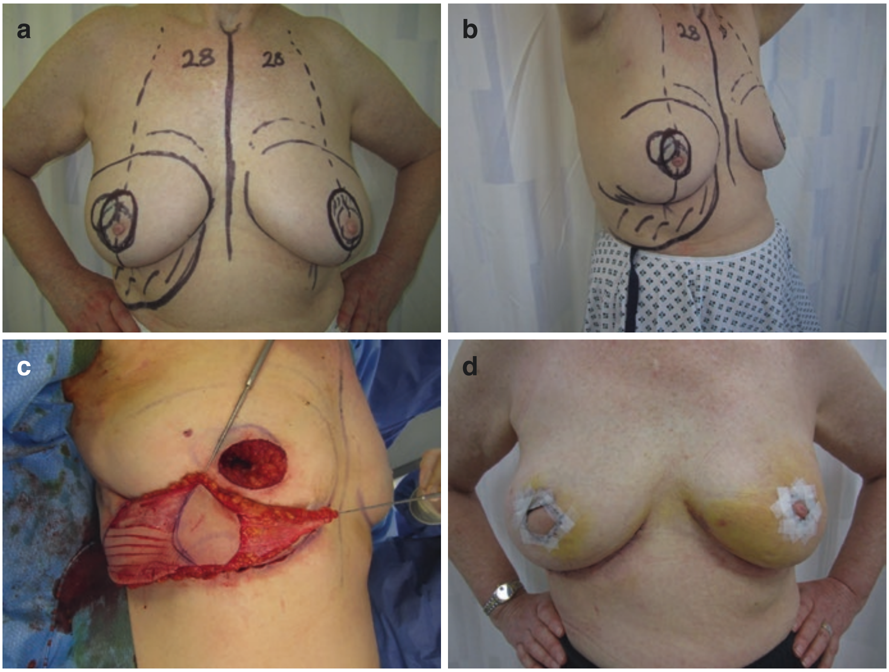


Fig. 15.4 Thoraco-abdominal flap used to replace central excision. (**a**, **b**) Preoperative planning. Large tumour excision after neoadjuvant chemotherapy from the right breast as indicated. Wide-based flap, location of base is relatively posterior to facilitate sufficient rotation. The size of the contralateral breast is larger; therefore, a "round block" reduction mastopexy is planned on the left side. (**c**) Partially de-epithelised flap in full length prior to rotation. The flap was tunnelled in underneath the breast and the chest wall to the central position. (**d**) Postoperative view

routine use of these flaps for immediate volume replacement outside of the lower quadrants of the breast should be avoided as the complication rate of these relatively longer flaps is generally higher and thus can threaten oncological safety due to a potential delay in adjuvant treatment [16].

The classic indication for the medially based TE flap is to facilitate closure of large chest wall defects after resection for advanced breast cancers [4]. While this is relatively rarely required nowadays for primary breast cancer, recurrent breast cancer, with cutaneous progression in particular, is the most common indication for large chest wall resection. If the chest wall resection extends laterally towards the axilla, superior rotation and medial advancement of the TE flap can be used for closure (Table 15.1). Alternatives for closure of large chest wall defects include latissimus dorsi flap or omental flap with split-skin grafts. Contraindications to closure with TE flap include previous midline laparotomy or incisions on the ipsilateral abdomen. If the large chest wall wound extends laterally towards the axilla, closure with a laterally based TA flap may be indicated. The TA flap can be rotated superiorly and advanced laterally. A contraindication to use of the thoraco-abdominal flap is an ipsilateral previous incision in the abdomen. For both flaps sufficient soft tissue laxity is required with careful preoperative planning for primary closure of the donor site. This may necessitate advancement of the skin from the lateral aspect of the abdomen medially to facilitate closure of the donor site after TE flap superior rotation. Conversely, a lateral advancement of the abdominal skin may be required for the closure of the donor site of a TA flap, which may require mobilisation of the skin across the midline of the abdomen.

A less common clinical application of the thoraco-epigastric flap is delayed correction of breast deformities after previous breast conservation [17]. Deformities, volume deficiencies in the lower aspect of the breast and classic "bird's beak" deformities can be treated with delayed volume replacement using axial TE or TA flaps. Postmastectomy-delayed breast reconstruction has also been described in the past using the TE flap, although the current clinical indication for this is very limited [3]. A further relatively rare clinical application includes salvage surgery when extensive skin necrosis develops in the lower aspect of the breast after reduction therapeutic mammoplasty carried out through a "Wise pattern" incision (Fig. 15.5).

Fig. 15.5 A rare indication for "classic" thoraco-abdominal flap: replacement of the lower third of the breast after extensive skin and fat necrosis following therapeutic mammoplasty, which caused significant volume loss in the lower aspect of the breast

Preoperative Evaluation and Planning

TE and TA flaps are designed as transposition flaps. Currently, the most common clinical indication is volume replacement after tumour excision located in the lower quadrants of the breast. When planning volume replacement oncoplastic breast conservation with this technique, indications and clinical preconditions need to combine for the optimal result (Table 15.2). The choice of flap is usually determined by the location of the tumour, i.e. a medially based flap – axial TE flap – is used if the tumour is located medially in the lower aspect. Conversely, a laterally based flap – axial TA flap – is raised if the tumour is located in the lower outer quadrant. In general, the base of the flap should be planned in proximity to the defect but allow sufficient room for rotation after tumour excision [18].

The TE flap is planned around the loose skin and subcutaneous adipose tissue "roll" located underneath the breast (Fig. 15.6). This can be seen and easily felt when the patient is in a sitting position with arms down alongside the body. A simple "pinch test" of the area greatly helps to identify the upper and lower borders of the flap and to define when primary closure is feasible. The upper margin of the flap is planned along the inframammary fold, while the lower margin is drawn along the skin crease underneath the excess abdominal wall fat forming the above-mentioned "tissue roll". The upper border of the TE flap is drawn from medial to lateral, usually starting 1–2 cm from the midline, which is vertically in line with the medial border of the breast. The lateral extension of the upper border of the flap ceases in the lateral third of the breast depending on tumour location as well as the width of the base of the flap. The line defining the upper border curves gently superiorly in the lateral aspect along the inframammary fold. The medially located base is therefore planned for the area lateral to the xiphoid process, where the sixth perforating branch of the internal thoracic artery can be found, which gives the main blood supply for the medially based thoraco-epigastric flap. In principle, the width of the TE flap is planned to allow the donor site to be closed directly with undermining of the abdominal skin and without caudal displacement of the inframammary fold. The lower border of the flap is drawn from medial to lateral in parallel with the upper border until the midline of the breast. Laterally the lower line gradually approximates the upper one and meets it at a sharp angle in the lateral third of the inframammary fold. If the tip of the flap is too narrow and spiky – especially if the line defining the upper border in the inframammary fold curves abruptly superiorly – it will need to be trimmed off later as the blood supply may be insufficient. The maximum lateral extension of the TE flap should not extend beyond the anterior axillary line (Fig. 15.6).

The laterally based axial TA flap is planned similarly to the medially based TE flap, but the planning is from lateral to medial (Fig. 15.3). It is designed around the same "roll" of excess abdominal tissue underneath the breast. The base of the flap is most commonly placed in the anterior axillary line. The upper end of the base can extend from the inframammary fold transversely downwards. The width and length

Fig. 15.6 Preoperative planning and surgical technique of fully de-epithelised axial thoraco-epigastric flap. (**a**) Base of the flap is located just lateral to the midline under the xiphoid process to include the sixth perforating branch of the internal thoracic artery. (**b**) The flap is planned around the submammary adipose tissue roll with the tip not extending beyond the anterior axillary line. (**c**) Large excision cavity requiring volume replacement in the lower medial aspect of the breast. (**d**) Medially based thoraco-epigastric flap is raised. (**e**) Flap is rotated superiorly into the excision cavity providing volume and skin replacement for the excision cavity. (**f**) Postoperative view. Flap base is rotated superiorly and included in the newly defined inframammary fold, which lies more inferiorly

of the flap and the location of the base are determined by the position of the tumour as well as the patient's anatomy. The broader the base of the breast, the closer the flap base is planned to the inframammary fold. The upper edge of the flap is drawn in the inframammary fold from lateral to medial, extending up until the midline in maximum length, if necessary. The lower border of the flap is drawn in parallel to the upper border until the midline of the breast and then the line is curved gradually superiorly to meet the line of the upper border in the inframammary fold (Fig. 15.3).

When a TE flap is raised, the midline denotes the most medial border of the flap base. In many cases, the flap base is more lateral, depending on the location of the defect. Ideally, the base of the flap does not extend further medially than the medial border of the ipsilateral breast. Closure of the donor site would otherwise result in a scar that does not lie within the inframammary fold [5]. Determination of flap length is not well defined, but its maximal length should not extend beyond the anterior axillary line [19]. In practice, the width of the flap is mainly determined by the ability to close the donor site defect primarily; otherwise, a split-thickness skin graft is required. Usually, a width of 7–8 cm can easily be closed primarily. The length of the flap mainly depends on the location of the defect [6]. Prior to outlining the flap dimensions, a Doppler evaluation of the perforators at the presumed flap base may be carried out. Usually, two to four audible perforators can be found lateral to the midline. It should be kept in mind that closure of the donor site creates a new inframammary fold, which is situated at the original level of the inframammary fold. Thus, the lower incision should not extend too far medially and caudally in order to facilitate tension-free closure. Undermining and advancement of the abdominal skin will facilitate the closure of the donor site.

During planning of the laterally based TA flap, it is important to consider that the blood supply for this flap is less well defined. Therefore, inclusion of multiple rows of segmental perforators at the base is desirable. Widening the base improves vascularity through inclusion of more perforators. Determination of the flap length depends on tumour location and the base width, but it is risky to plan a laterally based flap crossing the midline. Flaps can be raised either above or below the level of the investing fascia of the external oblique musculature. Raising the flap with the fascia improves its blood supply in general, so this should be considered for longer flaps or flaps with a short base width. A slightly oblique planning of the flap increases the number of involved perforators and hence provides a safer blood supply. The location of the lateral cutaneous branches of the posterior intercostal artery, which give the blood supply for the TA flaps, is constant. They originate in the anterior edge of the serratus anterior muscle, at the termination of its insertion onto the rib. Due to this anatomical relationship with the serratus anterior muscle, the emergence point of these perforating branches is displaced posteriorly as we go down the ribs, which should be considered during planning [6]. Donor site closure is achieved primarily for laterally based flaps through abdominal wall undermining.

Surgical Technique

Before raising the flap, any oncologic resection should be completed, so that the exact amount of tissue that is required for replacement can be determined. In most cases resection of all the remaining breast parenchyma inferior to the tumour towards the inframammary fold is recommended, as this facilitates the rotation of the flap into the excision cavity (Figs. 15.1 and 15.2). In selected cases a prepectoral tunnel can be created underneath the breast parenchyma, and the de-epithelised flap can be transposed to the defect site through the tunnel. This may be indicated when the flap is applied for central defects or defects in the upper outer quadrant, for example (Fig. 15.4). If patient selection is appropriate, a tissue defect of up to one-quarter of the breast can be replaced with the pedicled TE or TA flaps. After excision of the lesion, the flap is mobilised, advanced and rotated to close the defect. The outlined borders of the flap are incised and incisions are carried down to the deep fascia. Harvesting of the TE flap continues from lateral to medial just on top of the deep fascia. When the laterally based TA flap is raised, it is dissected from medial to lateral, towards the base. All small perforating vessels supplying the distal portion of the flaps should be cauterised meticulously. Once the base of the flap or the area of the marked perforators is approached, care should be taken to spare the perforators supplying the flap. The use of surgical loupes and a headlight is recommended to maximise visibility around the perforator area. Avoiding monopolar diathermy makes the dissection safer. Theoretically, one large perforator with a visible pulse will be sufficient. More than one perforator can be spared, however, if rotation of the flap does not kink the detected perforating vessels. To gain length, the deep fascia around the perforators is incised, and the vessel can be traced through the rectus abdominis muscle [5]. The flap may be raised together with the external oblique and anterior rectus sheath fascia taking care not to damage the superior epigastric vessel perforators that emerge through the medial third of the rectus muscle. This would improve the blood supply of longer- and/or narrow-based flaps, although the fascia is relatively rarely raised together with the flap [20]. When the deep fascia is included in the flap, it may increase donor site morbidity.

Once the flap has been raised, it can be tailored according to the needs of the defect. The whole flap can be de-epithelised and buried, or a skin defect can be reconstructed with a partially de-epithelised TE or TA flap (Figs. 15.3, 15.4, 15.5 and 15.6). The flap is then rotated upwards into the defect and fixed with a few absorbable stitches. As a final step, the donor site is closed over a drain. The patient is positioned in the supine position on a flexible adjustable operating table with both arms abducted at approximately 90°. The lower abdominal wall is then advanced and sutured to the inframammary fold. In order to avoid the closure being under undue tension, a generous undermining of the lower wound edge is advised, as in a reverse abdominoplasty. This undermining can extend down even to the level of the umbilicus if necessary. It is important to close the donor site over a negative pressure drain, as the undermining of the abdominal wall may lead to significant seroma formation, which requires drainage in the early postoperative days. The superficial fascia needs to be fixed with long-lasting absorbable sutures to the periosteum of the ribs underlying the new inframammary fold. This will recreate a natural-looking breast mound. Alternatively, closure of the donor site can take place first before anchoring the flap in the defect. It avoids dislocation of the fold and avoids tension in the flap, thereby improving perfusion and reducing the risk of fat necrosis. The flap itself requires only a few sutures at the edge of the glandular defect and is supported by the reconstituted inframammary fold. It is important in the postoperative period to advise the patient to wear soft supporting brassieres. A tight or underwired brassiere may create unnecessary pressure on the flap which could impede the blood supply to more distal areas leading to partial flap necrosis.

For reasons of oncological safety, partial breast reconstruction using a TE or TA flap can also be carried out in the delayed setting. It may be indicated in cases when the resection margins are less likely to be clear, although with current imaging modalities available, rates of incomplete excision after oncoplastic breast conservation tend to be lower compared to simple wide local excision [21, 22]. Therefore, a staged procedure is very rarely indicated in modern practice. In cases of involved resection margins following TE or TA flap insertion, a re-excision can be carried out relatively easily, as the original tumour margins are well preserved and easily recognisable. As the flap itself maintains the tumour cavity, orientation of the excision margins is easy after the flap is taken down temporarily at the time of re-excision. Alternatively, if re-excision is required, the flap may not have to be removed from its inset completely. Depending on which margin is involved, a couple of long retractors with one lit retractor may be enough to facilitate surgery. Due to anatomical considerations of flap rotation, the breast parenchyma is excised down to the upper border of the axial flap during tumour excision, except for in the rare cases when the flap is tunnelled into the excision cavity. Hence, theoretically, the inferior margin should not be involved. Due to the nature of this flap, the skin can easily be replaced by bringing in skin with the flap; therefore, the anterior margin is also unlikely to be involved with this technique. The medial, superior and lateral radial margins can be identified, and further excision can be carried out if necessary. When the flap is taken down during re-excision, it is important to make sure that the blood supply is not harmed during mobilisation. It is also important to note that the newly created inframammary fold will need to be taken down in most cases when the flap is mobilised; hence, re-suturing it to the chest wall (with 2-0 Vicryl or Polysorb) after re-excision should not be forgotten.

Surgical Complications and Solutions

It is particularly important to try to avoid complications after oncoplastic breast surgery, as any complication has the potential to delay the start of adjuvant treatment [16]. Proper patient selection, based on a combination of appropriate indications, is therefore highly important (Table 15.2). This flap is used primarily to reconstruct defects in the lower quadrants of the breast. By extending the incision of the axial TE flap laterally or the TA flap medially, the upper quadrant of the breast or a central defect can be reconstructed in selected patients. If the flap is too long, however, vascular compromise can occur. The vascularity of the flap is most vulnerable at the tip of the flap. To ensure adequate blood supply, a broader-based flap can be designed. While this guarantees a better supply of perforators, it restricts the arc of rotation at the same time. Harvesting the fascia with the flap increases vascularity to the distal portion of the flap, but it also increases donor site morbidity and, therefore, this technique is applied rarely. Nevertheless, if the slightest doubt of the adequacy of the blood supply to the tip of the flap arises intraoperatively, trimming backwards from the tip until sufficient blood flow is observed is the only solution. Inadequate vasculature at the distal tip may lead to partial flap loss, liquefied fat discharge or formation of hard lumps secondary to fat necrosis [23].

The main principle of the management of complications after oncoplastic breast conservation surgery is to avoid delay in adjuvant treatment [16]. Total flap loss requires repeat surgery during which debridement of the flap should be carried out to facilitate timely wound healing (Fig. 15.7). After debridement the wound can usually be closed with an abdominal advancement flap or "classic" TA or TE flap depending on the size of the remaining cavity (Fig. 15.7). Partial flap loss requires debridement of the necrotised area of the flap. Primary closure can usually be carried out as the defects are comparatively smaller (Fig. 15.8). Impaired aesthetic results can be corrected after the adjuvant treatment has been completed.

Fig. 15.7 Total necrosis of thoraco-epigastric flap. (**a**) Necrosed thoraco-epigastric flap. (**b**) Debridement of necrotised flap. (**c**) Large cavity to close before delayed closure after debridement and refreshment of margins. (**d**) "Classic" thoraco-abdominal flap is raised with repositioning of the umbilicus to close the defect. (**e**) Postoperative view

Fig. 15.8 Partial necrosis of thoraco-abdominal flap used for volume replacement after central excision with the nipple-areola complex. (**a**) Partial necrosis of the flap. (**b**) Primary closure after debridement. (**c**) Postoperative result after radiotherapy

Lipomodelling is the first choice of technique for this [24]. When mobilisation or the location of the flap base is inadequately planned, the flap can be rotated in a strained position, which can potentially harm the vascularisation of the lower margin of the flap. In these cases partial flap necrosis may develop at the edge in the lower margin. In the majority of cases, this does not require further intervention as the area is relatively small, although it may impair the aesthetic outcome slightly and can potentially delay the start of radiotherapy.

Results

The relevant literature regarding TE and TA flaps focuses mainly on the description of the surgical techniques [5, 6, 15, 18, 19]. Studies analysing outcomes after volume replacement surgery occasionally include data on patients treated with TE flaps, but there is no single series reported on patients treated exclusively with this flap. The number of patients with TE or TA flap reconstruction is usually low in the studies and represents a relatively small proportion of all patients treated with volume replacement surgery. A national audit in Scotland on oncoplastic breast conservation surgery revealed that the use of a TE or TA flap accounted for only 2.5% of the total of 498 oncoplastic breast conservation procedures analysed [25].

Kronowitz et al. investigated the timing of various partial breast reconstructive techniques in relation to radiotherapy [26]. They compared various techniques such as local tissue rearrangement, breast reduction, latissimus dorsi myocutaneous flap or TE flap used before or after radiotherapy. Fifty patients underwent immediate reconstruction at the time of the partial mastectomy and prior to radiation therapy, while 19 patients had delayed reconstruction after partial mastectomy and radiation therapy. The complication rates for immediate and delayed reconstruction were 26% and 42%, respectively. In the setting of immediate reconstruction, the flap technique was associated with a higher complication rate than local tissue rearrangement and breast reduction. However, in the setting of delayed reconstruction, the flap technique was associated with a lower complication rate than the other two techniques. In the immediate setting, TE or latissimus dorsi flap reconstructions were less likely to provide an excellent or good aesthetic outcome when compared to breast reduction techniques.

We analysed the oncological outcomes of patients treated with oncoplastic breast conservation using volume replacement techniques in Glasgow [27]. Thirteen patients had TE or TA flap breast reconstruction, and a further 17 patients had reconstruction using a perforator flap (LICAP, LTAP, TDAP) or crescent flap or matrix rotation. The mean preoperative tumour size on radiology was 25.4 mm. Overall incomplete excision rate was 10%, but none of the patients treated with TE/TA flap had involved margins. This is consistent with the systematic review by Yiannakopoulou et al., who found that margin-positive resection rates range between 0% and 26.6% [28]. Postoperative complication rate was 26.7% in our series, which led to a delay in adjuvant therapy in two patients only. One patient had DCIS, 9 patients had stage I, 16 patients had stage II, and 2 patients had stage III disease. During a median follow-up time of 48.5 months, one local recurrence was detected, and no distant metastases were reported [27]. Previously published studies and reviews on volume replacement oncoplastic conservation reported local recurrence rates between 0% and 8.1% throughout highly variable follow-up periods [28–30].

Yang et al. reported a series of 107 women treated with oncoplastic volume replacement surgery including 7 patients treated with TE flap [31]. All patients had small- to moderate-sized breasts. There were no complications reported among patients treated with TE flaps, and the majority of patients was satisfied with the cosmetic outcome. In another series, Yang et al. reported on 213 women treated with volume replacement surgery including 8 patients with TE flaps [32]. Lower quadrant tumours with a resection weight between 50 and 150 g (mean, 95 g) were treated with TE flap. Overall 82% of all the patients were satisfied with the cosmetic outcome, which was slightly lower in patients treated with TE flaps (76%).

An analysis on partial flap necrosis and its potential effect on the delay of adjuvant treatment was published by Park et al. [33]. Twenty-five local skin flaps to cover large chest wall defects (mean defect size, 436.2 cm^2) after surgical ablation for locally advanced breast cancer were studied. Three different types of flaps were used: "classic" TE ($n = 10$), "classic" TA ($n = 9$) and bilateral abdominal advancement flaps ($n = 6$). They found that two patients with TA flap and six patients with TE flap developed distal flap necrosis, necessitating skin grafts in two of the patients with TE flap. The incidence of flap necrosis tended to be the highest in TE flap patients, which lead to significant delays in adjuvant radiation therapy (41 days versus 28–30 days for patients with the other two types of flaps). A similar study which included patients treated with "classic" TE flap confirmed the relatively high post-operative partial flap necrosis rate (up to 33%) for local flaps covering large chest wall defects for fungating breast cancers [34].

Conclusions

The classic indication for the medially based TE or the laterally based TA flaps is to facilitate closure of large chest wall defects after resection for advanced breast cancer or recurrent breast cancer with cutaneous progression in particular.

Axial flaps were developed from the flaps described above to facilitate immediate volume replacement after tumour excision. The axial TE flap is offered for volume replacement in the lower inner quadrant; the axial TA flap is indicated for volume replacement in the lower outer quadrant of the breast. In selected patients, indications may be extended. Longer TE and TA flaps can reach up to the relevant upper quadrants or the central area of the breast.

They are planned around the loose skin and subcutaneous adipose tissue "roll" located underneath the breast, and they are rotated superiorly to fill in the excision cavity. These flaps are relatively reliable and safe, and their preparation requires fairly simple surgical technique. The flaps can be fully or partially de-epithelised, or not de-epithelised at all in case the breast skin overlying the cancer needs to be replaced, too.

Further clinical application of the axial TE and TA flaps includes salvage surgery when extensive skin necrosis develops in the lower aspect of the breast after reduction therapeutic mammoplasty or correction of breast deformities in the lower quadrants after surgery and radiotherapy.

Reference Video

- https://youtu.be/govUUZW_1gE

References

1. Noguchi M, Yokoi-Noguchi M, Ohno Y, Morioka E, Nakano Y, Kosaka T, et al. Oncoplastic breast conserving surgery: volume replacement vs. volume displacement. Eur J Surg Oncol. 2016;42(7):926–34.
2. Mansell J, Weiler-Mithoff E, Stallard S, Doughty JC, Mallon E, Romics L. Oncoplastic breast conservation surgery is oncologically safe when compared to wide local excision and mastectomy. Breast. 2017;32:179–85.

3. Dakin RL, Jobe RP. Toward a more natural breast: the interpolated thoracoepigastric pedicle in breast reconstruction. Plast Reconstr Surg. 1991;88(3):510–3.
4. Cronin TD, Upton J, McDonough JM. Reconstruction of the breast after mastectomy. Plast Reconstr Surg. 1977;59(1):1–14.
5. Huemer GM. Partial mastectomy: breast reconstruction with the pedicled thoracoepigastric flap. In: Fitzal F, Schrenk P, editors. Oncoplastic breast surgery a guide to clinical practice. Vienna: Springer; 2010. p. 127–32.
6. Acea Nebril B, Builes Ramirez S, Garcia Novoa A, Varela Lamas C. Rotational flaps in oncologic breast surgery. Anatomical and technical considerations. Cirugia Espanola. 2016;94(7):372–8.
7. Brown RG, Vasconez LO, Jurkiewicz MJ. Transverse abdominal flaps and the deep epigastric arcade. Plast Reconstr Surg. 1975;55(4):416–21.
8. Hamdi M, Craggs B, Stoel AM, Hendrickx B, Zeltzer A. Superior epigastric artery perforator flap: anatomy, clinical applications, and review of literature. J Reconstr Microsurg. 2014;30(7):475–82.
9. Hamdi M, Stillaert FB. Pedicled perforator flaps in the trunk. Clin Plast Surg. 2010;37(4):655–65. vii.
10. Beahm EK. Timing and key considerations in reconstruction for breast-conserving therapy. In: Nahabedian MY, editor. Oncoplastic surgery of the breast. Washington, DC: Saunders; 2009. p. 21–45.
11. Losken A. Reconstruction of partial mastectomy defects: classification and methods. In: Spear SL, editor. Surgery of the breast: principles and art, vol. 1. Philadelphia: Lippincott Williams & Wilkins; 2011. p. 140–64.
12. Hamdi M, Van Landuyt K, Ulens S, Van Hedent E, Roche N, Monstrey S. Clinical applications of the superior epigastric artery perforator (SEAP) flap: anatomical studies and preoperative perforator mapping with multidetector CT. J Plast Reconstr Aesth Surg: JPRAS. 2009;62(9):1127–34.
13. Mansell J, Weiler-Mithoff E, Martin J, Khan A, Stallard S, Doughty JC, et al. How to compare the oncological safety of oncoplastic breast conservation surgery – to wide local excision or mastectomy? Breast. 2015;24(4):497–501.
14. Clough KB, Ihrai T, Oden S, Kaufman G, Massey E, Nos C. Oncoplastic surgery for breast cancer based on tumour location and a quadrant-per-quadrant atlas. Br J Surg. 2012;99(10):1389–95.
15. Park HC, Kim HY, Kim MC, Lee JW, Chung HY, Cho BC, et al. Partial breast reconstruction using various oncoplastic techniques for centrally located breast cancer. Arch Plast Surg. 2014;41(5):520–8.
16. Khan J, Barrett S, Forte C, Stallard S, Weiler-Mithoff E, Doughty JC, et al. Oncoplastic breast conservation does not lead to a delay in the commencement of adjuvant chemotherapy in breast cancer patients. Eur J Surg Oncol. 2013;39(8):887–91.
17. Clough KB, Cuminet J, Fitoussi A, Nos C, Mosseri V. Cosmetic sequelae after conservative treatment for breast cancer: classification and results of surgical correction. Ann Plast Surg. 1998;41(5):471–81.
18. Matros E, Disa JJ. Uncommon flaps for chest wall reconstruction. Semin Plast Surg. 2011;25(1):55–9.
19. Baroudi R, Pinotti JA, Keppke EM. A transverse thoracoabdominal skin flap for closure after radical mastectomy. Plast Reconstr Surg. 1978;61(4):547–54.
20. Della Rovere GQ. Skin incisions, glandular reshaping, and local flaps. In: Della Rovere GQ, Benson JR, Nava M, editors. Oncoplastic and reconsructive surgery of the breast, vol. 2. Boca Raton: CRC Press; 2010. p. 138–40.
21. Campbell EJ, Romics L. Oncological safety and cosmetic outcomes in oncoplastic breast conservation surgery, a review of the best level of evidence literature. Breast Cancer (Dove Medical Press). 2017;9:521–30.
22. Clough KB, Gouveia PF, Benyahi D, Massey EJ, Russ E, Sarfati I, et al. Positive margins after oncoplastic surgery for breast cancer. Ann Surg Oncol. 2015;22(13):4247–53.

23. Dolan R, Patel M, Weiler-Mithoff E, Mansell J, Stallard S, Doughty JC, et al. Imaging results following oncoplastic and standard breast conserving surgery. Breast Care (Basel, Switzerland). 2015;10(5):325–9.
24. Perez-Cano R, Vranckx JJ, Lasso JM, Calabrese C, Merck B, Milstein AM, et al. Prospective trial of adipose-derived regenerative cell (ADRC)-enriched fat grafting for partial mastectomy defects: the RESTORE-2 trial. Eur J Surg Oncol. 2012;38(5):382–9.
25. Romics L, Macaskill J, Fernandez T, Simpson L, Morrow E, Pitsinis V, et al. Outcomes from the Scottish audit of oncoplastic breast conservations: surgical techniques, incomplete excision rate and complications – analysis of 498 patients from 11 units. Eur J Surg Oncol. 2017;43(5):S31.
26. Kronowitz SJ, Feledy JA, Hunt KK, Kuerer HM, Youssef A, Koutz CA, et al. Determining the optimal approach to breast reconstruction after partial mastectomy. Plast Reconstr Surg. 2006;117(1):1–11. discussion 2–4.
27. Ho W, Stallard S, Doughty J, Mallon E, Romics L. Oncological outcomes and complications after volume replacement oncoplastic breast conservations-the Glasgow experience. Breast Cancer: Basic Clin Res. 2016;10:223–8.
28. Yiannakopoulou EC, Mathelin C. Oncoplastic breast conserving surgery and oncological outcome: systematic review. Eur J Surg Oncol. 2016;42(5):625–30.
29. Lee J, Jung JH, Kim WW, Hwang SO, Kang JG, Baek J, et al. Oncologic outcomes of volume replacement technique after partial mastectomy for breast cancer: a single center analysis. Surg Oncol. 2015;24(1):35–40.
30. Losken A, Schaefer TG, Carlson GW, Jones GE, Styblo TM, Bostwick J 3rd. Immediate endoscopic latissimus dorsi flap: risk or benefit in reconstructing partial mastectomy defects. Ann Plast Surg. 2004;53(1):1–5.
31. Yang JD, Kim MC, Lee JW, Cho YK, Choi KY, Chung HY, et al. Usefulness of oncoplastic volume replacement techniques after breast conserving surgery in small to moderate-sized breasts. Arch Plast Surg. 2012;39(5):489–96.
32. Lee JW, Kim MC, Park HY, Yang JD. Oncoplastic volume replacement techniques according to the excised volume and tumor location in small- to moderate-sized breasts. Gland Surg. 2014;3(1):14–21.
33. Park JS, Ahn SH, Son BH, Kim EK. Using local flaps in a chest wall reconstruction after mastectomy for locally advanced breast cancer. Arch Plast Surg. 2015;42(3):288–94.
34. Sood A, Daniali LN, Rezzadeh KS, Lee ES, Keith J. Management and reconstruction in the breast cancer patient with a fungating T4b tumor. Eplasty. 2015;15:e39.

Lateral Pedicle Mammoplasty

16

Cicero Urban, Flávia Kuroda, and Vanessa Amoroso

Introduction

As the popularity of breast conservation therapy (BCT) has increased, several oncoplastic surgery (OPS) techniques have been introduced in an attempt to optimize the balance between the risk of local recurrence and good aesthetic outcomes. These techniques include local tissue rearrangement, reconstruction with reduction mammoplasty or mastopexy approaches, and transfer of locoregional flaps. The combined plastic surgery techniques of tissue replacement or rearrangement provide a wider local excision, while achieving better breast shape and symmetry in most of cases [1–21].

There are various management algorithms and approaches for mastopexy and reduction patterns in OPS, including different skin reduction techniques, nipple-areola complex (NAC) pedicles, and glandular rearrangements [2–4, 16–18, 21]. The various techniques for immediate reconstruction must be oncologically and aesthetically individualized case by case, so the best outcomes can be achieved. OPS with lateral pedicle mammoplasty is a good option for tumors in the upper-medial and medial quadrants of the breast. It consists of a large tumor resection with free margins, including or not the overlying skin in the upper-medial or medial quadrants of the breast, along with central repositioning of the nipple-areola complex (NAC). This is a relatively simple and oncologically safe approach that allows the surgeon to perform wide excisions in a delicate quadrant, where the risk for bad aesthetic outcomes with traditional lumpectomy or quadrantectomy is high.

C. Urban (✉)
Department of Breast Surgery, Our Lady of Grace Hospital, Positivo University Medical School, Curitiba, Paraná, Brazil

F. Kuroda
Department of Breast Surgery, Our Lady of Grace Hospital, Curitiba, Paraná, Brazil

V. Amoroso
Department of Breast Surgery, Our Lady of Grace Hospital and Little Prince Medical School, Curitiba, Paraná, Brazil

V. S. Klimberg et al. (eds.), *Oncoplastic Breast Surgery Techniques for the General Surgeon*, https://doi.org/10.1007/978-3-030-40196-2_16

This chapter will review lateral pedicle mammoplasty technique in early breast cancer, showing in which cases it is better indicated. Details of this technique step-by-step, advantages and limitations, and oncologic/cosmetic outcomes and complications will be described.

Indications

The main indication for the lateral pedicle mammoplasty technique is prevention of distortion and retraction in the upper-medial and/or medial parts of the breast after resection in these areas and, at the same time, to avoid the distortion of the NAC. They are frequent when traditional lumpectomy or quadrantectomy are done there (Fig. 16.1) and are difficult (sometimes impossible) to do satisfactory late corrections. It represents about 13% of OPS indications in our practice, as we follow a specific flowchart for pre-operatory decisions in OPS (Table 16.1 and Fig. 16.2). In addition, it may correct deformities caused by previous surgical procedures in this area too. Then, this technique may be performed in the following conditions:

Fig. 16.1 Examples of bad aesthetic outcomes after traditional lumpectomy and quadrantectomy in medial and upper-medial quadrant resections

Table 16.1 Characteristics of 246 patients undergoing to oncoplastic surgery level 2 with ipsilateral symmetrization at Our Lady of Grace Hospital in Curitiba (Brazil) 2004–2014

Age	
30–40	16/241 (6.6%)
41–50	49/241 (20.3%)
>50	176/241 (73%)
Menopause	
Premenopausal	76/215 (35.3%)
Postmenopausal	139/215 (64.7%)
Nutritional status	
Eutrophic	34/98 (34.7%)
Overweight	38/98 (38.8%)
Obesity I	19/98 (19.4%)
Obesity II	6/98 (6.1%)
Obesity III	1/98 (1%)
Breast volume	
S	35/209 (16.7%)
M	97/209 (46.4%)
L	69/209 (33%)
XL	8/209 (3.8%)
Prior breast surgery	42/245 (17.1%)
Tobacco	24/232 (7.3%)
Hypertension	54/244 (22.1%)
Diabetes	24/244 (9.8%)
Family history of breast cancer	
Positive history	40/245 (16.3%)
Tumor location	
Upper-outer quadrant	67/246 (27%)
Upper-medial quadrant	33/246 (13.3%)
Superior quadrant	25/246 (10.1%)
Inferior-medial quadrant	10/246 (4%)
Histologic type	
Invasive ductal carcinoma	157/246 (63.9%)
Ductal carcinoma in situ	36/246 (14.6%)
Invasive lobular carcinoma	17/246 (6.9%)
Others	36/246 (14.6%)
T	
T1	160/239 (66.9%)
T2	38/239 (15.8%)
T3	1/239 (0.4%)
T4	1/239 (0.4%)
T*is*	39/239 (16.3%)

- Position of the tumor: upper-medial or medial quadrants. The majority of surgeons who perform OPS use the inverted-T or coma incisions together with periareolar de-epithelialization (depending on the amount of skin to be resected). When skin is compromised or very close to the tumor in the upper-medial or medial quadrants, lateral pedicle mammoplasty with a plug flap is well indicated (Fig. 16.3).

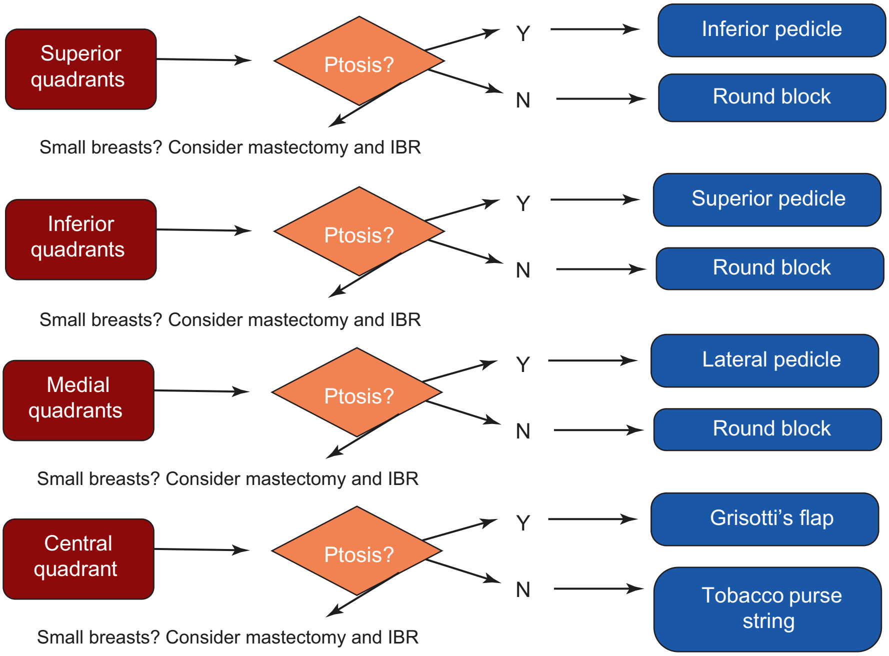


Fig. 16.2 Flowchart for oncoplastic technique decision (*IBR* immediate breast reconstruction)

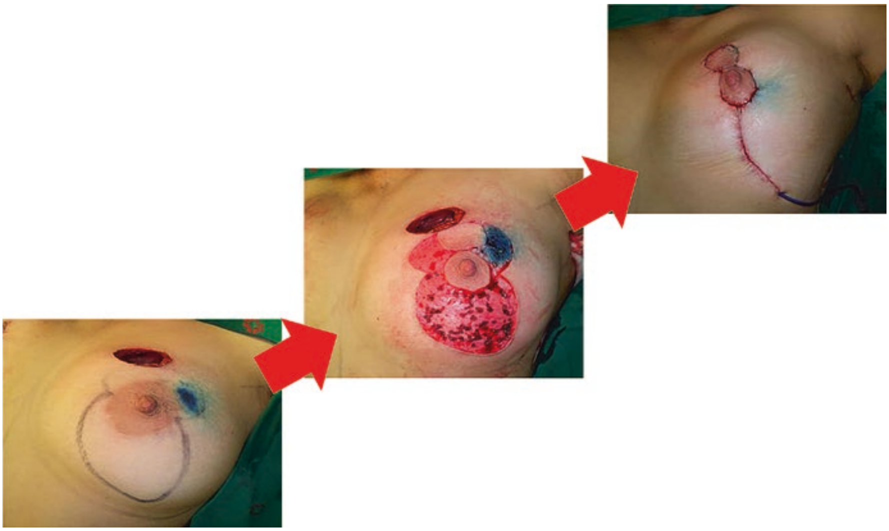


Fig. 16.3 43y/o patient with a T3 N1 Luminal B with residual tumor close to the skin after neoadjuvant chemotherapy in the upper-medial quadrant of the left breast resected using lateral pedicle plug-flap technique

- Ratio of tumor to breast volume: when the size of tumor and resection are borderline for breast conservation compromising aesthetic outcome. It is particularly suited for resection of cancers that are of large size in relation to the overall dimensions of the breast.
- Volume of the breast: medium to large cup size.
- Degree of ptosis: breast with a mild to high degree of ptosis and whose amount of glandular tissue in the inferior quadrants are sufficient to permit satisfactory reconstruction of the defect in the upper-medial and/or medial quadrants.
- Ideal for revision for incomplete margins and after neoadjuvant chemotherapy in the upper-medial or medial quadrants [8].

Relative Contraindications

All relative contraindications are based on clinical, psychological, and oncological conditions:

- Previously irradiated breasts: risk of necrosis, infection, retraction, and bad aesthetic outcomes is high.
- Low-volume breasts and without ptosis: in these cases skin-sparing or nipple-sparing mastectomy with immediate breast reconstruction is better indicated.
- Patient-related risk factors particularly smoking and uncontrolled diabetes: risk for necrosis, infection, and bad aesthetic outcomes.
- Inflammatory breast cancer.
- Exaggerated patient’s expectations with aesthetic outcomes.
- Multicentric tumors: if the patient has a good volume and the tumors can be resected inside mammoplasty plan, without compromising NAC vascularization, then OPS is suitable; in other cases, it is necessary to do a mastectomy with immediate breast reconstruction.

Preoperative Planning

Patients were seen preoperatively by a multidisciplinary team who discusses the case and reviews all the exams, in combination with physical examination. MRI is particularly useful for young patients, dense breasts, hereditary cancers, invasive lobular carcinoma, and in neoadjuvant chemotherapy. The selection of patients from oncological, aesthetic, and psychological point of view is critical for the success of this surgery. It is important to plan the tumor removal (with or without radiographic guidance), and all attempts should be made to minimize the risk of positive margins. It is critical in the pre-operatory time to define areas of excision and to decide and design reduction techniques. Preoperative photographs are taken in front view, three-quarter view right and left, and lateral view, right and left (Fig. 16.4).

The drawings are done with the patient in a standing position. Landmarks are boldly indicated, as they provide orientation for intraoperative tailoring, guiding

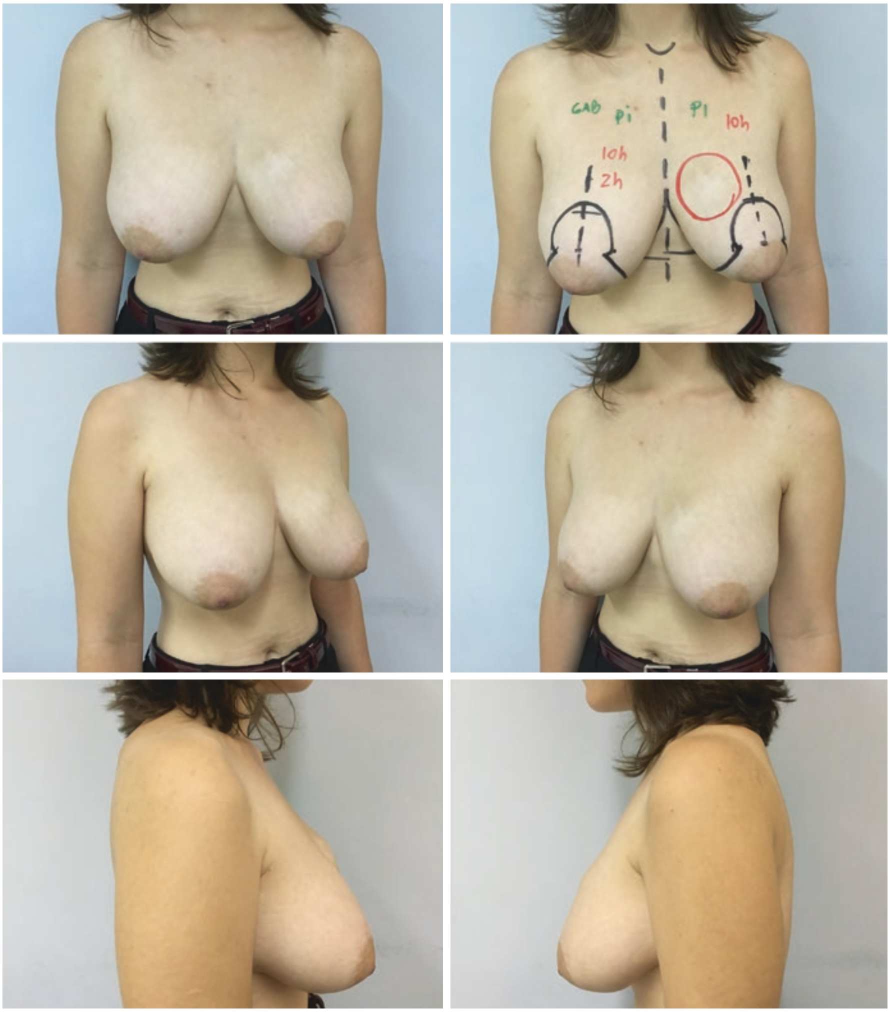


Fig. 16.4 Pre-operatory photos and draws for planning a lateral pedicle mammoplasty in an upper-inner tumor in a left breast

both oncologic and the reconstructive surgeons to prevent unnecessary or errant incisions or excisions. The landmarks include a midline extending from the sternal notch until the middle part of the abdominal wall. The anterior axillary line and the inframammary fold are also marked. The axis of each breast is determined and typically runs from the midclavicular line to the NAC, and difference in the level of NACs is assessed. Repositioning of the NAC depends on the degree of ptosis. In breasts with minimal ptosis there is no requirement for elevation of the NAC, which will simply be displaced medially. By contrast, significant grades of ptosis warrant

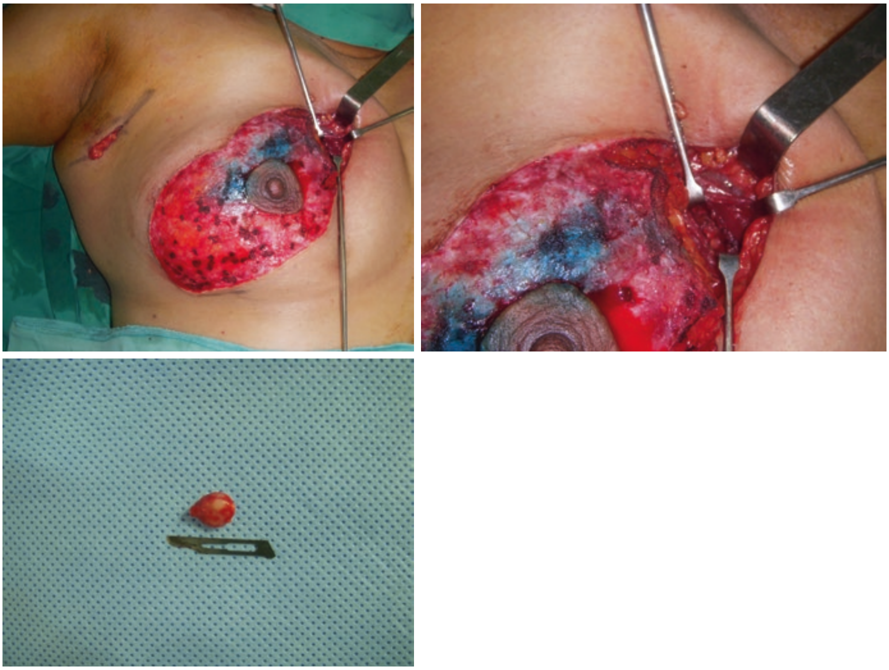


Fig. 16.5 Sentinel node dissection in internal mammary chain in case of an upper-medial tumor using lateral pedicle mammoplasty

a proportional elevation together with a concurrent medial repositioning the NAC. Position of the tumor is marked, and skin resection is designed, according to the grade of ptosis or if the skin over the tumor is compromised or not. Lateral pedicle mammoplasty allows the excision of a considerable amount of breast tissue. Specimen can reach 300 g or more, depending on the volume of breast. Sentinel node biopsy and/or axillary dissection may be done through the tail of the wound or, alternatively, in a separate incision. In some cases, where sentinel node is located in internal mammary chain, it is possible to do the biopsy in the same incision (Fig. 16.5).

Surgical Technique

The skin around the NAC is de-epithelialized, and every attempt is made to preserve the subdermal plexus of veins for nipple viability. The tumor and surrounding margins are removed en bloc with the overlying skin whenever necessary, down to the pectoralis fascia. The excision wide area takes the shape of a wedge, with the base in contact with the NAC and apex at the superior breast extremity.

The weight of the lumpectomy specimen should be recorded to determine the amount of additional breast tissue to be removed on the ipsilateral side and the total amount to be removed on the contralateral side. All tissue removed is routinely marked and prepared for histopathological analysis. Intraoperative frozen section analysis helps the margin evaluation and can decrease the need for reoperation by allowing surgeons to resect additional breast tissue. In our breast unit, intraoperative frozen section together with shaving margins and OPS reduces reoperation rate in 50%, which is under 5% [12]. Surgical clips are placed in the tumor bed to allow targeted postoperative radiotherapy [4, 10] (Figs. 16.6 and

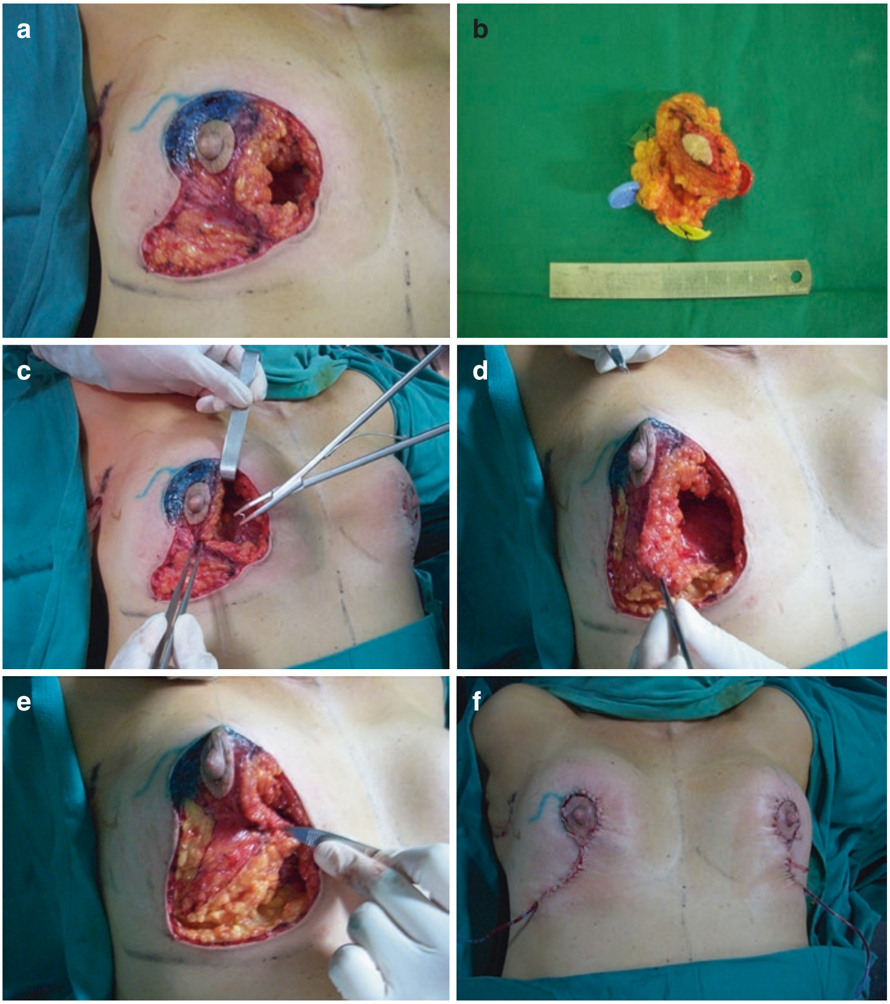


Fig. 16.6 Lateral pedicle mammoplasty step-by-step. (**a**) Resection of the tumor in the medial quadrants of the right breast. (**b**) Demarcation of the margins to guide the pathologist. (**c**) Putting the clips to guide the boost. (**d**) Identification of the amount of the defect. (**e**) Analyzing the possibilities for reshaping. (**f**) Bilateral reshaping and final aesthetic outcome at the end of surgery

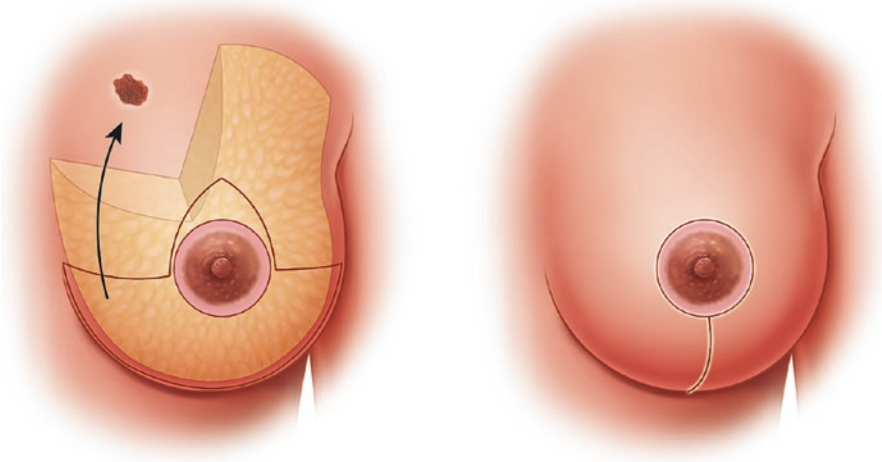


Fig. 16.7 Lateral pedicle mammoplasty oncoplastic surgery scheme

16.7). In case of microcalcifications, an intraoperative specimen radiography may be done to demonstrate the margins of tumors and normal tissue and the excision of all microcalcifications.

Once the tumor had been removed, the breast mound is reshaped and undermined slightly around the NAC to allow more freedom for relocation of the nipple. This is required because, when the breast is reconstituted after excision, bottom of the breast footprint and conus will be reduced. It always involves medialization and usually elevation, the later depending on the degree of preoperative ptosis (Fig. 16.8). Then it is reconstituted using some stitches, a single drain is placed, and the skin is then approximated first with a deep dermal layer and then with a subcuticular layer. Normally the NAC should sit nicely on top of the breast mound. If this is not the case, the NAC can be inset with staples temporarily and the circle of the new breast mound corrected so the NAC sits nicely in the middle. It is practice to anticipate the effects of radiation contraction by leaving the therapeutic mammoplasty side slightly larger at the end of surgery, if it is possible. Reconstructed breast should be at least 10% larger than the contralateral remodeled breast because one should expect some shrinking and changing in volume due to late effect of radiotherapy.

Contralateral Breast

A total of 70–90% of patients who undergo OPS may require surgery of the contralateral breast in order to obtain better symmetry or to improve the aesthetic appearance of both breasts. This surgery may be done as an immediate or a delayed procedure. Some authors believe that it is not prudent to routinely do this procedure at the same time of oncological surgery as there is a risk that the final margins will be incomplete and either further surgery or a mastectomy will be required. Others prefer to wait the irradiated breast to settle and attain a more definitive shape and

Fig. 16.8 Pre- and late post-operatory outcomes after lateral pedicle mammoplasty

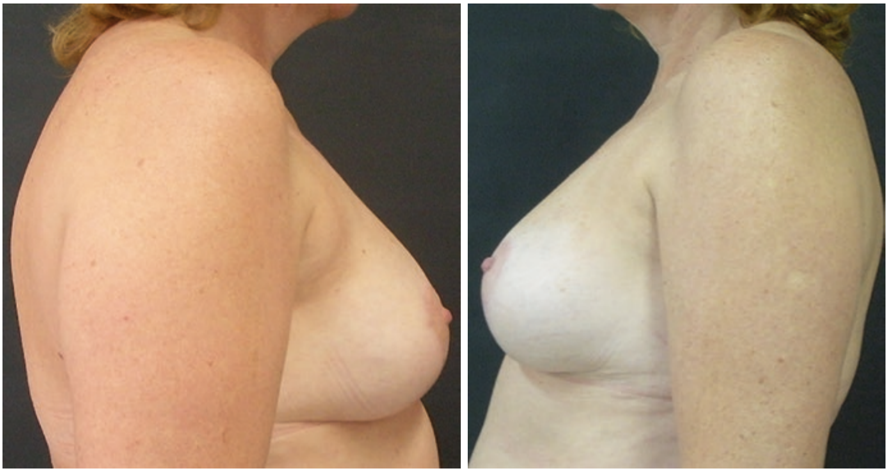


Fig. 16.8 (continued)

volume, thus minimizing the chance for any subsequent delayed mismatch to develop. In our breast unit, we routinely perform the same procedure in a mirror-image fashion during the same operation for the contralateral breast. The psychosocial effect and costs of breast reconstruction are better with immediate procedure. In addition, mammoplasty of the contralateral breast offers an opportunity for tissue sampling [11]. The rate of occult breast cancer found in contralateral symmetrizing reduction specimens in patients undergoing breast reconstruction ranges from 4.6% to 11% [13].

Oncologic Outcomes

To date, the published literature supports the use of OPS in comparison to historical techniques. Although there are no randomized trials comparing them and many reported series are retrospective and non-controlled ones, it is enough to incorporate OPS in current BCT. Clough et al. have reported a prospective analysis of a 101-patient series undergoing level 2 OPS, with 5-year overall and disease-free survival rates of 95.7% and 82.8%, respectively [14]. Rietjens et al. have reported an overall local recurrence of 3% in their series involving similar surgical techniques [15]. Indeed there is increasing evidence that reduction mammoplasty techniques, within the setting of OPS, result in wider excisions, low risk of reoperation, and more effective radiotherapy planning [2, 16, 17]. Haloua et al. [18], in a review of 11 prospective series, found 7–22% positive margin rate in OPS in comparison to the 20–40% in standard BCT. This difference resulted in lower re-excision rate. Losken et al. [11] in a meta-analysis also demonstrated larger resection volumes, increased satisfaction with aesthetics, and decreased rates of positive margins, re-excisions and local recurrences in favor of OPS. No significant delay in adjuvant chemotherapy and radiotherapy was related despite the increased complexity of these surgeries [4]. Long-term survival has been equivalent to BCT series [4, 11].

Aesthetic Outcomes

The rates of satisfactory aesthetic outcomes are encouraging with oncoplastic surgery as they range between 84% and 89% compared with lumpectomy which range from 60% to 80% [18]. A meta-analysis showed significantly higher satisfaction with aesthetic results in OPS group (89.5 vs 82.9% in lumpectomy) [11] (Fig. 16.7). Santos et al. used three different tools (BCCT.core software, specialists and patients evaluation) for comparing aesthetic outcomes and found higher proportion of excellent aesthetic outcomes in OPS group, when comparing with lumpectomy group [19]. The most common reasons for an unsatisfactory aesthetic outcome following lateral pedicle mammoplasty are deformity of the upper-medial part of the breast, bad scar, and displacement and loss of the roundness of the NAC.

Complications

The lateral pedicle mammoplasty is relatively safe and effective. However, some complications can occur. Careful patient selection will minimize the incidence of postoperative complications. Overall complication rate for OPS ranges from 15% to 30% and has been well documented [2–5, 8, 20]: hematoma, infection, retraction deformity of skin and/or NAC, necrosis, loss of sensibility, and asymmetry. NAC necrosis, in particular, is an exception event as the vascular supply in this pedicle is not usually threatened, as it is not usually moved so far. If adjuvant chemotherapy is planned, it may begin even if complete healing of the incisions has not occurred and can be followed by radiation therapy. Complications that interfere with wound healing may delay the onset of radiation therapy [2].

Conclusions

Surgeons play an influential role in the care of the breast cancer patient. OPS allows for an oncologic-aesthetic-functional individualized surgical approach. Such an advance means a new philosophy in breast cancer surgery. In this way, lateral pedicle mammoplasty is a valuable tool. This is a relatively simple, safe, and reliable technique that leaves patients with minimal breast deformities in a delicate breast area, following proper treatment without compromising oncologic safety with minimal risk of complications. Careful patient selection, coordinated planning, and meticulous intraoperative management are keys to favorable surgical outcomes.

References

1. Clough KB, Cuminet J, Fitoussi A, Nos C, Mosseri V. Cosmetic sequelae after conservative treatment for breast cancer: classification and results of surgical correction. Ann Plast Surg. 1998;41(5):471–81.
2. Chang M, Huston T, Ascherman J, Rohde C. Oncoplastic breast reduction: maximizing aesthetics and surgical margins. Int J Surg Oncol. 2012;2012:907576.

3. Piper M, Peled AW, Sbitany H. Oncoplastic breast surgery: current strategies. Gland Surg. 2015;4(2):154–63.
4. Urban C, Lima R, Schunemann E, Spautz C, Rabinovich I, Anselmi K. Oncoplastic principles in breast conserving surgery. Breast. 2011;20(Suppl 3):S92–5.
5. Fitoussi AD, Berry MG, Famà F, Falcou MC, Curnier A, Couturaud B, et al. Oncoplastic breast surgery for cancer: analysis of 540 consecutive cases. Plast Reconstr Surg. 2010;125:454–62.
6. Berrino P, Campora E, Santi P. Post-quadrantectomy breast deformities: classification and techniques of surgical correction. Plast Reconstr Surg. 1987;79(4):567–72.
7. Haloua MH, Krekel NM, Winters HA, Rietveld DH, Meijer S, Bloemers FW, et al. A systematic review of oncoplastic breast conserving surgery: current weaknesses and future prospects. Ann Surg. 2013;257(4):609–20.
8. Losken A, Dugal CS, Styblo TM, Carlson GW. A meta-analysis comparing breast conservation therapy alone to the oncoplastic technique. Ann Plast Surg. 2014;72(2):145–9.
9. Urban C, Rietjens M. Preoperative planning for oncoplastic surgery. In: Urban C, Rietjens M, editors. Oncoplastic and reconstructive breast surgery. Italia: Springer; 2013. p. 109–16.
10. Clough KB, Oden S, Ihrai T, Massey E, Nos C, Sarfati I. Level 2 oncoplastic surgery for lower inner quadrant breast cancers: the LIQ-V mammoplasty. Ann Surg Oncol. 2013;20:3847–54.
11. Losken A, Styblo T, Carlson G, Jones G, Amerson B. Management algorithm and outcome evaluation of partial mastectomy defects treated using reduction or mastopexy techniques. Ann Plast Surg. 2007;59(3):235–42.
12. Urban CA, Spautz C, Amoroso V. Cavity shaving margins in breast cancer (letter). N Engl J Med. 2015;373(22):2187.
13. Petit J, Rietjens M, Contesso G, Bertin F, Gilles R. Contralateral mastoplasty for breast reconstruction: a good opportunity for glandular exploration and occult carcinomas diagnosis. Ann Surg Oncol. 1997;4(6):511–5.
14. Clough K, Lewis J, Couturaud B, Fitoussi A, Nos C, Falcou M. Oncoplastic techniques allow extensive resections for breast-conserving therapy of breast carcinomas. Ann Surg. 2003;237(1):26–34.
15. Rietjens M, Urban C, Rey P, Mazzarol G, Maisonneuve P. Long-term oncological results of breast conservative treatment with oncoplastic surgery. Breast. 2007;16(4):387–95.
16. Spear S, Patel K, Parikh P. Reduction mammaplasty as part of breast conservation therapy of large-breasted patient. In: Spear S, editor. Surgery of the breast: principles and art. 3rd ed. Philadelphia; Lippincott. 2011. p. 213–7.
17. Iwuchukwu OC, Harvey JR, Dordea M, Critchley AC, Drew PJ. The role of oncoplastic therapeutic mammoplasty in breast cancer surgery – a review. Surg Oncol. 2012;21(2):133–41.
18. Haloua M, Krekel N, Winters H, Al E. A systematic review of oncoplastic breast conserving surgery: current weaknesses and future prospects. Ann Surg. 2013;257(4):609–20.
19. Santos G, Urban C, Edelweiss M, Zucca-Matthes G, de Oliveira V, Arana G, et al. Surgery and lumpectomy in breast Cancer patients. Ann Surg Oncol. 2015;22(8):2500–8.
20. Munhoz A, Montag E, Arruda E, Pellarin L, Filassi J, Piato J. Assessment of immediate conservative breast surgery reconstruction: a classification system of defects revisited and na algorithm for selecting the appropriate technique. Plast Reconstr Surg. 2008;121:716–27.
21. Berry MG, Fitoussi AD, Curnier A, Couturaud B, Salmon RJ. Oncoplastic breast surgery: a review and systematic approach. J Plast Reconstr Aesthetic Surg. 2010;63(8):1233–43.

17 Oncoplastic Breast Reconstruction: Extreme Oncoplasty and Split Reduction Techniques

Sadia Khan, Nirav B. Savalia, and Melvin J. Silverstein

Introduction

For 100 years, starting in the 1880s, Halsted mastectomy reigned as the only treatment for breast cancer. Then, during the 1970s and 1980s, prospective randomized trials showed survival equivalence for breast conservation when compared with mastectomy for patients with tumors ≤5 cm [1–6]. Although survival was equal, there was a higher local recurrence rate with breast conservation therapy. This was accepted in exchange for a better cosmetic result and a happier, more intact patient.

During the past 30 years, there has been significant progress in breast cancer diagnosis and treatment. This includes earlier stage of diagnosis with improved imaging techniques, better hormonal and chemotherapy, improved radiation therapy techniques, and an increased understanding of breast cancer biology and genomics. This progress has led to improved overall and breast cancer-specific survival. In addition, it has yielded decreased rates of local recurrence after both mastectomy and breast conservation. Recent prospective randomized trials have reported local recurrence rates less than 1.5% at 5 years for patients randomized to lumpectomy plus standard whole breast radiation therapy [7, 8]. With local recurrence rates this low, breast conservation should be considered the default approach for breast cancer treatment, unless there are oncologic reasons to perform a mastectomy.

For patients with tumors ≤5 cm, a reduction mammoplasty using a Wise pattern allows for successful breast conservation with a superior cosmetic result compared with standard lumpectomy followed by radiation. A split reduction is used when the lesion that falls outside the standard Wise pattern and overlying skin is required. During a split reduction, the anterior skin is taken over the lesion, and the pectoralis

S. Khan (✉) · N. B. Savalia · M. J. Silverstein
Hoag Memorial Hospital Presbyterian, Newport Beach, CA, USA

Department of Surgery, Keck School of Medicine, University of Southern California, Los Angeles, CA, USA

V. S. Klimberg et al. (eds.), *Oncoplastic Breast Surgery Techniques for the General Surgeon*, https://doi.org/10.1007/978-3-030-40196-2_17

muscle fascia is removed, eliminating the possibility that the anterior and posterior margins will be involved. In this modification, the lower inner or outer triangle used in the reduction is moved superiorly to accommodate the skin over a lesion that has been removed (Fig. 17.1).

Prospective randomized data supporting breast conservation exist only for patients with tumors ≤5 cm [1–6]. Because of this, many patients with larger tumors are denied a chance to pursue breast conservation. When breast conservation is performed for patients with larger tumors, it requires a larger resection which may yield a poor cosmetic result. Neoadjuvant chemotherapy, to reduce the size of the primary lesion, will convert some tumors to a more appropriate size for breast conservation therapy. For selected patients with larger tumor spans, the surgical answer may be *extreme oncoplasty*.

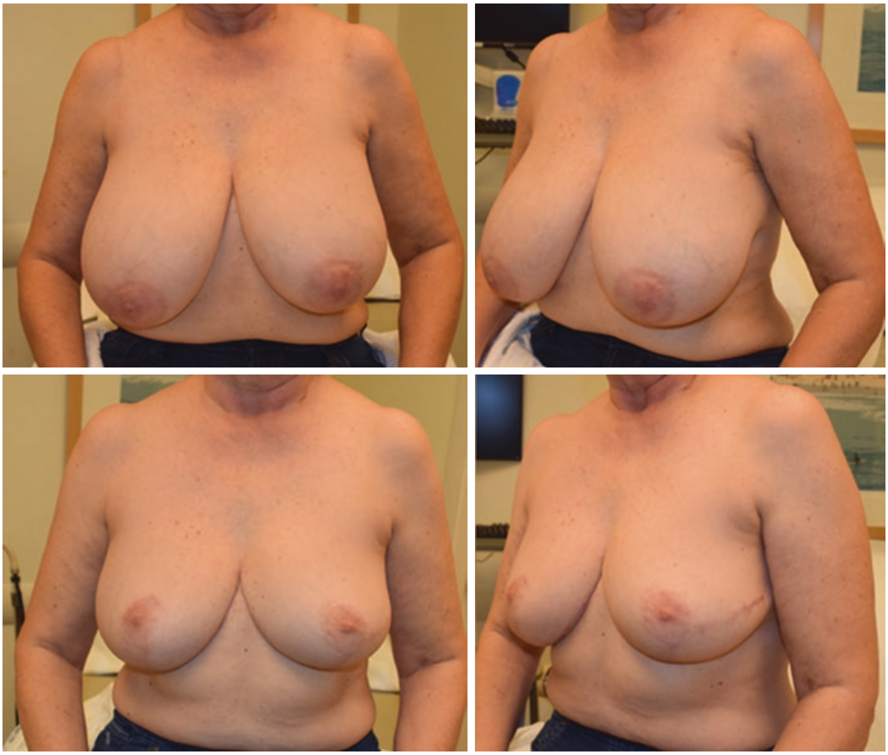


Fig. 17.1 57-year-old female with multifocal calcifications spanning 60 mm left breast ductal carcinoma in situ (DCIS), calcifications close to the lateral skin on preoperative imaging. Surgical plan was for left breast wire-directed segmental resection, left split reduction, and contralateral mastopexy for symmetry. Upper photos: preoperative photos; lower photos: 6-month postoperative photos showing – in the left breast – upper outer quadrant incision in the upper outer quadrant that represents the "split" or "Z" pattern incision. In the right breast, the standard Wise pattern inverted "T" scar is seen

Extreme oncoplasty is a breast-conserving operation, using oncoplastic techniques, in a patient who, in most physicians' opinions, requires a mastectomy.

Extreme oncoplasty applies to breast conservation using a reduction mammoplasty technique in patients with larger lesions, with the goal of clear surgical margins, while maintaining or improving the cosmetic outcome. These lesions are generally large, >5 cm, multifocal, or multicentric tumors. They may be locally advanced and many will have positive lymph nodes. Most of these patients will require radiation therapy, even if they are treated with mastectomy [9, 10].

Oncoplastic reconstruction generally yields a cosmetic result superior to a mastectomy with immediate reconstruction and radiation therapy. There is less operative and postoperative morbidity with extreme oncoplasty and less number of surgeries required, and finally, radiation therapy is far kinder to breast conservation than to mastectomy with reconstruction [11, 12].

Indications

Historically, women were commonly left feeling deformed after breast cancer surgery when a lumpectomy cavity was left to form a seroma that later scars down, leading to dimpling after radiation therapy. In a typical lumpectomy, an incision is made over the tumor, the tumor is removed, and no specific effort is made to fill the defect left with remaining breast tissue. Even when surrounding breast tissue is used to fill with a small local tissue flap advancement, this can still lead to puckering or dimpling when the patient is out of the supine position and sitting or standing upright. Unfortunately, as many as 36% of simple excisions fail to achieve adequate margins in a single operation, leading to re-excision, worsening cosmesis, and conversions to mastectomy [13]. Oncoplastic surgery, using a reduction mammoplasty, allows removal of the tumor but also prevents undue distortion of the breast by allowing the defect to be filled with remaining breast tissue.

Oncoplastic surgery can be performed in tandem with a lumpectomy in most cases where the tumor is ≤5 cm. Extreme oncoplasty can be considered when women with tumors >5 cm patients are seeking an alternative to mastectomy, when oncologically feasible. In either case, oncoplastic surgery allows for breast-conserving therapy with a better cosmetic result [14, 15]**.** Oncoplastic surgery should be considered in all patients who are candidates for surgical treatment of breast cancer**.**

Preoperative Evaluation and Planning

Oncoplastic surgery requires a multidisciplinary approach and thorough preoperative planning. Multidisciplinary planning requires discussion, at minimum, with the oncologic surgeon, radiologist, and plastic surgeon. Other team members should be included as well. Oncoplastic surgery requires a philosophy that the appearance of the breast after tumor excision is important. All of the preoperative imaging tests must be carefully evaluated and integrated with information about the pathologic subtype, tumor size, location in relation to the nipple, skin quality, and patient preferences. Other particular concerns include invasive lobular cancers that may be larger on the microscopic level than expected based on initial imaging, extensive in situ components with similar risk for under-staging on imaging, and also, the consideration of radiation effects on the size and shape of the ipsilateral breast compared with the contralateral side undergoing a symmetry procedure.

A common misconception is that the goal of breast reconstruction is to create the "perfect breast." The goal should be to achieve an outcome that best suits the *patient's* goals for reconstruction and desires for final breast appearance, while still taking into account the primary goal of treating the cancer.

The reconstructive plan can be formulated only after analysis of the tumor size and location and the preoperative breast shape, size, and degree of ptosis and understanding the patient's oncologic and reconstructive desires. The ideal is to minimize the amount of surgery, recovery period, risk of complications, and surgical failure rates, while maximizing the desired aesthetic and oncologic outcome [16].

At our institution, the oncologic breast surgeon assumes the role of "leader" to guide the team and ensure excellent communication among all team members. During the first visit, we generate a surgical plan that summarizes the diagnosis, includes photos of the patient's chest and relevant imaging, and lists the plan of action leading up to and including the planned operation (Fig. 17.2). The surgical plan is given to the patient, as well as distributed to all team members, and updated as the patient moves through the consultation process.

Preoperative workup should still include a full history and physical paying close attention to prior breast surgery and location of prior surgical incisions. Breast imaging should include a combination of mammogram, ultrasound, and breast magnetic imaging (MRI). MRI can often better determine extent of disease in mammographically subtle findings and has improved sensitivity for invasive lobular carcinoma [17].

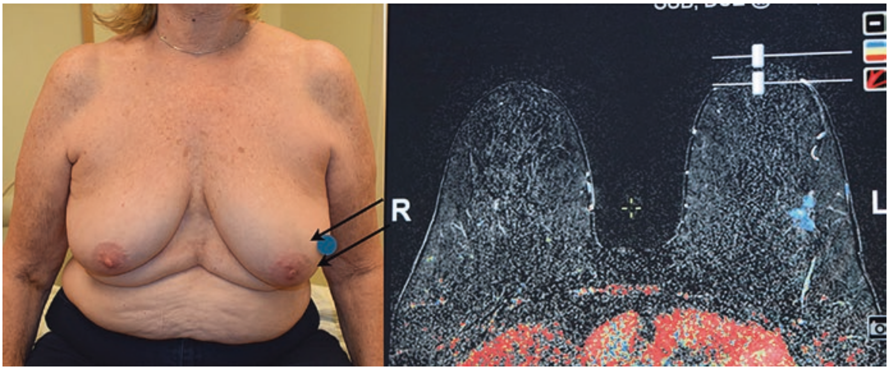
Surgical Technique

The workhorse of oncoplastic surgery at our facility is the Wise pattern mammoplasty [18]. This versatile technique is the ideal option for women with preoperative macromastia [19–21]. Based on tumor location, a skin pattern and nipple-areolar complex (NAC) pedicle are designed preoperatively to allow for resection of the tumor and filling of the tumor cavity defect with the remaining breast tissue. This technique can also be applied to tumors that fall outside the Wise pattern by shifting tissue and rotating the reduction pattern [22]. The wide amount of skin excised allows for correction of ptosis, exposure to the entire breast, and the ability to widely resect tissue from any quadrant and significantly reduces overall breast volume to aid radiation dose homogeneity. Once the amount of required tissue resection is determined on the ipsilateral side, the contralateral breast is reduced to match as a symmetrizing procedure [23].

SURGEON NAME DATE

PATIENT NAME
PATIENT MRN

Diagnosis: 61F presents with LEFT BREAST mass spanning 30x34x20mm on MRI at 2:00 6cm from Nipple - Invasive Ductal Carcinoma Grade 3, SBR 8/9 ER+100% PR+100% HER2 NEG Ki67 10%. FH: Sister and Maternal Aunt with Breast CA.



LEFT Breast Invasive Ductal CA - Clinical Stage cT2NO, Stage IIA

PLAN:

1. Genetic Testing - PENDING
2. Medical Oncology Consultation
3. Radiation Oncology Consultation
4. Plastic Surgery Consultation for LEFT breast oncoplastic Split Reduction with contralateral mastopexy for symmetry
5. SURGICAL PLAN: LEFT BREAST wire directed segmental resection, LEFT axillary sentinel lymph node biopsy with possible axillary lymph node dissection

Fig. 17.2 Surgical plan sheet that includes summary of pathology and imaging findings, involved consultants, and proposed surgical plan. This plan goes with the patient through their journey and can be adjusted as needed when the treatment plan changes

The need to be certain of the anterior tumor margin led our group to develop the split reduction. The main strength of the Wise pattern is the independence of the skin resection and the parenchymal resection. The parenchymal reduction does not need to follow the skin reduction pattern; the end goal is creation of a breast mound over which the skin can be redraped. For an aesthetic breast reduction, it is desirable to place the scars in the least visible areas. Thus, the Wise pattern is designed to limit the scars to the circumareolar border, the vertical midline of the breast, and the inframammary crease. For oncoplastic breast surgery, we do not need to limit ourselves to this ideal skin pattern. Since the need for tumor clearance trumps this aesthetic ideal, we may modify the traditional Wise pattern to displace a hidden scar from the medial or lateral inframammary fold onto the visible breast, directly over the tumor, in favor of clearing the anterior margin in lesions close to the skin. This modification, which we term a split reduction, allows definitive clearance of the anterior (skin) margin or access to a lesion that falls out of the standard Wise pattern. The end result is resection of the same amount of skin as a traditional Wise pattern but higher visibility of the scar. In our opinion, this trade-off is acceptable, since the alternative of a close or involved anterior margin, leading to mastectomy, is avoided (Fig. 17.1).

The Wise pattern mammoplasty requires the creation of three triangles: vertical, medial, and lateral. The inferior borders of all three triangles are incorporated into the inframammary fold incision, limiting the scars to the circumareolar border, the vertical midline of the breast, and the inframammary crease (Fig. 17.3). Tumors located in the inferior pole can be easily incorporated in the incision, with the overlying skin, through a standard Wise pattern. The vertical pillars are then plicated and the NAC inset into the keyhole. If the NAC cannot be saved, a nipple can be recreated immediately or as a delayed procedure. This technique allows the lower pole and central tumors to be easily excised along with the overlying skin to avoid a close or positive anterior margin. When the tumors are located in areas that do not naturally fall within a standard Wise pattern, two options exist. The first is to perform a standard Wise pattern technique and to tunnel under skin flaps to reach the distant tumor. This is acceptable if the tumor is deep and the anterior margin is not felt to be of concern. However, for most cases when the tumor is located outside the Wise pattern, our preferred alternative is to excise the tumor with the anterior skin margin to decrease the need for re-excision or mastectomy with close or positive margins. For tumors located in the upper outer or upper inner quadrants, the Wise pattern may be reconfigured to include the tumor with the overlying skin, in a split reduction.

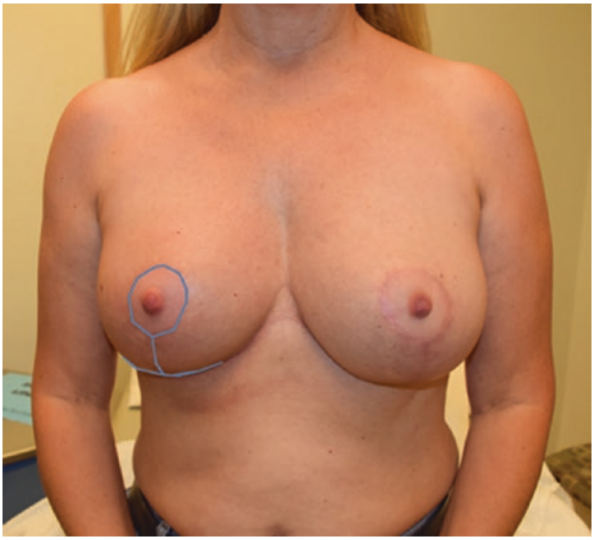
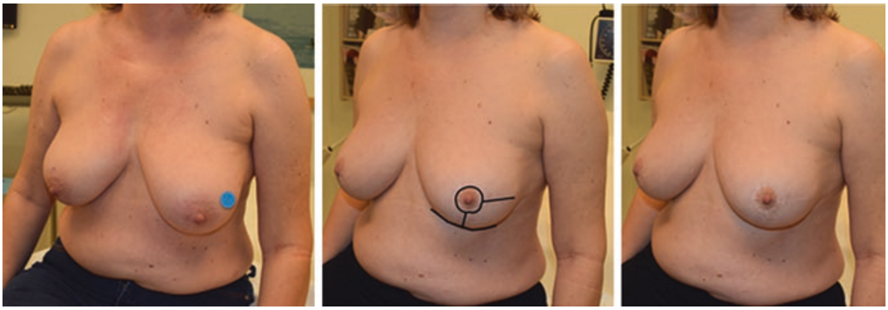


Fig. 17.3 Photo representing the typical incisions for a standard Wise pattern reduction. Surgical scars outlined in inframammary crease, periareolar border, and vertical midline of the breast

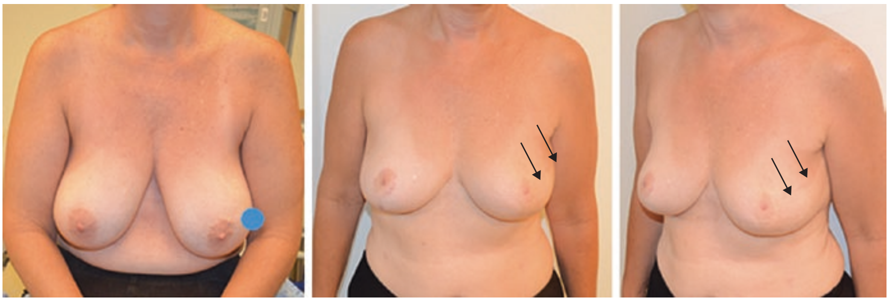
When the tumor is located in the upper central breast, the split occurs at the apex of the keyhole rather than along the vertical limbs of the pattern (Fig. 17.4).

If the NAC is involved by tumor, the central excision of breast tissue is incorporated into an inverted T mammoplasty that allows for reshaping and immediate NAC reconstruction. In a split reduction, the lateral or medial triangle of the Wise pattern is not positioned at the base of the breast but advanced cephalad to a position directly overlying the tumor (Fig. 17.5). The medial or lateral vertical limb of the inverted T is split on the side of the tumor excision to accommodate the higher position of the medial or lateral triangle [9, 10, 24].



Pre-op **Pre-op 2 years**

Fig. 17.4 56-year-old female with an 18 mm left breast ductal carcinoma in situ (DCIS) close to skin on preoperative imaging. Surgical plan was for left breast wire-directed segmental resection and intraoperative radiation therapy, left split reduction (split from the keyhole), and contralateral mastopexy for symmetry. Left photo: preoperative photo with approximate tumor location marked. Middle and right photo: 2-year postoperative photo outlining split reduction scar oriented radially from the keyhole to remove skin over the lesion



Pre-op **Pre-op 5 years**

Fig. 17.5 Split reduction**:** 58-year-old female with a 36 mm left breast invasive ductal carcinoma. Surgical plan was for left breast wire-directed segmental resection, left split reduction, and contralateral mastopexy for symmetry. Left photo: preoperative photo with approximate tumor location marked. Middle and right photo: 5-year postoperative photo, after whole breast radiation therapy, outlining split reduction scar in upper outer quadrant to remove skin over the lesion

Surgical Complications and Solutions

When using plastic oncoplastic approaches, the breast surgeon without plastic surgery training should partner with a plastic reconstructive surgeon to become comfortable performing the basic techniques. Overtime and with collaboration and practice, the breast surgeon can add these oncoplastic techniques to their armamentarium of surgical tools. Complications when using split reductions and extreme oncoplasty are those that are commonly associated with cosmetic mastopexy and reductions: wound infections, hematoma, fat necrosis, wound breakdown, delayed wound healing, and nipple necrosis [25].

A few of the factors implicated in poor cosmetic results after breast conservation are age >60; T2 or larger tumors; small breast size; re-excision for inadequate margins; improper scar orientation; breast tissue resection greater than 100 cm^3 independent of breast size; breast ptosis; tumors located in the central, medial, or lower quadrants; and radiation dose inhomogeneity [23, 26–29].

Results

The rationale for breast-conserving therapy comes from a group of prospective randomized trials performed in the 1970s [2, 4–6]. In these trials, the maximum tumor size allowed was 5 cm. When breast preservation is performed in patients with tumors larger than 5 cm, there are no prospective randomized data to support it. Nevertheless, in clinical practice, it is commonly done. When breast conservation was first adopted, the recurrence rates were higher for those randomized to breast conservation therapy compared with mastectomy. In spite of higher local recurrence rates, survival at 20 years was similar [1, 3]. Surgeons and patients have long accepted a higher local recurrence rate in exchange for a better aesthetic and sensory outcome and a happier patient with no decrease in survival.

Breast conservation can generally be done in one operation without drains, as an outpatient surgery. There is less postoperative pain, and it is less expensive for the patient as multiple operations and procedures are avoided. There is no foreign body and no donor site. It is more functional when compared with mastectomy and allows patients to keep their natural breast shape and sensation. The patient often has a better-perceived body image [30, 31]. For these reasons, if it is technically possible and oncologically reasonable, we should consider breast conservation as the first option for our patients.

Breast cancer patients with macromastia presents a challenge for radiation oncologists planning for whole breast radiation therapy. A larger more pendulous breast often requires higher-energy photos to ensure delivery to a deeper depth of tissue. This leads to hot spots of radiation and can lead to significant toxicity to the skin and tissue [32].

Whether for standard or extreme cases, it is important to maintain a multidisciplinary approach. There are many patients who are relegated to mastectomy as the only option, simply due to an erroneous judgment that a deformity would inevitably result with breast conservation. These patients are referred for plastic surgical consultation with a plan for mastectomy already in place and therefore are counseled as such.

Extreme oncoplasty pushes the oncoplastic surgery envelope. Patients seeking an alternative to mastectomy are turning to a modern take oncoplastic breast surgery. The use of standard and modified reduction excisions and oncoplastic reconstruction dramatically increases the probability of complete excision with an acceptable aesthetic outcome in most patients seeking breast conservation therapy. Moreover, now that the standard for an adequate margin has been relaxed to no ink on tumor for invasive disease [33], the probability of a successful outcome increases.

Our institution's experience with extreme oncoplasty and standard oncoplastic surgery is outlined in Table 17.1. In the extreme series, 88% of tumors with a mean size of 74 mm were excised with no ink on tumor. Only 6 patients of 200 (3%) patients who attempted to save their breast after being advised to have a mastectomy were converted to mastectomy after final pathology was reviewed. All six had multiple positive or close margins. An additional 16 patients (8%) underwent re-excision and then continued on with breast conservation and radiation therapy. Eight patients (4%) have developed a local recurrence.

For selected patients who need a mastectomy based on current standards, such as patients with large multifocal or multicentric tumors, those with small breast size relative to tumor extent, those with locally advanced tumors, or those with a previously irradiated breast that develops local recurrence or a new cancer, the alternative for some of them may be extreme oncoplasty (Fig. 17.6).

Table 17.1 Table comparing Wise pattern reduction mammoplasty (standard oncoplasty), including patients with split reductions, versus extreme oncoplasty

Variable	Standard oncoplasty	Extreme oncoplasty
N	500	200
Mean sample weight	141 g	201 g
Mean tumor span	22 mm	74 mm
No ink on tumor	97%	88%
Margin ≥1 mm	90%	70%
Re-excision	3%	8%
Mastectomy	1%	3%
Median follow-up	28 months	20 months
Any local recurrence	3%	4.1%

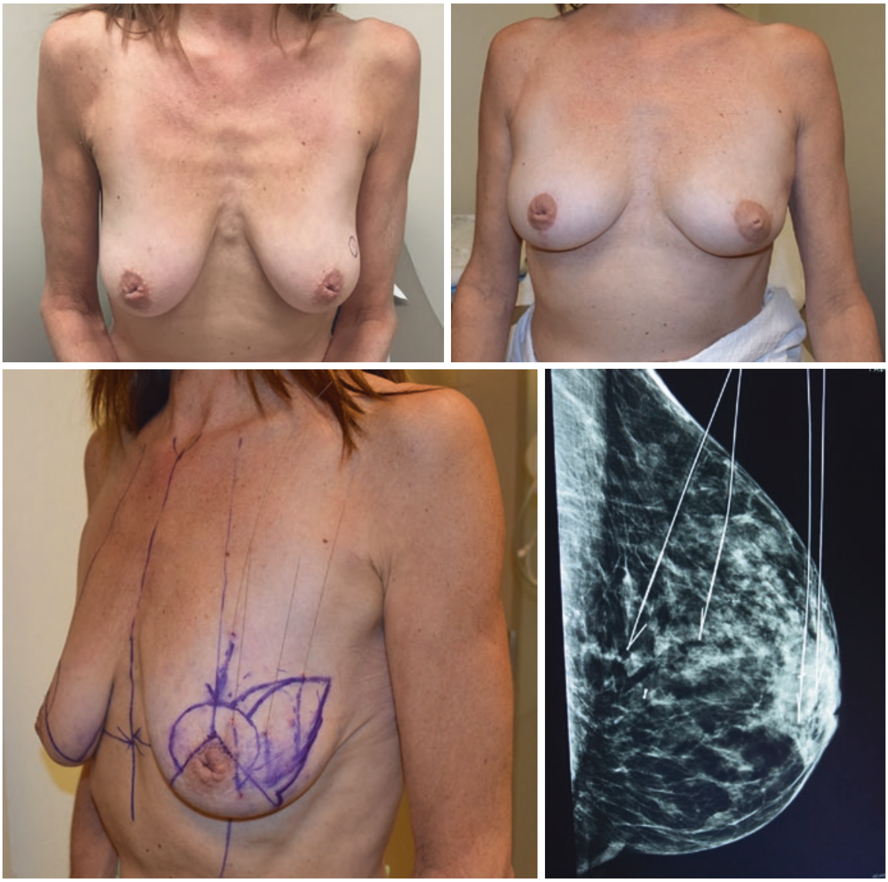


Fig. 17.6 Extreme oncoplasty: 52-year-old female with a 56 mm area of left breast calcifications – ductal carcinoma in situ (DCIS). Surgical plan was for left breast wire-directed segmental resection, left split reduction (extreme oncoplasty), and right mastopexy for symmetry. Left photo: preoperative photo; right photo: 1-year postoperative photo after left whole breast radiation therapy. Lower right: preoperative wires for surgical localization of calcifications; lower left: preoperative markings for extreme oncoplasty

Conclusions

The techniques discussed above are promising new concepts in oncoplastic breast surgery. The premise of each technique is generally discussed but must be individualized for each particular patient. Many patients present to us seeking breast conservation after having been told elsewhere that it would be technically challenging or impossible. A large number of these women have been spared mastectomies by using the carefully selected and designed techniques described. The importance of individualization of these techniques cannot be overstated: the ability to maintain flexibility is important, and communication between disciplines is critical.

Oncoplastic surgery combines sound oncologic surgical principles with plastic surgical techniques. Coordination of these two disciplines helps avoid poor cosmetic results after standard lumpectomy and increases the number of women who can be treated with breast-conserving surgery by allowing larger breast excisions with more acceptable cosmetic results. Oncoplastic breast surgery is a win-win approach, allowing removal of the cancer with wide margins while often achieving better cosmesis than prior to surgery. It requires a philosophy that the appearance of the breast after cancer surgery is important.

Extreme oncoplasty allows successful breast conservation in selected patients with large >5 cm multifocal/multicentric tumors. In addition, it may be useful in patients with locally advanced tumors. From a quality of life point of view, it is often a better option than the combination of mastectomy, reconstruction, and radiation therapy for select patients. Long-term data on recurrence and survival are not available. Based on historical data, it is expected that the local recurrence will be somewhat higher but that there will be little or no impact on survival [9, 10].

Reference Video

- https://youtu.be/WREWgvyPs4Q

References

1. Fisher B, Anderson S, Bryant J, Margolese RG, Deutsch M, Fisher ER, et al. 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. 2002;347(16):1233–41.
2. Fisher B, Bauer M, Margolese R, Poisson R, Pilch Y, Redmond C, et al. 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. 1985;312(11):665–73.
3. Veronesi U, Cascinelli N, Mariani L, Greco M, Saccozzi R, Luini A, et al. Twenty-year follow-up of a randomized study comparing breast-conserving surgery with radical mastectomy for early breast cancer. N Engl J Med. 2002;347(16):1227–32.
4. Veronesi U, Saccozzi R, Del Vecchio M, Banfi A, Clemente C, De Lena M, et al. Comparing radical mastectomy with quadrantectomy, axillary dissection, and radiotherapy in patients with small cancers of the breast. N Engl J Med. 1981;305(1):6–11.
5. Lichter AS, Lippman ME, Danforth DN Jr, d'Angelo T, Steinberg SM, DeMoss E, et al. Mastectomy versus breast-conserving therapy in the treatment of stage I and II carcinoma of the breast: a randomized trial at the National Cancer Institute. J Clin Oncol. 1992;10(6):976–83.
6. Bartelink H, Fentiman I, Lerut T, Mignolet F, Olthuis G, Sylvester R, et al. Randomized clinical trial to assess the value of breast-conserving therapy in stage I and II breast cancer, EORTC 10801 trial. J Natl Cancer Inst Monogr. 1992(11):15–8.
7. Vaidya JS, Wenz F, Bulsara M, Tobias JS, Joseph DJ, Keshtgar M, et al. Risk-adapted targeted intraoperative radiotherapy versus whole-breast radiotherapy for breast cancer: 5-year results for local control and overall survival from the TARGIT-A randomised trial. Lancet. 2014;383(9917):603–13.
8. Veronesi U, Orecchia R, Maisonneuve P, Viale G, Rotmensz N, Sangalli C, et al. Intraoperative radiotherapy versus external radiotherapy for early breast cancer (ELIOT): a randomised controlled equivalence trial. Lancet Oncol. 2013;14(13):1269–77.

9. Silverstein MJ, Savalia N, Khan S, Ryan J. Extreme oncoplasty: breast conservation for patients who need mastectomy. Breast J. 2015;21(1):52–9.
10. Silverstein MJ. Radical mastectomy to radical conservation (extreme oncoplasty): a revolutionary change. J Am Coll Surg. 2016;222(1):1–9.
11. Behranwala K, Dua R, Ross G, Ward A, A'hern R, Gui G. The influence of radiotherapy on capsule formation and aesthetic outcome after immediate breast reconstruction using biodimensional anatomical expander implants. J Plast Reconstr Aesthet Surg. 2006;59(10):1043–51.
12. Boughey JC, Hoskin TL, Hartmann LC, Johnson JL, Jacobson SR, Degnim AC, et al. Impact of reconstruction and reoperation on long-term patient-reported satisfaction after contralateral prophylactic mastectomy. Ann Surg Oncol. 2015;22(2):401–8.
13. Chagpar AB, Killelea BK, Tsangaris TN, Butler M, Stavris K, Li F, et al. A randomized, controlled trial of cavity shave margins in breast cancer. N Engl J Med. 2015;373(6):503–10.
14. Silverstein MJ, Mai T, Savalia N, Vaince F, Guerra L. Oncoplastic breast conservation surgery: the new paradigm. J Surg Oncol. 2014;110(1):82–9.
15. Piper M, Peled AW, Sbitany H. Oncoplastic breast surgery: current strategies. Gland Surg. 2015;4(2):154.
16. Macmillan RD, McCulley SJ. Oncoplastic breast surgery: what, when and for whom? Curr Breast Cancer Rep. 2016;8(2):112–7.
17. Boetes C, Veltman J, van Die L, Bult P, Wobbes T, Barentsz JO. The role of MRI in invasive lobular carcinoma. Breast Cancer Res Treat. 2004;86(1):31–7.
18. Wise RJ. A preliminary report on a method of planning the mammaplasty. Plast Reconstr Surg. 1956;17(5):367–75.
19. Chang E, Johnson N, Webber B, Booth J, Rahhal D, Gannett D, et al. Bilateral reduction mammoplasty in combination with lumpectomy for treatment of breast cancer in patients with macromastia. Am J Surg. 2004;187(5):647–51.
20. Newman LA, Kuerer HM, McNeese MD, Hunt KK, Gurtner GC, Vlastos GS, et al. Reduction mammoplasty improves breast conservation therapy in patients with macromastia. Am J Surg. 2001;181(3):215–20.
21. Spear SL, Pelletiere CV, Wolfe AJ, Tsangaris TN, Pennanen MF. Experience with reduction mammaplasty combined with breast conservation therapy in the treatment of breast cancer. Plast Reconstr Surg. 2003;111(3):1102–9.
22. Hudson DA. A modified excision for combined reduction mammoplasty and breast conservation therapy in the treatment of breast cancer. Aesthet Plast Surg. 2007;31(1):71–5.
23. Foersterling E, Golatta M, Hennigs A, Schulz S, Rauch G, Schott S, et al. Predictors of early poor aesthetic outcome after breast-conserving surgery in patients with breast cancer: initial results of a prospective cohort study at a single institution. J Surg Oncol. 2014;110(7):801–6.
24. Silverstein MJ, Savalia NB, Khan S, Ryan J, Epstein M, DeLeon C, et al. Oncoplastic split reduction with intraoperative radiation therapy. Ann Surg Oncol. 2015;22(10):3405–6.
25. Iwuagwu O. Additional considerations in the application of oncoplastic approaches. Lancet Oncol. 2005;6(6):356.
26. Munshi A, Kakkar S, Bhutani R, Jalali R, Budrukkar A, Dinshaw K. Factors influencing cosmetic outcome in breast conservation. Clin Oncol. 2009;21(4):285–93.
27. Taylor ME, Perez CA, Halverson KJ, Kuske RR, Philpott GW, Garcia DM, et al. Factors influencing cosmetic results after conservation therapy for breast cancer. Int J Radiat Oncol Biol Phys. 1995;31(4):753–64.
28. Hennigs A, Hartmann B, Rauch G, Golatta M, Tabatabai P, Domschke C, et al. Long-term objective esthetic outcome after breast-conserving therapy. Breast Cancer Res Treat. 2015;153(2):345–51.
29. Waljee JF, Hu ES, Newman LA, Alderman AK. Predictors of breast asymmetry after breast-conserving operation for breast cancer. J Am Coll Surg. 2008;206(2):274–80.
30. Cochrane R, Valasiadou P, Wilson A, Al-Ghazal S, Macmillan R. Cosmesis and satisfaction after breast-conserving surgery correlates with the percentage of breast volume excised. Br J Surg. 2003;90(12):1505–9.

31. Al-Ghazal S, Blamey R, Stewart J, Morgan A. The cosmetic outcome in early breast cancer treated with breast conservation. Eur J Surg Oncol. 1999;25(6):566–70.
32. Moody A, Mayles W, Bliss J, A'Hern R, Owen J, Regan J, et al. The influence of breast size on late radiation effects and association with radiotherapy dose inhomogeneity. Radiother Oncol. 1994;33(2):106–12.
33. Moran MS, Schnitt SJ, Giuliano AE, Harris JR, Khan SA, Horton J, et al. Society of Surgical Oncology–American Society for Radiation Oncology consensus guideline on margins for breast-conserving surgery with whole-breast irradiation in stages I and II invasive breast cancer. Int J Radiat Oncol Biol Phys. 2014;88(3):553–64.

Skin-Reducing Mastectomy: Dermal Sling

18

Maurizio Bruno Nava, Nicola Rocco,
and Giuseppe Catanuto

Introduction

Skin reduction as part of the reconstructive process was suggested for the first time by Carlson in the late 1990s [1].

The classification of skin-sparing mastectomies presented at that time included a subtype denominated type 4 in which a Wise pattern surgical incision was suggested for large and ptotic breast. This access allowed symmetrical scarring when the contralateral breast was reshaped for mastopexy or breast reduction. However the creation of long and ischemic flaps on the mastectomy side generated a very high complication rate (26.5% skin flap necrosis compared to 9.5% of type 1 SSM with standard elliptical skin access), despite most of these patients having breast reconstruction with fresh tissue from autologous flaps.

Skin reduction was even more desired with the increased popularity of implant-based reconstructions. A change in the surgical paradigm of breast reconstruction was allowed by the introduction of anatomical implants with extra-projection [2].

M. B. Nava
School of Plastic Surgery, University of Milan, Milan, Italy

Group for Reconstructive and Therapeutic Advancements, G.RE.T.A, Milan, Naples, Catania, Italy

N. Rocco (✉)
Group for Reconstructive and Therapeutic Advancements, G.RE.T.A, Milan, Naples, Catania, Italy

Multidisciplinary Breast Unit, Azienda Ospedaliera Cannizzaro, Catania, Italy

G. Catanuto
Group for Reconstructive and Therapeutic Advancements, G.RE.T.A, Milan, Naples, Catania, Italy

Department of Clinical Medicine and Surgery, University of Naples "Federico II", Naples, Italy

V. S. Klimberg et al. (eds.), *Oncoplastic Breast Surgery Techniques for the General Surgeon*, https://doi.org/10.1007/978-3-030-40196-2_18

The original aim of recreating a similar breast to that removed with the mastectomy could not be pursued with a relatively limited range of implants. Moreover the shape of the prosthesis is quite far from that of sagging and large glands, and autologous flaps were considered mandatory for these patients [1, 3].

This concept was replaced by a new one in which the reconstructive surgeon replaces the removed gland with a medium-sized extra-projection implant with good cosmetic appearance irrespective of the original size and shape. On the contralateral side, a cosmetic operation was performed to minimize the asymmetry. Thus, small-/medium-sized breasts were treated by skin-sparing mastectomy with elliptical or circumareolar access, with contralateral augmentation, whereas large and ptotic breasts were treated with skin reduction and contralateral breast reduction [2] using a bilateral inverted T scar with final symmetrical results.

Clearly the T-junction was at a very high risk of necrosis that contrary to reconstruction with autologous flaps may let the process fail with implant exposure followed by removal.

This was the reason why a dermal-adipose de-epithelialized flap created from the lower pole of the breast was proposed to protect the critical regions of the skin access so that in case of necrosis a protective layer could save from implant exposure. The surgical technique was described for the first time by Bostwick et al. [4] and indicated for mastectomy for benign disease. Nava et al. [5, 6] presented the oncological results of the technique.

The idea of skin reduction and dermal sling for coverage of the lower pole and DTI breast reconstruction was very ambitious, but complication rates were still quite high. A feasible alternative was proposed by the same team with a two-stage approach [7] that proved to be a safe alternative with very low complications.

The increased popularity of nipple preservation during mastectomy for cancer or high risk conditions posed a new dilemma about skin reduction with dermal slings and reconstruction with implants. Nipple repositioning could be attempted when the nipple-areola complex distance was not exceeding 23–25 cm leaving the NAC on a de-epithelialized skin flap, although this option may raise concerns about oncological and surgical safety.

Indications

Before attempting a skin reduction approach, an accurate evaluation of patient morphology, clinical conditions, and oncological stage should be performed.

The technique could be recommended in patients with high risk conditions for family history of breast cancer. These are usually young ladies seeking for rewarding cosmetic results with good skin quality and may benefit the most from using skin reduction patterns [8].

Smokers or diabetic patients may have a compromised microvascular blood supply and therefore are exposed to severe complications and possibly implant exposure [9, 10].

Other patients with comorbidities who require breast reconstruction may undergo SRM successfully as the technique does not pose any specific challenge in this setting.

The technique was originally intended for patients with large and ptotic breast.

If a DTI breast reconstruction with nipple ablation was planned, the nipple-areola complex distance should not be less than 25 cm and (most important) the areola-inframammary fold distance should be at least 8–9 cm. These distances are mandatory to create a pouch large enough to accommodate a medium-sized extra full or full projection implant without exceeding skin tension [11–13].

A DTI with nipple preservation should be indicated only when the nipple-areola complex distance is between 22 and 23 cm and the areola-IMF distance is not less than 8 cm.

Patients with a nipple to sternal notch distance longer than 24 cm and areola to inframammary fold distance longer than 8 cm could be candidate to a two-stage approach and nipple areola complex removal. Smaller breast with moderate severe ptosis may still have similar distances but a smaller dermal sling at the lower pole. I.

When nipple preservation has to be performed in a two-stage procedure, the nipple to sternal notch distance should not exceed 24 cm.

Skin-reducing mastectomies share the same indications of other kind of conservative mastectomies.

Early-stage multicentric breast cancer either invasive or intraductal may be candidate to skin reduction with dermal slings. We do not exclude patients with cancer in the lower pole although these cases may require a more careful dissection of the dermal-adipose flap [5, 6].

Nipple preservation is indicated when retroareolar ducts are free of disease after intraoperative frozen section and post-op permanent histology.

Skin preservation in patients with locally advanced breast cancer who had complete resolution of cutaneous involvement could be considered carefully.

Patients at high risk of postmastectomy radiotherapy as anticipated by pre-op positive nodes or poor response to PST should be advised about the risk of subsequent poor results.

We indicate two-stage procedures in patients at high risk of skin necrosis [8, 9]. Tissue expansion could be suitable when a minimal dermal sling can be obtained from the lower pole.

When flap vascularity is not threatened, we can offer DTI. This technique could be advantageous for patients likely to be candidate to PMRT [14–17].

We do not perform intra-op assessment of flap viability as this could lead to overestimation of risk of necrosis.

Nipple preservation is challenging when the nipple-areola complex is far from the jugulum; this procedure is indicated according to measurements as previously described.

Technique

A good mastectomy starts always with an accurate pre-op planning. Markings performed the day before the operation are therefore mandatory. This could be one more chance to rediscuss and summarize all the surgical options with the patient.

With the patient standing in front of us, we first mark the position of the new nipple along the midclavicular line at a distance between 19 and 23 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, we erase the semicircular drawing representing the position of the new nipple-areola complex, and we prolong the two vertical limbs up to the new nipple position. Alternatively we may create a disk of skin on the superior mastectomy flap that can recreate the areola region (Figs. 18.1, 18.2, 18.3, 18.4, 18.5, 18.6, 18.7, 18.8, and 18.9).

The length of the two limbs 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 limbs are then extended medially and laterally with patient lying in the supine position, so as to intercept the previously marked inframammary fold.

In case of nipple preservation, we suggest to replicate the same marking of a superior pedicle breast reduction. Compared to this the upper border of the NAC could be placed 1 cm lower (20 cm rather than 19) in order to reduce tension after suturing on the dermal flap bearing the NAC.

Fig. 18.1 A 51-year-old BRCA1-mutated patient presenting an invasive ductal arcinoma at the left upper-outer quadrant and a ductal carcinoma in situ (with an area of micro infiltration) at the right upper-outer quadrant. Right: sternal notch-nipple distance 30 cm. Left: sternal notch-nipple distance 32.5 cm. Preoperative view

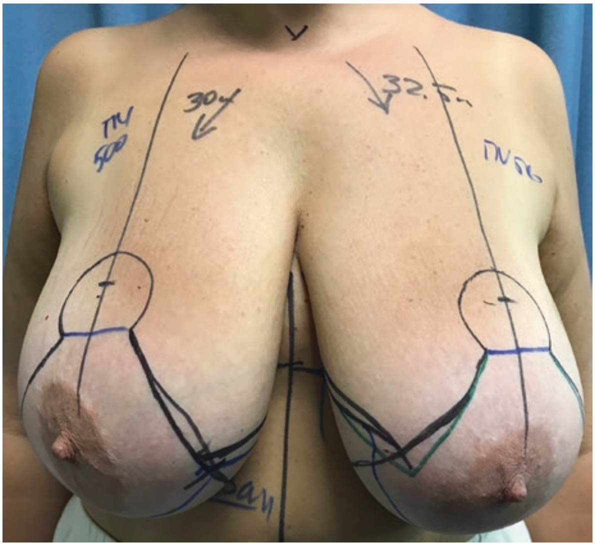


Fig. 18.2 Same patient as in Fig. 18.1. Preoperative markings for the skin-reducing mastectomy and Allergan MV 500 expander positioning

Surgical Procedure

After incision along the skin marks, the lower pole of the breast should be de-epithelialized. Sometimes it could be easier to perform this with a blade especially close to the inframammary fold; otherwise, the surgeon may use scissors but possibly without performing tumescence as this may compromise the correct identification of the surgical plane.

The dissection of the dermal sling starts from the superior border. After incision of the dermis and of the subcutaneous layer, identification of the superficial fascia should be performed. The dissection runs superficially to this plane with identification of Cooper's ligaments and careful removal of glandular islands down to the inframammary fold. Accurate preservation of this anatomical landmark is advised to obtain acceptable cosmetic results.

Skin hooks can be useful to raise the medial and lateral flaps of the mastectomy; even in this case, preservation of the subdermal plexus is mandatory. Careful handling of these angulated flaps is necessary. If nipple preservation is planned, this can be performed as the third step of the operation. A careful dissection of the duct bundle should reach the dermis of the nipple-areola complex with careful preservation of identifiable blood vessels. During this stage we excise a small sample from the residual NAC, and we send it to frozen section. If positive, nipple excision is performed, and the skin is closed with a purse string; if negative the NAC is preserved on the dermis without detaching it. Once the gland is completely detached from the skin flaps, the dissection should follow on the deep plane with preservation of the fascia of the pectoralis major and of the serratus anterior. We dissect then the pectoralis major from its lower insertion at the level of the inframammary fold, and laterally we harvest the serratus fascia. At this stage the superior aspect of the pouch

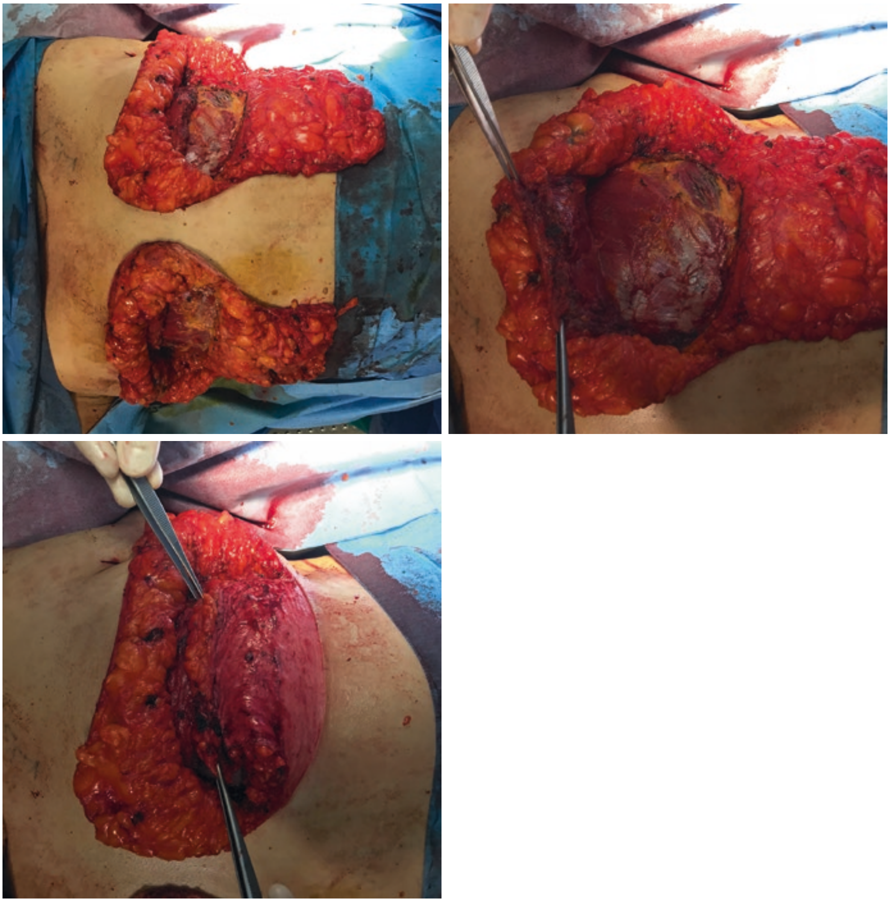


Fig. 18.3 Same patient as in Fig. 18.1. Intraoperative view. The inferior dermoadipose flap has been bilaterally prepared

Fig. 18.4 Same patient as in Fig. 18.1. One-month postoperative follow-up after bilateral positioning of Allergan MV 500 expander

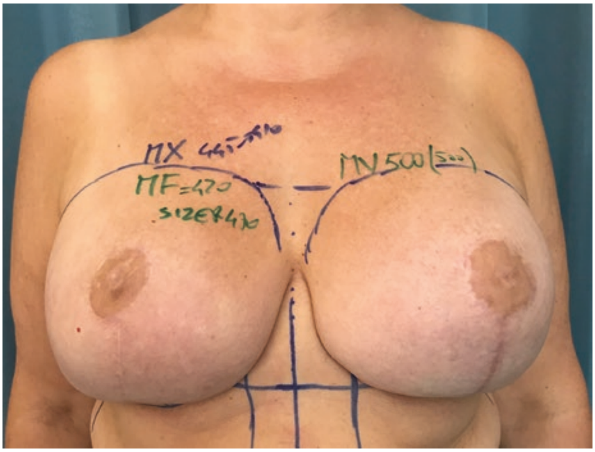


Fig. 18.5 Same patient as in Fig. 18.1. Preoperative drawings before the expander substitution with permanent implant

Fig. 18.6 Same patient as in Fig. 18.1. One-month postoperative view after expander substitution with Allergan Style 410 MX 445 cc permanent implant

is complete, the permanent implant or tissue expander can be inserted, and after placing vacuum drains, we suture the upper border of the dermal-adipose flap with the lower border of the pectoralis major and of the serratus fascia in order to provide complete coverage.

Skin closure follows as for a standard Wise pattern reduction. The contralateral reduction is a standard one; we normally leave the nipple on a superomedial or on an inferior/posterior pedicle.

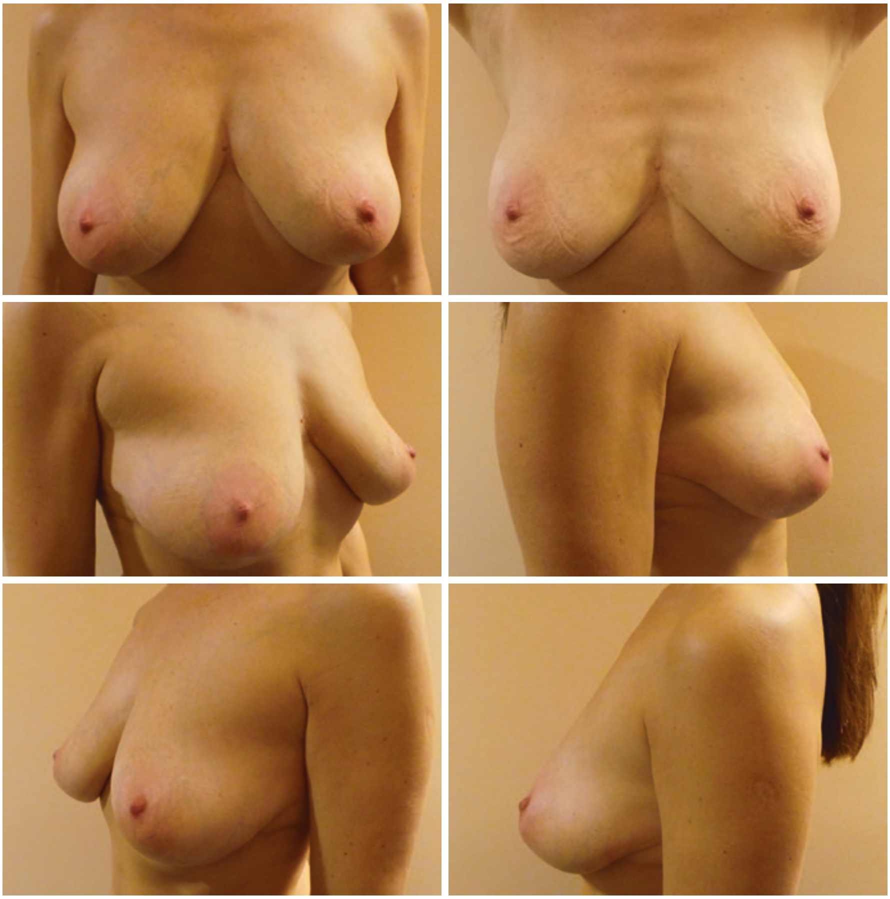


Fig. 18.7 A 45-year BRCA1-mutated patient undergoing bilateral risk-reducing mastectomy. Preoperative view

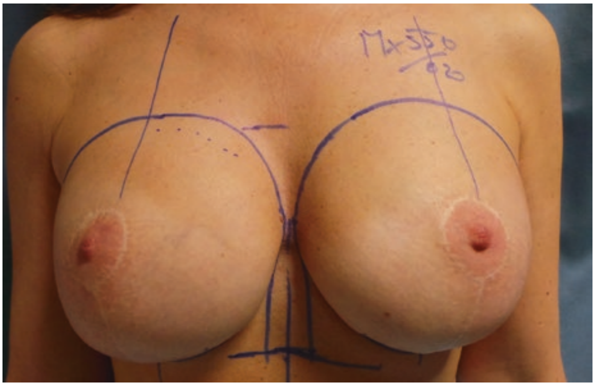


Fig. 18.8 Same patient as in Fig. 18.7. Skin-reducing mastectomy and bilateral positioning of Allergan MV 600 expanders. Six-month follow-up, before the substitution of the expanders with the permanent implants

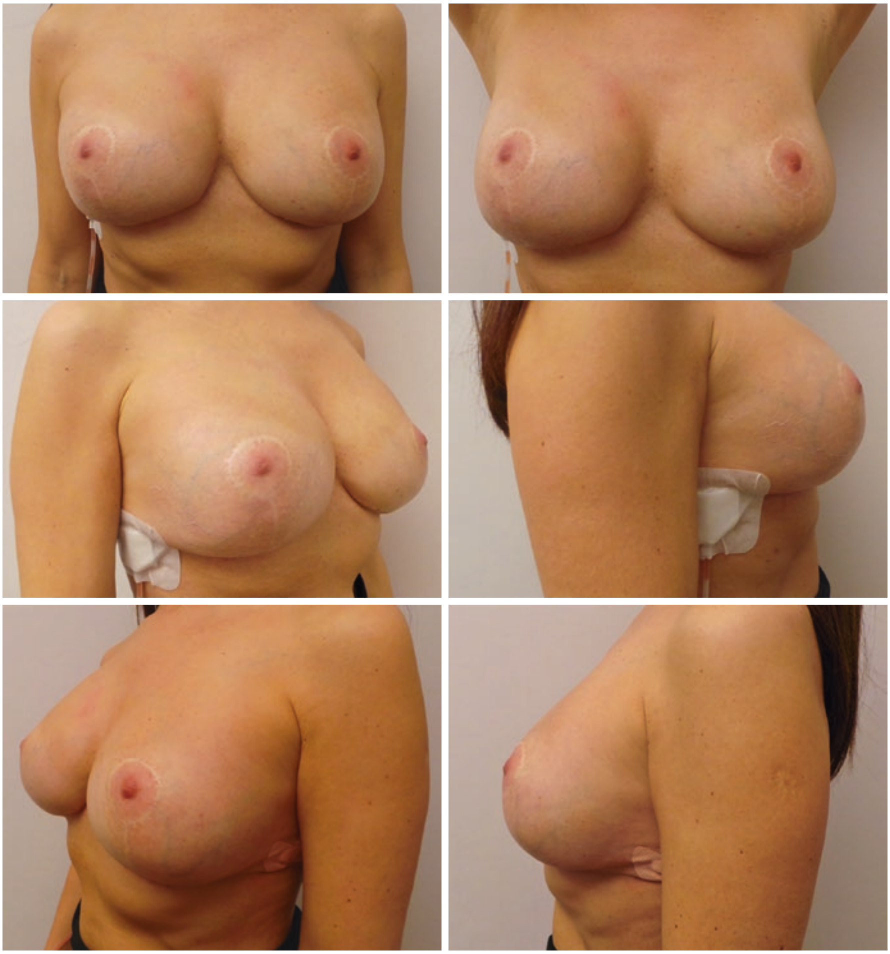


Fig. 18.9 Same patient as in Fig. 18.7. One-month postoperative view after the substitution of the expanders with Allergan Style 410 MX 550 cc permanent implants

Results

The skin-reducing technique when correctly performed generates rewarding cosmetic results. The conic shape of the breast is perfectly preserved, and the nipple-areola complex (if preserved, or the preserved skin pad) lies in the correct position at the top of the implant projection. The final symmetry is satisfactory although the contralateral ptosis may relapse in patients with poor skin elasticity. In some patients with very large and ptotic breast, some skin excess may be visible especially on the medial aspects of the reconstructed breast. The biggest challenge of skin-reducing mastectomy is the complication rate with skin suffering and implant exposure. In the first series published in 2006, the complication rate reported was 20% with an implant extrusion rate of 13%. In the second series that we published in 2011, the implant loss rate was more or less the same (14.2%) as a demonstration that severe complications are not likely to be related to the learning curve.

The mean volume of the prosthesis in our second series was 442 cc [5] as demonstration that large breast can be replaced by medium volume implants with simultaneous contralateral reduction. This is confirmed by the high rate of contralateral procedures reported (87.8%). At the time of our series, PROMs were not available; therefore, a very simplified visual analogue scale was used to assess patient rating of breast reconstruction. In 52 (78.7%) cases, the cosmetic outcome was rated as “good,” in 13 cases “medium,” and in 1 case “bad.” Tissue expanders were considered in these two series, a backup option when a DTI approach failed.

The issue of complication was explored in another series by the same team [7] that tested skin-reducing mastectomies and reconstruction with tissue expanders. The reported failure rate was 5.5%. We concluded that patients at high risk of skin suffering and necrosis may be better served by a two-stage approach.

The skin-reducing technique is not different from every kind of skin- or nipple-sparing mastectomy. In our series of 2011 [5, 7], we published about a follow-up of 36 months. The overall survival rate was 98.1%. Only one case of local recurrence was reported in a patient who underwent re-excision and was alive at the time of her last follow-up. No patients experienced a recurrence in the preserved NAC although this subset of patients was poorly represented in this series. Two patients were alive with disease (overall disease-free survival 94.9%; distant disease-free survival 96.6%). Interestingly the specimen of the contralateral reduction revealed an occult breast cancer in three cases (intraductal disease). These results can be considered in keeping with similar series of conservative mastectomies.

Type 4 skin-sparing mastectomies were described by Carlson [1, 18, 19, 20–24] in the original classification of skin-sparing mastectomies. This was part of a large retrospective series published at the end of the 1990s and at the beginning of the new series.

The overall LR was 5.5% over a follow-up of 65.4 months. Twenty-four patients (77.4%) among this developed a systemic relapse, and 7 (22.6%) patients remained free of recurrent disease at a mean follow-up of 78.1 months.

After this first report, a high number of studies of poor quality followed, and a final experimental comparison between standard and conservative mastectomies was never published. Therefore our current practice is still based on the data reported by Carlson and confirmed by subsequent series.

Type 4 mastectomies (with or without dermal-adipose slings) were reviewed recently by in a systematic review by Corban [25].

A comparison between two-stage and DTI type 4 mastectomies was performed after revision including 561 cases. For direct-to-implant reconstructions, the pooled complication rate was 30%, while for those using tissue expansion, it was 20.3%. Rates of skin flap necrosis ranged from 4.69% to 9.70%, delayed wound healing from 0.77% to 2.77%, infection from 2.54% to 3.91%, seroma from 1.15% to 4.68%. The conclusion from this systematic review is clearly supporting the two-stage approach although the authors clearly stated that the power of this meta-analysis is impaired by the poor quality of the studies reported.

A recent report confirmed that the two-stage approach with tissue expansion first is a safer option in high risk patients and that the complication rate is comparable to that of standard skin-sparing mastectomies [26].

Among all risk factors examined in this series, smoking was the only one significantly associated.

Alternative techniques of type 4 mastectomies with dermal slings are proposed in literature. One of the most interesting was suggested by Folli and colleagues [27] who suggest to keep the nipple-areola complex on a double pedicle and perform a standard two-stage breast reconstruction with a subpectoral pocket. This technique is specifically designed for women with a nipple to sternal notch distance of 24 cm or more where a preservation of the NAC on the superior pedicle may not warrant sufficient vascularity. Despite the presence of long and ischemic flaps, the authors claim no total nipple loss and a low rate of delayed wound healing at the junction of the inverted T.

In order to reduce this kind of complication, some authors evaluated a vertical access for breast reconstruction in women with macromastia [28].

The authors tested this technique on a short cohort of patients candidate to prophylactic mastectomy who obtained good results and a low complication rate. This technique, like the skin-reducing introduced by Nava et al. [5, 7], requires a compound pouch with lower pole de-epithelialized flap sutured to the inferior border of the pectoralis major. Although a vertical scar may protect from skin suffering at the T junction, prediction of final results may be impaired, and secondary surgical revisions may be required.

A modified skin-reducing mastectomy was suggested by Caputo et al. [29, 30].

This variation included a preservation of the pectoralis major that is replaced by porcine-derived acellular dermal matrix. The preliminary report describes 33 cases on 27 patients with a low complication rate without implant loss. Using an ADM to complete the upper pole of the pouch seems promising although results must be validated on longer and controlled series. The real limitation relies on the cost of using a second prosthetic device.

Conclusions

A generalized lack of evidence is associated to mastectomies and reconstructions with dermal flaps. However these technique may warrant good cosmetic results in women with macromastia who can benefit from contralateral adjustment with symmetrical scarring. When performing DTI breast reconstructions, the complication rates may be rather high with skin necrosis especially at the junction of the inverted T. For this reason a two-stage breast reconstruction would be advisable especially for patients at high risk (smokers, overweight, diabetic). Nipple preservation is related to the nipple to sternal notch distance. For more than 24 cm, a preservation on a double pedicle could be performed safely with few necrotic complications and predictable final results. When the nipple to sternal notch is higher than 29 cm, nipple saving is not recommended as a standard.

References

1. Carlson GW, Bostwick J 3rd, Styblo TM, Moore B, Bried JT, Murray DR, Wood WC. Skin-sparing mastectomy. Oncologic and reconstructive considerations. Ann Surg. 1997;225(5):570–5; discussion 575–8.
2. Nava MB, Spano A, Cadenelli P, Colombetti A, Menozzi A, Pennati A, Catanuto G. Extra-projected implants as an alternative surgical model for breast reconstruction. Implantation strategy and early results. Breast. 2008;17(4):361–6. https://doi.org/10.1016/j.breast.2008.01.009. Epud 2008 May 16.
3. Losken A, Carlson GW, Bostwick J 3rd, Jones GE, Culbertson JH, Schoemann M. Trends in unilateral breast reconstruction and management of the contralateral breast: the Emory experience. Plast Reconstr Surg. 2002;110:89e97.
4. Jones GE. Bostwick's plastic and reconstructive breast surgery. 3rd ed. St. Louis: Quality Medical Publishing Inc; 2010.
5. Nava MB, Cortinovis U, Ottolenghi J, Riggio E, Pennati A, Catanuto G, Greco M, Rovere GQ. Skin-reducing mastectomy. Plast Reconstr Surg. 2006;118(3):603–10; discussion 611–3.
6. Nava MB, Ottolenghi J, Pennati A, Spano A, Bruno N, Catanuto G, Boliglowa D, Visintini V, Santoro S, Folli S. Skin/nipple sparing mastectomies and implant-based breast reconstruction in patients with large and ptotic breast: oncological and reconstructive results. Breast. 2012;21(3):267–71. https://doi.org/10.1016/j.breast.2011.01.004. Epud 2011 Mar 23.
7. Della Rovere GQ, Nava M, Bonomi R, Catanuto G, Benson JR. Skin-reducing mastectomy with breast reconstruction and sub-pectoral implants. J Plast Reconstr Aesthet Surg. 2008;61(11):1303–8. Epub 2007 Aug 10.
8. McCarthy MC, Mehrara BJ, Riedel E, Davidge K, Hinson A, Disa JJ, Cordeiro PG, Pusic AL. Predicting complications following expander/implant breast reconstruction: an outcomes analysis based on preoperative clinical risk. Plast Reconstr Surg. 2008;121(6):1886–92. https://doi.org/10.1097/PRS.0b013e31817151c4.
9. Hirsch EM, Seth AK, Kim JY, Dumanian AG, Mustoe AT, Galiano RD, Fine NA. Analysis of risk factors for complications in expander/implant breast reconstruction by stage of reconstruction. Plast Reconstr Surg. 2014;134(5):692e–9e. https://doi.org/10.1097/PRS.0000000000000607.
10. Frey JD, Choi M, Salibian AA, Karp NS. Comparison of outcomes with tissue expander, immediate implant, and autologous breast reconstruction in greater than 1000 nipple-sparing mastectomies. Plast Reconstr Surg. 2017;139(6):1300–10. https://doi.org/10.1097/PRS.0000000000003340.
11. Catanuto G, Rocco N, Nava MB. Surgical decision making in conservative mastectomies. Gland Surg. 2016;5(1):69–74. https://doi.org/10.3978/j.issn.2227-684X.2015.05.12. Review.
12. Rocco N, Catanuto G, Nava MB. What is the evidence behind conservative mastectomies? Gland Surg. 2015;4(6):506–18. https://doi.org/10.3978/j.issn.2227-684X.2015.04.19. Review.
13. Nava MB, Rocco N, Catanuto G. Conservative mastectomies: an overview. Gland Surg. 2015;4(6):463–6. https://doi.org/10.3978/j.issn.2227-684X.2015.04.06. Review.
14. Cordeiro PG, Albornoz CR, McCormick B, Hudis CA, Hu Q, Heerdt A, Matros E. What is the optimum timing of postmastectomy radiotherapy in two-stage prosthetic reconstruction: radiation to the tissue expander or permanent implant? Plast Reconstr Surg. 2015;135(6):1509–17. https://doi.org/10.1097/PRS.0000000000001278.
15. Fowble B, Park C, Wang F, Peled A, Alvarado M, Ewing C, Esserman L, Foster R, Sbitany H, Hanlon A. Rates of reconstruction failure in patients undergoing immediate reconstruction with tissue expanders and/or implants and postmastectomy radiation therapy. Int J Radiat Oncol Biol Phys. 2015;92(3):634–41. https://doi.org/10.1016/j.ijrobp.2015.02.031. Epub 2015 Apr 28.
16. Ho AL, Bovill ES, Macadam SA, Tyldesley S, Giang J, Lennox PA. Postmastectomy radiation therapy after immediate two-stage tissue expander/implant breast reconstruction: a University of British Columbia perspective. Plast Reconstr Surg. 2014;134(1):1e–10e. https://doi.org/10.1097/PRS.0000000000000292.

17. Cordeiro PG, Albornoz CR, McCormick B, Hu Q, Van Zee K. The impact of postmastectomy radiotherapy on two-stage implant breast reconstruction: an analysis of long-term surgical outcomes, aesthetic results, and satisfaction over 13 years. Plast Reconstr Surg. 2014;134(4):588–95. https://doi.org/10.1097/PRS.0000000000000523.
18. Carlson GW, Styblo TM, Lyles RH, Jones G, Murray DR, Staley CA, Wood WC. The use of skin sparing mastectomy in the treatment of breast cancer: the Emory experience. Surg Oncol. 2003;12(4):265–9.
19. Carlson GW, Styblo TM, Lyles RH, Bostwick J, Murray DR, Staley CA, Wood WC. Local recurrence after skin-sparing mastectomy: a manifestation of tumor biology or surgical conservatism? Ann Surg Oncol. 2003;10(2):108–12.
20. Losken A, Carlson GW, Bostwick J 3rd, Jones GE, Culbertson JH, Schoemann M. Trends in unilateral breast reconstruction and management of the contralateral breast: the Emory experience. Plast Reconstr Surg. 2002;110(1):89–97.
21. Carlson GW, Moore B, Thornton JF, Elliott M, Bolitho G. Breast cancer after augmentation mammoplasty: treatment by skin-sparing mastectomy and immediate reconstruction. Plast Reconstr Surg. 2001;107(3):687–92.
22. Carlson GW, Losken A, Moore B, Thornton J, Elliott M, Bolitho G, Denson DD. Results of immediate breast reconstruction after skin-sparing mastectomy. Ann Plast Surg. 2001;46(3):222–8.
23. Carlson GW. Local recurrence after skin-sparing mastectomy: a manifestation of tumor biology or surgical conservatism? Ann Surg Oncol. 1998;5(7):571–2.
24. Carlson GW. Risk of recurrence after treatment of early breast cancer with skin-sparing mastectomy: two editorial perspectives. Ann Surg Oncol. 1998;5(2):101–2.
25. Corban J, Shash H, Safran T, Sheppard-Jones N, Fouda-Neel O. A systematic review of complications associated with direct implants vs. tissue expanders following wise pattern skin-sparing mastectomy. Plast Reconstr Aesthet Surg. 2017;70(9):1191–9. https://doi.org/10.1016/j.bjps.2017.02.028. Epub 2017 Mar 14.
26. Dietz J, Lundgren P, Veeramani A, O'Rourke C, Bernard S, Djohan R, Larson J, Isakov R, Yetman R. Autologous inferior dermal sling (autoderm) with concomitant skin-envelope reduction mastectomy: an excellent surgical choice for women macromastia and clinically significant ptosis. Ann Surg Oncol. 2012;19(10):3282–8. https://doi.org/10.1245/s10434-012-2549-2. Epub 2012 Aug 10.
27. Folli S, Mingozzi M, Curcio A, Buggi F, Rossi C. Nipple-sparing mastectomy: an alternative technique for large ptotic breast. J Am Coll Surg. 2015;220(5):e65–9. https://doi.org/10.1016/j.jamcollsurg.2015.01.028. Epub 2015 Jan 29.
28. Peker F, Yuksel F, Karagoz H, Ozturk S. Breast reconstruction using de-epithelialized dermal flap after vertical-pattern skin-sparing mastectomy in macromastia. ANZ J Surg. 2015;85(1–2):64–8. https://doi.org/10.1111/ans.12570. Epub 2014 Apr 22.
29. Caputo GG, Marchetti A, Dalla Pozza E, Vigato E, Domenici L, Cigna E, Governa M. Skin-reduction breast reconstruction with prepectoral implant. Plast Reconstr Surg. 2016;137(6):1702–5. https://doi.org/10.1097/PRS.0000000000002227.
30. Vidya R, Masià J, Cawthorn S, Berna G, Bozza F, Gardetto A, Kolacinska A, Dell'Antonia F, Tiengo C, Bassetto F, Caputo GG, Governa M. Evaluation of the effectiveness of the prepectoral breast reconstruction with Braxon dermal matrix: first multicenter European report on 100 cases. Breast J. 2017;23(6):670–6. https://doi.org/10.1111/tbj.12810. Epub 2017 May 8.

Simple and Skin Sparing Mastectomy

19

Stephanie A. Valente and Stephen R. Grobmyer

Introduction

Supporting Evidence for Simple and Skin Sparing Mastectomy for Treatment of Breast Cancer

Simple/Total Mastectomy vs. Radical Mastectomy

Controversy over the importance of breast skin removal in the management of breast cancer dates back to the 1800s. Radical mastectomy involving removal of the breast, overlying skin, pectoralis major and minor muscles, and axillary lymph nodes level I–III was developed as a treatment for breast cancer in the 1860s by Charles Hewitt Moore in London [1]. The use of the radical mastectomy for the treatment of breast cancer was popularized by Dr. William Halsted in the United States. Halsted's initial operation involved wide excision of the skin and skin grafting [2].

Willy Meyer from New York advocated a similar operation for the treatment of breast cancer with the removal of breast tissue, pectoralis major muscle, and axillary nodes; however, the technique of Meyer did not require skin grafting as Meyer limited the amount of skin removal to that which could be closed (Fig. 19.1) [3].

In the 1950s and the 1960s, many surgical groups did not agree with the radical removal of axillary nodes, pectoralis muscle, and breast skin for the treatment of

S. A. Valente
Lerner College of Medicine, Cleveland Clinic, Cleveland, OH, USA
e-mail: valents3@ccf.org

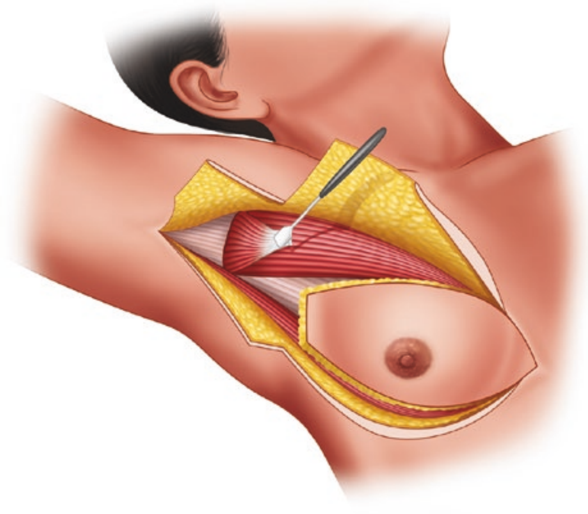
S. R. Grobmyer (✉)
Cleveland Clinic Abu Dhabi, Abu Dhabi, UAE
e-mail: grobmys@ccf.org; grobmys@clevelandclinicabudhabi.ae

V. S. Klimberg et al. (eds.), *Oncoplastic Breast Surgery Techniques for the General Surgeon*, https://doi.org/10.1007/978-3-030-40196-2_19

breast cancer. Williams et al. reported in 1953 similar outcomes for patients treated with simple mastectomy and radical mastectomy for early stage breast cancer (Fig. 19.2) [4].

These and other retrospective studies were instrumental in the development and conduct of randomized controlled trials in the United States to study the impact of the extent of surgery and radiation on outcomes of patients with breast cancer, NSABP Protocol B-04 [5]. Beginning in 1971, patients without clinical axillary nodal involvement were randomized to receive (a) radical mastectomy, (b) simple

Fig. 19.1 Technical approach to mastectomy of Dr. Willy Meyer with skin creation of skin flaps permitting primary closure of the defect without skin grafting [3]



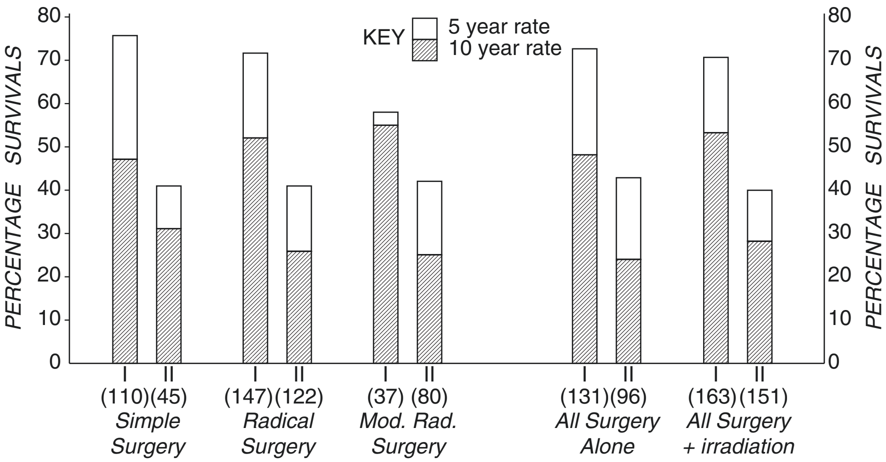


Fig. 19.2 Comparison of outcomes of patients having simple, radical, and modified radical surgery for treatment of breast cancer

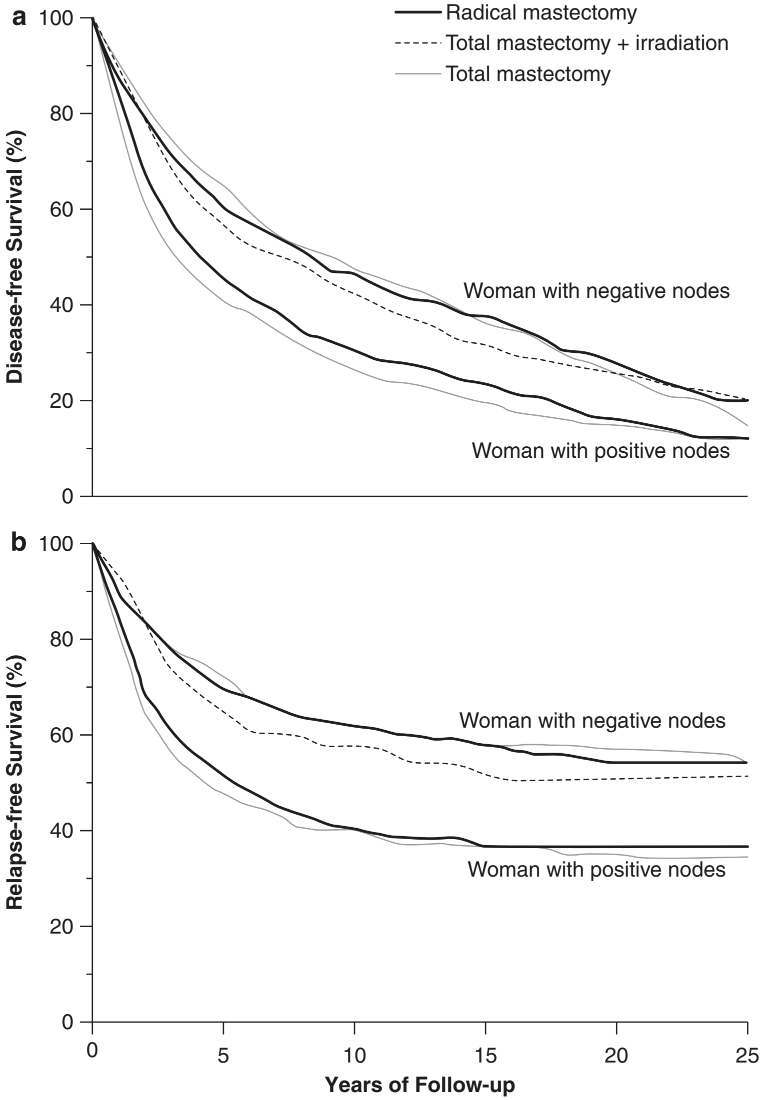
mastectomy followed by regional irradiation, and (c) simple mastectomy alone. Patients presenting with clinically positive axillary nodes were randomized to (a) radical mastectomy and (b) simple mastectomy followed by regional irradiation. Twenty-five year follow-up of patients in this trial demonstrated no significant difference in outcome comparing patients having simple vs. radical mastectomy for treatment of breast cancer [6]. The NSABP B-04 trial represents the cornerstone of the modern approach to utilization of simple mastectomy for the treatment of patients with early-stage breast cancer (Fig. 19.3) [5].

Skin Sparing Mastectomy vs. Simple Mastectomy

The traditional mastectomy with primary closure has evolved to include the skin sparing mastectomy for planned immediate reconstruction with the premise of treating the skin as merely an extended margin. Skin sparing mastectomy removes the nipple-areolar complex but leaves a significant amount of the skin envelope intact to allow for immediate breast reconstruction with either a tissue expander/implant or autologous reconstruction. Preserving the skin envelope allows for maintenance of breast symmetry and restoration of the natural shape and contour of the breast with minimal scaring.

Freeman reported on skin sparing mastectomy technique for benign lesions with the immediate reconstruction in 1962 with promising results [7]. Early reports of skin sparing mastectomy for cancer date back to the early 1990s. Kroll et al. reported on 87 patients having “preservation of uninvolved skin” to facilitate immediate reconstruction. In this report, the authors reported on 87 patients with a local recurrence rate of 1.2% with a mean follow-up of 23.1 months [8]. Toth and Lappert reported on the use of a modified skin incision and immediate reconstruction in 17 patients with excellent technical outcomes and no flap loss [9].

Initial concern regarding the skin sparing mastectomy technique was the prospect of potentially leaving residual glandular breast tissue behind and subsequent increased risk of cancer recurrence or development of a new primary breast cancer. Several groups demonstrated that residual breast tissue and/or residual tumor may be left in the skin flaps in the vicinity of the underlying tumor following skin sparing mastectomy [10–12]. These concerns lead initially to the relatively slow adoption of skin sparing mastectomy in the management of breast cancer; however, over time, numerous studies demonstrated the oncologic safety of skin preservation for the purpose of immediate reconstruction [13]. These studies demonstrated the oncologic safety of using the skin envelope of the breast to provide a framework for immediate reconstruction, specifically addressing that saving the breast skin envelope for immediate reconstruction does not increase the risk of a local in-breast recurrence when compared to a traditional mastectomy. A meta-analysis of observational studies by Lanitis et al. [14] demonstrated no significant difference in local or distance recurrence comparing skin sparing mastectomy with non-skin sparing mastectomy. Skin sparing mastectomy with immediate reconstruction is commonly employed in operations for breast cancer risk reduction, and for therapeutic



No at Risk

Negative nodes			
Radical mastectomy	362	170	45
Total mastectomy + irradiation	352	177	39
Total mastectomy	365	159	45
Positive nodes			
Radical mastectomy	292	92	21
Total mastectomy + irradiation	294	83	23

Fig. 19.3 Twenty-five-year follow-up of patients from NSABP-B04 trial comparing simple to radical mastectomy in patients with and without clinical axillary nodal involvement. Analysis shows no association between extent of surgery and long-term outcome

operations (including following neo-adjuvant chemotherapy [15]). It is now recognized that immediate reconstruction following mastectomy provides the important psychosocial benefit to women related to restoration of appearance and body image. In fact, the NCCN guidelines state that all women undergoing surgical treatment for breast cancer should be educated on their reconstruction options [16].

Terms

- Radical mastectomy, Halstead mastectomy
  - Complete removal of the breast gland, pectorals major and minor muscles with resection of level I–III axillary lymph nodes
- Modified radical mastectomy
  - Complete removal of the breast gland with resection of level I & II axillary lymph nodes
- Simple mastectomy, total mastectomy, complete mastectomy
  - Complete removal of the breast gland
- Skin sparing mastectomy
  - Complete removal of the breast gland and nipple-areolar complex, but preservation of the breast skin, for immediate reconstruction
- Nipple sparing mastectomy, total skin sparing mastectomy
  - Complete removal of the breast gland, but preservation of the breast skin and nipple-areolar complex, for immediate reconstruction

Indications for Mastectomy

A mastectomy is a surgical treatment option for:

- Patient preference for primary treatment option for invasive breast cancer or ductal carcinoma in situ (DCIS)
- Risk reduction in patients at high risk for breast cancer
- Multicentric breast cancer (cancer 2 or more quadrants) (whenever oncoplastic breast conservative surgery cannot be performed)
- A large cancer, in a small breast for which the tumor to breast size ratio prohibits breast conservation
- Locally advanced breast cancer
- Patients with a history of prior whole breast radiation-relative indication
- Patients with a contraindication to radiation

Contraindications/Cautions to Mastectomy

- Any patient with the diagnosis of breast cancer or ductal carcinoma in situ has the option to have a mastectomy for the treatment of breast cancer.

- The operation and the presence of a drain could limit the patient's ability in post-operative period to perform individual activities of daily living such as driving or lifting, pushing, pulling more than 5–10 lbs. These limitations and patient expectations need to be discussed as part of the decision making process.
- Patients who are smokers or those who have a high BMI are candidates for a mastectomy. However, their risk for complications for a skin sparing mastectomy with subsequent elective immediate reconstruction is higher [15, 17]. Careful consideration of these high risks and offering immediate reconstruction in this patient population need to be discussed. An option would be to perform a simple mastectomy and then perform a delayed reconstruction after breast cancer treatment if the patient has stopped smoking or has achieved a lower BMI for which the risk of surgical complications can safely be reduced.
- The traditional treatment for inflammatory breast cancer, due to its poor prognosis, is a modified radical mastectomy without immediate reconstruction. Reports of delayed autologous reconstruction have been published, once patients have received post-mastectomy radiation and survival has been established [18]. Modern literature has suggested the relative safety of performing a skin sparing mastectomy with immediate reconstruction in patients who have achieved an excellent clinical response to neoadjuvant chemotherapy [19].
- Although nipple sparing mastectomy may yield a better cosmetic mastectomy option, not all patients are candidates for a nipple sparing mastectomy.
  - A skin sparing mastectomy is indicated for patients who have involvement of their nipple by Paget's disease, direct extension of the cancer to the nipple, retraction of the nipple, bloody or clear nipple discharge suggestive that the nipple is involved or an invasive cancer or DCIS located close to the nipple [20].
  - Anatomically, some patients also require a skin sparing mastectomy; this traditionally includes patients with large or ptotic breasts. These patients are at increased risk for nipple necrosis or loss due to blood supply issues, or cosmetic asymmetry due to concerns in repositioning the nipple. Recent literature has proposed various techniques to attempt nipple preservation such as maintaining a pedicle dermal blood supply [21], nipple delay procedures [22], or free nipple graft techniques.

Surgical Anatomy

The anatomic boundaries of the breast glad are as follows:

- Superiorly, below the clavicle
- Inferiorly – the inframammary crease
- Medially – the lateral portion of the sternum
- Laterally – the mid axillary line, anterior edge of the latissimus dorsi muscle

Technical Features of Mastectomy

Preoperative Evaluation and Planning

Preoperative Marking

Simple Mastectomy

The design of the simple mastectomy incision is such that the nipple and areolar complex are removed. The amount of skin excised for a simple mastectomy allows for complete primary closure of the wound without increased tension. The risk of an incision that is too tight is primary wound dehiscence, or limited motion of the upper extremity. The excess laterally is called a “dog ear deformity,” which can be difficult to manage at the time of the initial operation. In some situations, revisional operations to manage dog ear deformity are necessary and techniques to reduce this should be followed [23]. On some occasions, revisional operations are requested by patients to reduce the redundancy of skin following simple mastectomy, particularly in patients with increased body mass index (Fig. 19.4).

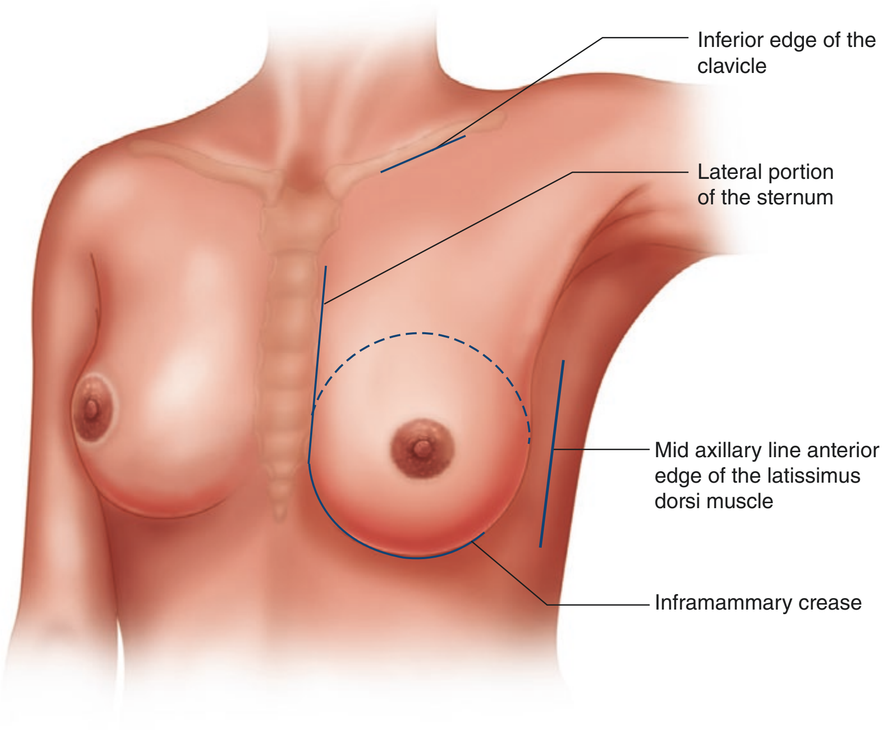


Fig. 19.4 Borders of dissection for patients having a simple or skin sparing mastectomy

Incision Design and Placement

Traditional mastectomy without reconstruction (Fig. 19.5):

- The elliptical skin incision is a transverse incision which incorporates the NAC. The ellipse can be orientated in a variety of ways including horizontal, oblique, or sigmoidal. The goal for incision of a mastectomy without reconstruction is to optimize tumor removal and to remove enough skin to allow primary closure of the breast skin without undue tension.

Skin Sparing Mastectomy

Ideally the patient should be marked by both the breast surgeon and the plastic/reconstructive surgeon where discussion and coordination of incisions can be made to ensure the overlying or involved skin is included in the incision but with a planned incision for a cosmetically favorable closure (Fig. 19.6).

The patient should be marked either standing or in a sitting position with shoulders relaxed. A meridian line is drawn from the sternal notch to the xyphoid process to mark patient midline.

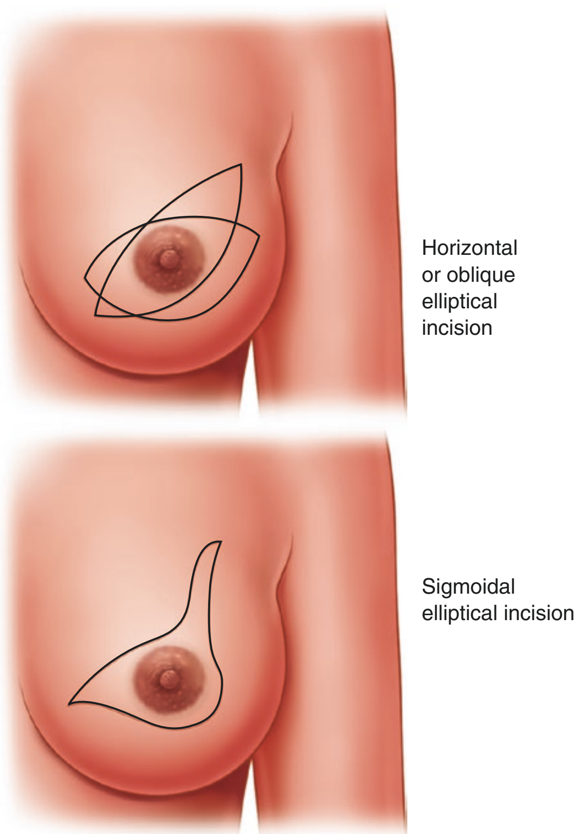


Fig. 19.5 Simple mastectomy incision

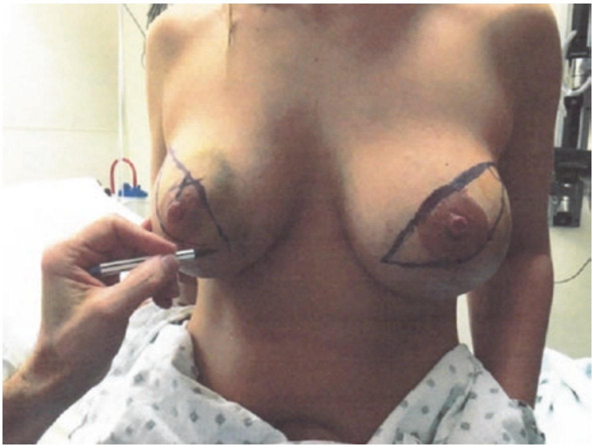


Fig. 19.6 Preoperative skin markings with the patient in upright position

Next, the four anatomical boundaries of the breast dissection should be marked; importantly the inframammary crease is marked, which is necessary to achieve a good cosmetic result without the reconstruction falling.

Incision placement for skin sparing mastectomy depends on achieving the mutual goals of complete tumor removal and optimal cosmesis following reconstruction. Depending on the base, shape, and ptosis of the breast, certain incisional allow for better cosmetic results that match the contralateral breast. In some cases, incisions need to be made to optimize complete tumor removal.

Finally, the incision location and length should be chosen to allow for complete removal of the breast tumor. Care should be taken to plan excision of skin overlying the cancer as an anterior margin in cases where the cancer is too close to the skin. The oncologic safety of the mastectomy procedure needs to trump the cosmetic results. A positive margin for a mastectomy mandates consideration of post-mastectomy radiation and, therefore, the surgical approach should include trying to avoid this. Tumor ultrasound guided incision (TUGI) is a mechanism by which the surgeon can identify a tumor close to the anterior skin margin and selectively place incisions to include the overlying skin [24].

Incisions should also be planned with immediate breast reconstruction in mind, such as to include excess skin removal, correct ptosis, or symmetry if a contralateral balancing procedure is planned.

Incision Design and Placement

Skin sparing mastectomy:

- In a skin sparing mastectomy, the nipple-areolar complex is also excised; however, the areolar either can be removed with the nipple or can stay. The areola can be treated as a skin margin.
- Options for skin sparing mastectomy incision and placement continue to evolve. Options include (A) periareolar incision, (B) peraireolar incision with radial

extension, (C) vertical elliptical incision, (D) horizontal elliptical incision, (E) combination incision which includes excision of skin over cancer as an anterior margin, and (F) wise pattern reduction incision [21, 24] (Fig. 19.7).

The periareolar elliptical is a miniature version of the classic, non-skin-sparing mastectomy incision (Fig. 19.8) The lateral incision can be extended to allow for

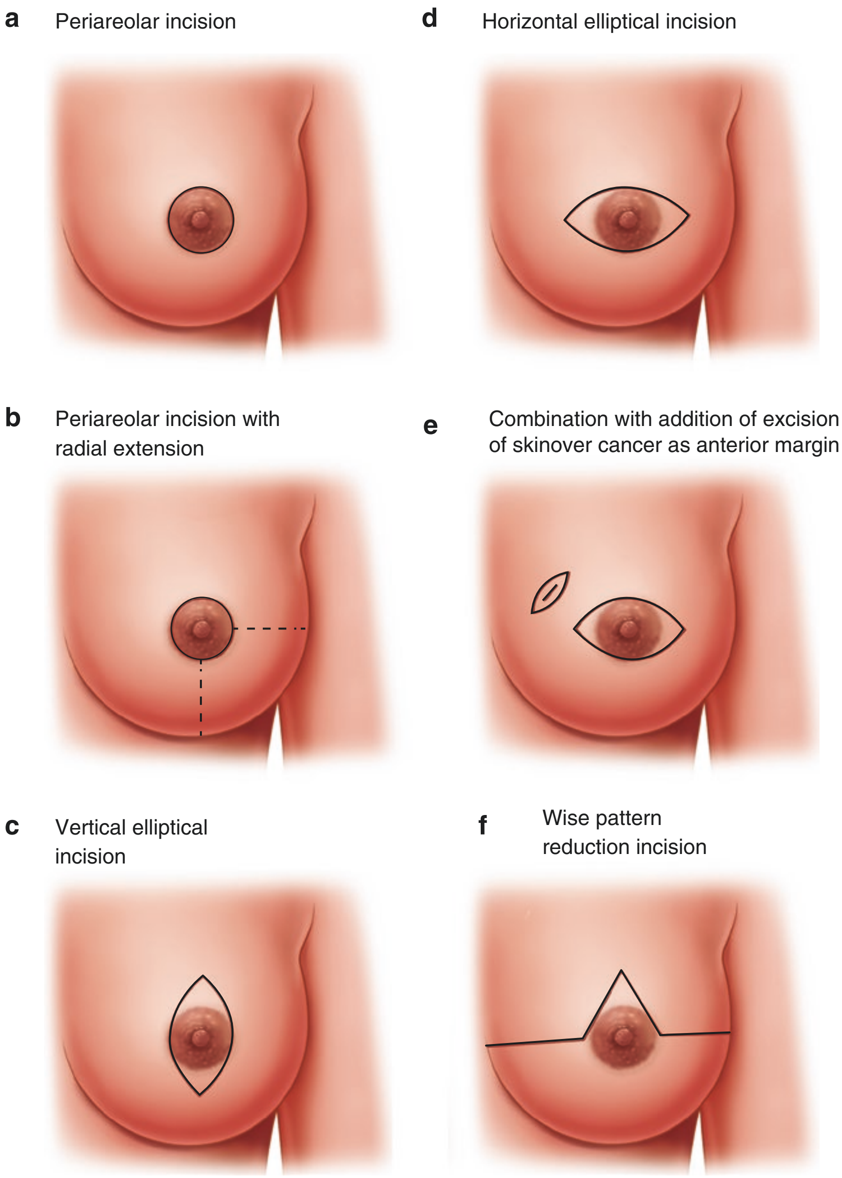


Fig. 19.7 Skin sparing mastectomy skin incision options

Fig. 19.8 Skin sparing mastectomy with horizontal elliptical incision and reconstruction

Fig. 19.9 Skin sparing mastectomy with reduction Wise pattern incision, reconstruction, and a contralateral reduction for symmetry

axillary access if necessary. The reduction mammoplasty incision is patterned from the Wise pattern incision (Fig. 19.9).

Patient Set-Up

The patient is placed on supine position on the operating room table, and general anesthesia is induced. The patient is then sterilely prepped with both breasts exposed, such that reconstruction can match the native breast size and shape, and the involved upper extremity and axilla can be prepped in the field to allow for passive movement of the upper extremity to test for tension of the skin closure on adduction of the arm. The arm is abducted and is secured on an armrest. The surgeon stands in the position next to the patient below the arm, and the assistant stands above the arm to help with retraction. For better visualization when creating the inferior or lateral flaps, the operating surgeon may also stand above the arm or the opposite side of the operating table.

Surgical Technique

A scalpel is used to create the skin incision and then retraction of the skin is obtained with the use of skin hooks, face-lift retractors, Adair clamps, or a similar retraction instrument placed on the cut edge to provide skin/dermis elevation retraction. The skin is gently lifted with limited, but steady tension by the assistant (Fig. 19.10). The surgeon applies counter-traction to the breast to allow for dissection on the anterior plane. Anterior skin flaps can be created using electrocautery or sharp dissection.

The skin flaps are created removing the anterior superficial fascia and Coopers ligaments, but preserving the dermal subcutaneous vasculature. The anterior plain of the breast is a relatively minimally avascular plane. Centripetal dissection enhances exposure and ensures uniform flap thickness. The ideal flap thickness varies by patient, but ideally is 4–8 mm in thickness. This thickness may be thinner in patients with a low body mass index and thicker in patients with a high body mass index. Care is taken to avoid ultrathin flaps which lead to flap necrosis or thick flaps which increase the risk of cancer recurrence. The dissection of the mastectomy flaps must be meticulous, with uniform thickness. Care is taken to avoid tension or trauma during retraction from excessive pulling or retraction of the skin flaps.

For the creation of long skin flaps, a lighted retractor, the use of a head light or an extended electrocautery tip, and long instruments can be extremely helpful. The

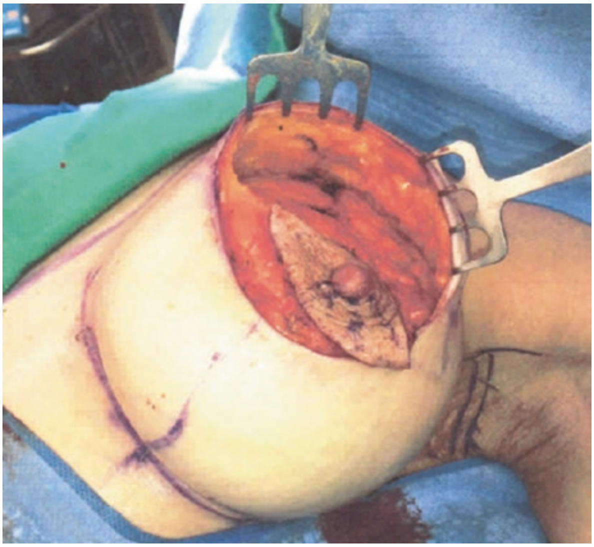


Fig. 19.10 Skin sparing mastectomy with uniform flap thickness and minimal tension retraction

dissection of the anterior flap is taken to the boarders of the breast gland circumferentially down to the chest wall musculature. Dissection is taken superiorly to the inferior portion of the clavicle, inferiorly to the inframammary crease, medially to the lateral portion of the sternum, and then laterally to the anterior edge of the latisimuss dorsi muscle.

Next, the breast is removed from the underlying chest wall with care to include the pectoralis fascia along with the breast tissue. Removal of the breast is performed from in a cranial to caudal fashion with the breast and fascia dissected off the pectoralis major muscle in a plane parallel to muscle fibers. The surgeon applies constant, inferior retraction of the breast. Care to identify and preserve the perforator vasculature is necessary. Medially, the blood supply to the breast includes the intercostal perforator arteries (T1–6) off the internal mammary artery (aka internal thoracic artery) and laterally the medial and lateral thoracic arteries arising from the thoracoacromial artery (Fig. 19.11).

With dissection of the breast tissue laterally, care is taken to include the axillary tail breast tissue which is anterior and medial to the origin of the pectoralis muscle. Lateral and inferior to the pectoralis minor muscle is the clavipectoral fascia, which is a thick band of connective tissue which serves as the transition between the breast tissue and axillary contents. For a simple mastectomy, the identification and preservation of the axillary lymph nodes is paramount, and the clavipectoral fascia can be transected in a careful manner of a feathering technique, which identifies the axillary fat and lymph nodes, which has a subtle but different texture than the breast tissue. The lateral thoracic vein, which drains the breast laterally and runs on the anterior axillary line, can be preserved but, if necessary, can also be ligated without consequence. The breast is then removed and appropriately marked for orientation for pathology.

An alternative use to electrocautery for the mastectomy is the use of the tumescent technique (Fig. 19.12). The tumescent technique utilizes hydrodissection to define a tissue plane and sharp dissection with scissors to remove the breast from the overlying skin [25]. The hydrodissection mixture of normal saline, local anesthetic, and epinephrine injected into the anterior mammary plan, beneath the dermis, causes vasoconstriction, which decreases operative bleeding, and the technique can create uniform flaps and decrease operating room time. Reports vary on whether this technique increases or decreases the complication risks of skin necrosis when combined with immediate reconstruction, but it is a useful alternative technique [26, 27].

Closed suction drain(s) are placed at the completion of the procedure prior to final skin closure to prevent fluid accumulation and seroma formation in the surgical bed following mastectomy.

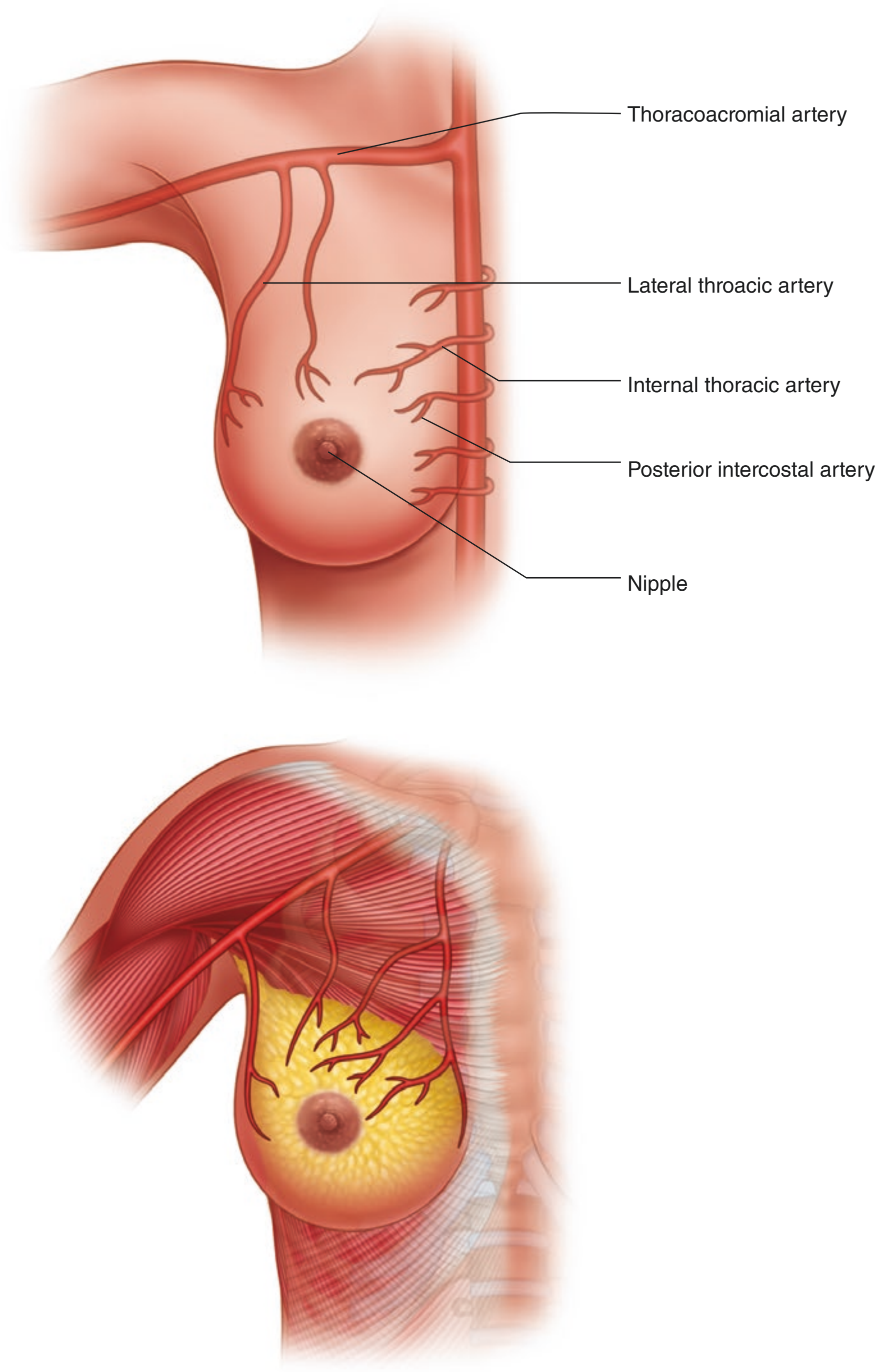


Fig. 19.11 Blood supply of the breast. Medially, intercostal perforator arteries T1-6 off of the internal thoracic artery; laterally, the medial and lateral thoracic arteries off of the thoracoacromial artery

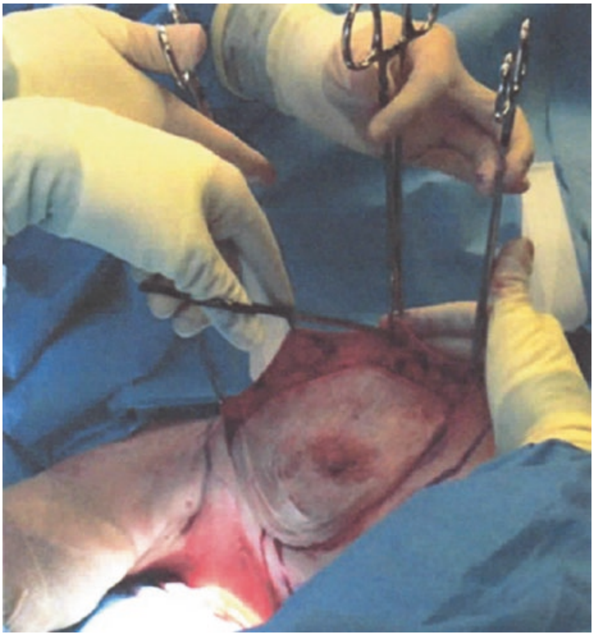


Fig. 19.12 Tumescent mastectomy using hydrodissection and Metzenbaum scissors

Axillary Surgery

Axillary surgery if indicated, either sentinel lymph node biopsy or axillary dissection can be performed either through the skin sparing mastectomy incision or through a separate incision. This choice depends on the mastectomy incision location and length and the ability to adequately perform surgery in the axillary area without undue excess tension of the mastectomy flaps.

Surgical Complications and Solutions

The complications that result from the mastectomy procedure include but are not limited to skin necrosis, skin loss, sensory paresthesias, infection, chronic pain, seroma, hematoma, infection, implant/flap loss, asymmetry, and scar formation.

- Flap Necrosis
  - Mastectomy flap skin necrosis is a complication that has a reported incidence rate of 5–30% [28]. Flap necrosis is the result of inadequate blood supply to the flap, initiating skin death, which can lead to subsequent wound breakdown and infection. Skin flap necrosis can be the result of patient factors such as smoking, obesity, diabetes, or large breast volume, to name a few. Skin necrosis can also be the result of surgical factors such as placement of surgical incisions, creation of ultrathin skin flaps, prolonged retraction during surgery, and tension placed on the flap by the immediate reconstruction volume. The receipt of breast radiation is known to significantly increase flap necrosis rates [29].

  - On post-operative examination, the use of the SKIN scoring system can be helpful to assess for tissue necrosis or loss with the use of similar definitions of partial and full thickness skin necrosis as well as the extent of necrosis involved (Table 19.1) [30].
  - Management of skin flap necrosis depends on severity and extent of necrosis. Options can include close observation, with the use of bacitracin, silvadene, or even nitroglycerin ointment on the mastectomy flap [31].
  - Operative management includes debridement or removal of all of the necrotic tissue and then assessment of the resultant skin loss [28]. The skin flaps can be primarily re-approximated if the area of necrosis debrided is small and re-approximation can be performed with minimal tension. At times, healing by secondary intention is an option. Wound management for healing by secondary intention can include daily dressing changes or placement of a wound vacuum device to allow for granulation of healthy tissue. For large areas of necrosis, replacing skin via skin grafting or skin flaps may be necessary.
- Infection
  - A single dose of pre-operative prophylactic intravenous antibiotics is the standard for breast surgery. The incidence of surgical site infection after mastectomy can range from 1% to 26%, with the incidence higher in patients with increased co-morbidities. Infection presentation can range from breast skin

Table 19.1 SKIN score for assessing severity and extent of mastectomy skin flap necrosis (MSFN)

Depth of MSFN		
Score	Definition	
A	None, no evidence of MSFN	
B	Color change of skin flap suggesting impaired perfusion or ischemic injury (may be cyanosis or erythema)	
C	Partial thickness skin flap necrosis resulting in at least epidermal sloughing	
D	Full thickness skin flap necrosis[a]	
Surface area of MSFN		
Score	% Area	Definition
1	0	None
2	1–10	Breast, change affects 1–10% of breast skin
		NAC, change affects 1–10% of nipple-areolar complex
3	11–30	Breast, change affects 11–30% of breast skin
		NAC, 11–30% of NAC affected, or total nipple involvement[b]
4	>30	Change affects >30% of breast skin or >30% of NAC

Each breast is assigned both a number and a letter score to characterize the severity of MSFN, based on 2 characteristics: (1) the greatest depth of MSFN and (2) the surface area of the most severe necrosis. In cases of nipple sparing mastectomy, the breast mound and nipple-areolar complex (NAC) are scored separately

[a]Areas that are not definitely full thickness should be considered partial thickness

[b]Because the nipple itself is considered key to breast aesthetics, if there is MSFN involving the entire nipple, the surface area score of the NAC is automatically upgraded to surface area score of at least 3, even if the nipple represents <11% of the surface area of the NAC

erythema, drainage at the incision site, abscess formation, or wound dehiscence. Cellulitis, which is the most common surgical site infection, is a superficial incisional infection, which can be treated with oral antibiotics. Management of infection can range from a course of oral antibiotics to IV antibiotics, with the goal to avoid implant loss.

Oral antibiotics
Intravenous antibiotics
Implant removal

- Seroma
  - Seroma is an accumulation of acute inflammatory exudate in the dead space area where breast tissue has been removed. Surgical techniques to reduce the incidence of seroma formation involve mechanisms to obliterate the dead space. These include quilting of the flap to the underlying chest wall tissue, use of sealants, compressive dressings, and use of negative pressure drains which help maintain flap opposition to the chest wall to allow for healing [32].
  - Drains are usually removed once the drainage falls to a minimum of 20–50 cc in the proceeding 24–48 h. Patients with a prior history of breast irradiation are more prone to form prolonged seromas following mastectomy.
  - Persistent seroma can create pressure on the surgical scar and create skin necrosis, wound dehisce, or chronic seroma. In this case, aspiration of the seroma, placement of a drain, or surgical excision of the pseudocapsule may be necessary.
- Hematoma
  - The overall risk of bleeding after mastectomy is approximately 2–11%, and risk of surgery to address bleeding is less than 1%. Post-operative bleeding is higher in patients with comorbidities such as congestive heart failure, obesity, and diabetes [33].

Follow-Up

Local regional recurrence after a mastectomy 1.2–5.4% and varies by stage of disease at presentation and the use of adjuvant therapies [34, 35]. Over 90% of local regional recurrence is within 5 years from the original surgery with 30–60% incidence of simultaneous metastatic disease [34]. Patients should be followed in accordance with national guidelines following breast cancer treatment in a breast cancer survivorship program [16].

Patients who have received a mastectomy can be educated on self-breast exam and signs of local recurrence such as a new palpable lump, or skin changes and should continue with clinical breast exams. Routine screening imaging for a mastectomy is not required, even in the setting of implant or autologous reconstruction [36].

Reference Video

- https://youtu.be/o_slBSndN8A

References

1. Moore CH. On the influence of inadequate operations on the theory of cancer. Med Chir Trans. 1867;1:244–80.
2. Halsted WS. I. 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. 1894;20(5):497–555.
3. Meyer W. An improved method of the radical operation for carcinoma of the breast. In: Medical record. New York: Trow Directory, Printing, and Bookbinding Co.; 1894. p. 1–16.
4. Williams IG, Murley RS, Curwen MP. Carcinoma of the female breast: conservative and radical surgery. Br Med J. 1953;2(4840):787–96.
5. Fisher B, et al. Ten-year results of a randomized clinical trial comparing radical mastectomy and total mastectomy with or without radiation. N Engl J Med. 1985;312(11):674–81.
6. Fisher B, et al. Twenty-five-year follow-up of a randomized trial comparing radical mastectomy, total mastectomy, and total mastectomy followed by irradiation. N Engl J Med. 2002;347(8):567–75.
7. Freeman BS. Subcutaneous mastectomy for benign breast lesions with immediate or delayed prosthetic replacement. Plast Reconstr Surg Transplant Bull. 1962;30:676–82.
8. Kroll SS, et al. The oncologic risks of skin preservation at mastectomy when combined with immediate reconstruction of the breast. Surg Gynecol Obstet. 1991;172(1):17–20.
9. Toth BA, Lappert P. Modified skin incisions for mastectomy: the need for plastic surgical input in preoperative planning. Plast Reconstr Surg. 1991;87(6):1048–53.
10. Cao D, et al. The superficial margin of the skin-sparing mastectomy for breast carcinoma: factors predicting involvement and efficacy of additional margin sampling. Ann Surg Oncol. 2008;15(5):1330–40.
11. Torresan RZ, et al. Evaluation of residual glandular tissue after skin-sparing mastectomies. Ann Surg Oncol. 2005;12(12):1037–44.
12. Ho CM, et al. Skin involvement in invasive breast carcinoma: safety of skin-sparing mastectomy. Ann Surg Oncol. 2003;10(2):102–7.
13. Bleicher RJ, Hansen NM, Giuliano AE. Skin-sparing mastectomy. Specialty bias and worldwide lack of consensus. Cancer. 2003;98(11):2316–21.
14. Lanitis S, et al. Comparison of skin-sparing mastectomy versus non-skin-sparing mastectomy for breast cancer: a meta-analysis of observational studies. Ann Surg. 2010;251(4):632–9.
15. Wengler CA, et al. Determinants of short and long term outcomes in patients undergoing immediate breast reconstruction following neoadjuvant chemotherapy. J Surg Oncol. 2017;116(7):797–802.
16. National Comprehensive Cancer Network. Breast cancer (Version 1.2018). https://www.nccn.org/professionals/physician_gls/pdf/breast.pdf. Accessed 23 June 2018.
17. Berry T, et al. Complication rates of radiation on tissue expander and autologous tissue breast reconstruction. Ann Surg Oncol. 2010;17 Suppl 3:202–10.
18. Chang EI, et al. Challenging a traditional paradigm: 12-year experience with autologous free flap breast reconstruction for inflammatory breast cancer. Plast Reconstr Surg. 2015;135(2):262e–9e.
19. Simpson AB, et al. Immediate reconstruction in inflammatory breast cancer: challenging current care. Ann Surg Oncol. 2016;23(Suppl 5):642–8.
20. Spear SL, et al. Nipple-sparing mastectomy for prophylactic and therapeutic indications. Plast Reconstr Surg. 2011;128(5):1005–14.
21. Dietz J, et al. Autologous inferior dermal sling (autoderm) with concomitant skin-envelope reduction mastectomy: an excellent surgical choice for women with macromastia and clinically significant ptosis. Ann Surg Oncol. 2012;19(10):3282–8.
22. Jensen JA, et al. Surgical delay of the nipple-areolar complex: a powerful technique to maximize nipple viability following nipple-sparing mastectomy. Ann Surg Oncol. 2012;19(10):3171–6.
23. Devalia H, et al. An oncoplastic technique to reduce the formation of lateral 'dog-ears' after mastectomy. Int Semin Surg Oncol. 2007;4:29.

24. Fernando EJ, et al. A tumor ultrasound-guided incision (TUGI) approach to nipple-sparing mastectomy: balancing oncologic safety and technical outcomes. Clin Breast Cancer. 2017;17(7):572–7.
25. Shoher A, Hekier R, Lucci A Jr. Mastectomy performed with scissors following tumescent solution injection. J Surg Oncol. 2003;83(3):191–3.
26. Khavanin N, et al. Tumescent technique does not increase the risk of complication following mastectomy with immediate reconstruction. Ann Surg Oncol. 2014;21(2):384–8.
27. Chun YS, et al. Use of tumescent mastectomy technique as a risk factor for native breast skin flap necrosis following immediate breast reconstruction. Am J Surg. 2011;201(2):160–5.
28. Robertson SA, et al. Mastectomy skin flap necrosis: challenges and solutions. Breast Cancer (Dove Med Press). 2017;9:141–52.
29. Wengler CA, et al. Determinants of short and long term outcomes in patients undergoing immediate breast reconstruction following neoadjuvant chemotherapy. J Surg Oncol. 2017;116(7):797–802.
30. Lemaine V, et al. Introducing the SKIN score: a validated scoring system to assess severity of mastectomy skin flap necrosis. Ann Surg Oncol. 2015;22(9):2925–32.
31. Hwang K. Effects of nitroglycerin ointment on mastectomy flap necrosis in immediate breast reconstruction: a randomized controlled trial. Plast Reconstr Surg. 2016;137(4):747e–8e.
32. Sampathraju S, Rodrigues G. Seroma formation after mastectomy: pathogenesis and prevention. Indian J Surg Oncol. 2010;1(4):328–33.
33. Nwaogu IY, et al. Economic impact of bleeding complications after mastectomy. J Surg Res. 2015;199(1):77–83.
34. Gonzalez EG, Rancati AO. Skin-sparing mastectomy. Gland Surg. 2015;4(6):541–53.
35. Langstein HN, et al. Breast cancer recurrence after immediate reconstruction: patterns and significance. Plast Reconstr Surg. 2003;111(2):712–20; discussion 721–2.
36. Freyvogel M, et al. Screening mammography following autologous breast reconstruction: an unnecessary effort. Ann Surg Oncol. 2014;21(10):3256–60.

Total or Nipple Skin-Sparing Mastectomy

20

Isabel T. Rubio

Introduction

Over the past decade, there has been an increasing interest in the use of total or nipple-sparing mastectomy (NSM). NSM entails the conservation of the nipple-areola complex (NAC) as well as the skin envelope while performing a complete excision of all the mammary gland. It differs from subcutaneous mastectomy in that all the breast tissue is removed and the retroareolar tissue is submitted separately for histologic evaluation. NSM is currently considered an alternative technique to improve the overall quality of life for women with similar oncologic outcomes. The increasing use of NSM has resulted in a completely different set of complications that were not present in the simple mastectomy procedure. NSM requires a careful surgical technique in order to achieve a complete excision of the breast tissue while decreasing the likelihood of damaging the blood supply of the skin and the NAC. In this chapter, we will review the indications, how to plan the incisions, complications, and solutions.

Indications

Initially, indications for NSM were limited because of the fear of leaving breast tissue in the retroareolar area and, consequently, to increase local recurrence. Retrospective studies on NSM have shown the short-term oncological safety of the procedure and, consequently, the indications expanded. As a result of increased genetic testing in women, the impact of systemic therapy on locoregional recurrences, and patient demand for better cosmetic outcomes, there has been a rapid

I. T. Rubio (✉)
Clinica Universidad de Navarra, Universidad de Navarra, Madrid, Spain
e-mail: irubior@unav.es

V. S. Klimberg et al. (eds.), *Oncoplastic Breast Surgery Techniques for the General Surgeon*, https://doi.org/10.1007/978-3-030-40196-2_20

increase in the utilization of NSM for women undergoing mastectomy and breast reconstruction. At present, a randomized clinical trial for nipple-sparing techniques vs. conventional mastectomy (followed by reconstruction) is neither feasible nor ethical; so all the data comes from retrospective studies and prospective registries. Appropriate patient selection is crucial for the success of the technique. Clearly, there are two different settings in the performance of NSM: as a risk reduction procedure for patients at high risk and as a therapeutic procedure for the treatment of breast cancer.

Risk Reduction

In women with an elevated lifetime risk of breast cancer, whether BRCA mutation carriers or a lifetime risk >20%, bilateral risk reduction NSM seems to be safe. Previously, Hartmann et al. [1] reported data on BRCA mutation carriers, and after 13.4 years median follow-up, no BRCA carriers developed breast cancer. At that time the risk reduction mastectomy was performed as a subcutaneous mastectomy, where no retroareolar tissue was differentially excised. Even less breast tissue is left behind the NAC with a NSM.

Most of the studies even with short follow-up show a very low risk of breast cancer occurrence that makes this technique feasible and safe for risk reducing (Table 20.1).

Therapeutic NSM

Initial Indications

These initial indications were based in factors that were predictors of cancer involvement in the nipple [5–7] and in those patients with an increased risk of complications from the NAC sparing procedure [8].

- Tumor ≤2 cm and >2 cm away from the NAC
- No positive nodes
- No prior radiation
- No prior breast surgery (reduction mastopexy mainly)

Over time, with more experienced team, the initial indications have changed to:

Table 20.1 Bilateral subcutaneous/NSM risk reduction in BRCA1/2 mutation carriers

Author	*N*	Time follow-up (years)	Breast cancer occurrence *n* (%)
Hartmann 2001, [1]	26	13.4	0
Peled 2013, [2]	26	3.7	0
Yao 2015, [3]	150	2.8	1 (0.7%)
Jakub 2017, [4]	202	4	0

- Early-stage and locally advanced breast cancer [9–11]
- Any tumor size as long as there is no clinical or imaging evidence of NAC involvement or skin involvement
- Cautionary in extensive DCIS
- After systemic therapy in good responders [12]

Contraindications

There are clearly some contraindications to preserving the NAC, and these are related to the initial affected nipple.

- Inflammatory breast cancer [13]
- Paget disease of the nipple
- Malignant nipple discharge

Relative Contraindications

Related to patient’s characteristics

- High body mass index (BMI)
- Large or ptotic breasts [14]
- Smoker
- Radiation

Patients with high body mass index can have favorable outcomes when the team is experienced in the NSM [15].

Many of these relative contraindications are because it increases the risk of complications. Smoking increases the risk of flap necrosis and infection, and in some centers, immediate reconstruction is not advisable if the patient is a smoker [16].

Preoperative Evaluation and Planning

1. Careful selection of patients. First thing is to analyze whether the patient is a candidate for NSM. For surgeons starting on the technique, choose patients with less risk of complications.
2. Secondly, take preoperative and postoperative photographs.
3. Preoperative breast imaging is crucial to evaluate the extent of the disease. Bilateral mammograms and breast and axillary ultrasound are necessary. Magnetic Resonance Imaging may help in some circumstances in addition to the physical exam to assess nipple invasion.
4. Assess body mass index (BMI), ptosis, and breast size and shape.

5. In the case of risk-reducing surgery, evaluate where to place the incision depending on breast size and shape.
6. In the case of NSM, besides breast size and shape, tumor location needs to be considered to avoid positive anterior margins.
7. If the patients have prior surgery, assess placement of the incision with consideration of the blood supply to the nipple. The dominant blood supply to the lateral aspect of the breast is from the lateral thoracic artery (LTA) that arise from branches of the second, third, and fourth intercostal spaces and travels toward the nipple. During a NSM, these vessels are found along the lower lateral border of the pectoralis minor muscle. Around the NAC, a plexus is created from branches of the LTA and the internal thoracic artery. It is important to know this distribution to maintain nipple viability [17].
8. Data should be collected to assess esthetic and oncologic outcomes. As rates of NSM continue to increase, it is important to retrieve confirmatory evidence in support of the oncologic safety of the technique for therapeutic as well as risk-reducing indications in high-risk patients. Ideally breast surgeons can collaborate in international prospective registries. These prospective registries have been designed to facilitate compiling information on metrics and techniques utilized, aesthetic outcomes, as well as oncologic outcomes of NSM. The target is to provide prospective robust evidence on its oncological safety: complications (associated risks of nipple and skin necrosis, infection rates, reconstruction loss, nipple symmetry) and patient reported outcome measures (PROMs). At the American Society of Breast Surgeons, the Nipple Sparing Mastectomy Registry (NSMR) has closed for enrollment as they have reached 2000 cases. In Europe, the International Nipple Sparing Mastectomy Registry (INSPIRE) (a European Cancer Audit (EURECCA) project) has recently closed the accrual [18, 19].
9. Review all factors that can increase complications from the procedure, such as smoking, body mass index, medical comorbidities, breast size, and ptosis.
10. Radiation therapy, before the NSM or after, will increase the complications. Patients should be counseled in consultation with plastic surgeons and radiation oncologists regarding benefits and cons of the procedure [20].

How to Choose the Incision

Decisions about incision placement are different depending on if it is a risk-reducing or a therapeutic mastectomy. In women for risk-reducing bilateral NSM, usually inframammary (IMF) or infralateral incision (Fig. 20.1) is the most commonly used as it carries the best cosmetic results as the scar is usually hidden by the small natural breast ptosis after the reconstruction. If the incision is placed infralateral, the branch from the superior epigastric that crosses the inframammary fold can be avoided. In the IMF, it is easier to preserve the fold as the inferior flap is the IMF; same can be applied to the infralateral incision. Generally the infralateral incision starts at 6 o’clock in the IMF and is taken laterally in the breast; most breast

Fig. 20.1 Inferolateral incision

Fig. 20.2 Periareolar incision with extended lateral

surgeons will go to 3 o'clock to have a good exposure of the breast, but the size of this incision will be decided on surgeon's preference.

In patients with undergoing a therapeutic NSM, consideration of tumor location is important to reduce the risk of anterior positive margins. Radial incisions are usually used when there is a suspicion of a positive retroareolar margin. In that way the incision can be extended to remove the NAC or the nipple, so the patient will not end up with two separate incisions.

Periareolar

Periareolar incisions with extension to the lateral part of the breast were initially utilized for NSM, when we were more worried about leaving breast tissue than having a partial nipple necrosis (Fig. 20.2). It is important, however, not to extend the periareolar incision more than half of the circumference of the areola in order to avoid an increased risk of necrosis. Decreasing the extent of the circumference of

Fig. 20.3 Wise pattern with dermal sling and free nipple graft

the NAC included in the incision will improve rates of nipple necrosis. Generally, the incision should not cover more than 180° of the areola in order to avoid a full-thickness necrosis. Even with just 90° of the circumference, the risk of partial thickness necrosis increases to 20%.

While the IMF approach has its advantages, it has been shown that the risk of positive margins is increased when compared with other approaches [22]. It is important to have this in mind in the preoperative evaluation especially in women who have larger breast and cancers in the upper part of the breast or the axillary tail.

Wise Pattern Reduction Techniques

There are patients that will benefit from a reduction mammoplasty at the same time the NSM is performed (Fig. 20.3). This include patients with large breast, ptosis, macromastia, or if the ipsilateral breast is bigger than the contralateral. In those patients a NSM with dermal sling can be performed. The excess skin is deepithelialized to preserve the dermal vessels, and after the mastectomy, the deepithelialized dermis is used as a dermal sling to reduce the skin envelope and offer coverage for the implant-based reconstruction (Fig. 20.4). It can be sewn to the pectoralis muscle (Fig. 20.4). Those patients with previous full periareolar incision for Wise pattern can have NSM if the incision for the mastectomy does not include the periareolar area.

Incision location is based mainly on patient factors, as described previously. In the decision-making process, it is crucial to balance the risk of flap/nipple necrosis and the risk of tumor-involved margins.

Surgical Technique

Mastectomy Flaps and Retroareolar Tissue of the Nipple-Areola Complex

Once the incision is placed, it is important to be very careful with the flaps, try not to damage the blood supply with the retractors. Skin hooks can be used initially for elevating the flaps in the first 5–6 cm, and then light retractors are helpful. Flap thickness have been a matter of discussion. There is no an ideal thickness, and

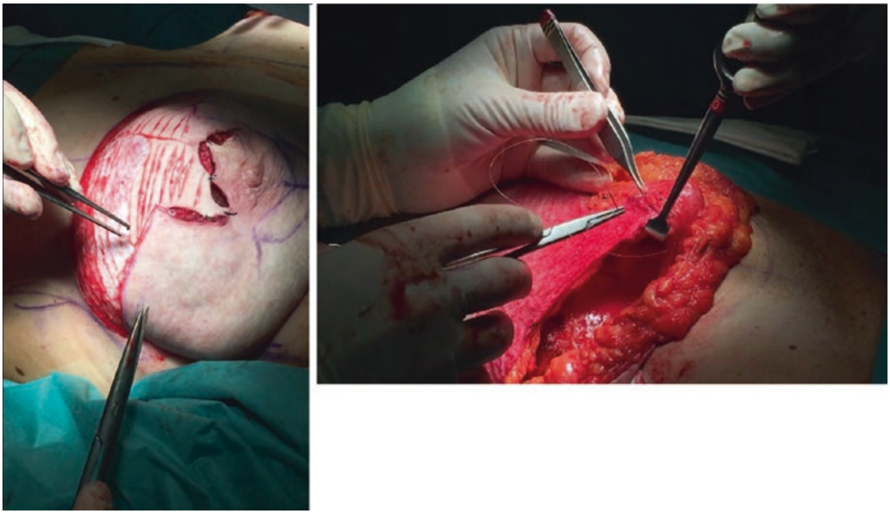


Fig. 20.4 De-epithelization of the dermis to be used as a dermal sling

there are actually great variations in the thickness of the subcutaneous layer between patients. Sometimes, the plane is easier to find and sometimes more difficult. Even in the same patient, generally the plane is easier to find in the lower quadrants than in the upper quadrants of the breast. The flap dissection should be carried through a subcutaneous layer that lies between the dermis and breast tissue, where there is minimal amount of breast epithelium [23]. It is clear that both surgeon's technique and patient characteristic's influence skin flaps thickness and viability.

Several methods of flap dissection have been described. It can be performed with sharp dissection or electrocautery or other types of blades (i.e., plasma). While reported in some studies differences between sharp and electrocautery dissection [24], in other studies, no differences in terms of necrosis or infection regardless of the method used have been reported [19, 22]. Other techniques that includes the use of cervical dilators have been reported with low rates of complications [10]. We prefer to use the electrocautery on the skin flaps and turn to the sharp when dissecting the NAC, to avoid heat damage. Surgeons should use whatever technique with which they are more comfortable.

Depending on where the incision is placed, the flap dissection can be done on the anterior plane of the breast or in both the anterior and the posterior plane (usually more helpful in the IMF and/or inferolateral incision). In this case, both planes can be performed at the same time. One can start with the anterior flap and then, subsequently, dissection of the posterior flap. It is crucial for NSM to use of light retractors, especially when doing the anterior flap dissection and in the upper quadrant flaps (Fig. 20.5).

The limits for doing the NSM are the same as for a simple mastectomy in order to leave the a minimum of residual breast tissue.

Fig. 20.5 Light retractors to help visualize the dissection of the flaps

It is always important to have the breast imaging available in the OR, especially when there are calcifications and the distance to the skin needs to be taken into account when performing the flaps. If the tumor is close to the anterior margin, it may be prudent to place a stitch in the overlying skin and if the intraoperative margin is positive, excision of the skin could be performed at the time of surgery. It can be also helpful to leave the stitch in the skin for definitive pathology and assess the value of radiation therapy for a positive anterior margin. Indications for radiation therapy after NSM are still controversial. While researchers agree on postmastectomy radiation therapy in those high-risk patients (T3 tumors, ≥4 positive nodes, and high-risk features), there are no consensus on other situations, like residual breast tissue, close or focally positive margins [25]. However, postmastectomy radiation therapy should not be a contraindication for receipt of a NSM.

Sentinel lymph node biopsy can be done through the same incision depending on access through the NSM incision. Generally, if the incision is in the IFM, another incision in the axilla is needed. If the inferolateral incision extends to the mid lateral quadrant of the breast, then the SLN can be performed through the same incision. If the SLN is positive and an axillary dissection (ALND) is needed, then the surgeon has to evaluate whether the full axilla can be reached from the incision. Once the breast is removed, it can be assessed whether it is feasible to perform the lymphadenectomy threw the same or a separate axillary incision.

Fig. 20.6 Marking and inking margins in the breast specimen

Preoperative prophylactic antibiotics (generally cephalosporin) administered 30 minutes before the surgery can help to reduce rate of wound infection by 40%. Prophylaxis for deep venous thrombosis is also recommended.

It is important to mark the margins in the mastectomy specimen and also put a stitch at the level of the spared skin of the NAC so the pathologist can ink this area differently for margin assessment (Fig. 20.6).

How to Excise the Retroareolar Tissue?

There are several ways of dissecting the retroareolar tissue. When we started performing NSM, we usually everted the nipple and cored all the retroareolar tissue. In these situations, we realized that there were higher rates of nipple necrosis. Because the ductal-lobular terminal ducts are uncommonly within the nipple, we changed the approach to identify and excise the ducts directly beneath the nipple. Two atraumatic forceps are placed in the duct and transected (Fig. 20.7). This tissue is sent separately for intraoperative frozen analysis. Intraoperative assessment of retroareolar tissue is performed always in a

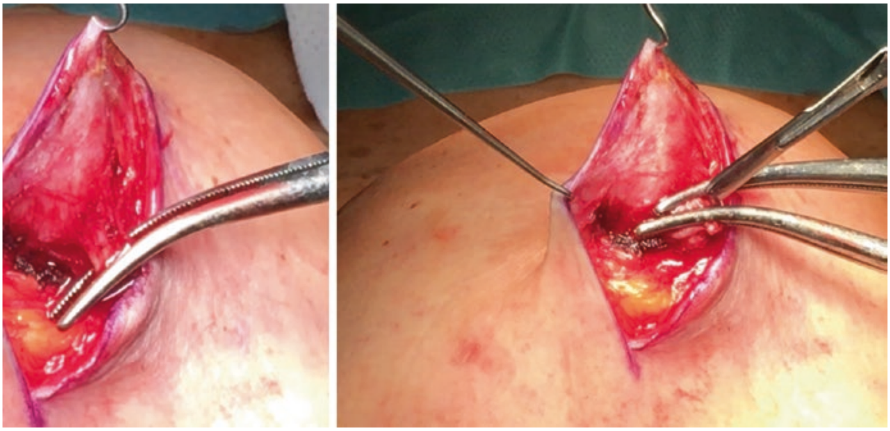


Fig. 20.7 Retroareolar tissue sent for intraoperative assessment

therapeutic NSM to rule out carcinoma. In cases of NSM for risk reduction where the risk of cancer is low, intraoperative evaluation of retroareolar tissue is not recommended.

Intraoperative Evaluation of Blood Supply

Risk of flap necrosis has been described in a range of 3–20% in various studies [26, 27]. Fluorescent angiography (FA) is a real-time imaging modality where an intravenous dye – namely, fluorescein and indocyanine green (ICG) – fluoresces and emits infrared energy upon excitation by a light source [28]. ICG, injected intravenously, is an effective method to assess blood flow in the flap and rates of postoperative flap necrosis have significantly reduced with its use, mainly with implant-based reconstruction techniques. ICG has a shorter half-life than fluorescein (2.5 vs. 23 min), although one of the limiting factors of ICG is that with the current technology the emitted light can only be detected up to 1 cm deep. For evaluating mastectomy flaps, this is not actually a limitation.

Margin Issues

Intraoperative Margin Evaluation

Intraoperative frozen section followed by permanent paraffin evaluation is usually performed during the NSM procedure, as it can offer an intraoperative diagnosis that may avoid a second surgery for a positive nipple margin. Rates of positive nipple margins in therapeutic NSM range from 0% to 14% [29–31]. Intraoperative frozen analysis of the retroareolar tissue has proven to have a sensitivity of 65–75% and a false-negative rate that ranges from 7% to 50% [32].

One important issue to consider is the intraoperative diagnosis of atypia. Distinguishing between atypia and carcinoma in situ in frozen section is difficult, and it can result in a false-positive result. In those cases, we recommend to wait for the final pathology in order to avoid unnecessary nipple excision [32]. Unless there is a clear positive diagnosis on the frozen section (i.e., invasive or in situ carcinoma), it is preferable to wait for the paraffin evaluation to maximize NAC preservation.

Management of Positive Nipple Margin

A positive nipple margin is considered if there is infiltrating or in situ carcinoma present on the resection edge (Fig. 20.8). There are different ways of managing a retroareolar positive margin but no clear consensus on which one is better or safer. One option is to excise the nipple and preserve the areola. Although there is short follow-up on this technique, it seems that it is a safe approach as there has not been described local recurrences in the preserved areola [33]. Another option is to give radiation therapy to the positive NAC without excision. In the group from Milan, Petit et al. [30] described use of a single dose of intraoperative radiation to the preserved NAC, with no recurrences in 1001 patients undergoing subcutaneous mastectomy at 20-month follow-up (including close and positive margins). Although with longer follow-up (50 months), there were 11 NAC recurrences (1%). Most of the groups do not give radiation therapy post NSM unless it is indicated for high-risk factors, as radiation increases complications (rates of nipple necrosis can be around 9%) and decreases cosmesis. In some studies, even with a positive margin, no further treatment is added. In those cases, there have not been recurrences in the NAC, although follow-up are very short. However, in a cohort of patients with positive nipple margins, additional tumor was found in 30% of excised nipples [34]. The pros and cons of follow-up and leaving a positive margin

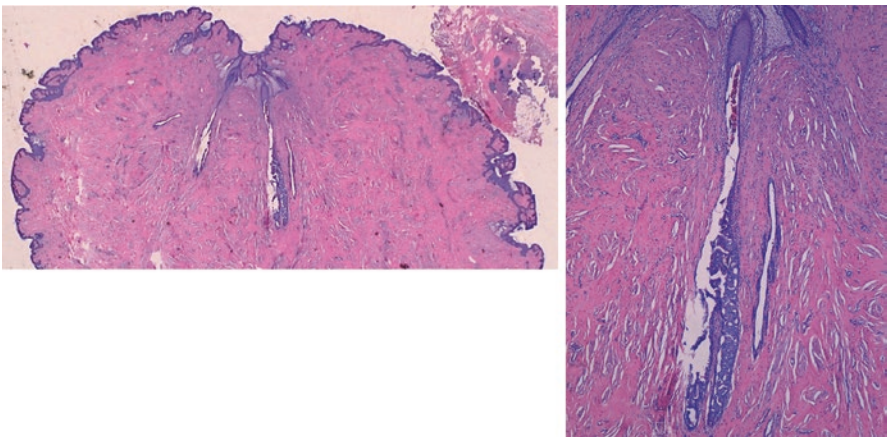


Fig. 20.8 Intraoperative positive margin for ductal carcinoma in situ

and NAC in place versus excision should be discussed with the patient with the understanding of the lack of sufficient follow-up in such cases.

Postoperative Dressing

The postoperative dressing depends mainly on the surgeon's preference. Regardless of the dressing, usually the NAC is covered with gauze only so it is easier to follow and check for early necrosis. Sometimes, the wounds are dressed with Steri-strips, and a postoperative bra is placed in the OR. Other surgeons prefer to leave a compressive dressing for the first 24 h and then change it for a bra. One drain is left in the thoracic wall and another in the axilla if an ALND has been performed. Patient can be discharged as early as 24 h later or when the drains are taken out, generally 3–4 days, depending on institutional protocols.

Surgical Complications and Solutions

Skin Flap Necrosis

Skin Flap necrosis can be partial or total. Large areas of necrosis that include the NAC and/or the surrounding breast skin envelope, either partial or total, have been reported in 2.3–5.2% of patients in the different series [26, 35].

Smoking, increasing body mass index, prior radiation, and periareolar incisions are associated with skin flap, nipple necrosis, or both [35].

Usually partial skin flap necrosis is managed conservatively, and silvadene ointment is a useful treatment (Fig. 20.9). In those cases with full skin thickness flap, especially if it is an implant-based reconstruction, it may be necessary to excise the necrosis and cover the defect.

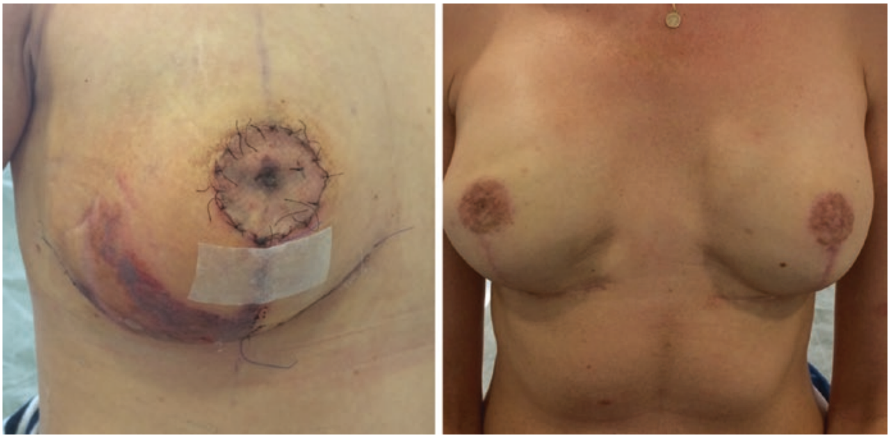


Fig. 20.9 Flap necrosis resolved with Silvadene topical treatment

Low-dose nitroglycerin ointment administration significantly decreases the rate of skin flap necrosis in patients who underwent breast reconstruction after skin-sparing or nipple-sparing mastectomy, without increasing the incidence of the side effects of nitroglycerin [36]. It can be given as a preventive measure or when the flap necrosis starts to appear.

Nipple Necrosis

In a systematic review with 6615 nipple-sparing mastectomies, the overall pooled complication rate was 22%, and the nipple necrosis rate was 7% [21]. Full-thickness necrosis that requires a NAC excision is less than 5%, while partial nipple necrosis can be as high as 20% decreasing after the initial studies. Nipple necrosis is different depending on type of reconstruction with 17% in the autologous vs. 4.1% in one stage implant reconstruction. Also, incision types increase the rates of nipple necrosis from 80% in the transareolar incision, 17% in the periareolar, to 9% in the inframammary. Overall complication and nipple necrosis rates are affected by incision location and reconstruction method [21].

Other factors that increased the nipple necrosis are prior radiation. It increases the risk of partial or total nipple necrosis compared with breasts that had no prior radiation (7.2% vs. 2.2%, respectively) [20].

Partial nipple necrosis can be managed conservatively with topical agents. Sometimes, partial necrosis and wound dehiscence need debridement and primary closure. In cases of full-thickness nipple necrosis (Fig. 20.10), excision of the NAC is required. In implant-based reconstruction avoiding an infection is crucial to avoid implant loss.

Fig. 20.10 Full-thickness nipple necrosis that required excision

Fig. 20.11 Necrosis after subareolar injection of methylene blue

When performing the SLN using blue dye, it is important to be aware that the use of subareolar injection of methylene blue can cause nipple necrosis [37] (Fig. 20.11). Other blue dyes may be better to be used instead of methylene blue. If after a few weeks of topical treatment the skin changes do not resolve, then debridement and closure of the NAC are recommended to avoid delaying treatments and decreasing the risk of infection.

Despite the risk of necrotic complications, the actual incidence of necrosis is low.

Hematoma

Rates of hematoma are reported to be <5%. Generally, if it appears in the first 24 hours postoperatively and especially if it is expanding, it is necessary to surgically drain the hematoma in order to avoid flap and/or nipple necrosis. If there is no tension, then managing it conservatively should be enough.

Infections

Rate of infections are reported to be between 0% and 18% in different series [20, 26, 27 30]. A round of oral intravenous antibiotics is generally necessary. In the case of extensive cellulitis and septic symptoms, a surgical procedure may be required. Cases of implant-based reconstruction may require removal of the implant.

Summary of complications are shown in Table 20.2.

Table 20.2 Complications in different studies

Study	*N* Procedure (pts)	Hematoma	Infection	Flap necrosis	Nipple necrosis
Italy 2016, [26]	1006 (913)	N/A	15 (1.5%)	23 (2.3%)	44 (4.8%)
UC-SF 2012, [27]	657(428)	N/A	117 (18%)	78 (11.9%)	23 (3–5%)
MSKCC 2011, [38]	353 (200)	0 (0%)	6 (2%)	69 (19.5%)	13 (3.5%)
MDA 2012, [16]	54 (33)	N/A	0 (0%)	6 (10%)	3 (5.6%)
Mass General 2014, [35]	482 (267)	8 (1.7%)	16 (3.3%)	25 (5.2%)	21 (4.4%)
Milan 2009, [30]	1001	N/A	20 (2%)	N/A	35 (3.5%)

Nipple Malposition

NAC repositioning after NSM is being reported similarly to the malposition seen in those patients with breast reduction. If the NAC has to be repositioned after the NSM, there is a greater risk of nipple necrosis. In the study by Choi and colleagues [39], with 1037 cases of NSM identified, 77 (7.4%) underwent nipple-areola complex repositioning. They found that previous radiation therapy (OR, 3.6827; $p = 0.0028$), vertical radical mastectomy incisions (OR, 1.8218; $p = 0.0202$), and autologous reconstruction (OR, 1.77; $p = 0.0053$) were positive independent predictors of NAC repositioning, while body mass index and adjuvant radiation therapy were not predictors of nipple-areola complex repositioning.

There are different techniques used for NAC reposition. It includes crescentic periareolar excision or excising of some skin directed to correct the malposition. In most cases, surgeons should not sacrifice the NAC when performing NSM because of malpositioning in the reconstructed breast. Careful evaluation is crucial before planning the NSM.

Results

Oncological Safety

With the increasing indications of NSM and breast reconstruction, it is important to ensure that the oncological outcomes remain low. Because nowadays a randomized trial comparing the NSM with other mastectomy types is not feasible or ethical, reports on the oncologically safe and outcomes come mainly from retrospective studies. Retrospective cohort studies comparing NSM with mastectomy have shown no significant difference in local or distant recurrence rates between the two procedures [40]. De la Cruz et al. published a systematic review of 20 studies with 5594 patients with NSM. Rates of disease-free survival (DFS) in studies with <3 years of follow-up, 3–5 years of follow-up, and >5 years of follow-up were 93.1%, 92.3%, and 76.1%, respectively. They did not detect adverse oncologic outcomes of NSM in selected patients [41].

In other systematic analysis including studies between January 1970 and January 2015 after a mean follow-up of 38 months (range, 7.4–156 months), the overall pooled locoregional recurrence rate was 2.38%, the overall complication rate was 22.3%, and the overall incidence of nipple necrosis was 5.9%. NSM appears to be an oncologically safe option for appropriately selected patients, with low rates of locoregional recurrence, even with this study that include many years and probably different techniques for the NSM procedure [42].

Studies have reported locoregional recurrence rates that range from 0% to 4.6% at 10–60 months of follow-up [43, 44]. Only a few studies report NAC recurrences, with very low rates (0.7–0.8%) [30, 45, 46] (Table 20.3).

In the study by Smith et al. [43], with 2182 NSM performed from 2007 to 2016, with 51 months median follow-up, 17 patients developed a recurrence of their cancer. At 51 months median follow-up, 3.7% of 297 patients had developed a locoregional recurrence, but no recurrence involved the retained NAC. Estimated disease-free survival was 95.7% at 3 years and 92.3% at 5 years. They previously reported a 2.6% rate of locoregional recurrence at 22 months median follow-up among their first 156 NSM. It is encouraging that even with longer follow-up, the rate of recurrences remains low.

Several factors have been described to increase the risk for local recurrences. It is clear that classical risk factors (age, positive nodes, size, molecular subtypes, etc.) similarly apply for the NSM as for the skin-sparing mastectomy. Again, patient selection is the key for decreasing complication and local recurrences.

In more recent years, there has been an increasing use of NSM for larger tumors, positive nodes and after neoadjuvant treatments. In these studies, rates of local recurrences are reported in a range of 2,5–6% with median follow-up of 20–40 months [10, 12, 47].

Because in all studies, complications and local recurrence rates remain low with the increased eligibility in groups with increasing experience, we consider that NSM can be performed safely for any tumor size as long as there is no clinical or imaging evidence of NAC involvement or skin involvement.

Cosmetic Outcomes

Several studies have reported cosmetic outcomes of the NSM procedures. The ASBS NSMR demonstrated compatibility of NSM with cup sizes A–E or larger for all degrees of ptosis using a variety of incisions for tissue expander (TE), direct-to-implant (DI), and autologous flap reconstruction, with consistent good to excellent cosmesis as rated by the patient and the surgeon [19].

Boneti et al. found that patients with NSM rating were significantly higher than the skin-sparing group [10].

Didier and colleagues [48], between 2004 and 2006, mailed a questionnaire to 310 women with NAC preservation and 143 patients with successive NAC reconstruction at follow-up 1 year after definitive complete breast reconstruction surgery. They found significant differences in favor of the NSM regarding body image

Table 20.3 Local recurrences of the NSM procedure

Author	Year	Cases, *N*	NAC excised %	Local recurrences %	NAC recurrences, n	F/U months
Crowe	2004	54	16.6%	0	0	0
Margulies	2005	50	18%	0	0	8
Caruso	2006	56	7.1	2	1	66
Petit	2006	114	7	1	0	13
Sacchini	2006	123	0	1.6	0	24.6
Benediktsson	2008	272	20.6	28.4	N/A	156
Petit	2009	1001	13.1	1.4	0.8%	19
Paepke	2009	109	11.9	0.9	0	34
Boneti	2011	281	2.5	4.6	0	34
Jensen	2011	99	N/A	3	0	60
Kneubil	2012	948	2.6	11.2	2	60
Wang	2014	633	N/A	3	0	29
Eisenberg	2014	208	9.6	N/A	1	33
Amara	2015	751	2.7	6.2	0	31
Orzalesi	2016	913	11.5	2.9	0.7%	36
Moo	2016	368	5.4	2.2	1	32
Smith	2017	297	6.4	3.7	0	51

satisfaction with the appearance of the nipple and with the sensitivity of the nipple. NSM has a positive impact on patient satisfaction, body image, and psychological adjustment. Similarly, Metcalf and colleagues included 37 women who completed the study with questionnaires; 53 (39%) had NSM and 84 (61%) had skin-sparing mastectomy. Women with NSM had better body image and sexual functioning compared with women with SSM, while both groups had comparable levels of cancer-related distress and perception of breast cancer risk [49].

NSM has been shown to be a better technique to preserve the integrity of the body, to improve cosmetic results, and to reduce psychological distress in most patients. Taken together, it is assumed that NSM will become more demanded from the patients.

Conclusions

With current techniques, NSM has an acceptable complication rate and low rates of local recurrences. Careful patient selection is key for a successful technique. Individualized planning for incisions and type of reconstruction taking into account patient and tumor characteristics (in therapeutic mastectomies) are crucial for decreasing complications.

While minor complications are common, NAC necrosis requiring excision or implant loss is rare. Nipple-sparing mastectomy is likely to continue to be an appealing operative option for selected patients.

Longer follow-up is planned to establish the long-term safety of NSM.

Appropriate patient selection may reduce complication rates, and full information gathered on prospective and international registry studies will contribute to the evidence-based information about NSM, which will assist in the treatment planning of our patients.

Reference Video

https://youtu.be/mDPKNvbD3zA
https://youtu.be/aZ7mD2ZBBVw

References

1. Hartmann LC, Sellers TA, Schaid DJ, et al. Efficacy of bilateral prophylactic mastectomy in BRCA1 and BRCA2 gene mutation carriers. J Natl Cancer Inst. 2001;93:1633–7.
2. Peled AW, Irwin CS, Hwang ES, Ewing CA, Alvarado M, Esserman LJ. Total skin-sparing mastectomy in BRCA mutation carriers. Ann Surg Oncol. 2014;21:37–41.
3. Yao K, Liederbach E, Tang R, et al. Nipple-sparing mastectomy in BRCA1/2 mutation carriers: an interim analysis and review of the literature. Ann Surg Oncol. 2015;22:370–6.
4. Jakub JW, Peled AW, Gray RJ, Greenup RA, Kiluk JV, et al. Oncologic safety of prophylactic nipple-sparing mastectomy in a population with BRCA mutations: a multi-institutional study. JAMA Surg. 2018;153(2):123–9.

5. Laronga C, Kemp B, Johnston D, Robb GL, Singletary SE. The incidence of occult nipple-areola complex involvement in breast cancer patients receiving a skin-sparing mastectomy. Ann Surg Oncol. 1999;6:609–13.
6. Cense HA, Rutgers EJ, Cardozo ML, Van Lanschot JJ. Nipple-sparing mastectomy in breast cancer: a viable option? Eur J Surg Oncol. 2001;27:521–6.
7. Brachtel EF, Rusby JE, Michaelson JS, Chen LL, Muzikansky A, Smith BL, Koerner FC. Occult nipple involvement in breast cancer: clinicopathologic findings in 316 consecutive mastectomy specimens. J Clin Oncol. 2009;27:4948–54.
8. Spear SL, Shuck J, Hannan L, Albino F, et al. Evaluating long term outcomes following nipple sparing mastectomy and reconstruction in the irradiated breast. Plas Reconstr Surg. 2014;133:605–14.
9. Krajewski AC, Boughey JC, Degnim AC, Jakub AW, et al. Expanded indications and improved outcomes for nipple sparing mastectomy over time. Ann Surg Oncol. 2015;22(10):3317–23.
10. Boneti C, Yuen J, Santiago C, Diaz Z, Robertson Y, et al. Oncologic safety of nipple skin sparing or total skin sparing mastectomies with immediate reconstruction. J Am Coll Surg. 2011;212(4):686–93.
11. NCCN clinical practice guidelines: breast cancer risk reduction v1.2017. Available at: http://www.nccn.org/professionals/physician_gls/pdf/breast.pdf.
12. Santoro S, Loreti A, Cavaliere F, et al. Neoadjuvant chemotherapy is not a contraindication for nipple sparing mastectomy. Breast. 2015;24:661–6.
13. Dawood S, Merajver SD, Viens P, et al. International expert panel on inflammatory breast cancer: consensus statement for standardized diagnosis and treatment. Ann Oncol. 2011;22:515–23.
14. Schneider LF, Chen CM, Stolier AJ, Shapiro RL, et al. Nipple sparing mastectomy and immediate free flap reconstruction in the large ptotic breast. Ann Plast Surg. 2012;69:425–8.
15. Muhnoz AM, Aldrighi CM, Montag E, Arruda EG, Aldrighi JM, et al. Clinical outcomes following nipple-areola-sparing mastectomy with immediate implant-based breast reconstruction: a 12-year experience with an analysis of patient and breast-related factors for complications. Breast Cancer Res Treat. 2013;140(3):545–55.
16. Wagner JL, Fearmonti R, Hunt KK, et al. Prospective evaluation of the nipple-areola complex sparing mastectomy for risk reduction and for early-stage breast cancer. Ann Surg Oncol. 2012;19:1137–44.
17. Rusby JE, Brachtel EF, Taghian A, Michaelson JS, Koerner FC, et al. Microscopic anatomy within the nipple: implications for nipple sparing mastectomy. Am J Surg. 2007;194:433–7.
18. http://essoweb.org/eurecca-inspire/.
19. Mitchell S, Beitsch P. The American Society of Breast Surgeons nipple-sparing mastectomy registry. In: Harness JK, Willey SC, editors. Operative approaches to nipple sparing mastectomy. Cham: Springer; 2017. p. 235–48.
20. Tang R, Coopey SB, Colwell AS, Specht MC, Gadd MA, Kansal K, et al. Nipple sparing mastectomy in irradiated breasts: selecting patients to minimize complications. Ann Surg Oncol. 2015;22(10):3331–7.
21. Endara M, Chen D, Verma K, Nahabedian MY, Spear SL. Breast reconstruction following nipple-sparing mastectomy: a systematic review of the literature with pooled analysis. Plast Reconstr Surg. 2013;132:1043–54.
22. Donovan CA, Harit AP, Chung A, Bao J, Giuliano AE, et al. Oncological and surgical outcomes after nipple-sparing mastectomy: do incisions matter? Ann Surg Oncol. 2016;23(10):3226–31.
23. Rusby JE, Kirstein LJ, Brachtel EF, Michaelson JS, et al. Nipple sparing mastectomy: lessons from ex vivo procedures. Breast J. 2008;14(5):464–70.
24. Matsen CB, Mehrara B, Eaton A, et al. Skin flap necrosis after mastectomy with reconstruction: a prospective study. Ann Surg Oncol. 2016;23:257–64.
25. Marta GN, Poortmans P, de Barros AC, Filassi JR, Freitas Junior R, et al. Multidisciplinary international survey of post-operative radiation therapy practices after nipple-sparing or skin-sparing mastectomy. Eur J Surg Oncol. 2017;43(11):2036–43.
26. Orzalesi L, Casella D, Santi C, Cecconi L, Murgo R, et al. Nipple sparing mastectomy: surgical and oncological outcomes from a national multicentric registry with 913 patients (1006 cases) over a six year period. Breast. 2016;25:75–81.

27. Piper M, Peled AW, Foster RD, Moore DH, Esserman LJ. Total skin-sparing mastectomy: a systematic review of oncologic outcomes and postoperative complications. Ann Plast Surg. 2013;70:435–7.
28. Komorowska-Timek E, Gurtner GC. Intraoperative perfusion mapping with laser-assisted indocyanine green imaging can predict and prevent complications in immediate breast reconstruction. Plast Reconstr Surg. 2010;125:1065–73.
29. Coopey SB, Smith BL. The nipple is just another margin. Ann Surg Oncol. 2015;22: 3764–6.
30. Petit JY, Veronesi U, Orecchia R, et al. 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. 2009;117:333–8.
31. Eisenberg RE, Chan JS, Swistel AJ, Hoda SA. Pathologic evaluation of nipple-sparing mastectomies with emphasis on occult nipple involvement: the Weill-Cornell experience with 325 cases. Breast J. 2014;20:15–21.
32. Dent BL, Chao JW, Eden DJ, Stone BV, Swistel A, et al. Nipple resection and reconstruction after attempted nipple-sparing mastectomy. Ann Plast Surg. 2017;78(1):28–34.
33. Amara D, Peled AW, Wang F, et al. Tumor involvement of the nipple in total skin-sparing mastectomy: strategies for management. Ann Surg Oncol. 2015;22:3803–8.
34. Tang R, Coopey SB, Merrill AL, Rai U, Specht M, et al. Positive nipple margins in nipple-sparing mastectomies: rates, management, and oncologic safety. J Am Coll Surg. 2016;222: 1149–55.
35. Colwell AS, Tessler O, Lin AM, et al. Breast reconstruction following nipple-sparing mastectomy: predictors of complications, reconstruction outcomes, and 5-year trends. Plast Reconstr Surg. 2014;133:496–506.
36. Yun MH, Yoon ES, Lee B, Park SH. The effect of low-dose nitroglycerin ointment on skin flap necrosis in breast reconstruction after skin-sparing or nipple-sparing mastectomy. Arch Plast Surg. 2017;44(6):509–15.
37. Lee JH, Chang CH, Park CH, Kim JK. Methylene blue dye-induced skin necrosis in immediate breast reconstruction: evaluation and management. Arch Plast Surg. 2014;41(3):258–63.
38. de Alcantara Filho P, Capko D, Barry JM, Morrow M, et al. Nipple sparing mastectomy for breast cáncer and risk reducing surgery: the Memorial Sloan Kettering Cancer Center Experience. Ann Surg Oncol. 2011 Oct;18(11):3117–22.
39. Choi M, Frey JD, Salibian AA, Karp NS. Nipple-areola complex malposition in nipple-sparing mastectomy: a review of risk factors and corrective techniques from greater than 1000 reconstructions. Plast Reconstr Surg. 2017;140:247–57.
40. De La Cruz L, Moody AM, Tappy EE, et al. Overall survival, disease-free survival, local recurrence, and nipple areolar recurrence in the setting of nipple-sparing mastectomy: a meta-analysis and systematic review. Ann Surg Oncol. 2015;22:3241–9.
41. Headin HL, Kasem A, Mokbel K. The oncological safety of nipple-sparing mastectomy: a systematic review of the literature with a pooled analysis of 12,358 procedures. Arch Plast Surg. 2016;43(4):328–38.
42. Gerber B, Krause A, Dieterich M, et al. The oncological safety of skin sparing mastectomy with conservation of the nipple areola complex and autologous reconstruction: an extended follow-up study. Ann Surg. 2009;249:461–8.
43. Smith BL, Tang R, Rai U, Plichta JK, Colwell AS, et al. Oncologic safety of nipple-sparing mastectomy in women with breast cancer. J Am Coll Surg. 2017;225:361–5.
44. Moo TA, Pinchinat T, Mays S, Landers A, Christos P. Oncologic outcomes after nipple-sparing mastectomy. Ann Surg Oncol. 2016;23(10):3221–5.
45. Lohsiriwat V, Martella S, Rietjens M. Paget's disease as a local recurrence after nipple-sparing mastectomy: clinical presentation, treatment, outcome, and risk factor analysis. Ann Surg Oncol. 2012;19:1850–e.
46. Peled AW, Foster RD, Stover AC, et al. Outcomes after total skin-sparing mastectomy and immediate reconstruction in 657 breasts. Ann Surg Oncol. 2012;19:3402–9.

47. Coopey SB, Tang R, Lei L, Freer PE, et al. Increasing eligibility for nipple-sparing mastectomy. Ann Surg Oncol. 2013;20:3218–22.
48. Didier F, Radice D, Gandini S, Bedolis R, Rotmensz N. Does nipple preservation in mastectomy improve satisfaction with cosmetic results, psychological adjustment, body image and sexuality? Breast Cancer Res Treat. 2009;118(3):623–33.
49. Metcalfe KA, Cil TD, Semple JL, Li L, Bagher S, et al. Long-term psychosocial functioning in women with bilateral prophylactic mastectomy: does preservation of the nipple-areolar complex make a difference? Ann Surg Oncol. 2015;22(10):3324–30.

Staged Nipple-Sparing Mastectomy for Patients with Large or Ptotic Breasts

21

Shawna C. Willey, Troy A. Pittman, and James M. Economides

Introduction

Nipple-sparing mastectomy involves the preservation of the skin of the breast including the nipple-areola complex (NAC) with the removal of all underlying breast parenchyma. This technique was first described in one form or another as early as the 1960s; however, concerns for its oncologic safety and technical feasibility impeded its widespread adoption [1–3]. Steadfast research into NSM, however, has demonstrated both safety and efficacy over the years.

Early work focused on safety in the prophylactic population. In 1999, a Mayo Clinic report on prophylactic mastectomy for risk reduction showed a 90–95% reduction in breast cancer risk following mastectomy in patients who underwent either total mastectomy or nipple-sparing mastectomy [4]. More recent advances in systemic therapies and surgical technique have extended the indications for NSM to patients with a diagnosis of cancer [5–8]. At the same time, genetic testing identifies increasing numbers of women who carry a higher risk for breast cancer for whom bilateral mastectomy is indicated. Increasingly these women demand the superior aesthetics afforded by preservation of the nipple-areola complex (NAC) [9].

Although NSM has grown increasingly popular as surgeons and patients have become more comfortable with the technique for both oncologic resection and

S. C. Willey
Peterson Chair of Breast Cancer Research, Inova Schar Cancer Institute, Inova Fairfax Hospital, Fairfax, VA, USA
e-mail: Shawna.Willey@inova.org

T. A. Pittman
Private Practice, Washington, DC, USA
e-mail: drpittman@pittmanmd.com

J. M. Economides (✉)
Private Practice, Arlington, VA, USA

Private Practice, Washington, DC, USA

V. S. Klimberg et al. (eds.), *Oncoplastic Breast Surgery Techniques for the General Surgeon*, https://doi.org/10.1007/978-3-030-40196-2_21

prophylaxis in breast cancer, it is most widely offered to patients with small or non-ptotic breast [9–12]. Several modifying techniques have been described with an aim toward allowing nipple preservation in the large or ptotic breast. In 1987, Woods first reported on a technique for "subcutaneous" mastectomy with concurrent mastopexy in a single stage; however, the technique as described required thick flaps to be raised and residual breast tissue to remain to allow adequate perfusion to the NAC and skin flaps [13]. Broer et al. described a similar single-stage technique of preserving the NAC on an inferiorly based pedicle at the time of NSM, which is performed through a Wise pattern incision [14]. In that report of eight patients, the fourth intercostal perforating artery is identified with the assistance of Doppler ultrasonography and incorporated into a large (10 cm) inferior pedicle which is de-epithelialized prior to mastectomy.

Others have described a two-stage approach to employ the use of the delay phenomenon to preserve perfusion to the NAC [15]. In a study of 20 patients by Jensen et al., NAC perfusion was successfully maintained in all patients undergoing an initial delay procedure involving undermining of the NAC and surrounding tissue with lymph node sampling and subareolar biopsy followed by NSM 7–21 days later. At the time of NSM, the NAC was raised using a hybrid peri-areola and lateral incision, or "hemi-batwing," design. This technique was similarly reported by several other groups [16–18]. Our institution and others have adopted yet another approach performed in two stages involving a first-stage nipple repositioning procedure (oncoplasty, reduction mammoplasty, or mastopexy) at the time of tumor extirpation and lymph node sampling followed by a second-stage definitive NSM and reconstruction at 10–12 weeks (Fig. 21.1).

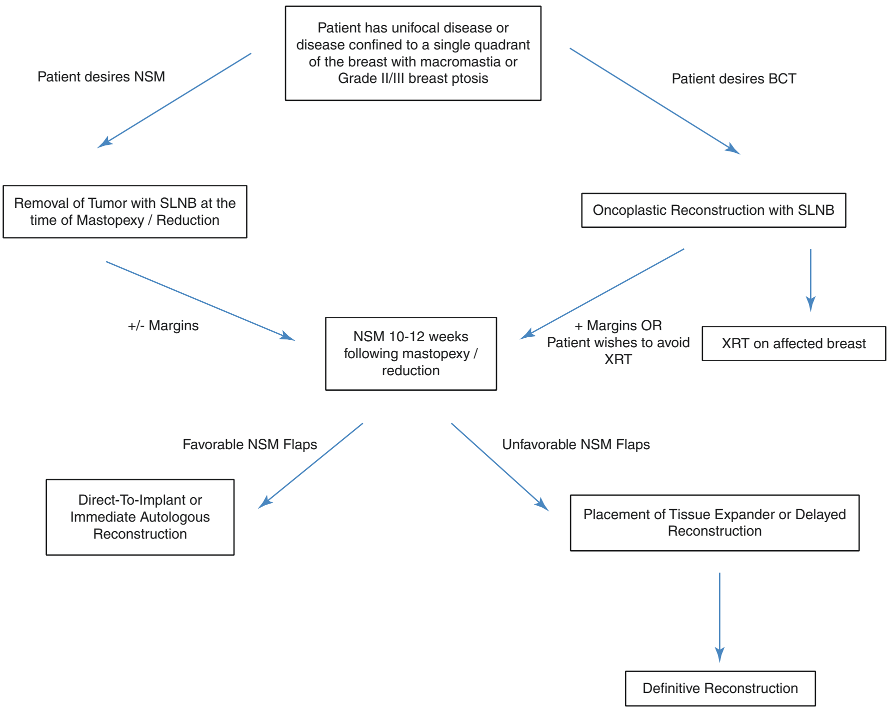


Fig. 21.1 Treatment algorithm for nipple-sparing mastectomy in the large or ptotic breast

Table 21.1 Georgetown criteria for therapeutic nipple-sparing mastectomy

Screening oncologic criteria	Patient anatomic criteria	Operative criteria
Tumor size <3 cm	No excessively large breasts	Introperative frozen section negative
Tumors >2 cm from nipple	No excessively ptotic breasts	Permanent pathology negative
No skin involvement or inflammatory CA/Paget's disease		
Possible preoperative MRI to exclude nipple involvement		
Possible preoperative ultrasound-guided mammotome biopsy		

From Spear et al. [27]

The Ideal NSM Candidate

Following mastectomy, the NAC and mastectomy skin flaps must survive only on perfusion supplied by the subdermal plexus, effectively restricting the quantity of tissue that can be adequately perfused. Conventional NSM, thus, is limited by the size of the breast envelope. In 2009, Spear et al. reported guidelines for the ideal candidate for NSM by introducing the Georgetown Criteria based not only on oncologic but also on anatomic parameters (Table 21.1) [19]. From an oncologic standpoint, NSM was offered to women with smaller peripheral tumors with clinically negative nodes. Anatomically, NSM was contraindicated in women with breasts that were excessively large or ptotic (Baker Grade II or III ptosis). These criteria were similar to other institutions such as the Mayo Clinic where NSM was offered to women with cancers 2 cm or smaller which were also 2 cm from the nipple based on clinical examination or preoperative imaging [12]. Similar to the Georgetown Criteria, anatomic contraindications at that institution included women with large or ptotic breasts, but also a high body mass index (BMI) or prior breast surgery (including reduction mammoplasty). Though the oncologic parameters for NSM have since been broadened by various centers, the anatomic realities of the larger, more ptotic breast still limit traditional NSM [20].

Challenging the Ideal: Nipple-Sparing Mastectomy After Mastopexy or Reduction Mammoplasty for the Large or Ptotic Breasts

Despite early apprehension to offering NSM for patients that had previously undergone reduction mammoplasty or mastopexy, it is now possible to extend the anatomical criteria to NSM through a two-stage approach. Breasts that were previously thought to be too large or ptotic for NSM may first be reduced and the nipple repositioned to a more anatomically appropriate location prior to mastectomy (Fig. 21.2a). In 2011, Spear et al. demonstrated that non-ideal patients with macromastia or Grade II/III ptosis may safely undergo a staged nipple-sparing mastectomy (NSM) [21].

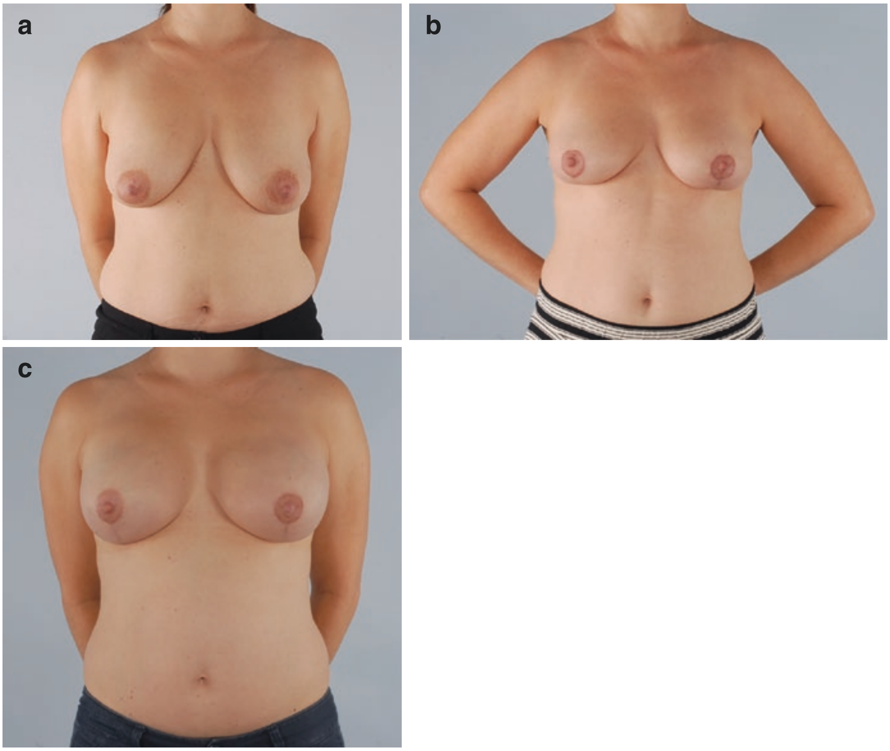


Fig. 21.2 (**a**) Preoperative clinical image of a patient with Grade II ptosis prior to right breast lumpectomy with oncoplastic reconstruction and left breast reduction mammoplasty. (**b**) Clinical image 12 weeks following right lumpectomy and oncoplastic reconstruction with contralateral nipple-repositioning operation. (**c**) Postoperative clinical image of the same patient 3 months following definitive bilateral nipple-sparing mastectomy and direct to implant reconstruction

In that series, patients underwent a nipple-repositioning procedure (either reduction mammoplasty or mastopexy) 3–4 weeks prior to definitive NSM with minimal complications. Of 24 breasts that underwent reduction mammoplasty or mastopexy prior to NSM, 17% required return to the operating room for the debridement of the NAC or skin flap necrosis, with only one implant explantation. This relatively high rate of reoperation ultimately resulted in delays in oncologic treatment as initiation of chemotherapy and/or radiation required complete soft tissue healing.

Further work has continued to build on that early experience, and our institution now incorporates a lumpectomy and lymph node biopsy at the time of the first-stage nipple-repositioning operation (Fig. 21.1). By including the extirpative surgery at the time of nipple repositioning, we are afforded an extended recovery of 10–12 weeks prior to the second stage and definitive NSM. This lengthier interval between stages allows for adequate tissue healing and reperfusion to minimize NAC loss. Since this change in procedure, our ongoing analysis of our new approach has shown a reduction in reoperation for mastectomy skin or NAC necrosis to 4%.

We have also noticed an increase in patients with larger breasts who otherwise would have pursued breast conservation therapy (BCT) now considering completion mastectomy to avoid radiation therapy. This has been particularly apparent in those patients whose lumpectomy surgical margins return positive. Incorporating the oncologic operation at the same time as nipple repositioning also creates an avenue toward NSM for a subset of patients who previously intended on pursuing BCT (Fig. 21.1). If surgical margins taken during lumpectomy and oncoplasty are found to be positive for residual cancer, patients who had intended to pursue BCT may now elect to proceed toward completion NSM with reduced risk of NAC loss. They may undergo adjuvant chemotherapy following lumpectomy and oncoplasty prior to NSM. This alternative pathway allows the patient to avoid the potential for further disfigurement caused by re-resection as well as radiation therapy required of BCT.

The safety and efficacy of the two-stage approach has since been duplicated. Alperovich et al. reported on a series of eight patients (13 breasts) with a history of previous reduction mammoplasty or mastopexy who underwent subsequent unplanned NSM [22]. No patients in that cohort experienced NAC or mastectomy flap loss at mean follow-up of 10.5 months. This study, however, was notable for the increased length of time between the nipple-repositioning operation and mastectomy at a mean interval of 51.8 months (r, 33 days – 11 years) demonstrating that a longer interval between stages could improve outcomes. This group was able to achieve successful outcomes despite the previous reduction pattern being unknown to the surgeon at the time of breast reconstruction.

Operative Technique

Stage One: Oncologic Resection and Nipple-Repositioning with Oncoplastic Reconstruction

The first-stage operation begins with surgical markings in the preoperative holding area made in conjunction with the breast oncology team and the aid of mammography to isolate the location of the tumor for resection (Fig. 21.3). A Wise-pattern skin reduction is marked, and a suitable NAC pedicle is chosen to allow for perfusion from a location away from that of the planned lumpectomy. Critically, pedicles are chosen which maintain as much periareolar dermis and superiorly based vasculature to the NAC as possible. Generally this will require maintaining the integrity of the dermis at the base of the chosen pedicle. This ensures that the blood supply to the NAC is not compromised during the second stage when an inframammary approach is used for NSM.

Intraoperatively, the NAC is marked with a cookie cutter and the chosen pedicle is de-epithelialized. After the completion of the oncologic resection by the breast oncology team, the plastic surgery team proceeds with oncoplastic reconstruction of the affected breast with the primary objectives of repositioning the NAC to an anatomically congruent location and reducing the skin envelope for a successful

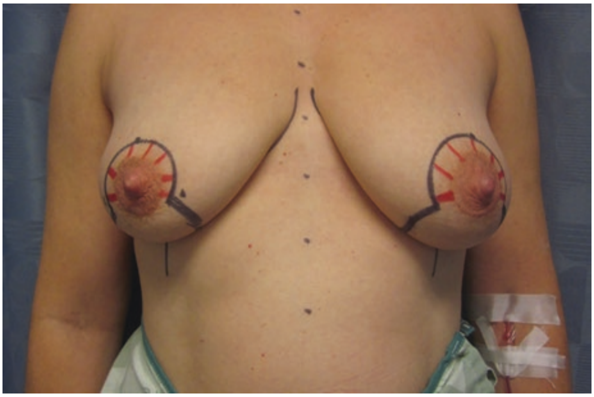


Fig. 21.3 Clinical image of preoperative surgical markings demonstrating a superiorly based pedicle for nipple-areola perfusion and Wise-pattern skin resection

reconstruction after second-stage completion mastectomy. Parenchymal resection at this stage is not the primary goal, as definitive reconstruction will occur after the second stage. Thus, no attempt is made at parenchymal repositioning or shaping. A contralateral reduction mammoplasty or mastopexy procedure is performed for symmetry at this time (Fig. 21.2b).

Stage Two: Completion NSM and Definitive Reconstruction

The second-stage completion NSM occurs at a minimum of 10–12 weeks following the index operation (Fig. 21.2c). This time period is within the range of standard practice for patients who would otherwise go on to receive radiotherapy following BCT. This lengthy interval between first and second stages is intended to reduce wound healing complications noted with more accelerated protocols. If required, adjuvant chemotherapy is performed following the ablative surgery and prior to definitive mastectomy once successful wound healing has been achieved. Chemotherapy commences within 8 weeks of the ablative surgery, in line with current recommendations [23].

The NSM is performed through an inframmmary incision by the breast oncology team and includes separate pathologic evaluation of retroareolar tissues [19, 24]. Past experience with periareolar and lateral incisions have proven to lead to untoward complications involving nipple necrosis and lateralization of the NAC [25]. By favoring superiorly based pedicles to the NAC during the first stage, this blood supply is not violated during an inframammary approach at the second stage.

It is essential that the mastectomy skin flaps are of adequate thickness to ensure tissue perfusion. Our institution routinely employs the use of fluorescence angiography to assess the vascularity of mastectomy flaps, and this technology has allowed us to offer direct-to-implant (DTI) reconstruction when adequate tissue perfusion is confirmed. The determination to proceed with direct-to-implant reconstruction or tissue expander-based reconstruction is made after both clinical assessment and fluorescence angiography. Particular attention is made to the inferolateral mastectomy flap immediately inferior to the NAC, which represents a watershed area of tissue most likely to have decreased perfusion with Wise-pattern scars. In vivo use of fluorescence angiography has the added benefit of assessing tissue perfusion in real time and in conjunction with the breast oncology team prior to reconstruction. As our experience grows with this technology, we have seen a trend toward more robust mastectomy flaps and thus our ability to perform direct-to-implant reconstructions. Prior to our routine use of this technology, 100% of patients underwent reconstruction with tissue expanders. Since our implementation of fluorescence angiography, however, 76.9% of patients undergoing prosthetic-based reconstruction have benefited from DTI reconstructions and are thus spared an additional operation required for exchange to a permanent prosthesis. Of this subset of patients, none have experienced NAC or mastectomy flap ischemia or necrosis, compared to up to 7.5% and 14.4%, respectively, in previously published reports of DTI following NSM [26].

Staged Reconstruction with Autologous Free Tissue Transfer

Despite the assistance of fluorescence angiography in improving rates of mastectomy flap and NAC necrosis, our continued experience with staged NSM following reduction mammoplasty and/or mastopexy has shown a trend toward higher rates of NAC and mastectomy flap ischemia following immediate autologous reconstruction. These ischemic changes were seen despite adequate intraoperative perfusion as seen on fluorescence angiography. We attribute these changes to postoperative flap edema seen in autologous reconstruction as well as the ischemic insult caused by prolonged retraction of the mastectomy flaps required for vessel exposure during microsurgery and now prefer to perform immediate tissue expander placement at the time of mastectomy, followed by delayed free tissue reconstruction.

Conclusion

Historically, anatomic considerations aimed at maintaining perfusion to the mastectomy skin flaps and NAC limited NSM to women with smaller, nonptotic breasts. Incorporating a two-stage approach to those with macromastia or Baker Grade II or III ptosis may allow more women to benefit from the superior aesthetics of NSM. In the initial stage, the tumor is removed and lymph nodes sampled similar to BCT. The affected breast is reconstructed with oncoplasty at that time and the contralateral breast undergoes a mastopexy or reduction mammoplasty for symmetry. After 10–12 weeks, the second stage proceeds with definitive NSM and reconstruction.

Reference Video

- https://youtu.be/hJk1K_0pXt8
- https://youtu.be/JlameV2MpHo
- https://youtu.be/Pqpdxmx_5RU

References

1. Freeman BS. Technique of subcutaneous mastectomy with replacement; immediate and delayed. Br J Plast Surg. 1969;22:161–6.
2. Hinton CP, Doyle PJ, Blamey RW, Davies CJ, Holliday HW, Elston CW. Subcutaneous mastectomy for primary operable breast cancer. Br J Surg. 1984;71:469–72.
3. Kissin MW, Kark AE. Nipple preservation during mastectomy. Br J Surg. 1987;74:58–61.
4. Hartmann LC, Schaid DJ, Woods JE, et al. Efficacy of bilateral prophylactic mastectomy in women with a family history of breast cancer. N Engl J Med. 1999;340:77–84.
5. Agarwal JP, Mendenhall SD, Anderson LA, Ying J, Boucher KM, Liu T, Neumayer LA. The breast reconstruction evaluation of acellular dermal matrix as a sling trial (BREASTrial): design and methods of a prospective randomized trial. Plast Reconstr Surg. 2015;135:20–8e.
6. Petit JY, Veronesi U, Orecchia R, et al. Risk factors associated with recurrence after nipple-sparing mastectomy for invasive and intraepithelial neoplasia. Ann Oncol. 2012;23:2053–8.
7. Gabos Z, Thoms J, Ghosh S, Hanson J, Deschenes J, Sabri S, Abdulkarim B. The association between biological subtype and locoregional recurrence in newly diagnosed breast cancer. Breast Cancer Res Treat. 2010;124:187–94.
8. Lin NU, Vanderplas A, Hughes ME, et al. Clinicopathologic features, patterns of recurrence, and survival among women with triple negative breast cancer in the national comprehensive Cancer network. Cancer. 2012;118:5463–72.
9. de Alcantara Filho P, Capko D, Barry JM, Morrow M, Pusic A, Sacchini VS. Nipple-sparing mastectomy for breast cancer and risk reducing surgery: the Memorial Sloan-Kettering Cancer Center experience. Ann Surg Oncol. 2011;18:3117–22.
10. Coopey SB, Tang R, Lei L, et al. Increasing eligibility for nipple sparing mastectomy. Ann Surg Oncol. 2013;20:3218–22.
11. Wang F, Peled AW, Garwood E, et al. Total skin-sparing mastectomy and immediate breast reconstruction: an evolution of technique and assessment of outcomes. Ann Surg Oncol. 2014;21:3223–30.
12. Krajewski AC, Boughey JC, Degnim AC, Jakub JW, Jacobson SR, Hoskin TL, Hieken TJ. Expanded indications and improved outcomes for nipple-sparing mastectomy over time. Ann Surg Oncol. 2015;22:3317–23.
13. Woods JE. Detailed technique of subcutaneous mastectomy with and without mastopexy. Ann Plast Surg. 1987;18(1):51–61.
14. Broer N, Narayan D, Lannin D, Grube B. A novel technique for nipple-sparing mastectomy and immediate reconstruction in patients with macromastia. Plast Reconstr Surg. 2010;126(2):89e–92e.
15. Jensen JA, Lin JH, Kapoor N, Giuliano AE. Surgical delay of the nipple-areolar complex: a powerful technique to maximize nipple viability following nipple-sparing mastectomy. Ann Surg Oncol. 2012;19(10):3171–6.
16. Bertoni DM, Nguyen D, Rochlin D, et al. Protecting nipple perfusion by devascularization and surgical delay in patients at risk for ischemic complications during nipple-sparing mastectomies. Ann Surg Oncol. 2016;23:2665–e72.
17. Palmieri B, Baitchev G, Grappolini S, et al. Delayed nipple sparing modified subcutaneous mastectomy: rationale and technique. Breast J. 2005;11:173–e8.
18. Martinez CA, Reis SM, Sato EA, Boutros SG. The nipple-areola preserving mastectomy: a multistage procedure aiming to improve reconstructive outcomes following mastectomy. Plast Reconstr Surg Glob Open. 2015;3:e538.
19. Spear SL, Hannan CM, Willey SC, Cocilovo C. Nipple-sparing mastectomy. Plast Reconstr Surg. 2009;123:1665–73.
20. Hieken TJ, Boolbol SK, Dietz JR. Nipple-sparing mastectomy: indications, contraindications, risks, benefits, and techniques. Ann Surg Oncol. 2016;23(10):3138–44.

21. Spear SL, Rottman SJ, Seiboth LA, Hannan CM. Breast reconstruction using a staged nipple-sparing mastectomy following mastopexy or reduction. Plast Reconstr Surg. 2012;129(3):572–81.
22. Alperovich M, Tanna N, Samra F, Blechman K, Shapiro RL, Guth AA, Axelrod DM, Choi M, Karp NS. Nipple-sparing mastectomy in patients with a history of reduction mammaplasty or mastopexy: how safe is it? Plast Reconstr Surg. 2013;131(5):962–7.
23. Chavez-MacGregor M, Clarke CA, Lichtensztajn DY, Giordano SH. Delayed initiation of adjuvant chemotherapy among patients with breast cancer. JAMA Oncol. 2016;2(3):322–9.
24. Spear SL, Hannan C, Seiboth L, Al-Attar A. Nipple-sparing mastectomy: a review of indications, techniques and safety. Plast Reconstr Surg. 2010;126:25.
25. Rawlani V, Fiuk J, Johnson SA, Buck DW 2nd, Hirsch E, Hansen N, Khan S, Fine NA, Kim JY. The effect of incision choice on outcomes of nipple-sparing mastectomy reconstruction. Can J Plast Surg. 2011 Winter;19(4):129–33.
26. Choi M, Frey JD, Alperovich M, Levine JP. Karp NS. "breast in a day": examining single-stage immediate, permanent implant reconstruction in nipple-sparing mastectomy. Plast Reconstr Surg. 2016;138(2):184e–91e.
27. Spear SL, Willey SC, Feldman ED, et al. Nipple-sparing mastectomy for prophylactic and therapeutic indications. Plas Reconstr Surg. 2011;128:1005–14.

Donut Mastectomy

22

V. Suzanne Klimberg

Introduction

Nipple skin-sparing mastectomy has been shown to be safe in terms of local recurrence and survival. As techniques have developed it has been shown to have a high success rate of preservation of the skin of the breast and the nipple and a low complication rate. Women with large and/or ptotic breasts who want a reduction and/or a lift have not in general been a good candidate for an immediate reconstruction with a nipple skin-sparing mastectomy. Either the volume of the breast cannot be matched and/or it would be too heavy given that it could be accomplished. There is also a limit to the size of the implant. In addition, many women with large breasts desire a reduction for health purposes. In these patients, one strategy is to first have a reduction mammoplasty with an oncologic extirpation followed by some months later a total skin-sparing mastectomy/nipple skin-sparing mastectomy (NSSM) [1]. The ability to safely perform delayed NSSM after prior breast surgery has been shown to have no greater risk for nipple loss or ischemic complications. Because two surgeries are not ideal, there has been a move to try and reduce the skin envelope at the time of the mastectomy while retaining a normal sized envelope of skin as well as the nipple areolar complex. Several authors have attempted dermomyofascial preservation of the nipple with various techniques [2]. Dietz et al. fashioned a wise-pattern taking care to preserve the full thickness of the dermal flap and folding the dermis on itself to complete the reduction and reshaping the breast with good results and obtaining immediate reduction and NSSM and reconstruction [3]. This required Wise-pattern-like incisions and in ptotic breast sometimes it may need a nipple graft to reduce nipple necrosis. The donut mastectomy represents another safe way to reduce the breast while preserving the skin of the nipple areolar complex (NAC) and much of the skin of the breast [4].

V. S. Klimberg (✉)
University of Texas Medical Branch, Galveston, TX, USA

MD Anderson Cancer Center, Houston, TX, USA

V. S. Klimberg et al. (eds.), *Oncoplastic Breast Surgery Techniques for the General Surgeon*, https://doi.org/10.1007/978-3-030-40196-2_22

Indications

- Gynecomastia in males.
- Women with breast cancer who want an alternative to implant or tissue reconstruction.
- Large-breasted women undergoing mastectomy who also want a reduction.
- Ptotic patients undergoing mastectomy who want a lift.
- Transgender female-to-male cosmetic mastectomies.

Men with gynecomastia have traditionally had simple mastectomies with large scars removing redundant skin with or without the nipple. In general, cosmetic results have been less than ideal. The donut mastectomy represents a way to reduce the amount of skin and retain the nipple areola skin without have a sunken central breast.

For women with large pendulous breasts, nipple skin-sparing mastectomies became possible with de-epithelization of the skin around the nipple areola if a donut fashion was performed and enfolded similar to a Benelli [5] reduction which has the effect of relocating the nipple areolar complex as well as flattening the chest wall.

Some women do not want reconstruction with an implant or tissue transfer. The donut mastectomy offers an alternative that can be done at the time of surgery leaving them with a small mound similar to a Goldilocks' reduction [6]. It can also be an intermediate step to through a post-chemotherapy surgery and have a later breast reconstruction.

In addition, to those with gynecomastia [4, 7, 8], a donut mastectomy can be utilized for female-to-male transgender patients with low morbidity, good cosmetic result, and high patient satisfaction.

Contraindications

- Locally advance breast cancer
- Greater than 4 cm donut width to achieve ultimate cosmesis
- Skin involvement
- Contraindications related to preservation of the NAC
- Presence of infection
- Prepubertal gynecomastia

Preoperative Evaluation and Planning

When performing a skin-sparing mastectomy, the surgeon must know the depth of the tumor so that a clear margin can be obtained. This can be accomplished by the standard needle localization (Chap. 7), intraoperative ultrasound-guided excision (Chap. 8), radioguided seed localization (Chap. 9), or fluoroscopic intraoperative neoplasia and nodal detection (Find) (Chap. 10). This can be up to the operator to use a technique that they can make sure they clear the margin when sparing the skin. When using the donut technique, the operator may have to do it from a remote scar as the scar is within the de-epithelized portion of the donut. If the lesion is too close but not involving, the skin then a separate skin ellipse can be made directly over the lesion.

Surgical Technique

Anesthesia

General anesthesia is the easiest modality to use for both the patient and the surgeon and is safe. Spinal, paraspinal, pectoral, and rib blocks with long-acting anesthetics or even botulinum toxin are also feasible for performing the operation and also for postoperative pain relief [1, 9]. In addition, botulinum toxin injected into the muscle can give long-lasting pain relief if expanders/implants are used for reconstruction.

Positioning and Marking

The patient is positioned on the edge of the table and the arm abducted at 90° (Fig. 22.1). The operator and assistant may stand on either side of the arm. The entire chest is prepped and draped so that both breasts can be visualized for attaining symmetry. It is important to position the patient so you can lift the patient during the surgery to assess symmetry. The sternal notch and xiphoid are marked with a line drawn in between them. A line from the midclavicular to the nipple and from the nipple to the inframammary fold is made that is approximately 10–12 cm from the midsternal line.

Intraoperative Localization

When operating on a non-palpable lesion or even a palpable one. It is important to be aware exactly the lesion is located and at what depth such that an adequate margin can be accomplished. This can be achieved with prior needle localization of a non-palpable lesion or with more modern and humane techniques such as intraoperative ultrasound, radioguided or magnetic localization, or fluoroscopic intraoperative neoplasia or nodal detection (FIND).

De-epithelization

This approach combines the Benelli or donut round block technique with a subcutaneous or in the case of cancer, a nipple skin-sparing mastectomy [5]. The procedure begins with de-epithelization of a donut of skin around the areola (Fig. 22.2).

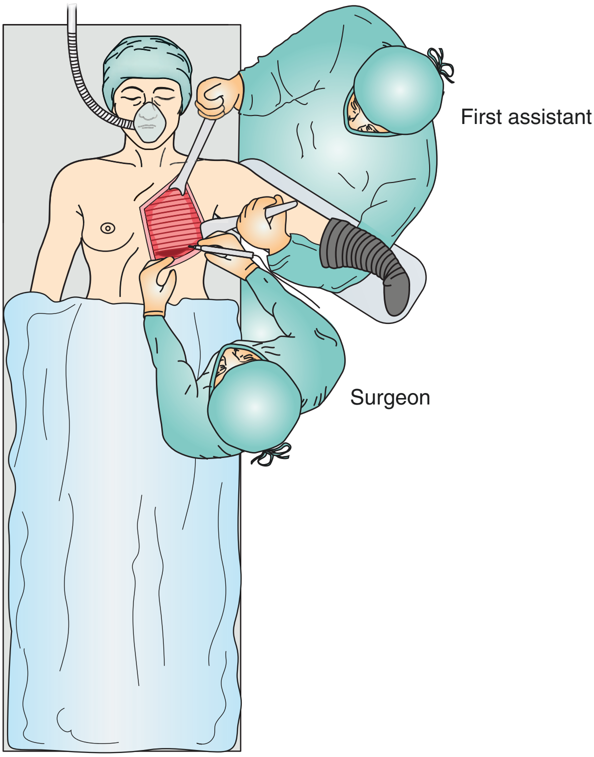


Fig. 22.1 The patient is positioned with the arm abducted at 90° so that the primary surgeon and assistant can stand on either side of the arm

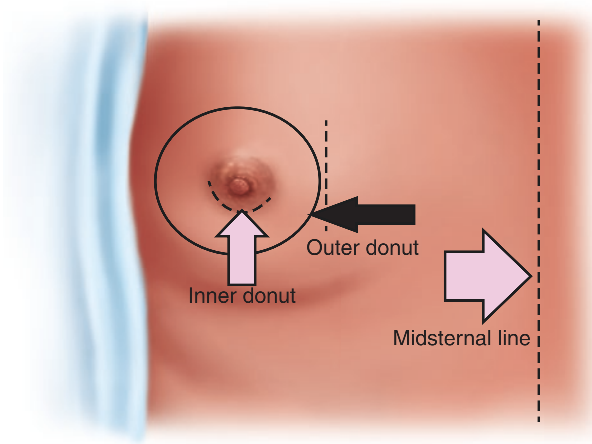


Fig. 22.2 Skin markings for formation of the de-epithelized donut around the nipple

The skin around the limbus of the areola is scored, and then similarly a second concentric circle no more than 4 cm wider is made. The width of de-epithelization is chosen based on the correction needed. For example, if the distance of the nipple from the midline is 15 cm, then the width of de-epithelization should be at least 3 cm, so to leave at least 9–10 cm from the nipple to the midline. The skin in between these two circles is then de-epithelized taking care to not injure the dermis and thus the blood supply to the nipple areolar complex.

Mastectomy

Access for the mastectomy is made through an incision in the de-epithelized portion of donut. This can be made in a curvilinear fashion or radially depending on the size of the breast to be removed (Fig. 22.3). A radial incision to the inframammary fold can be used if better or larger access is needed. A mixture of short- and long-acting anesthetics injected in the fat plane between the skin and the glandular tissue has been described but has not shown any difference of flap necrosis. A series of dilators can be used to create the correct plane to create a viable flap (Fig. 22.4) [1]. The flaps are made circumferentially and then the anterior dissection performed removing the breast from the chest wall.

NAC Dissection

Special care needs to be used in removing the nipple areolar complex from the skin of the nipple areolar complex and is best down under very little tension and sharply as electrocautery can damage the dermis.

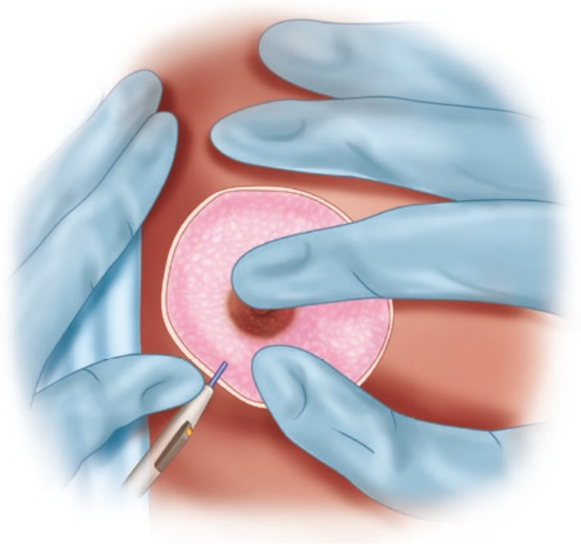


Fig. 22.3 Incision for access to mastectomy in de-epithelized zone

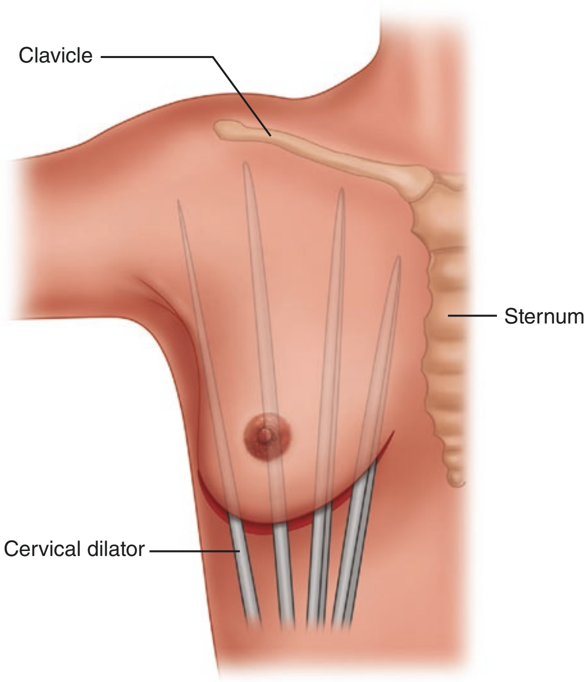


Fig. 22.4 Dilation technique for determining the plane of flap dissection is performed with successive dilators 19–44 French

Closure Including Drain

After thorough irrigation, a drain is placed and the incision in the dermis closed. Initial closure of the dermis is made in a "clover leaf" pattern and continued bisection between each suture until the nipple areolar complex is surrounded by tissue (Fig. 22.5). A nonabsorbable suture is used to make the subcuticular stitch in a purse-string fashion (Fig. 22.6). Figure 22.7a–c shows the same procedure in a female patient with breast cancer desiring a mastectomy and a reduction in the size of the breasts. Because she had neoadjuvant chemotherapy, the plastic surgeon wanted to delay reconstruction.

Surgical Complications and Solutions

Pitfalls and Pearls

In making the de-epithelized donut, care should be made to make it no more than 4 cm so as to preserve the blood supply of the nipple areola. Of note is that the donut does not need to be symmetrical within the same breast or compared to the contralateral breast. Most patients are not symmetrical a priori. Thus if the nipple areolar

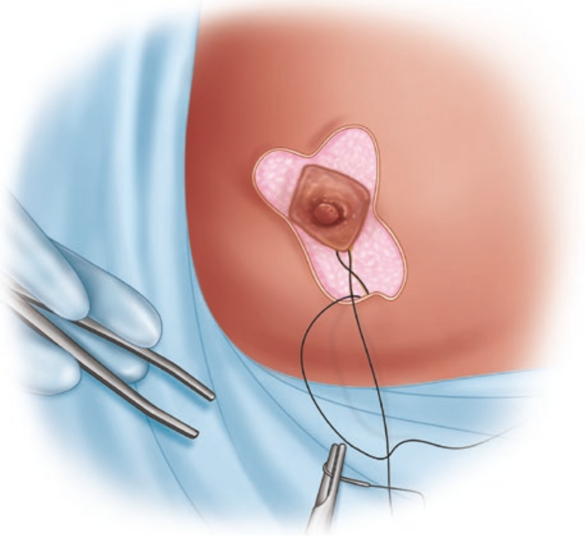


Fig. 22.5 Initial closure of donut de-epithelized tissue in "clover leaf" pattern

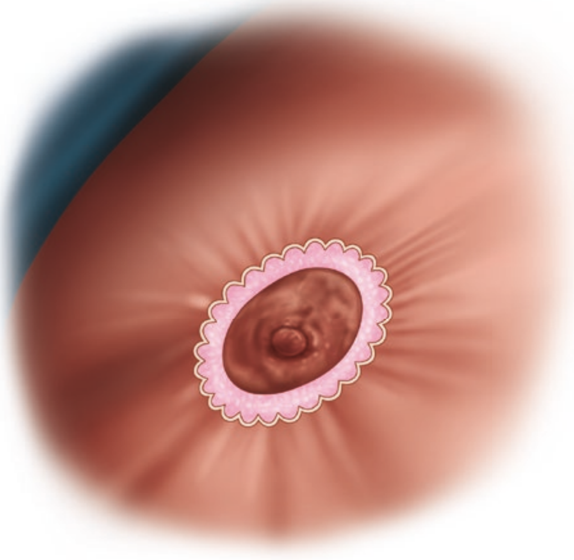


Fig. 22.6 Final closure subcutaneous with a single circumferential incision

complex needs to be moved up or in, the donut can be altered to move the nipple in that direction. This procedure should not be used in smokers.

This procedure should not be used in prepubertal patients with gynecomastia as they may correct themselves.

This procedure should not be used in patients with cancer that involves the nipple areolar complex.

Fig. 22.7 Donut mastectomy for breast cancer. (**a**) De-epithelized nipple areolar complex with incision in dermis for access to mastectomy. (**b**) Closure without implants. (**c**) Two weeks postoperative results

Postop Management

Most operative management is the same for most mastectomy patients where drains are removed in 7–10 days when the drainage is less than 30 mls. One caveat to that, is that if the patient is not having or delaying reconstruction, some seroma formation may prevent wrinkling of the overlying skin and may be beneficial in which case drains can be removed after a few days.

Complications

Complications, in general, include those of any mastectomy – infection, wound dehiscence, flap necrosis, and persistent seroma. In addition, with the donut mastectomy, the periareolar scar can widen if a permanent purse-string closure is not used or that stitch is removed postoperatively.

Results and Conclusions

The round block technique has similar rates of complication and lower re-excision rates and better cosmesis to standard wide local excision. Its use in conjunction with a mastectomy has not been well studied. Dietz and others have shown that when combined with a nipple skin-sparing mastectomy, complication rate are low and cosmetic results are improved in the large-breasted and ptotic patient [3].

Video Reference

https://www.youtube.com/watch?v=oJLls3GjpXU

References

1. Boneti C, Yuen J, Santiago C, Diaz Z, Robertson Y, Korourian S, Westbrook KC, Henry-Tillman RS, Klimberg VS. Oncologic safety of nipple skin-sparing or total skin-sparing mastectomies with immediate reconstruction. J Am Coll Surg. 2011;212(4):686–93.
2. Rochlin DH, Nguyen DH. Deepithelialized skin reduction preserves skin and nipple perfusion in immediate reconstruction of large and ptotic breasts. Ann Plast Surg. 2018;81(1):22–7.
3. Dietz J, Fedele G. Skin reduction nipple-sparing mastectomy. Ann Surg Oncol. 2015;22(10):3404.
4. Mancino A, Young Z, Bland KI. In: Bland KI, Copeland EM, Klimberg VS, Gradnishar WJ, editors. Gynecomastia in the breast. Philadelphia: Elsevier; 2017. p. 104–15.
5. Lanitis S, Hadjiminas DJ, Sgourakis G, Al Mufti R, Karaliotas C. Modified Benelli approach for superior segmentectomy: a feasible oncoplastic approach. Plast Reconstr Surg. 2010;126(4):195e–7e.
6. Richardson H, Aronowitz JA. Goldilocks mastectomy with bilateral in situ nipple preservation via dermal pedicle. Plast Reconstr Surg Glob Open. 2018;6(4):e1748.
7. Cordova A, Moschella F. Algorithm for clinical evaluation and surgical treatment of gynaecomastia. J Plast Reconstr Aesth Surg. 2008;61:41–9.
8. Tunio MA, Al-asiri M, Al-Amro A, Bayoumi Y, Fareed M. Optimal prophylactic and definitive therapy for bicalutamide-induced gynecomastia: results of a meta-analysis. Curr Oncol. 2012;19:e280–8.
9. Layeeque R, Hochberg J, Siegel E, et al. Botulinum toxin infiltration for pain control after mastectomy and expander reconstruction. Ann Surg. 2004;240(4):608–14.

Technology-Assisted Mastectomy: Robotic- and Endoscopic-Assisted Mastectomy

23

Benjamin Sarfati and Giuseppe Sanese

Introduction

Historical Background: Origins of Endoscopic and Robotic Surgery

Over time, the extent of breast cancer surgery has varied, and less extensive mastectomies are employed today, as more extensive surgeries did not mean an improvement in survival. Surgeons have moved from the Halsted mastectomy to breast-conserving surgery, and the incorporation of breast reconstruction has become an important step in the management of breast cancer. In this evolution, ever less mutilating and invasive forms of mastectomy ("technology-endoscopic or robotic-assisted mastectomies") have been developed.

The first report regarding video-assisted surgery for breast cancer was written by Friedlander et al. [1] in 1995. They performed experimental surgery using an endoscope and an original tripod elevator initially on porcine models and thereafter on cadavers. Their surgery consisted of total mastectomy, axillary dissection, and reconstruction of the breast with the rectus abdominis muscle. They thought of applying this surgery to patients with large ductal carcinoma in situ and lobular carcinoma in situ who required complete removal of the mammary gland. They also suggested the application of such surgery for benign breast disease. In 1997, Yamagata and Iwai [2] reported on endoscopic partial mastectomy and axillary dissection for breast cancer.

B. Sarfati
Service de Chirurgie Plastique et Reconstructrice, Gustave Roussy, Villejuif, France
e-mail: contact@docteursarfati.com

G. Sanese (✉)
PhD School on Medical-Surgical Applied Sciences-Plastic Regenerative research area, "Tor Vergata" University of Rome; Federated Specialization School on Plastic, Reconstructive and Aesthetic Surgery, "Sapienza", University of Rome and "Tor Vergata" University of Rome, School of Medicine, Rome, Italy

V. S. Klimberg et al. (eds.), *Oncoplastic Breast Surgery Techniques for the General Surgeon*, https://doi.org/10.1007/978-3-030-40196-2_23

The access to the breast was done by an incision around the areola, they performed partial mastectomy using a lifting system and axillary lymph node dissection under gas insufflation after a blunt dissection using a balloon system.

The futuristic mini-invasive and video-assisted techniques of mastectomy have undergone several and rapid evolutions in the last decades. Many have contributed to the evolution of futuristic mini-invasive or video-assisted techniques of mastectomy. The latest development of this process was the use of surgical robotic platform (Da Vinci Robot™, Intuitive Surgical, CA) to perform the NSM applying an endoscopic approach. The use of this technology has further improved the accuracy of tissue dissection with the use of a tridimensional vision and articulated surgical instruments that were able to accommodate the round shape of breasts.

The first successful robotic transaxillary nipple-sparing mastectomy was performed by Zonta et al. in 2011, and it actually opened a new horizon in the panorama of breast surgery [3]. In 2015 Toesca published their series with an improved technique [4].

Mastectomy and Endoscopic Surgery

Endoscopic (or laparoscopic) surgery is a technique that optimizes cosmetic outcomes because it is performed through small hidden incisions in inconspicuous areas. It is widely used in the gastrointestinal [5, 6], urologic, and thoracic surgical fields. Endoscopy-assisted breast surgery (EABS), which is performed through minimal axillary and/or periareolar incisions, was initially developed to facilitate breast augmentation [7, 8], but it is now increasingly used to excise benign breast tumors [9–11], resect malignant breast tumors [12–15], and to assist in sentinel lymph node biopsy (SLNB) [16, 17].

EABS has been shown to be an effective breast-conserving technique for early breast cancer [13, 15, 18–20]. In addition, endoscopic approaches can be used to perform skin-sparing mastectomy (SSM) and NSM [14, 21] followed by IBR with implants [22–24] or autologous flaps [25, 26].

Robotic breast surgery can be considered a direct evolution of endoscopic one, because it allows overcoming some of the limits imposed by this technique. In favor of endoscopic surgery is the large difference in costs, much lower in endoscopic compared to robotic surgery.

Nipple-Sparing Mastectomy and Robotic Surgery

SSM and NSM, often called “conservative mastectomies”, are results of a paradigm shift in breast cancer, summarized by Umberto Veronesi’s maxim “from maximum tolerable treatment, to minimum effective treatment” [27]. The shift was ushered in by the development of breast-conserving surgery (quadrantectomy or lumpectomy).

This was followed by sentinel node biopsy, which allowed surgeons not to perform axillary lymph node dissection if the sentinel node was negative [28]. Subsequently, avoidance of axillary surgery was shown to be adequate in selected cases with positive sentinel nodes [29] as highlighted elsewhere in this book. Conservative mastectomies are also a direct result of the development of oncoplastic surgery, which combines tumor removal and preparation of skin flaps with usually immediate breast reconstruction and remodeling to provide superior aesthetic outcomes, without compromising local disease control.

Immediate reconstruction spares women the ordeal of repeat surgery to restore body image [30].

In SSM, robotic mastectomy is not indicated because, being forced to excise part of the skin envelope, it is more practical to proceed through the classical mastectomy incisions.

Nipple-sparing mastectomy (NSM) is closely similar to SSM but is the real conservative innovation in that the nipple-areola complex is preserved as well as the skin. Both techniques are associated with superior aesthetic outcomes and increased patient satisfaction compared to non-conservative mastectomy [31]. One may wonder why the surgeon should go through the trouble of saving the nipple-areolar complex if it can be easily reconstructed in a later operation under local anesthesia. The reasons are that patients generally report low satisfaction with a reconstructed nipple [32] and both psychosocial well-being and sexual well-being are lower following SSM compared to NSM [33].

Evaluating NSM for risk reduction, it appears as an attractive option as a risk-reducing procedure for patients with an high possibility of developing breast cancer. A number of studies have provided evidence [34, 35].

Nipple-sparing mastectomy finds its higher expression in robot-assisted breast surgery, due to the scar reduction allowed and the good prepectoral reconstruction obtained, thanks to the “gentle” manipulation of the skin flaps.

The use of robotics in surgery has captured the imagination of many. It is a growth area across the breadth of surgical specialties, with many procedures becoming routinely classed as “robot-assisted.” The rapid increase in surgical research involving robotic assistance can be witnessed by the rising number of articles published in consecutive years related to the subject.

Different brands and models of surgical robots have been developed. All surgical robots are characterized by the ability to reproduce as much as possible, in a faithful manner, the movements and instruments of the surgeon and those of a part of the operating team, providing tools for advanced vision and the possibility of acting through reduced surgical accesses.

An important step in the field of surgery was made when a robot was first used in the operating theater about 25 years ago. The robot was a PUMA 200™ (*Westinghouse Electric, Pittsburgh, PA)* which was used for needle placement in a CT-guided brain biopsy [36, 37].

In our experience, in the field of breast surgery, the most commonly used robotic device is the Da Vinci Robot™, used in the majority of studies reported.

Da Vinci Robot™

The Da Vinci Xi ™ Dual Console System Model IS4000 (Intuitive Surgical®, Sunnyvale, CA) is shown in Fig. 23.1.

A first machine called “Patient cart” consisting of four robotic arms handled by contact or by remote control, equipped with a three-dimensional endoscope and articulated, sterilizable instruments insertable into the patient (Fig. 23.1).

A second machine called “Surgeon console (Surgeon cart)” consisting of three-dimensional optics binocular visualization of the operating field transmitted by the endoscope, as well as the manual telehandlers of the Patient cart arms (Fig. 23.1).

A third machine called “Vision cart,” which contains vision and energy technologies and provides communications across da Vinci system components. It provides the integration of power generation, image processing, and information systems. It also includes the display that shows a live feed of the procedure (Fig. 23.1).

The “fourth generation” Da Vinci® Xi ™ equips specifically:

- Laser system for station positioning with pre-sets setup and position of the arms, according to the surgical procedure;
- Narrow arms that, when introduced in a cavity (such as the oropharingeal cavity), allow working in deep and narrow spaces;
- Motion scaling, tremor abolition, and the 7 degrees of motion freedom at the tips of the robotic instruments, enhancing precision as further described;
- A high-definition three-dimensional auto-adjustable endoscope which offers a tenfold magnified view of the operating field;

Fig. 23.1 Da Vinci robot™ surgical system: from left to right the Surgeon cart, the Vision cart, and the Patient cart (see text). (© [2019] Intuitive Surgical, Inc.)

- A Firefly Fluorescence Imaging System
- Integration of energy generators within the Vision cart trolley for optimization of the use of tele-robotised instruments (monopolar, bipolar, vessel-seal, harmonic)
- A motorized Patient cart with articulated arms from a single mobile and displaceable axis (called station), optimized for 4-quadrant surgery in laparoscopic surgery
- Carbon dioxide insufflation replacing the retractors used in the open technique and being quite less invasive

Endoscopic-Assisted Versus Robotic-Assisted Breast Surgery

Surgical robots are designed to assist surgeons overcome inherent issues with minimally invasive surgery. A human wrist has seven degrees of freedom, while movement during laparoscopic surgery is restricted to four. Other issues, characteristic of laparoscopic surgery, include limited vision in two dimensions, non-ergonomic positioning of the surgeon and patient, and an amplification of physiologic hand tremor.

Surgical robots allow visualization of the patient in three dimensions. The manipulators have a number of end-effectors and movement capabilities more similar to a human wrist. Scaling down surgeon movements at the end-effectors allows for greater control, bypasses the fulcrum effect of using endoscopic tools and the elimination of physiological tremor being an attractive promise for microsurgery. Surgeon control over the robotic arms is from an independent console, facilitating tele-surgery and increasing comfort. Dual cameras in the scope produce a three-dimensional image, while the endoscopic vision is bidimensional without the possibility of widening the field of vision or moving the visual in all the direction.

A major belief concerning endoscopic breast surgery is that it is time-consuming, since it usually takes more time than a traditional operation, and that it seems to have a higher complication rate than traditional methods. However, it improves cosmetic results, which was the primary reason for introducing it. Chin-sheng Hung et al. [38] also reported, in a retrospective review, that no obvious learning curve was found in partial mastectomies.

On the other hand, there are ongoing studies aiming to evaluate the improvement in time of robotic NSM and its learning curve, which lead to think that robotic surgery may be superior from this point of view [22, 39].

The combined data from the above three studies show that endoscopy seems to be a time-consuming method, which exhibits limited improvement in this respect, even with mature skills.

Robotic-assisted surgery has been developed in order to attempt to improve these outcomes.

Robotic Technologies in Plastic Surgery

The benefits of robotic surgery have been well documented, although with no large studies, and include reduced blood loss, reduced postoperative pain, faster recovery, and improved cosmesis [40]. In relation to plastic and reconstructive surgery, the elimination of tremor, the greater degree of freedom of the instrument, and the motion scaling all have the potential to improve the accuracy and reproducibility of surgery (e.g. microsurgery). The evidence suggests that while there are stages in the learning curve, proficiency in microsurgical skills using the robot can be gained in a short number of sessions [41].

Robotic surgery has shown advantages in reconstructive surgery using free-perforator flaps approaching the limits of human dexterity. However, to fully exploit this, there is a need for development in the field of robotic devices design, expanding the portfolio of micro-instruments. Also, the potential for robotic head and neck reconstruction is huge and is one of the areas that will most definitely see growth due to the obvious benefits it offers (higher precision and capability to work in narrow and deep spaces or cavities). The current limitation to more widespread utilization is, again, the instrument design in order to perform microvascular anastomoses and easier inset. For example, with cancer resection, it is possible access to difficult anatomical areas such as the oropharyngeal cavity [42].

Robotic surgery's main disadvantage remains the high cost of purchasing and maintaining the equipment. This will undoubtedly improve with time as a greater number of procedures are performed using the robot and the unit cost per operation reduces. This is well described in the literature, for example, in trans-oral robotic cleft surgery (TORS) [43] and for the surgical treatment of endometrial cancer [44].

Lack of haptic feedback is also often cited as another disadvantage of robotic surgery, with studies demonstrating that operators of assisted robotic surgical systems prefer those with haptic feedback [45]. However, other studies such as by Hagen and colleagues who looked at 52 individuals and their perception of haptic feedback while performing robotic surgery demonstrated that visual cues are able to give the perception of haptic feedback, even when true haptic feedback is not present [46]. Despite this evidence, there is still a tremendous amount of work looking at ways to incorporate haptic feedback into robotic systems, summarized in a review by Okamura [47].

Finally, robotic surgery often results in longer operative times, although this improves with proficiency and in some cases is now comparable to traditional techniques.

The future of robotics in plastic surgery is clearly exciting. Over the last 5 years, the range of procedures using the daVinci® robot, attempted by the plastic surgery community, has increased significantly and, as technology continues to improve, this will gain further momentum. Of the 68 studies included in a review [48], only three used a robotic system other than the daVinci®. This dominance is beginning to be challenged, and it will be the development of further robotic surgical instruments that will allow greater use of the robot in the field of plastic and reconstructive surgery. The combination of motion scaling and tremor-free instruments manipulation with new instruments design will also allow new avenues in surgery and microsurgery that have to date been too technically demanding to be explored. Furthermore, the introduction of a new single port addition to the daVinci® system will allow greater access in trans-oral surgery, improving instrument maneuverability within the tight confines of the intra-oral cavity.

Recently, robotic surgery has been applied to the field of breast reconstructive surgery either prophylactic or therapeutic. So it is now possible to perform robotic-assisted procedures such as mastectomies, pedicled flaps (like robotically harvested latissimus dorsi), and also free breast flaps like robotic-assisted DIEP flaps harvesting for breast reconstruction [17, 49].

The latest trends in the field of robotic-assisted oncoplastic breast surgery consist in limiting the use of robots only for those specific steps of the procedures, in which it actually represents an advantage with respect to traditional surgery.

For example, after the execution of a classical subcutaneous mastectomy with scissors, the dissection of the prepectoral region of the mammary gland can be performed with robotic assistance, which allows a better visualization and increased precision [50].

In the second decade of twenty-first century, the single small hidden axillary scar Robotic Nipple-Sparing Mastectomy (RNSM) and Immediate Robotic Breast Reconstruction (IRBR) with implants surgical technique has been published, as an evolution of endoscopic-assisted breast surgery.

Indications

First of all, it is necessary in order to establish indications relative to robotic mammary surgery, to understand the goals to achieve and which are the advantages offered by robotic breast surgery in achieving them. The five goals to evaluate are:

- Functional and aesthetic scar amelioration
- Improvement of breast skin flaps quality and viability
- Bleeding reduction and control of hemostasis
- Higher quality of visualization to enhance the surgeon’s accuracy
- Finer instruments motion capability and accuracy,

These are the fundamental elements to weigh the added benefit of using technology-assisted surgery, always keeping in mind that the oncological safety must remain at least comparable to that of current traditional techniques.

From this perspective, indications for endoscopic-assisted breast surgery (EABS) include [14–16]:

1. Early-stage breast cancer (ductal carcinoma in situ (DCIS), stage I or II
2. Tumor size smaller than 5 cm
3. No evidence of multiple lymph node metastasis
4. No evidence of skin or chest wall invasion

Patients for whom EABS is contraindicated included those with:

1. Inflammatory breast cancer
2. Breast cancer with chest wall or skin invasion
3. Locally advanced breast cancer
4. Breast cancer with extensive axillary lymph node metastasis (stage IIIB or higher)
5. Patients with severe co-morbid conditions (heart disease, renal failure, liver dysfunction, and poor performance status as assessed during presurgical evaluation)

Moreover, in our experience, the indications for the use of robotic surgery are identical to those of non-robotic-assisted nipple-sparing mastectomy, adding also the limitations related to the intrinsic characteristics of the breasts to be treated (ptosis grade, breast cup size, etc.) and some limitations related to the patients general conditions (e.g., ASA physical status classification system).

According to the literature, NSM is oncologically safe provided that the following indications are respected [51]:

- Early stage
- Biologically favorable histology
- Invasive breast cancer or DCIS at least 2 cm from the nipple
- Imaging findings indicating no nipple involvement
- Free nipple margin
- No nipple discharge
- No Paget's disease

These recommendations are supported by accumulated experience with conservative mastectomies, but indications have broadened with expertise in the technique.

Nipple-sparing mastectomy can be performed when it is safe and accurate from both surgical and oncologic points of view [52–56]. Indications include prophylactic or risk-reducing and therapeutic mastectomy, breast conservative surgery with an expected poor aesthetic result (more than 30% resection), and no oncoplastic technique indicated, medium or small breast with <8 cm NAC-IMF distance, negative retroareolar frozen sections, and patient preference (if completely informed on its advantages and disadvantages) [57].

Moreover, in our case series, we usually include in the robotic mastectomy protocol patients according to the following criteria (all indications must be validated during a multidisciplinary consultation meeting):

Indications for robotic nipple-sparing mastectomy, besides the ones mentioned above and in other chapters of the book, are substantially the same as those of conventional nipple-sparing mastectomies in breasts with a breast cup size (Bonnet) A, B, or C maximum (based on bra size) and a maximum ptosis grade B 2 (Regnault ptosis scale) (otherwise a skin-reducing nipple-sparing mastectomy could be indicated).

Usually we tend to include patients with an Eastern Cooperative Oncology Group scale (ECOG) score between 0 and 1 (published by Oken et al. in 1982), also called the WHO or Zubrod score (after C. Gordon Zubrod) [58].

We tend to avoid robotic mastectomies in the following settings:

1. Patient at high risk of skin necrosis (active smokers with an average of 1 pack per day, 20 cigarettes/day, uncontrolled diabetes mellitus, and any intercurrent pathology contraindicating surgery)
2. Planned postoperative radiotherapy
3. Patient with history of breast surgery on the side to be treated
4. Pregnant women, likely to be pregnant or breastfeeding at the time of surgery

In general, in cases where post-robotic-mastectomy reconstructions have to be performed with a submuscular prosthetic implant or by harvesting a latissimus dorsi flap, it will then be necessary to individualize mastectomy indications for each patient.

Preoperative Evaluation and Planning

Preoperative protocol of evaluation includes the following exams and imaging studies:

1. Clinical examination:
   (a) Evaluation of cardiovascular risk factors (tobacco, diabetes, hypertension)
   (b) Palpation of the breasts and lymph node areas
   (c) Evaluation of the breast volume
   (d) Evaluation of the skin quality (pinch test, presence of *striae cutis*)
2. Complete mammography, ultrasound, and MRI imaging assessment, if needed
3. Preoperative photography in standard positions (frontal with arms along the body, right and left profile, ¾ right and left, arms raised and so on)

All the patients are postoperatively evaluated according to a scheduled follow-up scheme lasting at least 12 months.

All the exams are repeated at least at 21 days post-op, 3 months, 6 months, 1 year.

Surgical Technique

Robotic-Assisted Breast Surgery

The robotic mastectomy is performed, to date, only in a few centers in the world, although the interest of the medical-scientific community for this technique is growing rapidly.

The technique performed in our center is described below. It has been validated in more than 140 breast surgeries successfully done with the DaVinci XI Robot™.

Robotic nipple-sparing mastectomy and direct-to-implant reconstruction consist of four phases, or surgical times, repeated cyclically for each breast:

1. Non-robotic surgery phase: refers to the step of transaxillary subcutaneous mastectomy.
2. Docking phase: the robot is positioned on the patient and the necessary instruments mounted and ready for the robotic surgery to start.
3. Robotic surgery phase: the robotic dissection of the mammary gland away from pectoralis muscle is performed while providing an accurate hemostasis.
4. Reconstructive phase: in this phase and depending on the surgical techniques and characteristics of the patient, the breast implants are positioned with or without meshes or ADMs in a subctutaneous or submuscular fashion, or alternatively a pedicled flap (usually latissimus dorsi) is harvested and inset.

During preoperative markings, the infra-mammary line, the extent of breast tissue, and the anterior axillary line are delineated with a marking pen. The skin incision is positioned to be hidden by the arm, behind the axillary line.

The patient is taken to the operating theater, positioned on the operating bed, and general anesthesia is applied. The first phase of the robotic mastectomy, also called "non-robotic surgery phase," starts.

A lateral-thoracic approach is associated with a high vertical scar of 3–5 cm, located within the footprint of the preferred bra of the patient, with a subcentimeter vertical scar, located 8–9 cm below the previous incision (Fig. 23.2).

These incisions are located 6–7 cm posterior to the lateral-mammary fold. Rather than being left exposed in a visible area, the scars are hidden under the patient's arm. Either mastectomy or breast reconstruction with implants are performed using the same approach. The higher scar enables the introduction of two trocars, the externalization of the gland at the end of the intervention and the introduction of the

Fig. 23.2 Robotic mastectomy preoperative drawing

Fig. 23.3 Robotic mastectomy initial patient position

prosthesis allowing for immediate breast reconstruction. The lower scar is used to insert the third trocar and to externalize the drain.

In the operating room, the patient is placed in a flat supine position with the robot at her head. To reduce the risk of brachial plexus injury, the procedure begins with the arm at 90° abduction. This position creates an optimal access to the axillary area (Fig. 23.3).

A 2-g dose of cefazolin is given 30 min before the incision. Infiltration with a saline solution containing 1 mg/mL of adrenaline is used to reduce bleeding and to facilitate subcutaneous dissection of the gland. Subcutaneous dissection is then performed as far as possible with scissors. Before inserting ports, we make sure that dissection is confluent between the two incisions to allow insertion of the instruments under endoscopic vision. Then, the arm is placed above the head with internal rotation and 90° abduction to reduce the conflicts between the arm of the patient and the robot. The upper incision is closed using a dedicated device, and three 8-mm diameter ports are inserted and fixed with stitches to the skin incision.

After positioning the robotic system at the patient's head, robot docking is guided using laser pointer, which has to be aligned with both the skin incision and the nipple (Fig. 23.4).

One port is connected to the gas insufflator to keep a constant pressure of 8 mmHg during the surgical intervention. Carbon dioxide insufflation creates an adequate working space for the robot. The 30° camera (Intuitive Surgical®, Denzlingen, Germany) is introduced first in the middle port to allow non-traumatic insertion of the instruments under endoscopic vision.

Dissection is performed with monopolar-curved scissors (Intuitive Surgical®, Sunnyvale, CA), whereas traction, counter-traction, exposure, and cauterization are performed by using bipolar grasping forceps (Intuitive Surgical®, Sunnyvale, CA) (Fig. 23.5).

Fig. 23.4 Change of arm position for robot docking, intraoperative view during a robotic mastectomy

Fig. 23.5 Robot positioning, intraoperative view during a robotic mastectomy

Complete subcutaneous dissection is performed by the surgeon at the console in a lateral to medial direction, up to the limits of the gland. Then, the gland is separated from the pectoralis major muscle in a lateral to medial direction. The medial portion of the breast is evaluated using a 30° camera to visualize the dissection and reach the muscular plane (Figs. 23.6 and 23.7).

After the robot is undocked (Figs. 23.8 and 23.9) the ports are removed and the patient arm is placed back on the surgical armrest. Thereafter, the gland is extracted *en bloc* through the largest incision and sent for pathological examination, marking the area under the nipple areola complex. A 5-cm incision is large enough to remove a C-cup mastectomy specimen. We never had to extend the incision to remove the gland. A drain is placed through the inferior infracentimetric scar. The anatomical

Fig. 23.6 Intraoperative external view of the treated breast during a robotic mastectomy: the right breast is inflated with CO_2 in order to avoid skin traumas and ensure a good internal vision

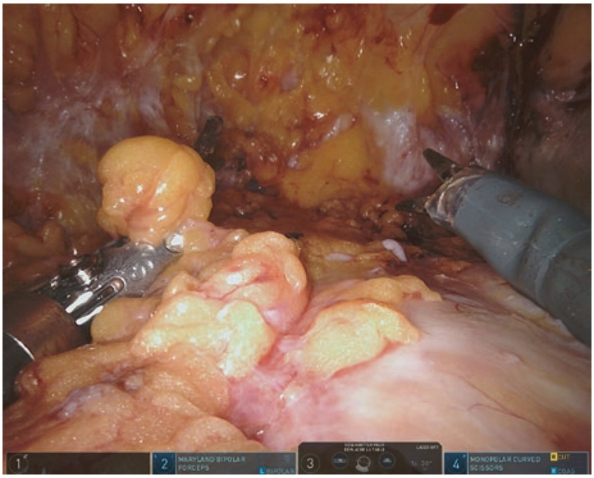


Fig. 23.7 A screenshot of a live intraoperative view of the surgical field as seen by the surgeon on the Vision cart monitor

implants, or tissue expanders, are inserted in a prepectoral position, using, if necessary, an ADM or a mesh. Finally, the implant pocket is closed laterally with two vertical parallel lines of single stitches between the skin and the thoracic wall to avoid any secondary malposition of the prosthesis. A postoperative compressive dressing is positioned in order to keep the prosthesis in position and compress the area.

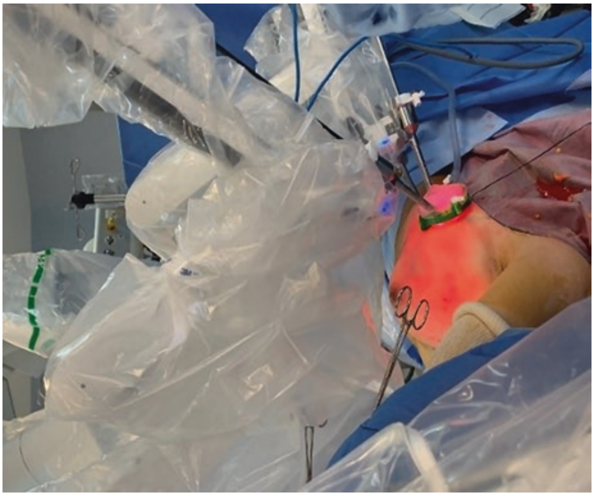


Fig. 23.8 Intraoperative view during a robotic mastectomy, robotic arms are protected with sterile covers

Fig. 23.9 Undocked view of Da Vinci Robot (Patient cart) after surgery

Surgical Complications and Solutions

Complications of robotic and endoscopic surgery are related to two different settings: those commonly attributable to mastectomy sensu *latu*, well known and described elsewhere in this book, and those specifically related to the technology-assisted techniques.

It is important to notice that complications are directly related to the achievements when using this technique:

- Functional and aesthetic scar amelioration
- Improvement of breast skin flap quality and viability
- Bleeding reduction and improved control of hemostasis
- Higher quality of vision and enhanced surgeon's accuracy
- Finer instrument motion capability and precision

Mastectomy-Related Complications

These complications are common to nipple-sparing mastectomies; some of them related to mastectomy procedures and others to the reconstructive options. Those are listed below and can be viewed in detail in the dedicated chapters.

General complication due to surgery:

- Infection
- Hematomas
- Seromas or lymphoceles
- Bleeding/hemorrhages
- Partial lung collapse
- Wound infection
- Chest infection
- Heart and lung complications
- Thrombosis
- Myocardial infarction or stroke
- Deep venous thrombosis

Specific risks due to the mastectomy:

- Skin alteration (ulceration, superficial, or deeper skin necroses)
- NAC necrosis and/or dystrophy
- Dehiscence of wounds and/or necrosis, ulcerations of wound edges, or difficult healing
- Pathologic scarring (hypertrophic, hypotrophic, atrophic, cheloid scars)
- Lymphedema of the arms
- Nerve damage producing sensitivity alterations (paresthesia, hypoesthesia, anesthesia, hyperesthesia, hyperalgesia)

- Nerve damage causing weakness and numbness of the arms and chest
- Nerve damage with alterations of arm movement due to shoulder stiffness after the operation
- Chronic pain after mastectomy in the area of the surgery
- Recurrence/incomplete removal of tumor
- Further treatments
- IMF disruption/violation

Complications related to the reconstructive technique:

- Capsular contractures
- Implant rotation/displacement
- Implant loss (in case of infections)
- Flap loss/necroses
- Infection/displacement/exposure/dehiscence of mesh/ADM

Technology-assisted surgery-related complications are as follows:

Scarring

As mentioned above, numerous studies have documented that preservation of the breast skin and the NAC contribute significantly to a woman's body image and quality of life [59, 60]. One of the main objectives of NSM surgical techniques is to preserve both skin flaps and NAC viability. In order to achieve this, many types of skin incisions have been described (e.g., periareolar, radial, inframammary, lateral mammary, transaxillary) [4, 61, 62]. All of these incisions seem to have similar outcomes, and the choice of the incision depends on the surgeon's preference and breast size. However, most of these incisions are visible following surgery and could, therefore, be unsatisfactory from an aesthetic perspective for the patients, often because they leave a permanent scar on the breast, which can often be the cause of complications or psychological distress for the patient. The possibility to access the breast via a small anterior axillary incision and to perform immediate robot-assisted breast reconstruction has two major advantages: an improved aesthetic outcome and a better positioning of the surgical access/scar, as shown in Figs. 23.10 and 23.11.

Placing the scar far from the breast (at anterior axillary fold), where the skin envelope is healthy, well vascularized, and not exposed to radiation therapy nor surgical dissection, could be useful, allowing ultimately a better cicatrisation (location of the scar is important as it may be a source of infection or other complications that may ultimately lead to a surgical failure). This also allows placing the scar far from the implants, which, in case of wound infection, reduces the risk of spreading of the infection to the implant. Placing the scar in the axilla could also reduce the phenomena of breast profile distortion secondary to scar contraction. Lowering the risk of postoperative wound irradiation and peri-incisional tissue damage during surgery, it may be possible to avoid all the wound complication mentioned above, also allowing a better scar quality. Furthermore, in case a secondary scar surgical treatment is needed, it would be simplified since the breast is quite far from the scar and therefore protected from surgical aggression.

Fig. 23.10 3/4 patient view showing axillary scar position. To note the good quality of scars

Fig. 23.11 Lateral view of a patient showing axillary scar position. To note the good quality of scars

Breast Skin Flap Quality

The procedure leaves the patient's breasts without any visible scar and with an extremely natural overall appearance. In fact since the breast skin envelope is intact, it allows maintaining a healthier post-reconstruction appearance. From a technical point of view, NSM could be difficult to perform using a small surgical access. In this case, the mastectomy skin flaps might be damaged by retractors or by an inadequate surgical exposure, sometimes even leaving breast tissue behind. Instead, the mastectomy flap can, in this way, completely preserve its superficial/dermal vascularization with the obvious consequence of a possible increase in flap viability and a better resistance to ischemia and necrosis.

This extreme respect of the skin flaps allows direct-to-implant reconstruction with subcutaneous positioning of the implants also without the need for ADM or a mesh. The presence of a healthy skin envelope reduces the ischemic risk also in the NAC area avoiding necroses and dystrophies. Even small areas of superficial necrosis are well tolerated by the skin with a high percentage of fast recovery and complete healing.

Bleeding Reduction and Control

As described by Toesca [4], the use of carbon dioxide enables the reduction of bleeding; moreover, the magnified three-dimensional vision allows evaluating all the bleeding foci and coagulate them, also in those zones that cannot be reached with endoscopic instruments because they have little or no range of motion unlike the robotic arms.

As above, endoscopic surgery has its limits with respect to robotic surgery as it uses retractors and linear optics that do not allow the surgeon the same freedom of vision and movement, so limiting surgeon's visualization.

The possibility of positioning the implant subcutaneously, due to the minimal damage to the skin flaps, spares the complications from dissecting under the pectoralis muscle, including bleeding. In case of excessive intraoperative bleeding, it is possible to convert the endoscopic/robotic mastectomy in the classic/open procedure, without the risk of unfavorable outcomes except from a wider scarring. In that case, in fact, the scars will be similar to the conventional mastectomy ones. Reinterventions for postoperative uncontrollable bleedings or hematomas/seromas are possible and rarely have a negative impact on outcomes that remain good despite the possible further interventions, above all because these complications are often minimal.

Quality of Vision and Enhanced Surgeon's Accuracy

Clearly, there is an advantage with the use of the tenfold image magnification, the three-dimensional view, and the intense lighting that increases the difference in contrast of colors of different structures, highlighting blood vessels, lymphatics, adipose lobules, Duret's crests, Cooper's ligaments, the mammary gland itself, and the skin. A further amelioration is offered by the sharpness and clarity of the image, associated with high precision movements of instruments, stability due to tremor abolition and greater accuracy, permitting a better detachment of the gland from its suspensory ligaments. In addition, the robotic optical window allows the intercostal perforators to be readily recognized and preserved, which contributes significantly to the overall blood supply of both the nipple-areola complex (NAC) and the mastectomy flaps [24].

Instruments Motion Capability

The robotic instruments have several degrees of freedom of motion, which allow negotiation around the curvature of the breast skin cupola, which was a limitation before. All these features have been reported as a limitation of endoscopic instruments [24, 62], which, being linear, have a narrower field of vision, devoid of stereoscopic and three-dimensional vision, presenting difficulties in circumventing curved anatomical structures such as the rib cage.

Concerns are related to time, costs, and surgeon learning curves in technology-assisted breast surgery. These elements are not real complications of the intervention but may be an obstacle for the diffusion, the success, and the feasibility of robotic surgery.

Results (Literature and Data)

The purpose of this paragraph is to provide, through the means of the most up-to-date literature and the experience of the authors, an update on the possibilities, advantages, and effects offered by robotic surgery.

Comparing the published studies in the literature about the robotic nipple-sparing mastectomy, the most important evolving case series appear to be those from Toesca et al. [4], Houvenaeghel et al. [63], Lai et al. [64], and Sarfati et al. [65]. There are differences in some aspects, and it could be interesting to analyze them in order to have a wider and deeper knowledge of the worldwide experience. At the time this book is published, a large-scale study, by the authors, is ongoing concerning the nipple-sparing robotic mastectomy (a sample of more than 140 breasts).

Regarding the surgical technique, there are two important differences between the technique described above and the other reported techniques. The first is related to the submuscular pocket dissection for implant positioning, performed by other authors but never performed in our surgical routine. The second is the subcutaneous mastectomy dissection that is performed using the robot by all the other authors except one group in Houvenaeghel study, where they used classical Metzenbaum scissors as we routinely do. Another important difference is the histologic evaluation of subareolar gland, performed by Houvenaeghel and Lai [63, 64] but not by Toesca et al. nor by our surgical team [4, 63–65].

Specifically, Toesca et al. performed a completely robotic mastectomy with dissection of a submuscular pocket, and our group performs a subcutaneous mastectomy using Metzembaum scissors and uses the robotic assistance only for the breast dissection away from the pectoralis muscle without the creation of submuscular pockets for implants positioning. Houvenaeghel et al. created three groups of patients, modifying in each group the type of subcutaneous gland and NAC dissection (group 1, dissection with robotic scissors using coagulation; group 2, dissection with robotic scissors without coagulation; and group 3, dissection with non-robotic scissors after subcutaneous infiltration with adrenaline serum and then robotic dissection). They also performed three different types of reconstruction (implant alone, by the means of robotic latissimus dorsi flap and both); Lai et al. performed a completely robotic mastectomy with dissection of a submuscular pocket, for implant positioning, or harvesting of a robotic latissimus dorsi flap, for autologous reconstruction.

It is difficult to perform a comparative analysis between robotic techniques due to the lack of homogeneity of the samples examined and the lack of standardization of the techniques. Dimensions and weight of the treated breast, age of patients, patients' characteristics (previous radiation/chemotherapy, history of vascular damaging pathologies) and robotic surgical techniques are also different.

Evaluating the reported data systematically, it appears complex to precisely compare the results obtained in the various centers, both in terms of surgical times and complications, because these variables are strictly dependent on sample demographics and patient characteristics and clinical history. The necessity of a standardization is more than mandatory: strict and homogeneous inclusion/exclusion criteria, like homogenous patients demographics, should be desirable in order to rapidly develop a large-scale knowledge about robotic breast surgery.

Patient arm position during surgery varies among different authors. In our center, it is placed above the head with internal rotation and 90° abduction along the body and with the upper arm hanging normally at the side of the body, slightly bent posteriorly (around 30°), with the elbow positioned close to the body, bent at about 30° so that hand, wrist, and forearm were straight and roughly parallel to the floor at the side of the body [65]. In our experience, no complications occurred with the further advantage of a high-quality field of vision [66]. In the other above-mentioned studies, Lai positioned the patient in the supine position and the arm was positioned with 90° abduction at the beginning of docking, after the operating side shoulder was elevated to 30° with draping and tilting to contralateral side to prevent conflict between the operating table and docking of robotic surgery system. In this position, the arms were aligned with the plane of the breast, nearly parallel to the floor, and the ports were docked to the robotic arms: no complications were reported. Houvenaeghel positioned the patient at first in a dorsal decubitus and then lateral on a side, keeping the arm in antiflexion: also in this case no important sequelae were reported.

Complications are also difficult to compare between studies. Despite similar types of complications in all studies, the lack of standardization of the procedures and homogeneity of the samples does not allow statistically significant comparations. Furthermore, the difference in infection rates may be related to the difference in the postoperatively antibiotics administration.

Further increase of sample size of all the ongoing studies will allow a better evaluation of data and a higher "statistical power" of the analyses.

There is clearly a significant cost related to purchasing the robots and maintaining them yearly. Although there are no published reports on robotic surgery costs, there is a concern about the apparently higher costs compared to conventional mastectomy. Some authors [4, 62, 67] have postulated that in a large hospital with high robot utilization, the robot purchase and maintenance costs are not different than the purchase of any other durable technology: the marginal cost of using the robot for nipple-sparing mastectomy and IBR is only represented by the additional operating room time and the cost of instruments [68].

A simplistic analysis of the costs starting from the published information can be attempted without any intent of generalization, considering the scarcity of data available and the many variables, which would require future study focused on the topic. To note that all costs in “Euros” have been converted and approximated into “Dollars” in order to allow a comparison.

On the basis of the information provided by the manufacturer of the robot, (Intuitive Surgical,® Sunnyvale, CA) and some published studies, the cost of the robot is standard and has an average between 1.680.000 and 2.600.000 USD; maintenance and video surveillance costs are also standard (mean 112.000 and 170,000 USD per year); start-up reusable equipment and accessories (200,000 USD) and surgeon training is free in some areas of Europe (but with an average of 6000 USD per surgeon in America). To these costs we must add the cost of the disposable materials (220 USD per surgery) and the reusable surgical materials (for robotic mastectomy 560 USD per surgery), for a total of 780 USD per surgery.

Considering the mean cost of an OR in France, 11 USD per min/675 USD per hour [69], and the hospitalization costs for each patient, which are around 505 USD per day, it becomes clear that the decrease in hospitalization time allowed by the lower invasivity of robotic surgery become desirable to cut the costs. We must also consider that a low rate of complications allows further cutting the costs (despite being much harder to predict) linked to hospitalization, reinterventions, and treatment of the complications, which has a range of 112 USD to around 5630 USD per day.

Moreover, in a wider analysis the robot turned out to be expensive to buy, but not to use. If the hospital already owns a robot, it will lose money if the output is low but it will recuperate its cost by attracting a higher number of patients and increasing surgeon’s volume. The real determinant of whether a robotic surgery is profitable is the contribution margin per case. Robotic procedures can have a positive contribution margin compared to open procedures if the revenue per procedure is higher than the cost. For this analysis, the price of the device itself is irrelevant. Case revenue is composed of the professional fee charged by the surgeon, usually based on the country-related surgical diagnosis-related groups (DRG) and the hospital or technical fees. Usually in many countries, there are no modifiers for robotic surgical procedures at this time, so the refunding for a robotic surgery is the same as for the corresponding open procedures and the diagnoses codifications are the same as well. Moreover, increased costs for robotic procedures are attributable to disposables/reusables, additional instrumentation, increased staff numbers, and increased procedural time. In contrast, costs may be decreased if minimally invasive procedures are associated with shorter lengths of stay, lower complication rates and enhanced recovery, and, least but not last, a reduced operative time. The balance of revenue and cost, or contribution margin per procedure, will determine whether it is cost-effective to perform a procedure robotically. It is crucial to evaluate the learning curve and operative times and all the factors influencing this variable: determining how many interventions are required to reach the shortest possible surgical time, with the best outcomes and the least number of complication. It is also important to understand which are the variable surgeon-/ procedure-/ or patient-related influencing the learning time and of surgical performances.

Conclusions

Robotic-assisted nipple-sparing mastectomy can be a good option for the patients (decreased morbidity with a good aesthetic outcome) and for the hospital, when the operative time and costs are reduced. In order to reduce costs, an analysis of surgical times, complications, and learning curves is mandatory.

Being a new technology with vast margins of improvement, robotic mastectomy represents an interesting option for the surgeons in the future, not only for the reduced invasiveness of the surgical procedure but also for the improved results in terms of aesthetics outcomes and patient satisfaction (Figs. 23.12, 23.13, 23.14, 23.15, 23.16, and 23.17). In order to reach this goal it is mandatory to select the patients and to tackle the weak spots still associated with this technique.

Fig. 23.12 Robotic mastectomy, preoperative frontal view

Fig. 23.13 Robotic mastectomy, postoperative frontal view

Fig. 23.14 Robotic mastectomy, preoperative lateral view

Fig. 23.15 Robotic mastectomy, postoperative lateral view

Fig. 23.16 Robotic mastectomy, preoperative 3/4 view

Fig. 23.17 Robotic mastectomy, postoperative 3/4 view

Reference Video

- https://youtu.be/st8U7ffxITU
- https://youtu.be/zY0c1z9rtM8

References

1. Friedlander LD, Sundin J, Bakshandeh N. Endoscopic mastectomy and breast reconstruction: endoscopic breast surgery. Aesthet Plast Surg. 1995;19:27–9.
2. Yamagata M, Iwai S. Endoscopic treatment for breast cancer. J Jpn Soc Endosc Surg., 7. 1997;2(3):272. (Japanese).
3. Zonta S, Sgarella A, Ferrari A, Pietrabissa A, Dionigi P. Robotic video assisted nipple sparing mastectomy for breast cancer. In: Vv. Aa. Proceedings of the 20th EAES Congress. Bruxelles, 20–23 June 2012.
4. Toesca A, Manconi A, Peradze N, Loschi P, Panzeri R, Granata M, et al. Preliminary report of robotic nipple-sparing mastectomy and immediate breast reconstruction with implant. Eur J Cancer. 2015;51(3):S309.
5. Carbonell AM. Minimally invasive gastric surgery. Surg Clin North Am. 2011;91(5):1089–103.
6. Lai HW, Tseng SH, Lee YT, Hsu CH, Chou DA, Wu HS, et al. Impact of AITS laparoscopic training centeron surgeons' preference for appendectomy. Surg Endosc. 2010;24:2210–5.
7. Momeni A, Padron NT, Bannasch H, Borges J, Bjorn Stark G. Endoscopic transaxillary subpectoral augmentation mammaplasty: a safe and predictable procedure. J Plast Reconstr Aesthet Surg. 2006;59(10):1076–81.
8. Ulusal BG, Cheng MH, Wei FC. Simultaneous endoscope-assisted contralateral breast augmentation with implants in patients undergoing postmastectomy breast reconstruction with abdominal flaps. Plast Reconstr Surg. 2006;118(6):1293–302.

9. Osanai T, Nihei Z, Ichikawa W, Sugihara K. Endoscopic resection of benign breast tumors: retromammary space approach. Surg Laparosc Endosc Percutan Tech. 2002;12(2):100–3.
10. Yamashita K, Shimizu K. Endoscopic video-assisted breast surgery: procedures and short-term results. J Nihon Med Sch. 2006;73(4):193–202.
11. Liu H, Huang CK, Yu PC, Chen HP, Hsieh PM, Hung KC, et al. Retromammary approach for endoscopic resection of benign breast lesions. World J Surg. 2009;33(12):2572–8.
12. Tamaki Y, Sakita I, Miyoshi Y, Sekimoto M, Takiguchi S, Monden M, et al. Transareolar endoscopyassisted partial mastectomy: a preliminary report of six cases. Surg Laparosc Endosc Percutan Tech. 2001;11(6):356–62.
13. Lee EK, Kook SH, Park YL, Bae WG. Endoscopy-assisted breast-conserving surgery for early breast cancer. World J Surg. 2006;30(6):957–64.
14. Sakamoto N, Fukuma E, Higa K, Ozaki S, Sakamoto M, Abe S, et al. Early results of an endoscopic nipple- sparing mastectomy for breast cancer. Ann Surg Oncol. 2009;16(12):3406–13.
15. Nakajima H, Fujiwara I, Mizuta N, Sakaguchi K, Hachimine Y. Video-assisted skin-sparing breast-conserving surgery for breast cancer and immediate reconstruction with autologous tissue. Ann Surg. 2009;249(1):91–6.
16. Yamashita K, Shimizu K. Evaluation of sentinel lymph node metastasis alone guided by three-dimensional computed tomographic lymphography in video-assisted breast surgery. Surg Endosc. 2009;23(3):633–40.
17. Yamashita K, Shimizu K. Video-assisted breast surgery can sample the second and third sentinel nodes to omit axillary node dissection for sentinel-node-positive patients. Surg Endosc. 2009;23(7):1574–80.
18. Park HS, Lee JS, Park S, Kim SI, Park BW. The feasibility of endoscopy-assisted breast conservation surgery for patients with early breast cancer. J Breast Cancer. 2011;14(1):52–7.
19. Ozaki S, Ohara M, Shigematsu H, Sasada T, Emi A, Masumoto N, et al. Technical feasibility and cosmetic advantage of hybrid endoscopy-assisted breast-conserving surgery for breast cancer patients. J Laparoendosc Adv Surg Tech A. 2013;23(2):91–9.
20. Takahashi H, Fujii T, Nakagawa S, Inoue Y, Akashi M, Toh U, et al. Usefulness of endoscopic breast conserving surgery for breast cancer. Surg Today. 2014;44(11):2037–44.
21. Fan LJ, Jiang J, Yang XH, Zhang Y, Li XG, Chen XC, et al. A prospective study comparing endoscopic subcutaneous mastectomy plus immediate reconstruction with implants and breast conserving surgery for breast cancer. Chin Med J. 2009;122(24):2945–50.
22. Kitamura K, Ishida M, Inoue H, Kinoshita J, Hashizume M, Sugimachi K. Early results of an endoscope assisted subcutaneous mastectomy and reconstruction for breast cancer. Surgery. 2002;131(Suppl 1):S324–9.
23. Ho WS, Ying SY, Chan AC. Endoscopic-assisted subcutaneous mastectomy and axillary dissection with immediate mammary prosthesis reconstruction for early breast cancer. Surg Endosc. 2002;16(2):302–6.
24. Tukenmez M, Ozden BC, Agcaoglu O, Kecer M, Ozmen V, Muslumanoglu M, et al. Videoendoscopic single-port nipple-sparing mastectomy and immediate reconstruction. J Laparoendosc Adv Surg Tech A. 2014;24(2):77–82.
25. Nakajima H, Sakaguchi K, Mizuta N, Hachimine T, Ohe S, Sawai K. Video-assisted total glandectomy and immediate reconstruction for breast cancer. Biomed Pharmacother. 2002;56(Suppl 1):205s–8s.
26. Lai HW, Wu HS, Chuang KL, Chen DR, Chang TW, Kuo SJ, et al. Endoscopy-assisted total mastectomy followed by immediate pedicled transverse rectus abdominis musculocutaneous (TRAM) flap reconstruction: preliminary results of 48 patients. Surg Innov. 2015;22(4):382–9.
27. Veronesi U, Botter V, Luini A, Veronesi P. Breast cancer: from “maximum tolerable” to “minimum effective” treatment. Front Oncol. 2012;2:125.
28. Veronesi U, Viale G, Paganelli G, Zurrida S, Luini A, Galimberti V, et al. Sentinel lymph node biopsy in breast cancer: ten-year results of a randomized controlled study. Ann Surg. 2010;251(4):595e–600.
29. Giuliano AE, Hunt KK, Ballman KV, Beitsch PD, Whitworth PW, Blumencranz PW, et al. Axillary dissection vs no axillary dissection in women with invasive breast cancer and sentinel node metastasis. JAMA. 2011;305:569e–75.

30. Rietjens M, Urban CA, Rey PC, Mazzarol G, Maisonneuve P, Garusi C, et al. Long-term oncological results of breast conservative treatment with oncoplastic surgery. Breast. 2007;16:387e–95.
31. Jabor MA, Shayani P, Collins DR Jr, Karas T, Cohen BE. Nipple-areola reconstruction: satisfaction and clinical determinants. Plast Reconstr Surg. 2002;110:457e–63. discussion 464–5.
32. Zhong T, Antony A, Cordeiro P. Surgical outcomes and nipple projection using the modified skate flap for nipple-areolar reconstruction in a series of 422 implant reconstructions. Ann Plast Surg. 2009;62(5):591e–5.
33. Wei CH, Scott AM, Price AN, Miller HC, Klassen AF, Jhanwar SM, et al. Psychosocial and sexual well-being following nipple-sparing mastectomy and reconstruction. Breast J. 2016;22(1):10e–7.
34. Yao K, Liederbach E, Tang R, Lei L, Czechura T, Sisco M, et al. Nipple-sparing mastectomy in BRCA1/2 mutation carriers: an interim analysis and review of the literature. Ann Surg Oncol. 2015;22(2):370e–6.
35. Manning AT, Wood C, Eaton A, Stempel M, Capko D, Pusic A, et al. Nipple sparing mastectomy in patients with BRCA1/2 mutations and variants of uncertain significance. Br J Surg. 2015;102(11):1354e–9.
36. Kwoh YS, Hou J, Jonckheere EA, Hayati S. A robot with improved absolute positioning accuracy for CT guided stereotactic brain surgery. IEEE Trans Biomed Eng. 1988;35(2):153–60.
37. Shah J, Vyas A, Vyas D. The history of robotics in surgical specialties. Am J Robot Surg. 2014;1(1):12–20.
38. Hung CS, Chang SW, Liao LM, Huang CC, Tu SH, Chen ST, Chen DR, Kuo SJ, Lai HW, Chou TM, Kuo YL. The learning curve of endoscopic total mastectomy in Taiwan: a multi-center study. PLoS One. 2017;12(6):e0178251.
39. Yamaguchi S, Asao T, Uchida N, Yanagita Y, Saito K, Yamaki S, et al. Endoscopy-assisted subcutaneous mastectomy and immediate breast reconstruction for breast cancer: advantage of the posterior approach. Int Surg. 2008;93(2):99–102.
40. Ponnusamy K, Mohr C, Curet MJ. Clinical outcomes with robotic surgery. Curr Probl Surg. 2011;48(9):577–656.
41. Alrasheed T, Liu J, Hanasono MM, Butler CE, Selber JC. Robotic microsurgery: validating an assessment tool and plotting the learning curve. Plast Reconstr Surg. 2014;134:794–803.
42. Khan K, Dobbs T, Swan MC, Weinstein GS, Goodacre TEE. Trans-oral robotic cleft surgery (TORCS) for palate and posterior pharyngeal wall reconstruction: a feasibility study. J Plast Reconstr Aesthet Surg. 2016;69(1):97–100.
43. Rudmik L, An W, Livingstone D, Matthews W, Seikaly H, Scrimger R, et al. Making a case for high-volume robotic surgery centers: a cost-effectiveness analysis of transoral robotic surgery. J Surg Oncol. 2015;112(2):155–63.
44. Ind TEJ, Marshall C, Hacking M, Harris M, Bishop L, Barton D, et al. Introducing robotic surgery into an endometrial cancer service–a prospective evaluation of clinical and economic outcomes in a UK institution. Int J Med Robot Comp. 2016;12(1):137–44.
45. Koehn JK, Kuchenbecker KJ. Surgeons and non-surgeons prefer haptic feedback of instrument vibrations during robotic surgery. Surg Endosc. 2015;29(10):2970–83.
46. Hagen ME, Meehan JJ, Inan I, Morel P. Visual clues act as a substitute for haptic feedback in robotic surgery. Surg Endosc. 2008;22(6):1505–8. https://doi.org/10.1007/s00464-007-9683-0.
47. Okamura AM. Haptic feedback in robot-assisted minimally invasive surgery. Curr Opin Urol. 2009;19(1):102–7.
48. Dobbs TD, Cundy O, Samarendra H, Khan K, Whitaker IS. Front a systematic review of the role of robotics in plastic and reconstructive surgery-from inception to the future. Front Surg. 2017;4:66.
49. Toesca A, Peradze N, Galimberti V, Manconi A, Intra M, Gentilini O, et al. Robotic nipple-sparing mastectomy and immediate breast reconstruction with implant: first report of surgical technique. Ann Surg. 2017;266(2):e28–30.

50. Sarfati B, Honart JF, Leymarie N, Rimareix F, Al Khashnam H, Kolb F. Robotic da Vinci Xi-assisted nipple-sparing mastectomy: first clinical report. Breast J. 2018;24(3):373–6.
51. NCCN. NCCN clinical practice guidelines in oncology: breast cancer, version 1. 2016. 2016. https://www.nccn.org/professionals/physician_gls/f_guidelines.asp. Accessed 20 May 2019.
52. Gerber B, Krause A, Dieterich M, Kundt G, Reimer T. The oncological safety of skin sparing mastectomy with conservation of the nipple-areola complex an autologous reconstruction: an extended follow-up study. Ann Surg. 2009;249:461e–8.
53. Botteri E, Gentilini O, Rotmensz N, Veronesi P, Ratini S, Fraga-Guedes C, et al. Mastectomy without radiotherapy: outcome analysis after 10 years of follow-up in a single institution. Breast Cancer Res Treat. 2012;134(3):1221e8.
54. Yi M, Kronowitz SJ, Meric-Bernstam F, Feig BW, Symmans WF, Lucci A, et al. Local, regional and systemic recurrence rates in patients undergoing skin sparing mastectomy compared with conventional mastectomy. Cancer. 2011;117:916e24.
55. De Alcantara Filho P, Capko D, Barry JM, Morrow M, Pusic A, Sacchini VS. Nipple-sparing mastectomy for breast cancer and risk-reducing surgery: the Memorial Sloan-Kettering Cancer Center experience. Ann Surg Oncol. 2011;18(11):3117e22.
56. Botteri E, Rotmensz N, Sangalli C, Toesca A, Peradze N, De Oliveira Filho HR, et al. Unavoidable mastectomy for ipsilateral breast tumour recurrence after conservative surgery: patient outcome. Ann Oncol. 2009;20(6):1008e12.
57. Rancati A, Gercovich FG. Introduction to conservative mastectomies. Gland Surg. 2015;4(6):450–2.
58. Young J, Badgery-Parker T, Dobbins T, Jorgensen M, Gibbs P, Faragher I, et al. Comparison of ECOG/WHO performance status and ASA score as a measure of functional status. J Pain Symptom Manag. 2015;49(2):258–64.
59. Gerber B, Krause A, Reimer T, Müller H, Küchenmeister I, Makovitzky J, et al. Skin-sparing mastectomy with conservation of the nipple-areola complex and autologous reconstructionis an oncologically safe procedure. Ann Surg. 2003;238:120–7.
60. Yueh JH, Houlihan MJ, Slavin SA, Lee BT, Pories SE, Morris DJ. Nipple sparing mastectomy: evaluation of patient satisfaction, aesthetic results, and sensation. Ann Plast Surg. 2009;62:586–90.
61. Voltura AM, Tsangaris TN, Rosson GD, Jacobs LK, Flores JI, Singh NK, et al. Nipple-sparing mastectomy: critical assessment of 51 procedures and implications for selection criteria. Ann Surg Oncol. 2008;15:3396–401.
62. Clemens MW, Kronowitz S, Selber JC. Robotic assisted latissimus dorsi harvest in delayed immediate breast reconstruction. Semin Plast Surg. 2014;28:20–5.
63. Houvenaeghel G, Bannier M, Rua S, Barrou J, Heinemann M, Van Troy A, et al. Breast cancer robotic nipple sparing mastectomy: evaluation of several surgical procedures and learning curve. World J Surg Oncol. 2019;17(1):27.
64. Lai HW, Wang CC, Lai YC, Chen CJ, Lin SL, Chen ST, et al. The learning curve of robotic nipple sparing mastectomy for breast cancer: an analysis of consecutive 39 procedures with cumulative sum plot. Eur J Surg Oncol. 2019;45(2):125–33.
65. Sarfati B, Struk S, Leymarie N, Honart JF, Alkhashnam H, Tran de Fremicourt K, et al. Robotic prophylactic nipple-sparing mastectomy with immediate prosthetic breast reconstruction: a prospective study. Ann Surg Oncol. 2018;25(9):2579–86.
66. Honart JF, Leymarie N, Sarfati B. Response to the reply to the letter to the editor "robotic-assisted nipple sparing mastectomy: a feasibility study on cadaveric models". J Plast Reconstr Aesthet Surg. 2017;70(4):560–1.
67. Selber JC, Baumann DP, Holsinger FC. Robotic latissimus dorsi muscle harvest: a case series. Plast Reconstr Surg. 2012;129(6):1305–12.
68. Ho C, Tsakonas E, Tran K, Cimon K, Severn M, Mierzwinski-Urban M, et al., editors. Robot-assisted surgery compared with open surgery and laparoscopic surgery: clinical effectiveness and economic analyses [Internet]. Ottawa: Canadian Agency for Drugs and Technologies in Health; CADTH Health Technology Assessments; 2011.
69. Agence technique de l'information sur l'hospitalisation: Etudes Nationales de Coûts. https://www.atih.sante.fr/information-sur-les-couts/etudes-nationales-de-couts-presentation-et-recrutement. Accessed 23 May 2019.

Goldilocks Mastectomy

24

Heather Richardson

Introduction

Described in 2012 and named after the storybook character Goldilocks who chose the "just right" option over one that was "too hot or cold" or "too hard or soft," the Goldilocks mastectomy seeks to combine the best attributes of time-tested techniques to create a third option [1].

The inevitable shift of oncological surgical strategy from focusing on removal of disease to a vision that incorporates preservation of the breast aesthetic has come on a steady trajectory. Many women are able to preserve their femininity and improve their quality of life through their years of survivorship because of advancements in reconstruction. The basis for the radical mastectomy was to remove as much tissue as possible to adequately treat the cancer [2]. In the last century, we have transitioned from tissue eradication to tissue sparing techniques [3–8]. Simple mastectomy is typically performed by excising the breast mound with an overlying ellipse of skin. It has advantages that include efficiency of time and simplicity of management that does not require any skill set outside of basic dissection and suturing abilities. It does not require the addition of any special material, such as artificial implants or expanders, and can be used on any patient regardless of comorbidities. However, few women would electively choose not to have a reconstruction when it is an option.

In the act of caring for a wide variety of patients, there inevitably lies a subset of patients who are not enthusiastic about having complex surgeries to recreate a breast that they may not feel is crucial to their lifestyle or identity. It is also important to recognize the inherent challenges of working with patients who do want reconstruction, but have factors such as obesity, advanced disease, history of radiation, or medical conditions like diabetes, or severe cardiovascular disease that

H. Richardson (✉)
Bedford Breast Center, Beverly Hills, CA, USA
e-mail: DrHeather@BedfordBC.com

V. S. Klimberg et al. (eds.), *Oncoplastic Breast Surgery Techniques for the General Surgeon*, https://doi.org/10.1007/978-3-030-40196-2_24

Fig. 24.1 Before and after – comparing traditional amputation style mastectomy results (top) with Goldilocks mastectomy (bottom). Retention of the lower pole flap material, which is typically discarded, allows for creation of a breast mound. Both patients had a single surgery and neither have implants or distal flap tissue present

make multiple surgeries or complex reconstructions an unrealistic means to an even less likely achievable aesthetic outcome [9, 10]. Figure 24.1 compares traditional amputation style mastectomy results (top) with Goldilocks mastectomy (bottom).

Simple mastectomy without reconstruction creates a tight hollow central portion and lateral and medial fullness at the ends of the incisions, which is the exact opposite of the configuration of a female breast with its central fullness that tapers medially and laterally. The basis of breast reconstruction is to recreate the fullness of a breast mound. This is achieved with the addition of an artificial implant that may take several procedures and may include the use of expanders, or require harvesting of autologous tissue from distant sites creating possible areas that may contribute to pain, wound issues, and, inevitably, scarring. Realizing that there can be a middle ground that could create the semblance of a mound by utilizing tissue present in the mastectomy flap itself, the Goldilocks mastectomy was devised as a means to address the needs of women facing mastectomy that either cannot have or do not want full reconstruction.

Indications

From an oncologic safety point of view, any candidate suitable for a skin or nipple sparing mastectomy can be considered for Goldilocks mastectomy. Any excision of the breast skin, axillary skin, or nipple that would be required for curative intent should be included as such and not omitted to facilitate preservation of local flap material. For patients that are not candidates for skin or nipple sparing mastectomies because of health issues, prior radiation, or disease state, Goldilocks mastectomy can be considered in lieu of simple mastectomy as long as there would be enough residual tissue to create a Wise pattern closure and the patient could tolerate additional operative time, which should not be more than double the length of time for a simple mastectomy and closure.

The ideal patient for Goldilocks mastectomy is one (1) with breast ptosis such that the nipple rests past the inframammary (IM) fold in the standing position, (2) with a well-developed plane of dermal fat that is safe to remain as local flap volume, and (3) who has expectations in line with having a significant decrease in breast size.

For those who do require excision of skin to obtain an anterior margin, the Wise pattern can be adjusted to accommodate most central-based lesions and is very forgiving to those along the 3:00 and 9:00 radius as well.

Two types of Goldilocks patients are typically found: those who would prefer an ideal aesthetic outcome associated with full reconstruction but who have contraindications because of their disease history or personal health, and those who could have full reconstruction but have reservations for personal reasons. Some patients prefer this technique because of its independence from artificial materials, whereas others wish to avoid multiple surgeries or scarring on distal sites, separate from the breast, associated with autologous tissue transfer.

Contraindications to Goldilocks mastectomy include: disease presence in the lower pole skin (especially inframammary (IM) fold region) that would prevent viable superficial blood flow to the remaining inferior pole tissue, disease presence in the upper pole skin that would prevent adequate residual skin to close the Wise pattern, transverse or curvilinear incisions (such as that for lumpectomy) that would interrupt the dermal and subcutaneous blood flow and leave unperfused tissue vulnerable to necrosis, especially along the IM fold. Prior breast lift and/or reduction may be a relative contraindication, depending on the length of time from surgery. Patients desiring nipple preservation who are deemed oncologically sound should be counselled that the reconfiguration of tissue makes preservation of adequate blood flow to the nipple unpredictable.

Preoperative Evaluation and Planning

Counselling and Patient Selection

In deciding any surgical approach, patient education and expectation management is paramount. When considering a patient for Goldilocks mastectomy, it is important to appreciate that it can be applied to almost any breast size or shape but will have the best aesthetic outcome for a larger breast with ptosis. While more residual dermal fat will make for more workable volume, even some smaller breasted women can benefit from this procedure. This is because of the inherent quality of a Wise pattern-based closure that recruits tissue from the lateral and medial sides of the breast to orient it more centrally. This will always be an improvement over a standard transverse elliptical incision that is tight centrally and has a tendency toward residual volume at the lateral and medial periphery, which is the antithesis of the form of a human breast. Most patients will be aware of the old-fashioned mastectomy without reconstruction and many will be aware of reconstructive options as well, and many have strong feelings about one or both options. Patients who are particularly averse to artificial material or who want a simplified approach may have researched ways to make their treatment goals possible. Some patients are obviously suited to Goldilocks because of their large ptotic breast size and their desire to have it smaller. Any patient whose disease presentation and history makes this feasible can be counselled to its pros and cons. It can be difficult to estimate the volume that will be present on physical exam alone. A patient with a larger breast who has a thinner dermal fat pad may have less residual fullness than a patient with a smaller breast, but thicker plane of fat that is able to be preserved. That there is little control over the projection and final size at the completion should be emphasized upon and discussed with the patients. For average size breasted patients, describing the likely final result as a “ballerina breast” or a “training bra breast” is a reassuring way to communicate expectations. For those who feel that this will not suit their frame afterwards, there are several ways to increase the breast volume appearance. For those with the nipple extending past the IM fold, they typically have a breast lift and reduction appearance that can be quite satisfactory and in some cases patients have considered it a significant improvement.

Patients who may want an optimal result but have breasts too large to make implant-based reconstruction feasible, are too obese, have contraindications to autologous flaps, or have disease present that requires radiation may not want to be as small as what results from use of Goldilocks mastectomy and have no reconstruction as the only option, most certainly find it preferable. Fat grafting, delayed implant placement, and prosthetic use are all reasonable ways to improve proportions if patients feel they are too small with their final result.

Workup

A standard preoperative work up as for any mastectomy should take place with optimization of any health issues for those without cancer and choosing to proceed with an elective prophylactic surgery for whatever reason. A magnetic resonance imaging (MRI) within 6 months of surgery should be performed in those with documented mutations [11]. Patients with areas of concern on an MRI with plans for upcoming bilateral mastectomy surgery are counselled either to choose immediate biopsy to discern the nature of the abnormality or to consider the addition of sentinel lymph node (SLN) biopsy on the affected side in case occult malignancy is present. Those with cancer should have a full history and physical and should be counselled on unilateral versus bilateral approaches, as there will be significant asymmetry if the contralateral side is left alone. Imaging may be done by the discretion of the physician. MRI is not absolutely necessary but can be helpful in advanced warning of disease presence in skin or nipple that would require including these with the mastectomy specimen as well as ensuring the absence of contralateral disease.

Preoperative and Perioperative Considerations

Photographic documentation of preoperative, perioperative, and postoperative appearance is necessary to gauge results and effectiveness. This may not be an automatic occurrence in the office of a physician practicing primarily general surgery, but should be adopted in anyone offering breast intervention regularly.

If plastic surgery colleagues are available to assist with planning and closure, this can be a great asset for the general surgeon just beginning to utilize Wise pattern design creation and may be necessary to perform a contralateral reduction if indicated and outside the scope of privileges at his or her center of practice. Tools for preoperative marking should be available (see Chap. 11 for preoperative marking).

Standard preoperative clearance for safe practices for any patient should be followed. Any patient deemed healthy enough to withstand simple mastectomy without reconstruction should also be healthy enough for Goldilocks mastectomy, considering the additional length of operative time for the de-epithelization and closure. Theoretically, there may be patients who could tolerate a regional block with sedation if their habitus would permit such a thing and they refused or were deemed unfit for general anesthesia.

The patient should be secured properly so that they may be raised and lowered into a sitting position to assess the configuration of the flap and to address symmetry as applicable. It is also helpful to have a skin stapler available to tailor tack the configuration, excise dog ears, and adjust any area requiring more de-epithelization prior to committing to final sutures. If free nipple grafting is planned, appropriate dressings should be available to bolster the graft in place.

Table 24.1 lists the reasons to consider Goldilocks mastectomy.

Surgical Technique

Marking

The initial markings delineate the filling and covering tissues. When laid out in the most ideal proportions, there will be a pattern that should lead to the creation of a central fullness that allows for what appears to be the ideal placement of a nipple site, medial cleavage, and an inframammary fold [12, 13]. When made correctly and

Table 24.1 List of reasons to consider Goldilocks mastectomy

Obese patient
Macromastia
Prior radiation history
Need for postmastectomy radiation therapy (PMRT)
Medical comorbidities associated with higher complication rates such as smokers, diabetics, collagen vascular disease, coagulopathies, chronic steroid, or anti-rejection medicine use
Patient aversion to artificial implants, complex surgeries
Patients with past surgical history making distal flap sites unsuitable
Patients desiring simplified approach

consistently, these can simplify the entire experience and keep the surgeon from adjusting and readjusting the final result, saving time in the operating room. When made incorrectly, they can result in a lack of tissue that results in a closure with tension or less than ideal cosmesis. There are several ways that a breast can be marked for reduction; however, in order to accomplish the creation of the two poles, the Wise pattern has been used most frequently and most consistently (see Chap. 11 for specific instruction on Wise pattern marking technique). The upper pole delineation is more crucial than the lower pole. If the upper pole proportions are misplaced, this can result in tension with closure. A novice may want to start with very large breasted patients as generous breasts are more forgiving. If marking proportions are not perfect, on-table adjustments at the time of closure are more easily made if there is more tissue present. For smaller breasted patients, once incisions have been made or de-epithelization has been performed, the surgeon is committed to this arrangement. While a standard Wise pattern is recommended to create the upper and lower pole demarcation, as the practitioner becomes more facile with the technique, they may recognize where small adjustments for a particular habitus may result in an improved outcome, or may be able to better tailor the final result to a patient's particular request. This is easier when the starting breast is larger and the patient has request for a petite and lifted appearance. In marking, the patient is always marked in a standing position, with arms relaxed at the side. The tools required for proper marking include: surgical marking pen for skin, tape measure with minimum length of 30 cm, and a device to create an angle (either template to the degree of the angle desired or protractor/goniometer).

De-epithelization Before vs. After Mastectomy

Removal of the epithelium from the tissue that will be placed as a flap that will be dwelling under another layer of epithelized tissue is an underappreciated step in the process. Too heavy handed a removal can mean interruption of the valuable subdermal plexus and thinning of the tissue. Too light a touch can mean loss of the plane and a frustrating, time consuming, piecemeal process. There are many options for de-epithelization techniques, and different patient's skin texture may be more suited to one technique over another (for additional information, see Chap. 11 regarding de-epithelization technique styles and instructions). You may want to try several maneuvers and to find what is easiest and most efficient for you. Most surgeons familiar with the process of de-epithelization will agree that this is most easily accomplished with tension on the skin, keeping the plane still and firm to maintain the proper depth. This is usually best accomplished before the mastectomy has been performed as the presence of the underlying tissue provides helpful resistance to maintain tension. For those that perform de-epithelization first, there may be overall time saved, but with the de-epithelization first comes commitment to the markings made.

If the mastectomy is performed first, and skin left intact, the flaps can be maneuvered and tailor-tacked in position and adjusted. Correctly placed markings should not need adjustment, but those just beginning to use the technique may appreciate the flexibility with which the lower pole flap area can be designed smaller if there is too much tension on the closure and more skin coverage needs to be recruited to the upper pole. This is less of an issue with a larger breast with a significant amount of redundant tissue. Surgeons accustomed to a certain tension on the flap for the mastectomy dissection will find that the lack of epidermis creates much more elasticity and "give" when separating the dermal fat plane from the parenchyma. It may be harder to stay in the correct plane with the difference in tissue texture and should be important to not contuse, rip, or perforate the flap as you are attempting to separate it from the breast mound.

Flap Creation

One might think the methods used to separate the breast tissue from overlying dermal fat and skin are fairly limited and provide consistent results from practitioner to practitioner, but this is not the case. Methods of dissection and rates of injury/necrosis vary widely [14, 15]. Average and expected rates appear to fall between 5% and 15%, but have been stated as high as 40% in some papers. Those who create a more aggressive dissection plane that includes much of the dermal fat plane with the specimen may find this technique lacking aesthetic outcome. Inclusion of the volume of the dermal fat plane that is contiguous with that of the trunk and upper abdomen is essential in preservation of the plexus that will supply the remaining skin and also provide the residual bulk of the breast mound as the local flap. Proper parenchymal removal should be attended, and any tissue involved with malignant disease should be excised with proper oncological technique. These two practices are not mutually exclusive to the creation of healthy mastectomy flaps that are made up of more than simply dermis. Preoperative imaging can often be helpful to gauge the potential thickness of the plane and aid in estimation of the likelihood of leftover volume. It may be helpful to review mammographic and ultrasound images to assess the relative ration of possible residual dermal fat and the proximity of the parenchymal plane. Varied proportions of parenchyma and adipose tissue can make the size and density a poor predictor of final outcome. Large breasted women may have thin dermal planes with parenchyma adherent to swatches of dermis with little residual

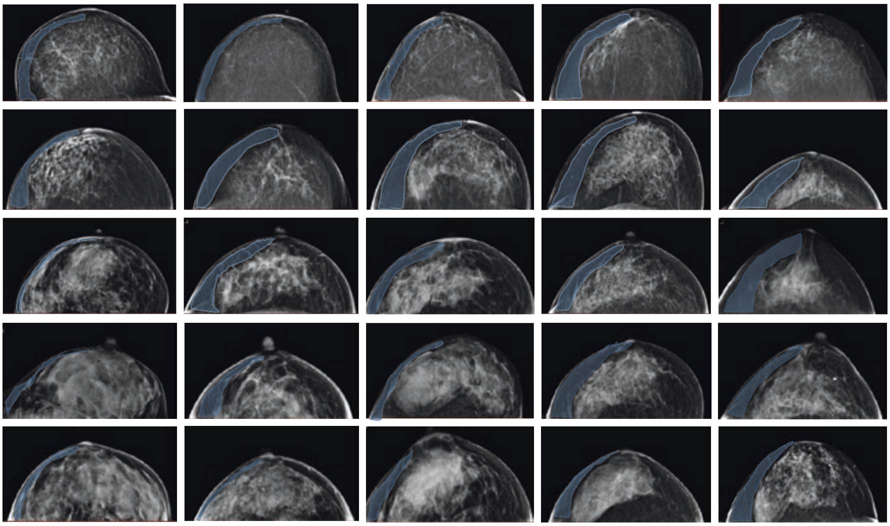


Fig. 24.2 Review of basic imaging can aid in the estimation of how much local flap material could potentially be available after mastectomy has been performed. Craniocaudal images from screening mammograms show the variety in breast tissue density and dermal fat patterns. Images are arranged so that density decreases from bottom to top and dermal fat thickness increases from left to right

volume to be left behind, and seemingly small breasted women may have breasts consisting of small central islands of glandular tissue with thick and well-developed fat planes that are easily preserved and reconfigured into a breast mound. This is Illustrated in Fig. 24.2.

Assembly of the Mound

Once the mastectomy flaps have been created and the lower pole has been de-epithelized, there will be a unique size and shape to each patient (and even left to right to a degree in a bilateral case). Shorter, wider flaps may not need to be affixed to the chest wall at all, but may be able to be rested against the pectoralis and will fall into a natural position under the upper pole with ease. The most common approach is to tack the superior medial border of the lower flap to the sternal pectoral insertion with absorbable suture of choice. Longer and more redundant lower pole flaps can be folded on a diagonal or in trifurcate to create more centro-medial bulk.

Once the lower pole is secured, the upper pole should be tacked with a simple suture or skin staple to the T-junction site on the border of the de-epithelized tissue to become the new IM fold. This is typically 10–12 cm from the sternum and should be measured for symmetry. It is often helpful to recruit lateral tissue medially to smooth the lateral chest wall/flank area and improve central fullness. Sitting the

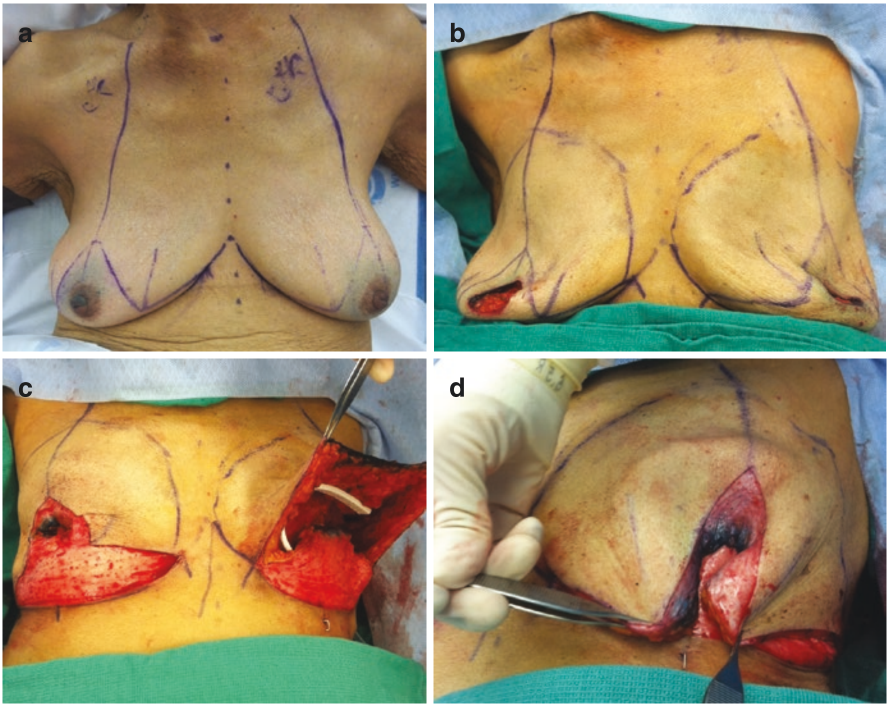


Fig. 24.3 Goldilocks mastectomy in steps. (**a**) Preoperative Wise pattern markings; (**b**) residual tissue after mastectomy has been performed; (**c**) de-epithelialized lower pole on right, divided upper and lower pole with drain in place on left; (**d**) upper pole position over lower pole to create neo breast mound

patient upright to assess for drape and symmetry is very helpful and should be done when tailor tacking or at initial assembly and prior to suturing.

Prior to closure, drains are placed through a separate stab incision and can be left over or under the lower flap as deemed fit, or into the axilla as may be needed with axillary tissue sampling. Once the assembly has been made and the final form chosen, the skin should be secured with a standard multilayer closure. The incision length of the IM fold and the newly created central-T should be documented. Billing can be made for the centimeters measured of complex multilayer closure and the mastectomy. Assembly is shown in Fig. 24.3 with final before and after results in Fig. 24.4.

Nipple Preservation

The initial description of the Goldilocks mastectomy did not call for nipple preservation. Free nipple grafting has been utilized successfully [16, 17]. Any patient that would be considered for nipple preservation in a full reconstruction setting could also be considered for nipple preservation with Goldilocks mastectomy. While free

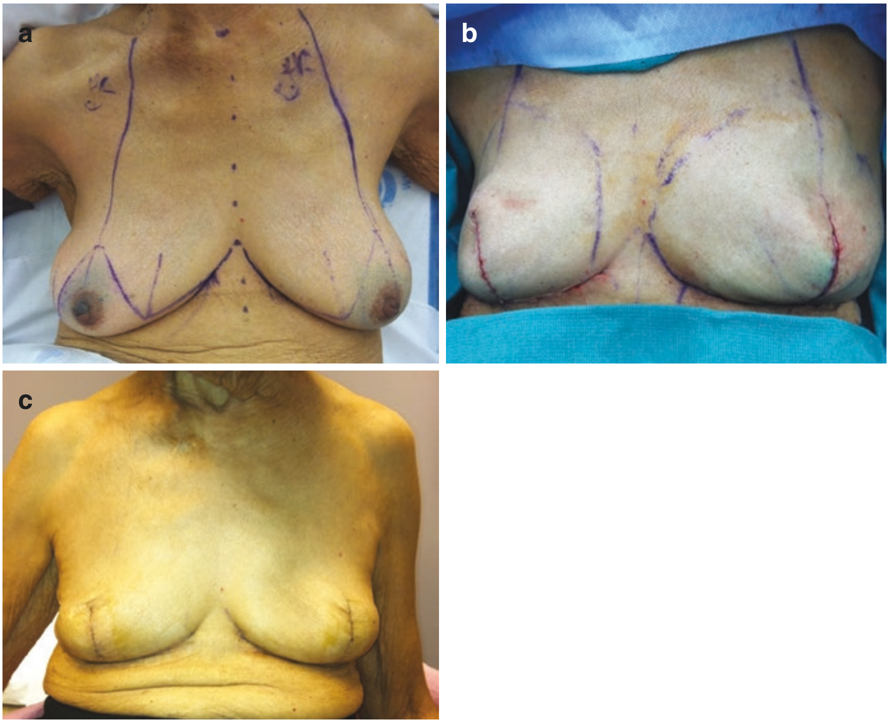


Fig. 24.4 94 y.o. patient with bilateral Goldilocks mastectomy for unilateral DCIS: (**a**) before; (**b**) on table result; (**c**) 8 weeks after surgery

nipple grafting is fairly straightforward, it can result in loss of pigmentation of the skin and projection of the nipple itself [18]. Figure 24.5 illustrates the use of a unilateral Goldilocks mastectomy with free nipple graft.

In situ preservation is technically possible [19], but requires careful maneuvering of the dermal connections. As the blood supply to the nipple areola complex (NAC) comes primarily from the upper outer medial and lateral trajectories stemming from the internal thoracic and lateral thoracic [20, 21], the most reliable way to preserve the NAC blood supply is by careful treatment of the medial and upper inner mastectomy flap and subdermal plexus. In performing the mastectomy, the lateral thoracic branches and upper outer blood vessels are typically sacrificed as they take a deeper course through the parenchyma, while the medial branches have a more superficial course and lend themselves to preservation.

As the nipple areolar blood flow will depend solely on the dermal plexus, even and careful de-epithelization is crucial, as is avoiding a full thickness incision when demarcating the areola. Even when the NAC blood flow is able to be preserved, redundancy and folding of the residual material as it lies beneath the upper pole can cause the vascular plexus to kink. Because of these challenges, patients who plan to have an attempt at nipple preservation should be prepared for a possibility of full thickness necrosis that is significantly higher than that of straightforward nipple sparing

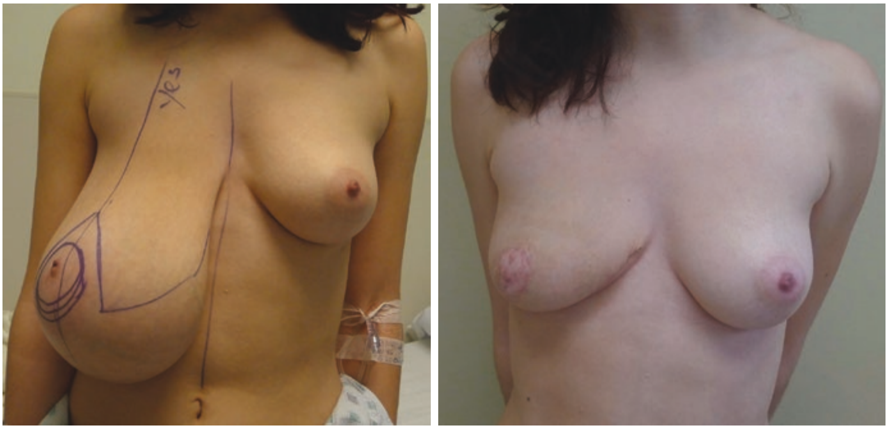


Fig. 24.5 Before and after photos of a 21 y.o. who underwent excision of a giant juvenile fibroadenoma with Goldilocks technique and nipple preservation via free nipple graft. (Photo courtesy of Maurice Nahabedian, MD)

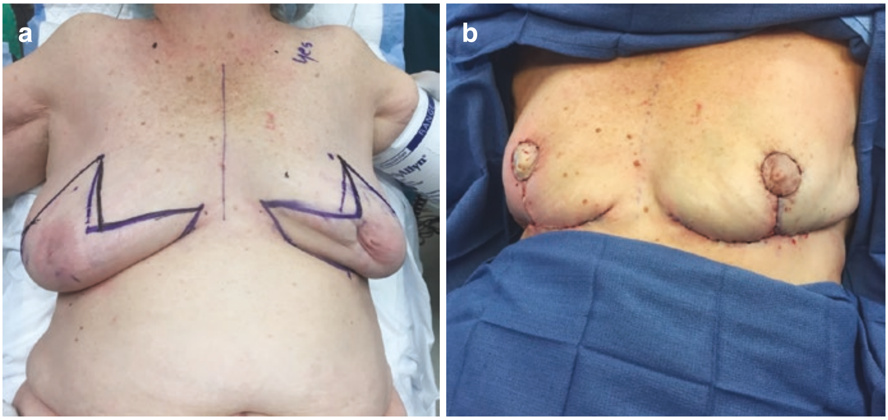


Fig. 24.6 Bilateral Goldilocks mastectomy with in situ nipple preservation. Intraoperative (**a**) before with Wise pattern marking and (**b**) on table result

mastectomy with reconstruction. Nipple preservation should be counselled as a possible bonus, rather than an expected outcome, due to the many obstacles to perfusion. Figures 24.6, 24.7, and 24.8 show steps and results of in situ NAC preservation.

Aftercare

Postoperative wound management is not dissimilar to that of a simple mastectomy. There is surprisingly little T-zone necrosis seen, but, as with breast reduction surgery, this watershed area is the most common site of healing difficulties. Postoperative

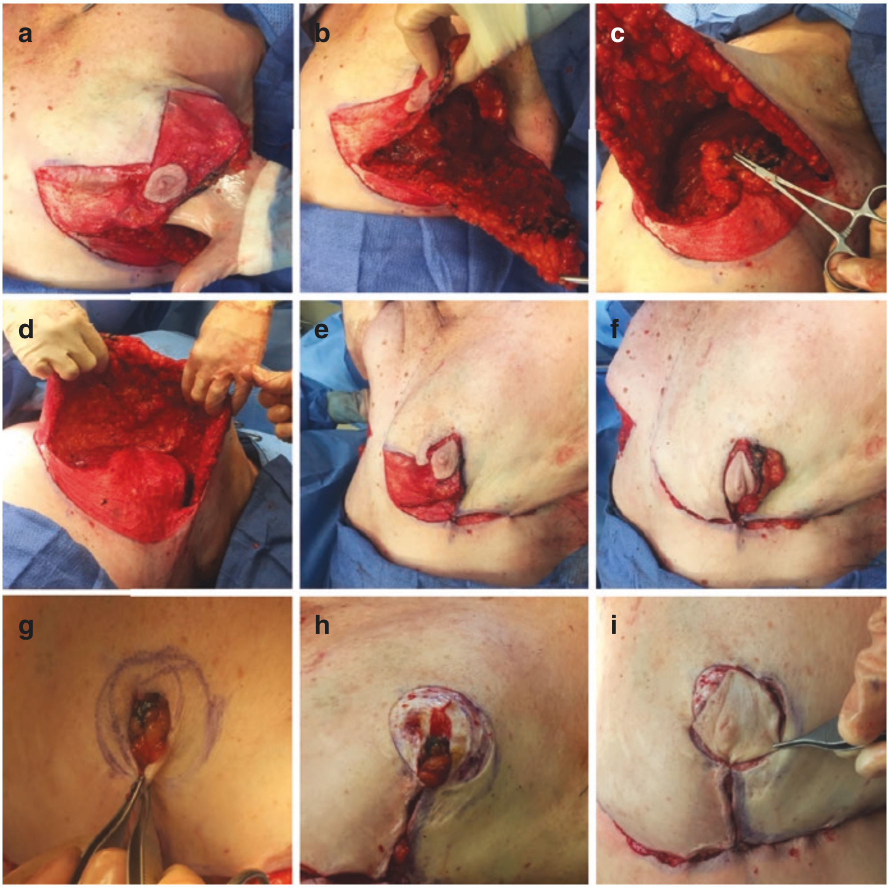


Fig. 24.7 Step-by-step process of in situ preservation of a nipple areolar complex with blood supply from the surrounding dermis. (**a**) The NAC on the superior flap with the surrounding epithelium removed. (**b**) Showing the upper pole and lower pole mastectomy flaps with the breast mound still in place. (**c**) With the breast mound removed, the bulk of the de-epithelialized lower pole is demonstrated and (**d**) affixed with sutures into the superior medial mastectomy site. (**e** and **f**) The upper pole T-points are affixed to the newly created inframammary fold. (**g**) With the nipple beneath the surface, a new site for the NAC is drawn with a cookie cutter on the upper pole and (**h**) de-epithelialized. (**i**) The NAC edges are manipulated through the opening and sutured in place. Gentle releasing of the dermis may be necessary, but full thickness incisions at the NAC border are avoided to maintain the dermal plexus blood flow

Fig. 24.8 In situ nipple preservation with blood supply via a dermal pedicle. Bilateral nipple sparing Goldilocks mastectomies: a 69 y.o. with a history of left lumpectomy and radiation with recurrent left IDC. (**a**) Before. (**b**) Postoperative day #5 with signs of NAC ischemia. (**c**) Five weeks postop with a rim of full thickness eschar on the lower outer right NAC and upper outer left NAC

instructions should include basic drain care instructions, and activity as tolerated is appropriate for most average patients.

Follow-Up

Ultrasound is cited as a useful tool in screening postoperative mastectomy patients in general but mammography is not a standard recommendation after mastectomy [22, 23]. Professional colleagues as well as patients may erroneously think that radiation and/or screening mammography are automatically necessary, as their physical exam findings may appear to be consistent with breast conserving therapy or even breast reduction. As more patients accrue, data may show in the future that screening modalities are helpful. Individual patients with disease patterns more concerning for locoregional recurrence should be considered for tailored follow-up imaging plans that may include MRI or mammography on a case-by-case basis.

Adjunctive Procedures

Once the patient has healed, if nipples were not preserved, a variety of prosthetic silicone nipples are available to improve the final appearance. Nipple reconstruction and tattooing should be able to be implemented just as it can be in non-nipple sparing mastectomies with reconstruction. If the patient feels that the final volume is not proportional to her size, prosthetic "helpers" are available to augment what was able to be preserved. Fat grafting to increase volume can be utilized as many times as necessary or possible. Even if it is expected that there will be an unsatisfactory final volume at the completion of the procedure, delayed implant placement after Goldilocks mastectomy may have benefit over attempting immediate implant-based reconstruction in obese women [24].

Results

Final results are dependent on the patient's habitus as well as surgical technique. Patients may choose a unilateral or bilateral approach. Those who choose a unilateral mastectomy are counselled that they will have asymmetry if they do not have the contralateral breast adjusted or make use of a prosthesis. The initial paper described 32 patients (50 breasts), and the reported complications (seroma, cellulitis, wound healing difficulty, fat necrosis) were similar to that of existing mastectomy techniques. No instances of locoregional recurrence were reported [1].

Additional applications of the technique have been explored to include a patient with giant juvenile fibroadenoma, [17] and to incorporate nipple preservation with free nipple grafting [16, 24]. The limitations were notably reported for smaller breasted women in Japan [25]. Figures 24.9, 24.10, and 24.11 show the results.

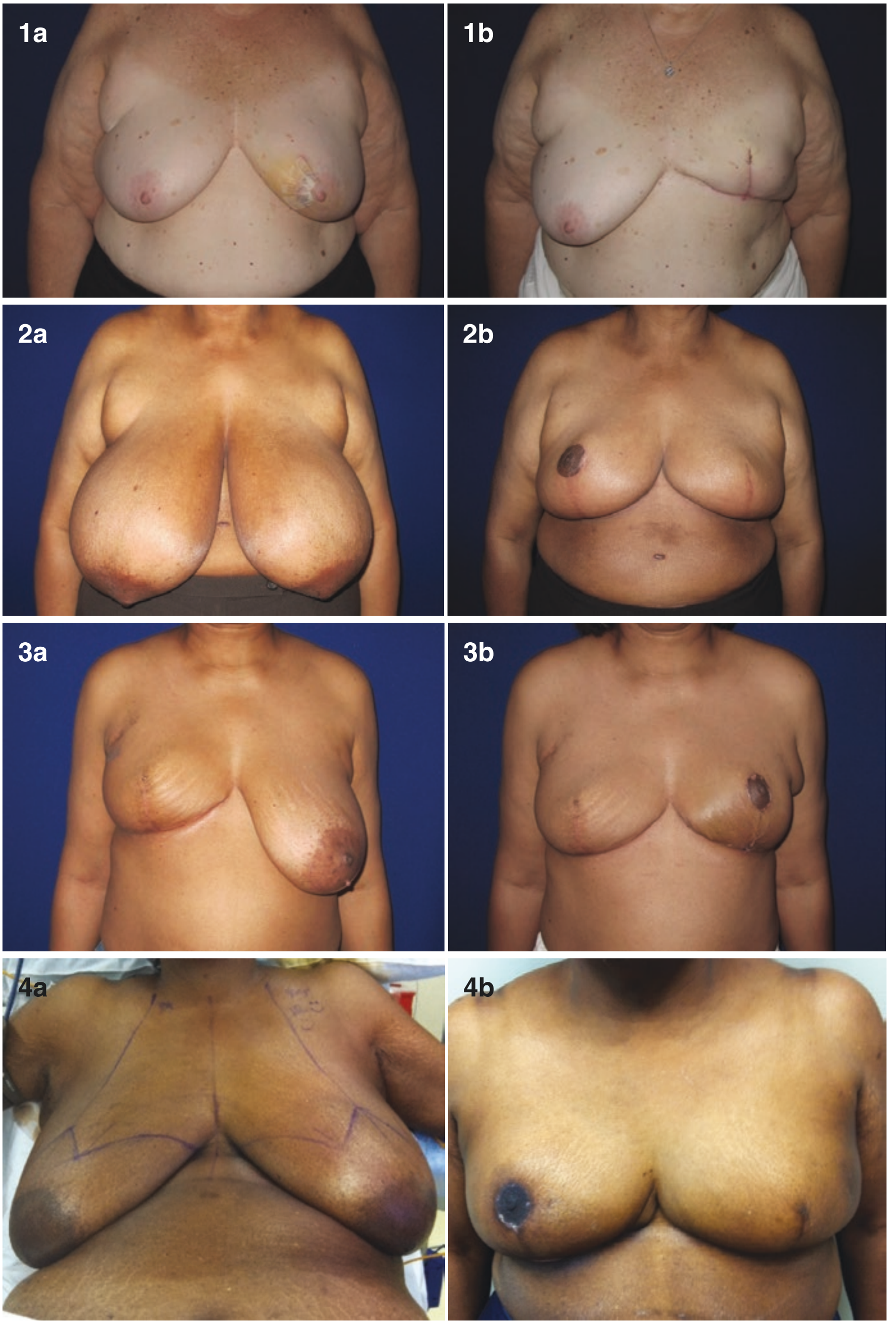


Fig. 24.9 Examples of unilateral Goldilocks mastectomy before (**a**) and after (**b**): (1a and 1b) 64 y.o., BMI 40.3, left Goldilocks mastectomy for adenoid cystic carcinoma. (2a and 2b) 59 y.o., BMI 34, left Goldilocks mastectomy for multifocal IDC with DCIS, right reduction mammaplasty. (3a and 3b) 56 y.o., BMI 30.6, s/p neoadjuvant chemo, right Goldilocks mastectomy for IDC, delayed left reduction mammaplasty for symmetry. (4a and 4b) 67 y.o., BMI 29.9 with multifocal left IDC and DCIS, left Goldilocks mastectomy, right reduction mammaplasty

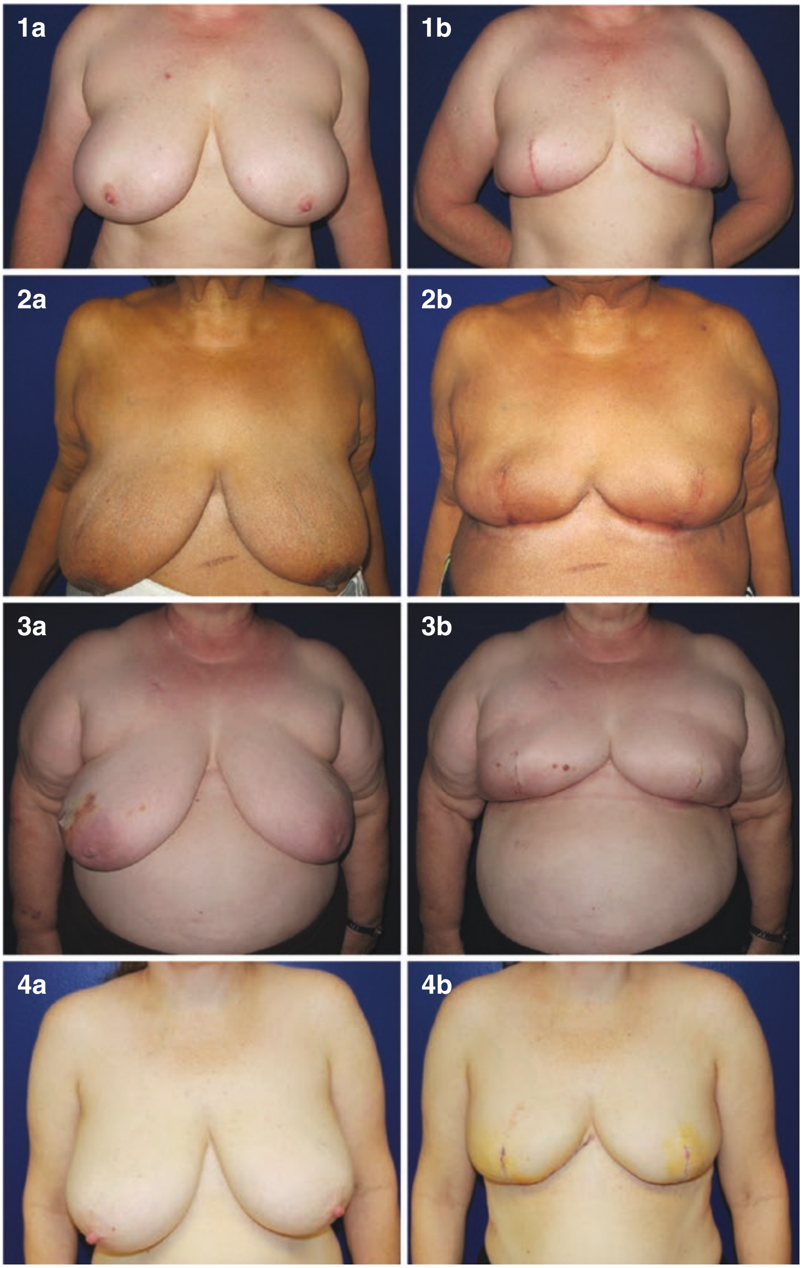


Fig. 24.10 Examples of bilateral Goldilocks mastectomy before (**a**) and after (**b**): (1a and 1b) 44 y.o., BMI 29.5, bilateral Goldilocks mastectomy for prophylaxis secondary to gene positive family history. (2a and 2b) 75 y.o., BMI 33.3, right Goldilocks mastectomy for DCIS, left prophylactic Goldilocks mastectomy. (3a and 3b) 58 y.o., BMI 51.9 initially treated for left IDC with lumpectomy and mammosite, DCIS of right breast noted; underwent bilateral Goldilocks mastectomies; history of kidney transplant. (4a and 4b) 50 y.o., treated for right DCIS with bilateral Goldilocks mastectomies

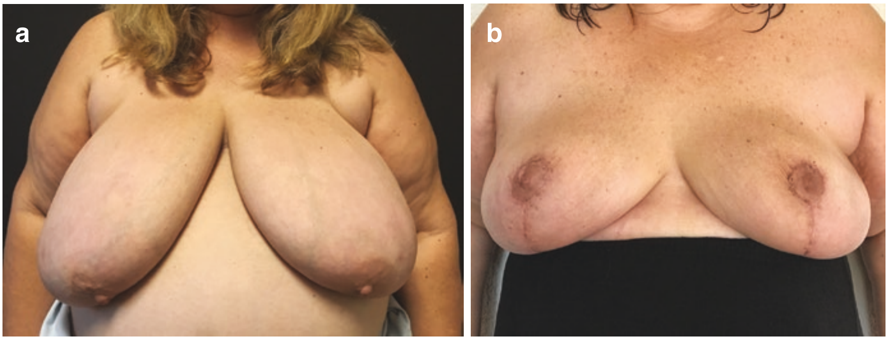


Fig. 24.11 (**a**) Before and (**b**) 8 weeks after photos of a 57 y.o. with right IDC who underwent bilateral Goldilocks mastectomies with nipple preservation via an in situ dermal pedicle

Conclusions

The patient population that cannot have or does not want full breast reconstruction after mastectomy is disadvantaged if simple mastectomy is the only option offered. Many of the patients in this category are elderly or obese with ptotic breasts. This makes them uniquely suited to utilize their own natural tissue that would have been discarded with a large mastectomy specimen, tissue that would have otherwise been spared if they were undergoing full reconstruction. This patient population is expected to grow and with it a likely increase in breast cancer diagnoses [26]. This technique may be able to be utilized in select patients with smaller breasts as well, as long as they are aware of the even smaller final volume or interested in the addition of volume via fat grafting after the act.

As the character Goldilocks discovered as she tried a variety of options before choosing the best one, there is some trial and error that is often encountered before finding what is "just right." For the surgeon who chooses to include this technique in their armamentarium, the effort may be worthwhile to a subset of patients.

References

1. Richardson H, Ma G. The Goldilocks mastectomy. Int J Surg. 2012;10:522–6.
2. Ghossain A, Ghossain MA. History of mastectomy before and after Halsted. J Med Liban. 2009;57:65–71.
3. Carlson G. Technical advances in skin sparing mastectomy. Int J Surg Oncol. 2011;2011:7.
4. Kroll SS, Ames F, Singletary SE, Schusterman MA. The oncologic risks of skin preservation at mastectomy when combined with immediate breast reconstruction. Surg Gynecol Obstet. 1991;172:17–20.
5. Kroll SS, Schusterman MA, Tadjalli HE, et al. Risk of recurrence after treatment of early breast cancer with skin-sparing mastectomy. Ann Surg Oncol. 1997;4:193–7.
6. Kroll, Stephen S., et al. Local recurrence risk after skin-sparing and conventional mastectomy: a 6-year follow-up. Plast Reconstr Surg. 1999104(2):421–425.
7. Simmons RM, Adamovich TL. Skin-sparing mastectomy. Surg Clin North Am. 2003;83:885–99.

8. Toth BA, Forley BG, Calabria R. Retrospective study of the skin-sparing mastectomy in breast reconstruction. Plast Reconstr Surg. 1999;104:77–84.
9. Davies, K., Allan, L., Roblin, P. et al. Factors affecting post-operative complications following skin sparing mastectomy with immediate breast reconstruction. February 2011, Breast. 20 21–5r.
10. Hanwright PJ, Davila AA, Hirsch EM, Khan SA, Fine NA, Bilimoria KY, Kim JY. The differential effect of BMI on prosthetic versus autogenous breast reconstruction: a multivariate analysis of 12,986 patients. 5, October 2014, Breast. 22, 938–945.
11. Ehsani S, Strigel RM, Pettke E, et al. Screening magnetic resonance imaging recommendations and outcomes in patients at high risk for breast cancer. Breast J. 2015;21(3):246–53.
12. Derderian CA, Karp NS, Choi M. Wise pattern breast reconstruction: modification using alloderm and a vascularized dermal-subcutaneous pedicle. Ann Plast Surg. 2009;62:528–32.
13. Heidenhain L. Über die Ursachen der lokalen Krebsrezidive nach Amputatio mammae. Arch. klin. Chir. 1889.
14. Patel KM, Hill LM, Gatti ME, Nahabedian MY. Management of massive mastectomy skin flap necrosis following autologous breast reconstruction. Ann Plast Surg. 2012;69(2):139–44.
15. Robertson SA, et al. Mastectomy skin flap necrosis: challenges and solutions. Breast Cancer. 2017;9:141–52.
16. Schwartz J-CD, Skowronski PP. Total single-stage autologous breast reconstruction with free nipple grafts. Plast Reconstr Surg Glob Open. 2015;3:e587.
17. Ter Louw RP, Bruce SB, Nahabedian MY. Partial breast reconstruction with Goldilocks technique after excision of giant fibroadenoma: a case report. Plast Reconstr Surg Glob Open. 2017;5:1200e.
18. Doren EL, Van Eldik Kuykendall L, Lopez JJ, Laronga C, Smith PD. Free nipple grafting: an alternative for patients ineligible for nipple-sparing mastectomy? Ann Plast Surg. 2014;72(6):112–5.
19. Richardson H, Aronowitz J. Goldilocks mastectomy with bilateral in situ nipple preservation via dermal pedicle. (Accepted for publication), PRS Open; 2018∗.
20. van PV D. The blood supply to the nipple-areola complex of the human mammary gland. Aesthet Plast Surg. 2004;28(6):393–8.
21. O'Dey DM, Prescher A, Pallua N. Vascular reliability of nipple-areola complex-bearing pedicles: an anatomical microdissection study. Plast Reconstr Surg. 2007;119(4):1167–77.
22. Farajado LL, Roberts CC, Hunt KR. Mammographic surveillance of breast cancer pateints: should the mastectomy site be imaged? Am J Radiol. 1993;161:953.
23. Lee JH, et al. US screening for detection of nonpalpable locoregional recurrence after mastectomy. Eur J Radiol. 2013;82(3):485–9.
24. Schwartz J-C. Goldilocks mastectomy: a safe bridge to implant-based breast reconstruction in the morbidly obese. PRS Glob Open. 2017;5(6):e1398.
25. Ogawa T. Goldilocks mastectomy for obese Japanese females with breast ptosis. Asian J Surg. 2015;38(4):232–5.
26. Torre LA, Siegel RA, Ward EM, Jemal A. Global cancer incidence and mortality rates and trends – an update. Cancer Epidemiol Biomark Prev. 2016;25(1):16.

Nipple–Areola Complex Reconstruction

25

Zoltán Mátrai

Surgical Anatomy of the Nipple–Areola Complex

The nipple is located on the most prominent part of the breast, which is surrounded by the pigmented areola of different sizes [1–4]. These two anatomical structures form the so-called nipple–areola complex (NAC). In the NAC area, there are several accessory areolar glands located (glandulae areoles, Montgomery tubercles) as well several sweat and sebaceous glands. On the tip of the nipple, lactiferous ducts are terminated into the lactiferous pores [2, 3].

The arterial system of the breast can be divided into superficial and deep vessels [2, 3]. The arteries of the superficial group are placed near the skin while the deep arteries penetrate forward along the Würinger-septum from the posterior surface of the breast. The superficial arteries run in the subcutaneous layer towards the nipple from the periphery [2, 3]. Subdermally, the two groups form an anastomotic network under the areola, which supplies the NAC. The second and fourth intercostal perforators of the internal thoracic artery are supplying the medial part of the breast [2, 3]. These three perforator branches provide the dominant arterial supply for the breast and nipple. Two arteries supply the breast laterally. The lateral thoracic artery from the axillary artery is the more dominant one, and it has deep and superficial branches. Besides the perforators of the internal thoracic artery, the lateral thoracic artery is an important arterial supply for the NAC [2, 3].

The veins are also grouped into two systems: superficial and deep [2, 3]. The veins of the superficial group form a network underneath the skin and plexuses around the nipple (plexus venosus mammillae) and areola (plexus venosus areolaris).

Sensory innervation of the NAC is mostly provided by the lateral cutaneous branch of the fourth intercostal nerve [2, 3]. The nerve has two anatomical

Z. Mátrai (✉)
Department of Breast and Sarcoma Surgery, National Institute of Oncology, Budapest, Hungary

V. S. Klimberg et al. (eds.), *Oncoplastic Breast Surgery Techniques for the General Surgeon*, https://doi.org/10.1007/978-3-030-40196-2_25

variations: in most of the cases, it runs inferomedially in the pectoralis fascia until reaches the midclavicular line, where it takes a 90° turn and travels along the Würinger-septum by perforating through the breast tissue, then it reaches the nipple from its posterior side. In the remaining cases, the nerve runs superficially in the subcutaneous tissue, thus reaches the nipple from its lateral side [2, 3]. The innervation of the NAC can be preserved most if the pectoralis fascia, Würinger-septum and the outer quadrants are left intact during surgery [2, 3].

The Aesthetic Units and Subunits of the Breast

According to Gulyás, from an anthropometric point of view, the proportion of the entire body and the ratio of the breasts correlating to each other determine the aesthetic appearance of the breast [4]. The significant discrepancy in the proportion of the breast and the body arouses a disharmony sensation in the beholder. The aesthetic units of the breast are determined by the breasts' relative ratio to each other and by the ratio of the structural elements of the breast to the entire breast [4]. In the proportion of the human body, the entire breast is an aesthetic unit. The aesthetic units can be further divided into subunits. The aesthetic units of symmetrical breast are the same. Incisions running at the border of the aesthetic units result in an ideal direction regarding wound healing and also hidden scars from an optical perspective. The replacement of aesthetic units facilitates the reconstruction of the breasts' volume, shape and symmetry [4].

The aesthetic subunits of the breast include the upper, lower, inner and outer poles of the breast, the inferior mammary fold (IMF), the lateral mammary fold (LMF), the nipple–areola complex and its immediate surroundings, and the central part of the breast [4].

The *décolletage*, the uncovered surfaces of the breasts facing each other, is not part of the artistic anatomy; however, the solidity of the upper and inner poles facing each other are an important aesthetic unit in the perspective of plastic surgery [4]. The parts of the breast uncovered by clothing, the inner–upper poles, have to be handled very prudently during the aesthetic and reconstructive surgical procedures.

Between the aesthetic subunits, the NAC has an outstanding role. According to Shestak, the nipple is an essential cosmetic feature of the breast and it is the hub around which the rest of the gland emanates [1]. It also confers to the breast both an aesthetic and a sexual dimension [1]. In a situation after a skin-sparing mastectomy with adequate postmastectomy breast reconstruction, even the optimal cosmetic result of the plastic surgical intervention is only a breast mound for the human perception. The presence or the absence of the NAC, a three-dimensional (3D) or only a tattooed two-dimensional (2D) one, can cause a significant difference, because only NAC reconstruction enables the visual transformation of the newly created breast mound into a breast organ. Subsequent pigmented or coloured areola gives to the reconstructed breast the maximum amount of realism that any breast reconstruction can ever achieve [1] (see Fig. 25.1a–c).

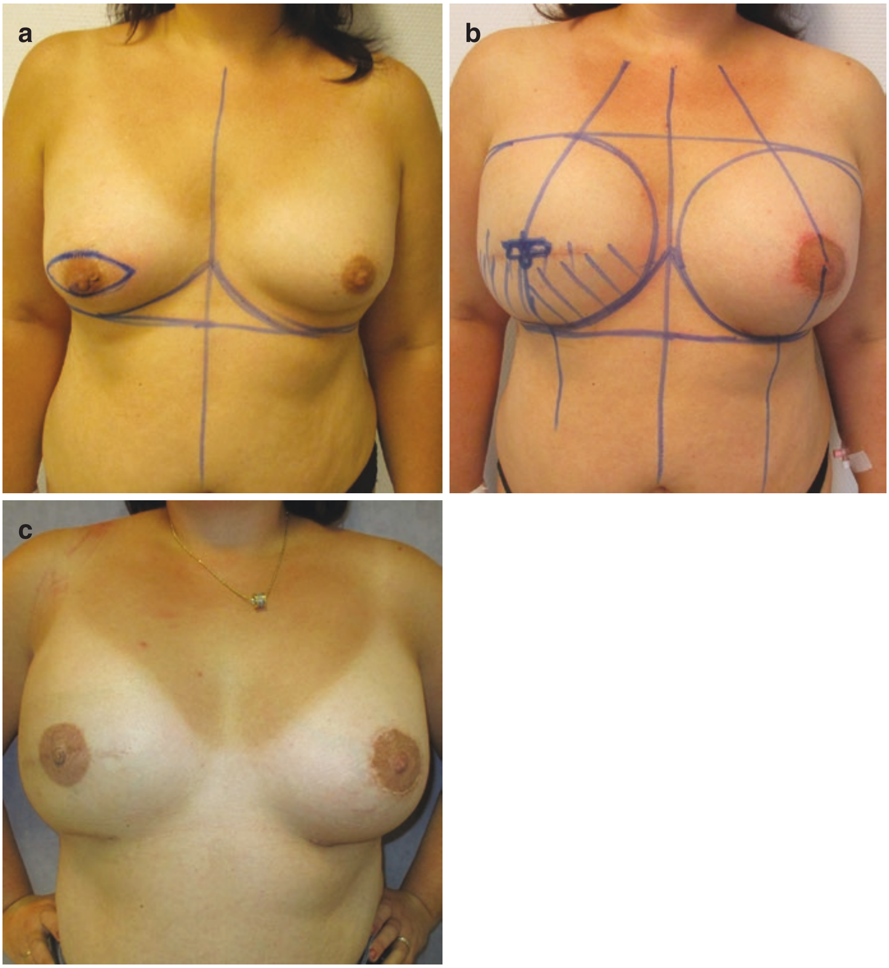


Fig. 25.1 (**a**) A 38-year-old patient underwent skin-sparing mastectomy and delayed-immediate breast reconstruction with submuscularly placed expander in her right breast. (**b**) Following the expander to silicone implant placement, the patient required as a third-stage operation a capsulo-plasty, lipomodelling and nipple reconstruction. (**c**) Four-month postoperative result after areola tattooing

The reconstructed NAC in its optimal position is able to increase the symmetry of the breasts and is able to subjectively overwhelm slight asymmetries of scars, volume or shape of the bilateral breasts. In contrast, malposition of the NAC increases the perception of asymmetry, even when shape and volume of the breasts are the same (see Fig. 25.2a–h).

Several artistic and mathematical methods exist to describe the aesthetic breast and to determine its proportions [4]. The method, which is able to evince the beauty of the breast with mathematical measurements, describes the ratio of the breast – the ratio between the distance of the nipple and the upper pole, and the distance of nipple and the lower pole measured to the vertical diameter of the breast [4]. We are talking about an optimal ratio and a nicely shaped breast when the ratio of distance between the nipple and the upper pole to the vertical diameter of the breast is 45%. The distance between the nipple and the lower pole is 55% of the vertical diameter [4]. Regarding the nipple position, Brown et al. stated that the horizontal nipple position was always lateral to the midclavicular line by a mean of 25 mm and the vertical position of the nipple was consistently lower than the mid-humeral line by a mean of 40 mm [5]. The vertical position of the nipple correlated significantly with the lowest point on the inframammary fold. The measurements have to be done directly on the chest wall and breast in a standing or sitting position (see Table 25.1).

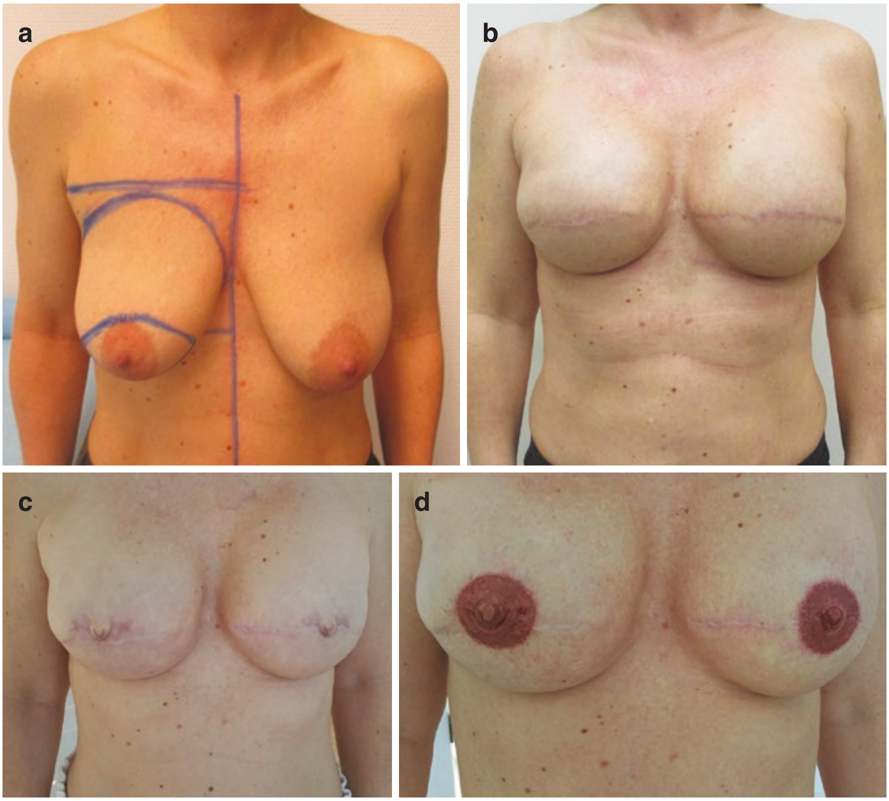


Fig. 25.2 (**a**, **b**) The 35-year-old woman had bilateral skin-sparing mastectomy. In her right breast the operation was performed because of invasive breast cancer. A synchronous contralateral prophylactic skin-sparing mastectomy with delayed-immediate reconstruction was performed because of a BRCA2 gene mutation, according to her will. (**c**) Cosmetic end result after expander to silicone implant placement and bilateral nipple reconstruction. Cosmetic results just after the nipple areola tattooing (**d**), and 3 months after (**e–h**)

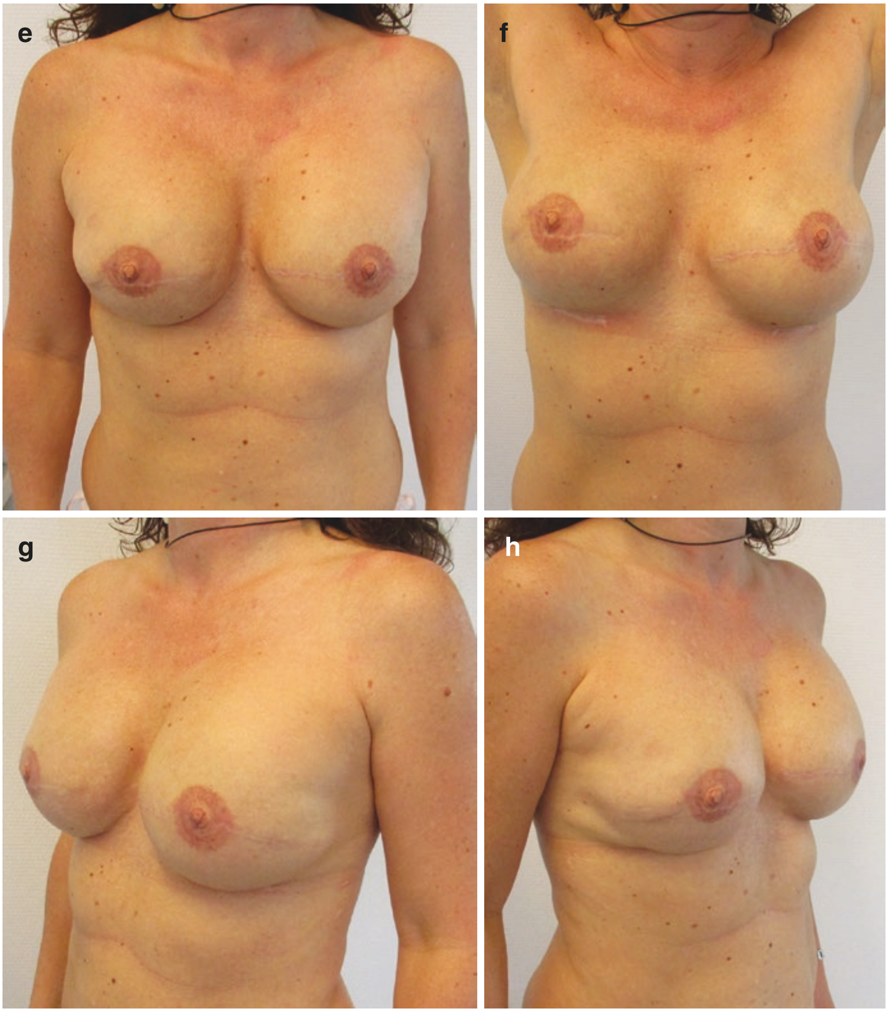


Fig. 25.2 (continued)

Table 25.1 Factors influencing breast symmetry [4]

Volume of the breasts
The identical height of the nipple on a horizontal plane
The distance of the nipples from the central part of the sternum
The position of the inframammary folds on a horizontal plane compared to each other
The diameter and shape of the nipple and areola

Table 25.2 Anatomical landmarks on the breast and chest wall, the measurable elements of the breast [4]

Sternal notch-to-nipple distance
Breast meridian, the vertical half-way line of the breast
The diameter of the nipple and areola
Inframammary fold and the footprint of the breast
Distance between the inframammary fold and nipple
Horizontal diameter of the footprint
Vertical diameter of the footprint
Projection of the breast

Anatomical Landmarks on the Breast and Chest Wall, the Measurable Elements of the Breast

In modern breast surgery, the basis of oncoplastic perspective is the unity in the reconstruction of the human body proportions and healing [4]. The anthropometric characteristics of the human body play a part in the localisation of the breast on the chest wall, thus also in the planning of the operation. The anthropometric differences should be considered when planning the reconstructive and aesthetic breast procedures [4] (see Table 25.2).

At the cosmetic evaluation of the breast, the location of the nipple, its shape and size all have a great importance [4]. The diameter of the areola is proportional to the size of the breast (3.5–5 cm). In average cases, the areola is round, its diameter is 3.8 cm, the diameter of the nipple is 0.8–1.5 cm and it can change depending on the volume of the breast [4]. The shape and the size of the nipple can change due to the irritation of smooth muscle; the erection can strain the nipple and areola; thus, a more precise marking and planning should be done in a stationary state. Psychological and patient satisfaction studies show that breast reconstructive surgeries can only be considered finished when the nipple is reconstructed [4].

Reconstruction of the Nipple–Areola Complex

The reconstruction of the NAC is an essential part of the breast reconstruction aiming high level cosmetic end result [6]. It should be performed under local anaesthesia in order to both reduce the number of general anaesthetics and increase its acceptability [1, 6]. An alternative to a surgically reconstructed nipple is the compromise to use of silicone prosthetic nipples or the option of 3D tattooing.

The reconstruction of the NAC is usually the final (second or third) stage of partial- or postmastectomy breast reconstruction [1, 6]. Optimally, the NAC reconstruction should be carried out only when the plastic surgeon is confident that an acceptable symmetry and shape of the reconstructed breast has been achieved [7]. From the practical point of view, the optimal time for NAC reconstruction is at least 3 months after the breast shape and volume reconstruction, allowing the breast mound to mature in terms of evolution of shape and gravitational settling [1]. The NAC reconstruction might have to be done at an even later stage when radiotherapy is needed. At this time, the plastic surgeon is able to objectively evaluate the end result and symmetry of the bilateral stable breasts, and define the optimal position of the NAC [1, 6]. In some of the cases, nipple reconstruction could be combined with a minor revisional or reshaping surgical procedure like re-pexia, capsuloplasty or lipomodelling. Other breast surgeons are performing the NAC reconstruction at the time of subsequent implant placement, or simultaneously at the time of exchanging the expander for an implant. This policy could carry a low but elevated risk of losing the implant due to wound healing problems and subsequent exposure and/or infection at the site of nipple reconstruction [1].

Positioning and Mark-Up of the New Nipple

Matching the position of the areola with respect to the opposite side is essential [6]. Mark-up can be done by the experts eye: for optimal positioning the use of measurements from anatomical landmarks, including the midline, midclavicular line and the inframammary fold, is essential.

Optimally, the patient is in standing position, and the plastic surgeon is sitting in front of her so that the breasts are located at eye level of the surgeon. As first step the midline has to be marked and as next the IMFs. If the patient has her natural NAC on one side (after symmetrisation operation of the breasts), then on this side the midclavicular-to-nipple line and its vertical projection to the IMF has to be marked up. The sternal notch to nipple distance has to be measured, which is optimally between 19 and 21 cm. The optimal location of the nipple from the midline is between 9 and 11 cm. If the breast has significant ptosis, the optimal height of the nipple can be approximately estimated if the right-handed surgeon puts his/her left hand below the lower pole of the breast and elevates the breast perpendicularly by the forefinger. As a next step, the measurements from the healthy breast have to be projected to the reconstructed contralateral one, if the breast mounds are symmetric enough, at 3 months after the postmastectomy breast reconstruction. In case of non-significant asymmetries of the healthy breast (even after symmetrisation by mastopexy, reduction, augmentation with implant placement or combination of these) and reconstructed side, the position of the nipples has to be symmetric. In case of a significant asymmetry (if the patient accepts the cosmetic result), the symmetric position of the nipples, even if it is somehow in malposition according to the suboptimally reconstructed breast, should be achieved. Beware of a suboptimal cranial (too high) malposition of the nipple, to cause ‘sunrise phenomenon’ from the bra, which is very unpleasant to the beholder and technically complicated to correct it, almost impossible without disturbing scars left behind.

In case of a bilateral breast reconstruction with an indication of bilateral nipple reconstruction, the optimal position of the nipples should be measured and marked up.

After marking up the nipple/s, the surgeon should check the position twice before cutting the skin. The surgeon should check the mark-ups from a position of one step backward and from the 45° and 90° angle positions.

In cases of asymmetry of the breast, or different breast reconstructive techniques and scars on the breasts, for checking the ideal position of the new NAC or NACs there is a simple but effective way to help to imagine the optimal mark-ups. The contours of the existing areola is outlined with a marker pen, and then the radius is traced onto a small piece of rectangular paper, which is folded twice. The tracing is cut out and so the folded paper forms a quarter of the circle. After cutting the tip of the paper, it unfolds to a circle having the patient's individual parameters and it is ready to be placed in the optimal position on the reconstructed breast.

The combination of these techniques allows optimal placement of the future nipple and compensates for any errors arising from measurements alone.

Reconstruction of the Nipple

Patients attach a great importance not only to the form, colour and size of the NAC, but also to the appearance and projection of the nipple [1, 6]. The combination of tattooing and a flap responds well to these demands [6].

Historically, the options for nipple reconstruction have been the use of composite grafts such as earlobe and labia minora, or most commonly a composite graft of a portion of the contralateral nipple from the opposite breast [1]. Numerous techniques have been described in the literature [6, 9–20].

Over the past decades, random skin flaps raised locally at the desired nipple position have represented the state-of-the-art of nipple reconstruction. The most commonly used flaps and surgical techniques for nipple reconstruction are listed in Table 25.3.

Table 25.3 Nipple reconstruction techniques [1, 6, 8]

Local random skin flaps	
F flap	The technique involves raising two adipo-cutaneous flaps that are vascularised by a common central base, then rolled, one into the other [6]. The two limbs are raised, taking care of the pedicle of the flap; the limbs are subsequently crossed, one over the other [6]
Z flap	This is a double-limbed flap, with each limb having its own separate pedicle [6]; vascularisation is therefore more reliable and the risk of necrosis is lower [6]
Skate flap [21–23]	The wings of the skate are harvested as a partial thickness flap, whilst the central part of the flap is elevated to include subcutaneous tissue that ensures good vascularisation to the flap and provides bulk to the nipple [8]
Star flap [12]	This technique comprises three opposing flaps connected at their bases; it gives good results, but the donor site closure in a T risks skin ischaemia [6]
Fishtail flap [17]	This is formed by rolling together two skin flaps with a common inferior pedicle so that the form evokes the tail fin of a fish [6]
CV flap [27]	This is a bi-triangular flap with a common base; two limbs are forming a C, and the third limb forms the superior part of the nipple [6]
S flap or double opposing flap [15]	An 'S' or 'H' is marked in the circle, with the central line on the mastectomy scar; this creates two identical, opposing flaps that are raised and sutured to each other first by their bases and then by their edges; the skin graft is tailored (and therefore necessitates a de-epithelialisation of the recipient site) [6]
Graft techniques	
Ear lobe	
Costochondral cartilage	
Labia minora	
Nipple sharing	
Two- and three-dimensional tattooing	

The reconstructive surgical techniques of a nipple are relatively simple and can be carried out as a day-case procedure, under local anaesthesia [1, 6]. Nipple reconstruction needs to be performed in sterile operating room due to the presence of an implant behind the skin and the tissue expansion by the implant, which definitely results in thinning of the subcutaneous fat and dermis layer over the implant and so the capsule of the implant could be easily focally opened at the time of nipple reconstruction.

Protuberance of the nipple is created with local random skin flaps and once healed, colour matching of both nipple and areola can be achieved in most of the cases with medical tattooing (see Fig. 25.3a–c).

Alternatively, a skin graft can be taken from the inner thigh etc., using an onlay technique (see below).

Some of the techniques previously employed for nipple reconstruction are being abandoned as it has become apparent that results are not durable with progressive flattening of the reconstructed nipple. For this reason, some surgeons reconstruct an over-sized nipple to compensate for a degree of atrophy and to achieve long-term symmetry or use composite grafts [1]. Steve Kronowitz recommends the use of costochondral cartilage grafts, which is harvested and subsequently banked under the breast skin at the time of breast reconstruction and subsequently retrieved for

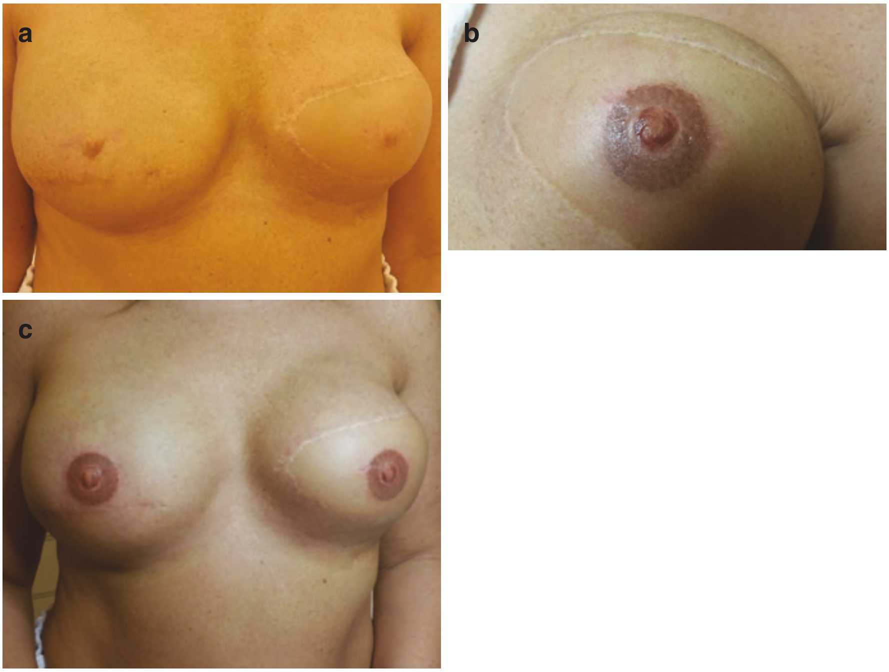


Fig. 25.3 (**a**) Bilateral mastectomy: on the right side, with skin-sparing mastectomy and implant-based reconstruction; on the left side, standard mastectomy followed by a latissimus dorsi myocutaneous flap and silicone implant, and bilateral nipple reconstruction. (**b**) The tattooed left breast. (**c**) Cosmetic end result after bilateral nipple areola complex reconstruction. (Photos by M. Vámos)

nipple reconstruction [24]. This technique can be combined with other minor revision procedures such as lipomodelling. The cartilage graft does not resorb and maintains long-term nipple projection, which could result in high levels of patient satisfaction [24].

At the moment there is no optimal method for nipple reconstruction but some general statement can be made. Performing nipple reconstruction flaps are delicate and must be handled with atraumatic techniques [1]. Flap mobilisation is done with scalpel and sharp dissection. Careful preparation is mandatory with no tension and no excessive twisting or bending on the flaps. Using too much and too tight skin or subcutaneous sutures is to be avoided [1, 6].

The preferred methods of nipple reconstruction at present are those that use local random flaps such as the popular skate flap or star flap [1, 6, 7]. Flap techniques elevate skin and subcutaneous adipose tissue of the reconstructed breast, detaching it at all areas but the base of the flap and then reconfiguring it into the desired nipple shape [1]. The elements in the flap responsible for the nipple projection are adipose tissue and the thickness of the dermis. The tissue used for reconstruction of the nipple is elevated, or pulled out, to at least a 90° angle from the surface of the breast mound. Such procedures are variations of the skate design originally proposed by Hartrampf, which were subsequently modified and refined by Little and Spear [1, 21–23]. The fishtail flap developed by McCraw also has the ability to produce a nipple with very marked projection [6, 17].

In case of a failed nipple reconstruction (the nipple is either too small or flat), the same procedure can be performed again and advantage taken of the fibrosis caused by the initial operation [1]. The results are frequently improved and necrosis is rare.

Nipple Sharing or Hemi-Nipple Graft

This technique is applicable in special circumstances of primary reconstruction where there are extremely thin and attenuated tissues or scarring in the desired position of nipple reconstruction in the patient who has a large opposite nipple that might serve as donor tissue for nipple reconstruction [1, 6, 25, 26]. The technique was first presented by Millard in 1972 and by Georgiade et al. in 1985. Harvesting can be performed in several different ways, depending on the form of the remaining nipple [1, 6]. Nipple sharing involves removal of either the distal or most anterior aspect of the nipple. It obviously decreases the size of the donor nipple, which in some cases may be a benefit [1, 6]. When such composite grafts are placed in the appropriate location and surrounded by an intradermal tattoo, they can produce a good simulation of the patient's opposite nipple [1].

CV Flap Surgical Technique

One of the most popular local random flap for nipple reconstruction is the star or cylinder flap [1]. After the control and mark-up of the correct neo position of the nipple, an arrow shape has to be marked up by the breast surgeon. The mid-point of the arrow forms the base of the reconstructed nipple, while the length of the arrow limbs gives the circumference of it and the width of the wings cause the projection of the nipple. At the mark-up procedure, do not forget to calculate with the mathematical formula for the circumference of the circle: $K = 2r\pi$. Optimally, the length of the arrow is no longer than the largest diameter of the optimal areola, which means 40–45 mm (see Fig. 25.4a–h).

Fig. 25.4 (**a**, **b**) Bilateral areola-sparing mastectomy and implant-based reconstruction. The marking up of CV flaps. (**c**) Skin incision and mobilising the cutaneous flap according to the planning on the right breast. The limbs of the flap are mobilised till the limbs are able to adapt tension free to each other. The base of the flap is not undermined. (**d, e**) Forming the nipple using monofilament 4.0 interrupted sutures. (**f**) Closing the donor area of the adipo-cutaneous flap. (**g, h**) Symmetry after bilateral areola-sparing mastectomy with implant-based postmastectomy breast reconstruction and nipple reconstruction

The size of the contralateral nipple will determine the measurements for the nipple on the side of reconstruction. When planning this dimension, it is important not to forget that approximately a 30–40% loss of projection will occur over time. Next step is the infiltration of local anaesthetic into the skin, with caution not to stich the implant if the overlying soft tissue coverage of the implant forms only a thin layer. After incision of the skin with a sharp scalpel, it is recommended to use the scalpel instead of the electric coagulator for all further steps. If subcutaneous fat is present, then mobilise the skin envelope of the pedicles of the nipple together with the subcutaneous fat except for the central core. At the base of the random flap do not undermine the flap, not even 1 mm further, from the point when tension allows free contact of the wings of the circumferential skin envelope of the neo mammilla to preserve the maximum amount of blood supply to the adipose tissue and skin arising deep within the flap [1]. Monofilament 4.0–5.0 interrupted sutures are necessary for configuration of the nipple.

Following nipple reconstruction, it is advisable to protect the nipple from external compressive and shearing forces with a special binding [1, 6]. Special dressings of doughnut formed gauze bandage for external support of the nipple can be applied for the first days or weeks.

Areolar Reconstruction

When nipple areola reconstruction is performed, the optimal visual appearance of the reconstructed nipple is achieved by simulating the best possible colour match with the opposite areola [1]. In the past, this was accomplished with the transplantation of a darkly pigmented full-thickness skin graft (vulva or proximal medial thigh skin). Currently, however, this is best done with an intradermal tattoo, which can produce the most predictable symmetry with the opposite areola in a wide variety of colours [1] (see Fig. 25.5a–g).

Symmetrically reproducing the size, shape and colour of the opposite areola must be the surgeon's goal in every nipple areola reconstruction [1]. The most important characteristics of a successful NAC are pigmentation, position and projection – in that order [1]. It is generally a mix of two or three colours tattooed successively that best reproduces the irregularities of the existing areola and avoids a monochrome effect to the reconstruction [1]. Unilateral tattooing is done if the colour is readily reproducible, and bilateral if the areolas are very pale. Visual symmetry between the colour and location of the NAC on the opposite breast and its position on the reconstructed breast mound is paramount for the optimal visual appearance of the reconstructed nipple [1]. The colour of the areola around the reconstructed nipple is more important than either the position or the projection of the areola. Indeed, colour patch symmetry can compensate for partial or even significant loss of nipple projection or slight abnormalities in position [1, 6].

Skin graft for reconstruction of the areola is described by Little (1987); this comprises the harvesting of a full-thickness skin graft of the size of the future areola,

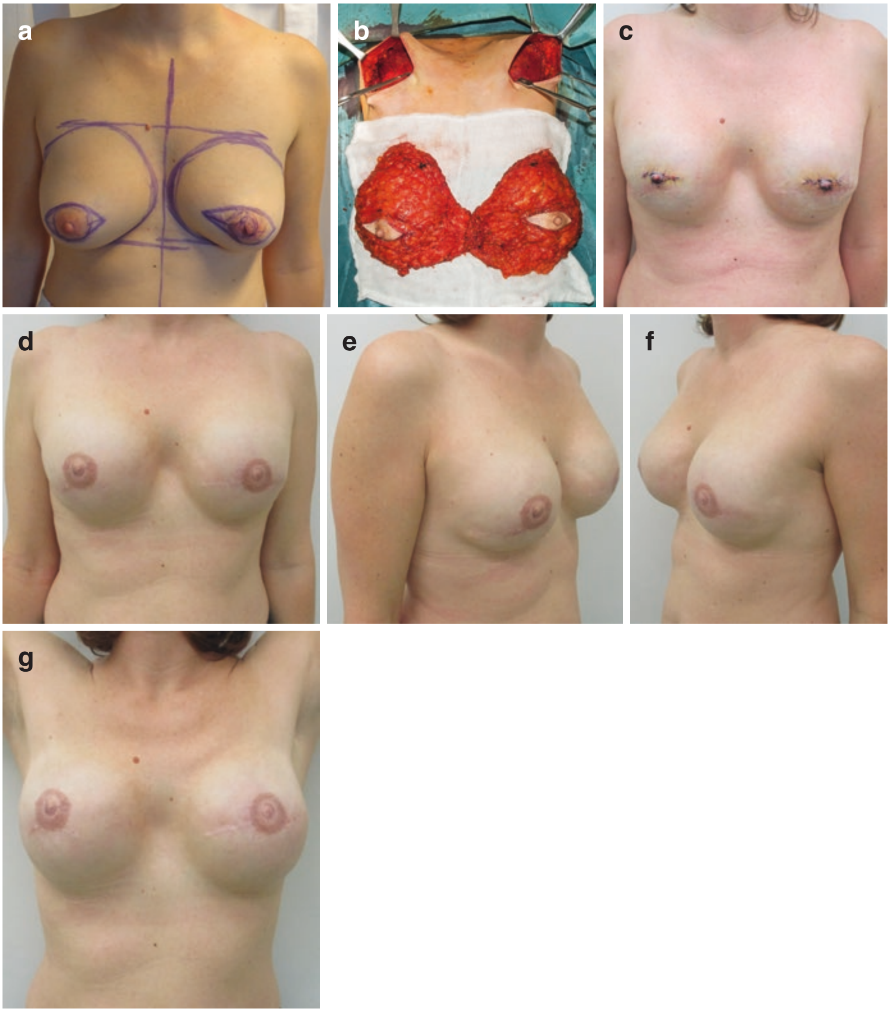


Fig. 25.5 (**a**, **b**) A 34-year-old patient with a verified BRCA2 gene mutation and left-sided early-stage breast cancer had bilateral skin-sparing mastectomy and sentinel lymph node biopsy on the left side. Preoperative markings and intraoperative status. (**c**) Postoperative result after bilateral expander to implant change and nipple reconstruction. (**d**, **g**) Cosmetic result at 45 months after reconstruction of the nipple areola complexes

with the usual donor site being the inguinal crease [16]. De-epithelialisation of the recipient site gives a reliable base for the graft, which is stitched in place with interrupted, non-absorbable sutures [1]. Note, however, that the graft tends to fade progressively and will undergo hypopigmentation with time. If a skin graft is used for the areola reconstruction, a bolster-type dressing is placed to ensure maximum contact of the graft with the underlying recipient tissue [1]. This bolster is left in place for a minimum of 5 to 7 days.

Problems With the Reconstructed Nipple

Problems associated with nipple reconstruction include asymmetries of position, differences in skin pigmentation and, most commonly, the loss of projection of the nipple [1].

When a reconstructed nipple comes to malposition, it can be moved, but usually only to a limited distance [1]. This may necessitate the re-elevation of the nipple by taking care to preserve its blood supply. If the nipple is significantly displaced, this can be very challenging to correct [1]. The options are to transfer the nipple as a rotation flap, a transposition flap or on a subcutaneous pedicle [1]. The resulting open wound where the nipple was located must be closed with a direct advancement closure, a V to Y technique or a skin graft [1]. When such wounds are located superior to the new location of the nipple, the outcome is usually less than aesthetically ideal. In such cases, it may be best to excise the reconstructed nipple with the shortest possible scar and redo the nipple reconstruction in the more appropriate position.

Partial or total necrosis of the nipple is extremely disappointing for the patient [1]. First step is to allow wound conditions to get under control. The acute inflammation and tissue oedema in the wound both have to be resolved completely. The minimum period of this healing is 3 months, but it may be considerably longer [1, 6]. When this tissue equilibrium is achieved, a nipple redo has to be done by an adequate reconstructive technique.

Causes of loss of projection are wound healing and contraction, ischaemia of the skin and adipose tissue, and expansion of the skin envelope of the breast over the implant [1]. According to Shestak, the incidence of loss of projection is about 40% with all types of flaps, and the majority of this loss occurs within the first 6 months of surgery [1]. Projection loss does continue up to 1 year, but it seems to be stable after that.

If the inclination of the nipple is incorrect, this can be corrected by excising skin into the very superficial dermal level at the base of the nipple and the inclination of the nipple [1]. This is needed when either the nipple is very large and gravity causes it to tilt inferiorly or there is excess contraction from scar tissue [1].

Most medical tattoos fade with time, and usually they must be redone at least once [1]. This is not a problem, and each patient must be informed of this possibility before the initial procedure. A more difficult situation is when the tattoo is too dark [1]. It may be possible to use a lighter pigment and tattoo over a darker area. However, this procedure is not successful in most cases. In this situation, it may be necessary to depigment the area. The most common manoeuvres involve dermabrasion of the hyperpigmented area [1]. On rare occasions, the area is excised and skin is grafted to the open wound, with a redo tattoo planned for a later time.

Areolar hypopigmentation can be treated and often improved by tattoo procedure [1].

If the resulting areolar pigment is too dark following a tattoo, it is best to wait and allow sufficient time for it to lighten [1]. If lightening does not take place, then the darker pigment can be addressed using a YAG laser, dermabrasion or excision of the skin with replacement using a full-thickness skin graft [1].

Reference Video

https://youtu.be/Ynlrk5nqOqI

References

1. Shestak KC. Revision of nipple areola reconstruction. In: Reoperative plastic surgery of the breast. Philadelphia, US: Lippincott Williams & Wilkins; 2006.
2. Pálházi P. Gross anatomy of the breast and axilla. In: Wyld L, Markopoulos C, Leidenius M, Senkus-Konefka E, editors. Breast cancer management for surgeons. Switzerland: Springer International Publishing AG; 2017.
3. Pálházi P. Az emlő és regionális nyirokelvezetés anatómiája. In: Mátrai Z, Gulyás G, Kásler M, editors. Az emlőrák korszerű sebészete. Budapest, Hungary: Medicina Kiadó; 2015.
4. Gulyás G. The breast as aesthetic unit. In: Mátrai Z, Gulyás G, Kásler M, editors. Az emlőrák korszerű sebészete. Budapest, Hungary: Medicina Kiadó; 2015.
5. Brown TP, Ringrose C, Hyland RE, et al. A method of assessing female breast morphometry and its clinical application. Br J Plast Surg. 1999;52:355–9.
6. Fitoussi A, Berry MG, Couturaud B, Salmon RJ. Oncoplastic and reconstructive surgery for breast cancer, The Institute Curie experience. Berlin: Springer; 2009.
7. Querci della Rovere G, Benson RJ, Nava M. Oncoplastic and reconstructive surgery of the breast. New York, US: CRC Press Taylor & Francis Group; 2010.
8. Lefemine V, Gomez FK. Nipple reconstruction. In: Wyld L, Markopoulos C, Leidenius M, Senkus-Konefka E, editors. Breast cancer management for surgeons. Switzerland: Springer International Publishing AG; 2017.
9. Amarante JT, Santa-Comba A, Reis J, et al. Hallux pulp composite graft in nipple reconstruction. Aesthet Plast Surg. 1994;18:299–300.
10. Klatsky SA, Manson PN. Toe pulp free grafts in nipple reconstruction. Plast Reconstr Surg. 1981;68:245–8.
11. Eskenazi L. A one-stage nipple reconstruction with the "modified star" flap and immediate tattoo: a review of 100 cases. Plast Reconstr Surg. 1993;92:671–80.
12. Anton MA, Hartrampf CR. Nipple reconstruction with the star flap. Plast Surg Forum. 1990;13:100.
13. Kroll SS. Integrated breast mound reduction and nipple reconstruction with the wraparound flap. Plast Reconstr Surg. 1999;104:687–93.
14. Weiss J, Herman O, Rosenberg L, et al. The S nipple areola reconstruction. Plast Reconstr Surg. 1989;83:904–6.
15. Cronin ED, Humphreys DH, Ruiz-Razura A. Nipple reconstruction: the S flap. Plast Reconstr Surg. 1988;81:783–7.
16. Little JW. Nipple-areolar reconstruction. Adv Plast Reconstr Surg. 1987;43:7.
17. McCraw JB. "Fish-tailed flap" for nipple reconstruction. Aesthetic and reconstructive surgery of the breast symposium sponsored by Manhattan Eye, Ear and Throat Hospital; 1992.
18. Brent B, Bostwick J. Nipple-areola reconstruction with auricular tissues. Plast Reconstr Surg. 1977;60:353–61.
19. Hallock GG, Altobelli JA. Cylindrical nipple reconstruction using an H flap. Ann Plast Surg. 1993;30:23–6.
20. Heitland A, Markowicz M, Koellensperger E, et al. Long-term nipple shrinkage following augmentation by an autologous rib cartilage transplant in free DIEP-flaps. J Plast Reconstr Aesthet Surg. 2006;59:1063–7.
21. Hartrampf CR Jr, Culbertson JH. A dermal-fat flap for nipple reconstruction. Plast Reconstr Surg. 1984;73:982–6.
22. Little JW III. Nipple-areola reconstruction. Clin Plast Surg. 1984;11:351–64.

23. Spear SL, Convit R, Little JW III. Intradermal tattoo as an adjunct to nipple areola reconstruction. Plast Reconstr Surg. 1989;83:907–11.
24. Kronowitz SJ. State of the art and science in postmastectomy breast reconstruction. Plast Reconstr Surg. 2015;135:755–71.
25. Georgiade GS, Riefkohl R, Georgiade NG. To share or not to share. Ann Plast Surg. 1985;14:180–6.
26. Millard DR Jr. Nipple and areola reconstruction by split-skin graft from the normal side. Plast Reconstr Surg. 1972;50:350–3.
27. Losken A, Mackay GJ, Bostwick J 3rd. Nipple reconstruction using the C-V flap technique: a long-term evaluation. Plast Reconstr Surg. 2001;108:1602–5.

Check for updates

Free Nipple Graft

26

Stergios E. Douvetzemis and Tibor Kovacs

Introduction

There are several contraindications for nipple–areola complex (NAC) preservation when a conservative mastectomy is planned for breast cancer or when reduction mammoplasty is planned for aesthetic or symptomatic purposes. In these occasions, the nipple–areolar complex (NAC) can be used as a free graft to ensure its viability, to increase oncological safety and to minimize complications.

Indications

Absolute contraindications for nipple preservation when a conservative mastectomy is planned include clinical or radiological evidence of NAC involvement, Paget's disease of the nipple and blood-stained nipple discharge. A more relative contraindication is tumour to nipple distance less than 2 cm on magnetic resonance imaging (MRI) or other imaging, as it is believed to confer a higher risk of NAC involvement.

Apart from oncological safety concerns, there is a potential risk of skin flaps or NAC necrosis, following conservative mastectomy, as the skin and NAC lose their

S. E. Douvetzemis
Breast Surgery, Guy's and St Thomas' NHS Foundation Trust, London, UK

King's College, London, UK

Department of Anatomy and Surgical Anatomy, Medical School, University of Athens, Athens, Greece

T. Kovacs (✉)
Breast Surgery, Guy's and St Thomas' NHS Foundation Trust, London, UK

King's College, London, UK

V. S. Klimberg et al. (eds.), *Oncoplastic Breast Surgery Techniques for the General Surgeon*, https://doi.org/10.1007/978-3-030-40196-2_26

parenchymal perforators due to the subcutaneous mastectomy and as a result the NAC and skin rely solely on their subdermal plexus blood supply.

Several risk factors have been identified for skin flap and NAC ischaemia, including smoking, high body mass index (BMI), hypertension, diabetes, age, type of incision and previous radiotherapy [1–4]. The incidence of NAC ischaemia varies widely across studies, from 0% to 48%, but most series report on rates between 10% and 15% [3]. Donovan and colleagues assessed 351 nipple-sparing mastectomies (NSMs) for ischaemic complications. NAC necrosis occurred in 14% of cases, but NAC resection following full-thickness necrosis was unavoidable in only 2% of cases [5].

Free NAC graft approach could represent a promising alternative to standard NSM in patients with high risk of NAC ischaemia (Fig. 26.1).

When nipple ischaemia is obvious intraoperatively, the NAC could be removed and reconstructed immediately as a free full-thickness nipple–areola graft.

Nipple-sparing mastectomy in ptotic breasts can be performed with encompassing a Wise pattern skin reduction, with preservation of the NAC on a superior or superior-medial dermal pedicle. However, 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 4–5 cm of elevation is required and the patient wishes to keep her nipple, then a safer option is a free transplantation of the NAC as a full-thickness skin graft.

Advances in surgical techniques and better understanding of the anatomy of the breast and the vascular supply of the NAC have challenged the limits set by the earlier experiences of surgeons at which free nipple grafting is preferred over transposition on a pedicle in breast reduction mammoplasty planning. The issue, of course, is the viability of the pedicle.

An intimate knowledge of the vascular anatomy of the breast and NAC can aid in ensuring nipple viability and a better aesthetic outcome, whether it be a nipple transposition on a pedicle or a free nipple graft. The most reliable pedicles are thicker and fashioned with a wider base without releasing their attachment to the pectoral fascia.

Fig. 26.1 Free nipple graft after a Wise pattern skin-reducing procedure

Fig. 26.2 Bilateral risk-reducing mastectomies (Wise pattern) with implant reconstruction and free nipple grafts

Free nipple graft is an operation that numerous surgeons prefer when there is uncertainty regarding the viability of the NAC in reduction mammoplasty as well (Fig. 26.2).

Breast reduction techniques had been first described in the late nineteenth century. Morestin reported transposing the nipple [6]. Maintaining the nipple on a dermoglandular pedicle was first suggested by Strombeck in 1960 [7]. Thorek was the surgeon who popularized free nipple grafting in breast reduction surgery, in 1922 [8]. He combined the free nipple graft with lower pole amputation and his technique is still used nowadays with a Wise pattern modification.

The most common indication for free NAC grafting in reduction mammoplasty is large breast size and especially gigantomastia, described as a breast that requires resection of more than 1800 g [9].

Wise et al. [10] in a report detailing their experience with reduction mammoplasties in 1963 have recommended free nipple grafting in all reductions of more than three bra sizes. This then increased from 1000 g (Gradinger [11]) to 1500 g (Robbins [12], Jackson et al. [13]) to 2500 g (Georgiade [14]). Georgiade has subsequently reported success without free nipple grafting in reductions of up to 3300 g, while Chang et al. [15] have successfully transposed reductions of up to 5100 g with a very low NAC necrosis rate of 1.2% over a 7-year period.

There are other indications as well for free NAC grafts in reduction mammoplasty, except from large breast size.

Pedicle length is a very common consideration in considering grafting over transposition of the nipple. Common concerns are viability of the blood supply to the NAC and pedicle, folding, as well as excess tissue beneath and over the pedicle, which can compromise it.

The recommended inferior pedicle length over which free nipple grafting should be considered has also increased over time from 15 to 25 cm [16]. This has been attributed to better handling of the pedicle, maintaining a wider base and retaining the attachment of the base of the pedicle to the chest wall so as not to compromise blood supply from the perforators.

Decisions in recommending free nipple grafting by some authors are based on sternal notch-to-nipple distance (SNN) exceeding 40 cm [17]. There has even been a suggestion that since the inframammary fold-to-nipple distance (IMFN), which determines pedicle length, remains relatively constant when compared to the increasing SNN in progressively larger breasts, the inferior pedicle technique with transposition of the NAC on the pedicle should be applicable to all breast reductions regardless of size, rendering free nipple grafting obsolete [13].

Another indication of free nipple grafting could be a relative closeness of the central breast tumour to the NAC. In order to obtain clear surgical resection margins in the retroareolar region, the NAC can be removed as a full-thickness skin graft and repositioned on the recipient area (de-epithelized skin).

Free nipple grafts are indicated if the NAC on a pedicle looks underperfused. Most surgeons would simply assess the nipple viability clinically (if, for example, the NAC looks healthy and warm to touch), or it can be confirmed intraoperatively by intravenous (IV) administration of 2 g of fluorescein followed by examination under a Wood's lamp 15 min later (yellow–green fluorescence of the NAC confirms an adequate blood supply, whereas a dark blue appearance indicates inadequate perfusion) [9]. In cases when NAC's viability is considered uncertain, any obvious potential reason that can be affecting this must be corrected immediately, such as tension due to closure or constriction at the base of the pedicle, haematoma or hypotension. If no reason can be identified, the NAC should be removed from the pedicle and sited as a free nipple graft.

Another indication of free nipple grafting is malposition of the NAC after any type of previous breast surgery, which, due to the extent of scarring, may not be feasible to correct otherwise (lateralization of the NAC after contracted lateral breast radial scars). In these occasions, free nipple graft consists an excellent and perhaps the only alternative to achieve symmetry (Figs. 26.3, 26.4 and 26.5).

Fig. 26.3 Lateralization (malposition) of the nipple–areola complex (NAC) after lateral radial incision for cancer. Planning of NAC repositioning with scar excision

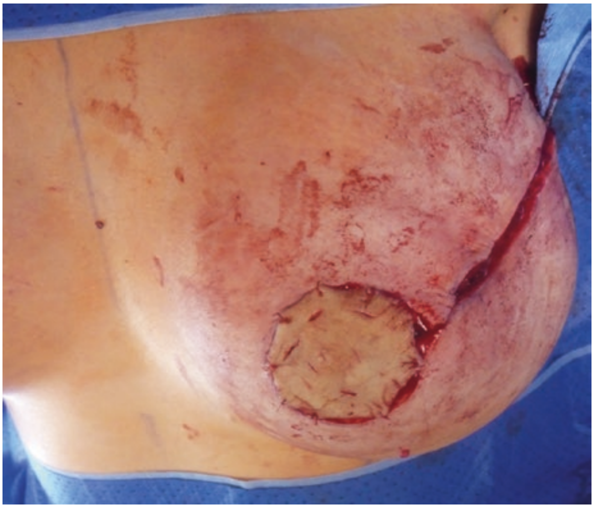


Fig. 26.4 Scar re-excision and nipple–areola complex (NAC) repositioning as a free NAC graft. The free skin graft is perforated to avoid underlying haematoma formation

Fig. 26.5 Different stages of healing of a free nipple–areola complex (NAC) graft with small areas of depigmentation at sites of fenestration

Free nipple grafting can also be used in male patients, with severe gynaecomastia undergoing gynaecomastectomy [18]. Moreover, gender reassignment surgery to the breast involves breast amputation with free nipple grafting. In these occasions, the areola also has to be reduced to approximate the smaller male areola.

We always have to bear in mind that the transposed NAC graft will lose significantly sensitivity and erectile capacity: the nipple area will be flatter and numb.

Preoperative Evaluation and Planning

Free nipple graft usually employs standard Wise pattern markings to fashion the skin envelope over the underlying breast parenchyma. Wise pattern marking is not in this chapter's purpose; however, marking of NACs position will be described.

The placement of the nipple is the most important part in preoperative planning. A superiorly displaced nipple is aesthetically unpleasant and may even be visible over the bra, causing distress to the patient. Moreover, correction of a high-position nipple is very difficult and will leave additional visible scars.

The breast meridian lines are drawn and the inframammary fold is transposed to the front of the breast. The sternal notch-to-nipple distance varies between 21 and 25 cm and should be tailored to the patient's size. This should roughly correspond to the inframammary fold. The nipple position is placed 1–2 cm below the measured nipple position along the meridian.

Women with gigantomastia frequently have excessively large areolas. The NAC is marked with a nipple ring prior to harvesting the free nipple graft.

Surgical Technique

The NAC is carefully removed and thinned with a pair of scissors, making sure that the smooth muscle of the nipple and the dermis of the nipple and areola will be preserved, as this is thought to more likely provide good postoperative projection. The NAC is then placed on a gauze moistened with saline. Small islands of fat from the dermis are entirely removed as this will constitute an obstacle for neovascularization (Figs. 26.6, 26.7, 26.8 and 26.9).

The new NAC site (recipient site) is de-epithelialized. At this stage, it is advisable to perforate the areola, with the use of a blade, to allow the grafted NAC to 'stick' to its place and to accommodate draining of any potential seroma formation, from the de-epithelialized area, just under the graft, which could compromise its viability (Figs. 26.10 and 26.11).

The graft is positioned onto the recipient site with interrupted sutures. A non-adherent gauze is placed over the grafted NAC and is left in place for 7–10 days.

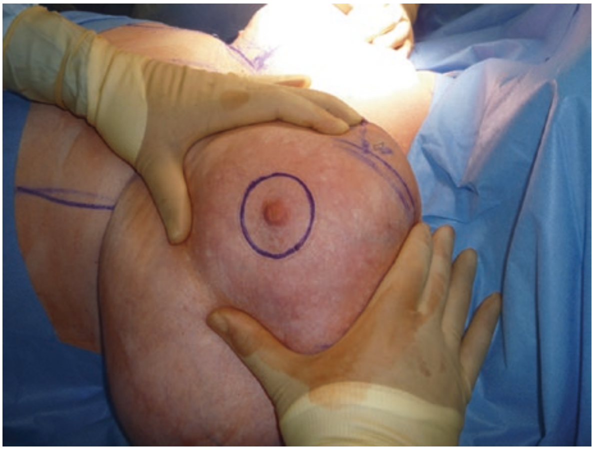


Fig. 26.6 Nipple–areola complex (NAC) graft size marked with nipple ring for harvesting

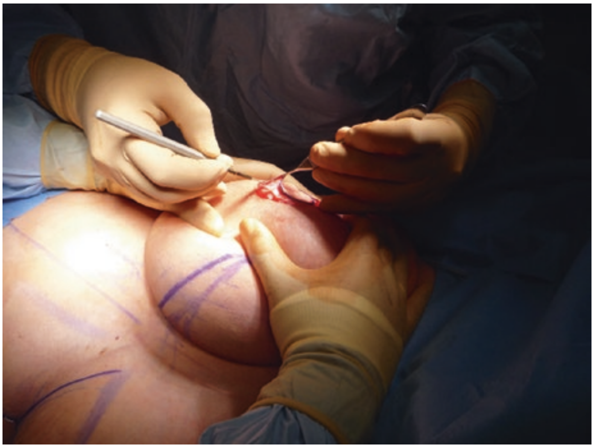


Fig. 26.7 Harvesting of nipple–areola complex (NAC) free full-thickness skin graft with scalpel. Progress from periphery towards the central nipple area

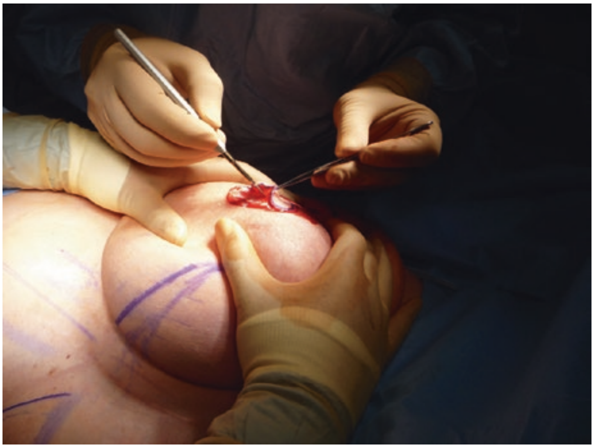


Fig. 26.8 Harvesting of nipple–areola complex (NAC) free full-thickness skin graft with scalpel. Progress from periphery towards the central nipple area

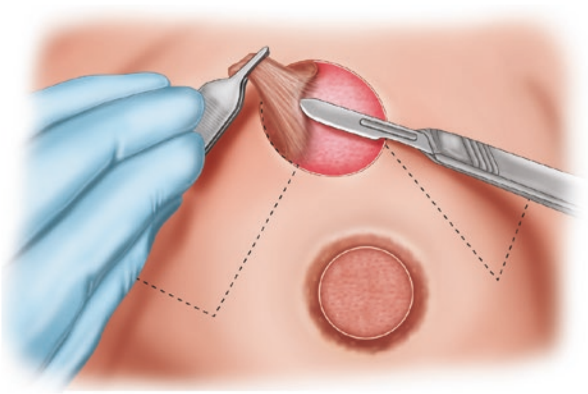


Fig. 26.9 Harvesting with the use of an Adson forceps and scalpel

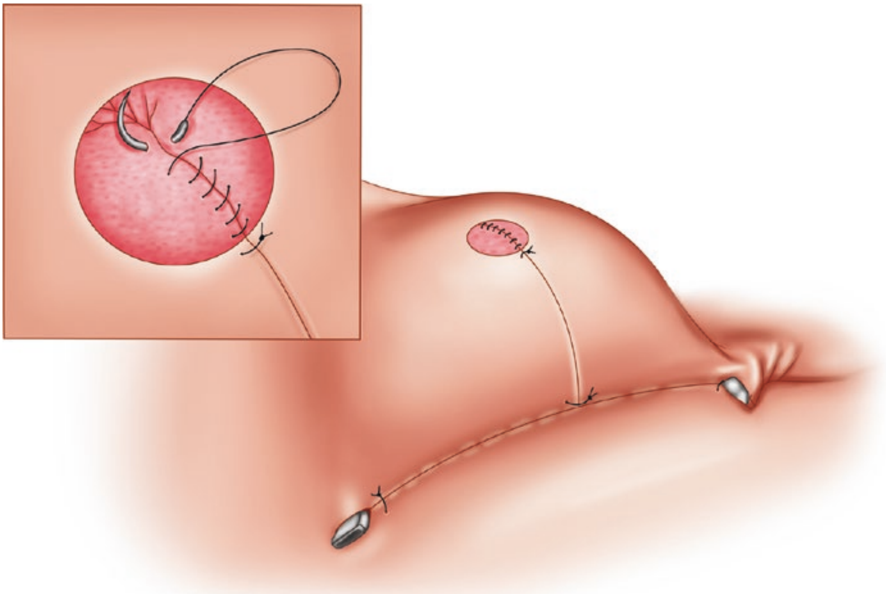


Fig. 26.10 Creation of the recipient site. If there is an underlying incision (Wise pattern closure), this has to be closed with deep dermal interrupted or running stitches to allow de-epithelization above the suture line

Surgical Complications and Solutions

Free nipple graft is considered to lead to greater postoperative loss of sensation in the NAC when compared to maintaining the NAC on a pedicle. While this may seem reasonable, given that the NAC is separated from its vascular and nerve attachments, some reports contradict these findings and support that even patients with free nipple grafts have a reasonable recovery in sensation and erectile function [19–24].

Fig. 26.11 Graft placed on recipient de-epithelized area and sutured to skin with interrupted 4/0 sutures. Graft fenestrated to avoid sero-haematoma development

Re-innervation from the intercostals and supraclavicular nerves probably explains why some patients regain some form of sensation after a free nipple graft [25, 26]. It has also been suggested that patients with gigantomastia have a chronic traction injury to the fourth intercostal nerve, relief of which contributes to improvement in sensation [27]. Good recovery rates in erectile function of the nipple graft have also been reported, which contradicts earlier conclusions by some authors that it was impossible to maintain erectile function in a free nipple graft. This could be related to retaining a good amount of areolar smooth muscle when fashioning the graft [22, 24].

Regarding cosmesis, nipple grafts are known to give cosmetic results with flat nipples lacking projection (Fig. 26.12).

Nipple necrosis can occur with a free nipple graft, although partial loss is more common (Fig. 26.13). This can be due to lack of vascularity of the parenchymal pedicle or improper harvesting and fashioning of the graft, or due to medical illnesses that limit vascularity as a whole. Partial nipple loss should be allowed to heal secondarily, with the patient warned about depigmentation. Nipple reconstruction should be planned for full nipple loss after allowing it to heal.

Hypopigmentation of the nipple is an unsightly complication that can occur even with good graft uptake. It seems more common in the darker areolas of patients of African origin [17]. Tattooing of the hypopigmented patches is frequently unsatisfactory. The patient must be made aware of the possibility of this complication (Fig. 26.14).

Lactation is obviously compromised in a free nipple graft, as the lactiferous ducts are severed. The younger patient in whom the free nipple graft is indicated must accept the fact that she will not be able to breast-feed or have her surgery delayed until after she completes her family.

All other common complications of breast surgery can also be encountered with a free nipple graft. These include bleeding, hematoma, seroma, wound infection, skin flap necrosis, fat necrosis and other wound complications. Complications seen

Fig. 26.12 Healed free nipple–areola complex (NAC) grafts with a certain degree of flattening of the nipple

Fig. 26.13 Partial skin graft loss and highly positioned graft. Graft left for secondary healing

Fig. 26.14 Graft healing with hypopigmentation. The thicker nipple skin area suffers more often ischaemic changes

in any other type of breast reduction can obviously also occur, such as breast asymmetry, a high-riding nipple, hypertrophic scarring and T-junction wound healing complications.

Results (Literature and Data)

Recently, Doren and colleagues retrospectively reviewed 36 skin-sparing mastectomies with free nipple grafting, in cases where NSM was considered at a high risk of NAC ischaemia and reported an average free nipple graft take of 93%, whereas full NAC loss was zero. This approach could represent a promising alternative in patients with high risk of NAC ischaemia [28, 29].

Conclusions

There is little doubt that free nipple grafting maintains its place as a therapeutic option especially for reasons of oncological safety or when patient fitness limits the operating time and when the NAC viability is compromised [30]. However, the decision to perform a free nipple graft is based on experience and lacks definite guidelines.

Reference Video

- https://youtube/FKXpIGhppFs
- https://youtube/gUMjpy5VgZw
- https://youtube/HG-AcF3O7pE

References

1. Janssen S, Holz-Sapra E, Rades D, Moser A, Studer G. Nipple-sparing mastectomy in breast cancer patients: the role of adjuvant radio- therapy (review). Oncol Lett. 2015;9(6):2435–41.
2. Colwell AS, Tessler O, Lin AM, Liao E, Winograd J, Cetrulo CL, et al. Breast reconstruction following nipple-sparing mastectomy: predictors of complications, reconstruction outcomes, and 5-year trends. Plast Reconstr Surg. 2014;133(3):496–506.
3. Carlson GW, Chu CK, Moyer HR, Duggal C, Losken A. Predictors of nipple ischemia after nipple sparing mastectomy. Breast J. 2014;20(1):69–73.
4. Gould DJ, Hunt KK, Liu J, Kuerer HM, Crosby MA, Babiera G, et al. Impact of surgical techniques, biomaterials, and patient variables on rate of nipple necrosis after nipple-sparing mastectomy. Plast Reconstr Surg. 2013;132(3):330e–8e.
5. Donovan CA, Harit AP, Chung A, Bao J, Giuliano AE, Amersi F. Oncological and surgical outcomes after nipple-sparing mastectomy: do incisions matter? Ann Surg Oncol. 2016;23(10):3226–31.
6. Morestin H. Hypertrophie mammaire. Bull Mem Soc Anat Paris. 1905;80:682.
7. Strombeck JO. Mammaplasty: report of a new technique based on the two pedicle procedure. Br J Plast Surg. 1960;13:79–90.
8. Thorek M. Possibilities in the reconstruction of the human form. N Y Med J. 1922;116:572.
9. Jones GE. Breast reduction. In: Mathes SJ, editor. Plastic surgery. 2nd ed. Philadelphia: Saunders Elsevier; 2005. p. 539–84.
10. Wise RJ, Gannon JP, Hill JR. Further experience with reduction mammaplasty. Plast Reconstr Surg. 1963;32:12–20.
11. Gradinger GP. Reduction mammoplasty utilizing nipple-areola transplantation. Clin Plast Surg. 1988;15(4):641–54.
12. Robbins TH. Reduction mammaplasty by the Robbins technique. Plast Reconstr Surg. 1987;79(2):308–9.
13. Jackson IT, Bayramicli M, Gupta M, Yavuzer R. Importance of the pedicle length measurement in reduction mammaplasty. Plast Reconstr Surg. 1999;104(2):398–400.
14. Georgiade GS, Riefkohl RE, Georgiade NG. The inferior dermal-pyramidal type breast reduction: long-term evaluation. Ann Plast Surg. 1989;23(3):203–11.
15. Chang P, Shaaban AF, Canady JW, Ricciardelli EJ, Cram AE. Reduction mammaplasty: the results of avoiding nipple-areolar amputation in cases of extreme hypertrophy. Ann Plast Surg. 1996;37(6):585–91.

16. Gerzenshtein J, Oswald T, McCluskey P, Caplan J, Angel MF. Avoiding free nipple grafting with the inferior pedicle technique. Ann Plast Surg. 2005;55(3):245–9.
17. Strauch B, Elkowitz M, Baum T, Herman C. Superolateral pedicle for breast surgery: an operation for all reasons. Plast Reconstr Surg. 2005;115(5):1269–77; discussion 1278–1279.
18. Tashkandi M, Al-Qattan MM, Hassanain JM, Hawary MB, Sultan M. The surgical management of high-grade gynecomastia. Ann Plast Surg. 2004;53(1):17–20; discussion 21.
19. Hoopes JE, Jabaley ME. Reduction mammaplasty: amputation and augmentation. Plast Reconstr Surg. 1969;44(5):441–6.
20. Craig RD, Sykes PA. Nipple sensitivity following reduction mammaplasty. Br J Plast Surg. 1970;23(2):165–72.
21. Courtiss EH, Goldwyn RM. Breast sensation before and after plastic surgery. Plast Reconstr Surg. 1976;58(1):1–13.
22. Townsend PL. Nipple sensation following breast reduction and free nipple transplantation. Br J Plast Surg. 1974;27(4):308–10.
23. O'Conor CM. Glandular excision with immediate mammary reconstruction. Plast Reconstr Surg. 1964;33:57–60.
24. Ahmed OA, Kolhe PS. Comparison of nipple and areolar sensation after breast reduction by free nipple graft and inferior pedicle techniques. Br J Plast Surg. 2000;53(2):126–9.
25. Sarhadi NS, Shaw Dunn J, Lee FD, Soutar DS. An anatomical study of the nerve supply of the breast, including the nipple and areola. Br J Plast Surg. 1996;49(3):156–64.
26. Farina MA, Newby BG, Alani HM. Innervation of the nipple–areola complex. Plast Reconstr Surg. 1980;66(4):497–501.
27. Slezak S, Lee DA. Quantitation of sensibility in gigantomastia and alteration following reduction mammaplasty. Plast Reconstr Surg. 1993;91(7):1265–9.
28. Doren EL, Van Eldik KL, Lopez JJ, Laronga C, Smith PD. Free nipple grafting: an alternative for patients ineligible for nipple-sparing mastectomy? Ann Plast Surg. 2014;72(6):S112–5.
29. Wyld L, et al. Breast cancer management for surgeons. Cham: Springer International Publishing AG; 2018. p. 209–11.
30. Shiffman M. Mastopexy and breast reduction. Berlin: Springer; 2009. p. 555–61.

27 Subpectoral Implant-Based Breast Reconstruction

Neil S. Sachanandani, Benny K. Tan, and James C. Yuen

Introduction

Implant-based breast reconstruction is the most common method for breast reconstruction in the modern era [7]. Patients frequently choose this method because of shorter surgery time and recovery at the trade-off of increased visits for postoperative tissue expansion fills in the office and a second-stage implant exchange procedure. In selected patients, a single-stage operation can be performed by insertion of the final breast implant, bypassing the tissue expander.

The advantages of implant-based breast reconstruction, especially with a single-stage implant insertion (direct-to-implant), are obvious. The surgery is localized to the same area, thus avoiding major surgical trauma, complications, and scars to other areas. The surgery does not eliminate the chance for autologous reconstruction if deemed necessary in the future. In a direct-to-implant reconstruction, the procedure is relatively simple and completed in a single step, not including any need for nipple reconstruction. In the case of tissue-expander reconstruction, the procedure is also relatively simple compared with the complexity of autologous reconstruction using pedicled or microvascular flaps. However, in addition to the need for a second operation, there is a major commitment for multiple office visits and a delay of 3–6 months between the two operations. These patients can decide, to a certain extent, on their final breast size, with the support and advice of their surgeon. Therefore, they gain the advantage of a sense of control when their femininity and normal health have been threatened by cancer.

N. S. Sachanandani
Beaumont Plastic and Reconstructive Surgery, Department of Surgery, Beaumont Health System, Royal Oak, MI, USA

B. K. Tan
Department of Plastic and Reconstructive Surgery, Johns Hopkins, Baltimore, MD, USA

J. C. Yuen (✉)
Division of Plastic Surgery, University of Arkansas for Medical Sciences, Little Rock, AR, USA

V. S. Klimberg et al. (eds.), *Oncoplastic Breast Surgery Techniques for the General Surgeon*, https://doi.org/10.1007/978-3-030-40196-2_27

Implant-based reconstruction is less invasive compared with autologous reconstruction; however, there are potential immediate and delayed complications. In unilateral cases, the natural breast will descend with age while the reconstructed side remains resistant to gravitational ptosis. In addition, it is generally more difficult to achieve a natural result compared with autologous tissue. After a simple mastectomy in a patient with a remaining large breast, the expanded soft tissue may have difficulty producing a well-defined inframammary crease or significant ptosis. Despite these challenges, many patients still choose to undergo implant-based reconstruction for various reasons. This decision may be influenced by the surgeon's choice or the patient may wish to avoid major flap reconstruction for concerns of associated complications and longer recovery time. She may also not have enough donor tissue.

While implant-based reconstruction is associated with multiple operations, so can autologous tissue reconstructions, because many cases require a second procedure for revision of the neo-breast or donor site.

Indications and Contraindications

- Indications
  - Simple mastectomy
  - Skin-sparing mastectomy
  - Total skin-sparing (i.e., nipple sparing) mastectomy
- Relative contraindications
  - Adjuvant radiation
  - Smoking
  - Severe obesity
- Contraindications
  - Metastatic disease
  - Unfavorable comorbidities
    (i.e., immunodeficiency, recent cardiopulmonary event, systemic illness)

Implant-based (prosthetic-based) reconstruction is indicated for the patient who wishes to avoid lengthy and complicated autologous reconstruction, risks of donor site morbidity, and/or prolonged recovery time. However, with implant-based reconstruction, the patient must accept the potential complications associated with implantation and she should accept the staged procedures. In unilateral cases, implant reconstruction is indicated only if the patient accepts the potential inherent asymmetry and the need for a contralateral procedure for symmetrization, such as mastopexy, with or without augmentation, and/or reduction mammoplasty. If the patient cannot accept the implant-related complications and the limitations of asymmetry in unilateral cases, or if she will not accept a contralateral procedure to improve symmetry when needed, then implant-based reconstruction is relatively contraindicated. In bilateral or even unilateral mastectomy, if the patient does not possess large enough volume of donor tissue for her desired breast size, then implant-based reconstruction may also be recommended in favor of autologous tissue reconstruction.

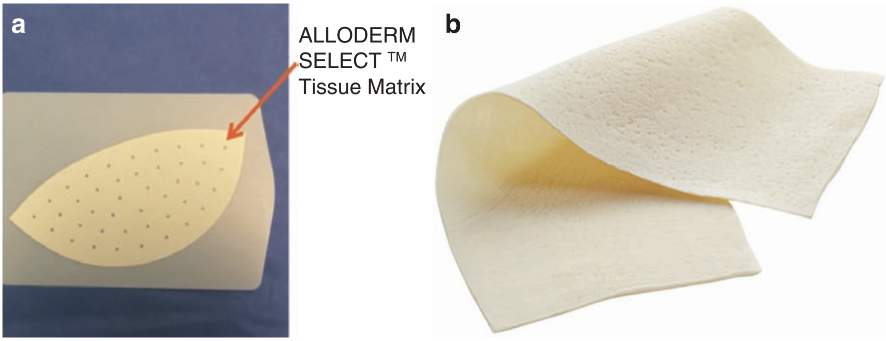


Fig. 27.1 Examples of an acellular dermal matrix products: (**a**) ALLODERM SELECT, shaped and perforated. (©2018 Allergan. All rights reserved. Used with permission) (**b**) Flex HD, nonperforated and rectangular. (©2018 Mentor Corporation. All rights reserved. Used with permission)

Many products of human and xenogeneic acellular dermal tissue matrixes have surfaced in the United States since early the 2000s: ALLODERM® Regenerative Tissue Matrix (RTM), ALLODERM® Ready-to-Use, and ALLODERM SELECT™ (Fig. 27.1a) (LifeCell Corporation, an Allergan affiliate, Branchburg, NJ); AlloMax™ (CR Bard/Davol Inc., Cranston, RI); Cortiva™ (RTI Surgical, Alachua, FL); DermACELL® (Lifenet Health, Virginia Beach, VA; FlexHD® Pliable; Musculoskeletal Transplant Foundation/Ethicon, Somerville, NJ) (Fig. 27.1b); STRATTICE™ (LifeCell Corporation, an Allergan affiliate, Branchburg, NJ); and SurgiMend™ (Integra LifeSciences, Plainsboro, NJ). These products are biologically prepared dermis in which components causing rejection are removed and viral, bacterial, and fungal organisms are tested for and removed. The advantages of the acellular dermal allograft are the following [3, 15, 20, 28]:

- Creates a large pocket, confluent with the pectoralis major muscle to accommodate a full permanent implant or a substantially inflated tissue expander
- Allows definition of inframammary and lateral mammary fold and may decrease risk of inferolateral migration of the implant
- Provides suspensory support of the implant at the lower pole
- Establishes a protective interface between the prosthetic device and the mastectomy skin flap
- Contributes to thickness of soft tissue over the prosthetic device
- Minimizes or even obviates the need for serial expansion in selected cases
- Decreases periprosthetic changes, such as soft-tissue atrophy and chest-wall deformity
- Prevents cephalad displacement of the pectoralis major muscle due to the approximation of the cephalad portion of the acellular dermal matrix (ADM) to the caudal portion of the pectoralis major muscle
- May mitigate the effects of radiation (capsular contracture) on reconstructed breast [19]
- Allows fuller lower pole expansion compared to total submuscular placement of the expander

Preoperative Evaluation and Planning

When evaluating the surgical candidate, it is important to consider the patient's overall health status and comorbid conditions. The degree of breast ptosis should be noted and breast measurements, including the base width, sternal notch to nipple distance, and the nipple to inframammary fold (IMF) distance, should also be noted. The base width is the most important measurement as it helps predict the actual tissue expander device that will be used for breast reconstruction. Choosing a device that is larger than the patient's native breast width generally would provide a suboptimal result. The sternal notch to nipple and nipple to IMF distances help give a general idea of preoperative symmetry and quantify the nature of the breast dimensions. The patient's body mass index (BMI) should be noted as this may have an impact on the risks of postoperative complications. The patient's tumor size, axillary node involvement, and tumor staging should be known as this information can affect the need for neoadjuvant and adjuvant treatments. The type of mastectomy chosen by the surgical oncologist should be determined:

- Modified radical mastectomy
- Standard mastectomy (conventional mastectomy)
- Skin-sparing mastectomy
- Nipple-sparing mastectomy (also known as total-skin-sparing mastectomy)

The need for adjuvant radiotherapy is one of most important risk factors, as this significantly affects the rate of complications for implant-based reconstruction and consideration should be given for autologous tissue reconstruction in that setting or in a delayed fashion.

Timing of Breast Reconstruction

If the patient is not highly motivated and is undecided about reconstruction, then delayed reconstruction may be considered. If the patient is undergoing a nipple-sparing mastectomy with moderate-sized or large breasts, depending on risk factors, immediate reconstruction may be recommended to avoid contour irregularities from skin retraction associated with delayed reconstruction. Immediate reconstruction provides a psychological benefit to the patients as compared with delayed reconstruction [27].

Informed consent should discuss the moderate rate of potential complications: bleeding, seroma, infection, dehiscence, skin flap necrosis, "window shading" phenomenon due to divided pectoralis major muscle (or animation deformity with pectoralis major contracting against the skin), implant exposure, explantation, deflation or leak of the implant, migration of implant, capsular contracture, contour irregularities, asymmetry, and pain (acute and chronic). The patient needs to be informed that body's response to implantation is quite subjective. While one person may suffer very little pain with the internal prosthesis in place, another person may have significant discomfort or pain. The process of tissue expansion can be quite uncomfortable for some, but less for others. While most patients would accept the prosthetic device without significant contracture, a small subset of the population may develop significant capsular contracture. In the event the patient requires postoperative radiation, the potential untoward effects of radiation, such as the development of future capsular contracture of the reconstructed breast and accentuated asymmetry (from soft tissue contracture, loss of volume, and ptosis), and methods of surgical revision to treat the capsular contracture need to be discussed with the patient ahead of time. In addition, the patient needs to understand that additional surgeries may be required (such as for symmetry procedures and implant exchange for rupture).

Breast implant-associated anaplastic large cell lymphoma (ALCL) is a rare T-cell lymphoma arising around breast implants placed for either reconstructive or cosmetic indication [6]. There is difficulty in conveying the exact risk of breast implant-associated ALCL, as the incidence and prevalence are evolving with growing recognition of the disease by the medical community. The clear majority of cases has involved textured implants rather than smooth implants. Given uncertainty regarding incidence, the manufacturer's processing causes, geographic distribution, and susceptibility factors, it is wise for the surgeon to consider informing all patients regarding breast-implant-associated ALCL during the informed consent process [4].

Surgical Technique

Immediate Two-Stage Prosthetic Reconstruction Technique

First Stage

The initial surgical incision is made by the breast surgeon and the mastectomy is performed. The reconstructive surgeon should note the weight of the mastectomy specimen. This added information may assist the surgeon in the final selection of the size of the expander or implant. The reconstructive surgeon begins the procedure by ensuring that the surgical field is hemostatic. Once this has been done, the dissection begins by exposing the lateral edge of the pectoralis major muscle. The loose areolar plane is developed in the subpectoral space above the ribs with control of any perforating vessels. The internal mammary perforators should be preserved as these provide blood supply to the mastectomy skin flaps. The inferior attachments of the pectoralis major are separated from the inferior chest wall, taking care not to overly detach the pectoralis major muscle origin from the sternum, since this can accentuate animation deformity. Centrally, laterally and then superiorly, the pectoralis major should be elevated enough to allow for placement of the tissue expander. The base width is measured in the subpectoral space with a sterile ruler. The appropriate implant is selected using the base width and, to a lesser extent, the mastectomy specimen weight. An appropriately sized piece of acellular dermal matrix is selected to reconstruct the inferior portion of the breast pocket. The lower portion of the acellular dermal matrix may be perforated or pie crusted.

The inferior portion of the acellular dermal matrix is secured medial to the sternum and along the inferior mammary fold using interrupted absorbable sutures, such as polyglactin 910 (Vicryl) or polydioxanone (PDS) (Ethicon, Somerville, NJ). The lateral area can be initially left open to facilitate placement of the tissue expander. The selected tissue expander is deflated and placed in the subpectoral pocket. The sutures tabs are secured to the chest wall using 3–0 or 2–0 PDS sutures to minimize postoperative displacement. Any open area of the lateral acellular dermal matrix is secured to the chest wall. The cranial aspect of the acellular dermal matrix is secured to the caudal aspect of the pectoralis major muscle using interrupted or running absorbable suture (Fig. 27.2). Two drains are placed to prevent seroma accumulation. The first drain is placed in the periprosthetic space and the second drain is placed in the prepectoral space. Both drains exit laterally to the IMF near

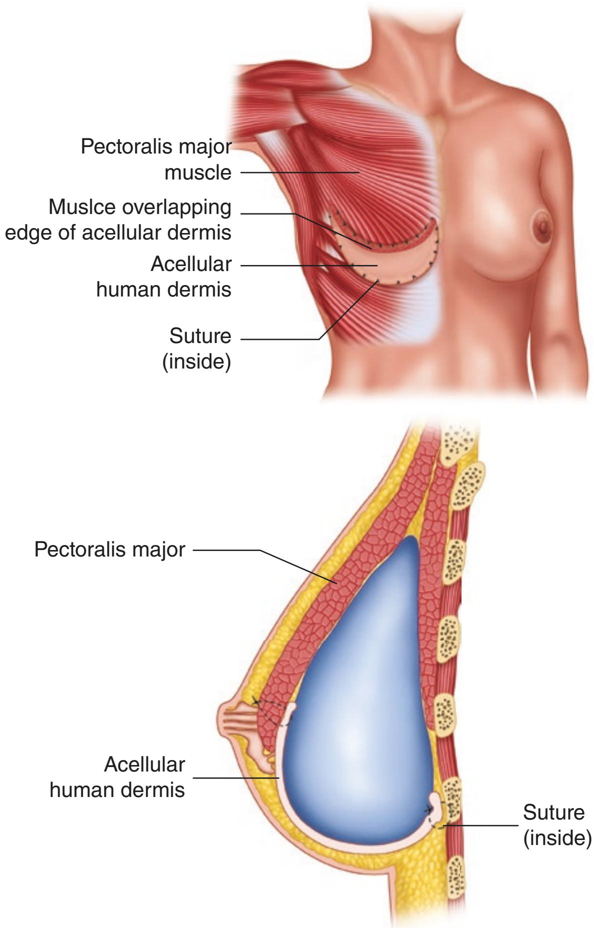


Fig. 27.2 Illustration showing subpectoral tissue expander coverage assisted with acellular dermal matrix (ADM). The ADM is secured to the inferior aspect of the pectoralis major muscle and to the fascia at the level of the inferior mammary fold

the anterior axillary line. The mastectomy skin edges are checked for adequate perfusion. The tissue expander is filled to the maximal volume that would not place tension on the skin closure or cause ischemia to the skin flaps. In the majority of cases, the initial fill should not exceed 50% of the total tissue expander volume as this has been shown to be associated with an increased risk of complications [22]. Although many surgeons keep the patient on prophylactic antibiotics while the drains are in place, there is evidence to suggest that 24 hours of perioperative antibiotic prophylaxis is equivalent to a prolonged course [17].

Total Submuscular Coverage of the Tissue Expander

Total submuscular coverage can be employed if an acellular dermal matrix is not desired for inferior pole coverage of the tissue expander or if patients indicate that they do not wish to have acellular dermal matrix implantation. Instead of dividing the inferior origins of the pectoralis major muscle off of the chest wall, the inferior dissection continues in a subfascial plane incorporating the rectus fascia to continue the prosthetic pocket inferiorly. Laterally, either the serratus fascia or the serratus muscle itself can be used for the coverage of the implant pocket (Fig. 27.3). It is important to note that the submuscular pocket should be large enough for the tissue expander without potential space for prosthesis to slide around. The main limitation of compete submuscular placement of the expander is underexpansion of the lower pole of the breast reconstruction. This issue is mitigated in cases where acellular dermal matrices are used.

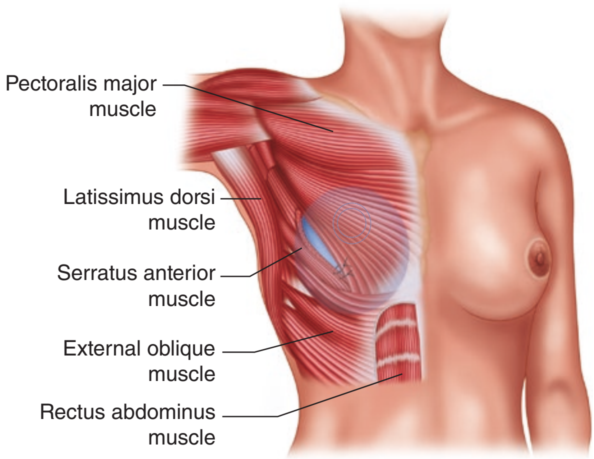


Fig. 27.3 Illustration showing total submuscular coverage of tissue expander by the pectoralis major and the serratus anterior muscles

Direct-to-Implant Reconstruction

If the mastectomy flaps are optimal with good perfusion, a permanent implant can be placed in the subpectoral space usually along with a piece of acellular dermal matrix. This can obviate the need to undergo a postoperative tissue expansion protocol. However, single-stage reconstructions have been associated with higher incidence of wound healing problems, such as wound dehiscence, skin necrosis, wound infections, reoperations for revisions, and explantation [5]. Selecting patients carefully, increasing understanding of risk factors, and developing surgical experience with this technique are required for good outcome [21]. The ideal patient would be one with minimal to no breast ptosis, with no wish to go larger than her current breast size, and with robust mastectomy skin flap.

Delayed-Immediate Approach

The delayed immediate approach is a two-stage approach utilized to optimize the reconstructive outcome when the need for adjuvant radiotherapy is unknown at the time of mastectomy [10]. During the initial mastectomy, a subpectoral tissue expander is placed to preserve the ptotic shape of the preserved breast skin envelope and then the final decision for postoperative radiotherapy is performed. If the patient requires radiation, the expander is deflated and the patient receives adjuvant radiotherapy. Conversion to autologous tissue reconstruction is then performed within a few months following the completion of radiotherapy. If no radiation is required, then the second-stage reconstruction is performed as early as 2 weeks following the mastectomy with autologous tissue transfer. After initial success with this technique, the indications of this approach have been expanded for use in higher stage breast cancers when adjuvant radiation is planned.

Tissue Expansion

Postoperative tissue expansion begins when the mastectomy incisions have started to heal, the mastectomy flaps are confirmed to have good perfusion, and there is no evidence of delayed wound healing or breakdown. The process can be initiated as early as 2 weeks from the time of tissue expander placement. The location of the port is identified by a magnetic port finder. The Mentor (Ethicon, Inc., Somerville, NJ) tissue expander requires a locator with a magnetic pendulum that becomes perpendicular at the center of the port. The injection site is marked and prepped out with antiseptic solution of choice. Sterile towels are placed to square off the neobreast to allow palpation in assessing skin tightness during filling. Usually, the volume of each fill is judged by the patient's tolerance and skin tightness. This volume is subjective and can be 30–50 cc for the small patient and up to 100 cc or more for the larger patient. Usually, more volume can be filled in the earlier expansion sessions. Sterile injectable saline is delivered via a 21-gauge needle at a perpendicular direction. Each expansion session is spaced 1 week apart but may be extended longer because of such timing issues as concurrent chemotherapy or distance travel. Expansion can be more frequent than weekly if needed. The expansion process is continued until the desired volume is reached. This volume is chosen by the patient with recommendation by the surgeon. Overexpansion should be 10–20% above the actual desired size of the breast mound to account for the natural retraction of the skin following expander removal. In skin-sparing mastectomy or total-skin-sparing mastectomy, overfilling may not be needed if the breast skin footprint is lax.

Second Stage

After the initial procedure has been performed and the postoperative tissue expansion protocol has been completed, the tissue expander can be exchanged for a permanent prosthesis. The choice of the implant has been made in the office and an appropriate size range of devices is made available for the operation. The previous incision is used on its lateral aspect to gain access to the implant capsule. If there was significant scar widening than the previous scar can be excised. Occasionally, a different incision, for example, one along the inframammary fold, may be utilized to approach the expander. The mastectomy skin flaps may be elevated slightly from the capsule above and below the skin incision. An oblique capsulotomy incision is performed to offset the capsular incision from the skin incision. Blunt finger dissection is performed around the expander to loosen any firm attachments to the capsule. The saline is evacuated from the tissue expander via technique of choice (e.g., closed method using a needle into the port or open method by incising the expander). The closed method of saline evacuation is recommended by the senior author to avoid incubated fluid content within the tissue expander from leaking into the surgical field. The tissue expander is then removed. Capsulotomies may be performed as needed using Bovie electrocautery on the inferior mastectomy skin flap to reduce constriction or help with enhancing breast ptosis. In addition, superomedial capsulotomies are frequently useful to help develop upper pole fullness with the implant. Usually capsulotomies are performed medially to help improve or attain good cleavage. An implant sizer is placed to ensure good fit of the proposed implant. The pocket is irrigated with antimicrobial solution (e.g., antibiotic solution with or without diluted Betadine). The skin around the incision is additionally prepped with Betadine solution. Surgical gloves are changed to a new pair. The implant is placed into the pocket with minimal contact of the skin. In the case of silicone gel implant insertion, the Keller Funnel (Allergan, Dublin, Ireland) can be employed to introduce the implant with a no-touch technique. For saline implant placement, the implant is inserted deflated and then filled to the desired size, followed by fill tube removal. Typical prosthetic devices used for reconstruction are depicted in Fig. 27.4.

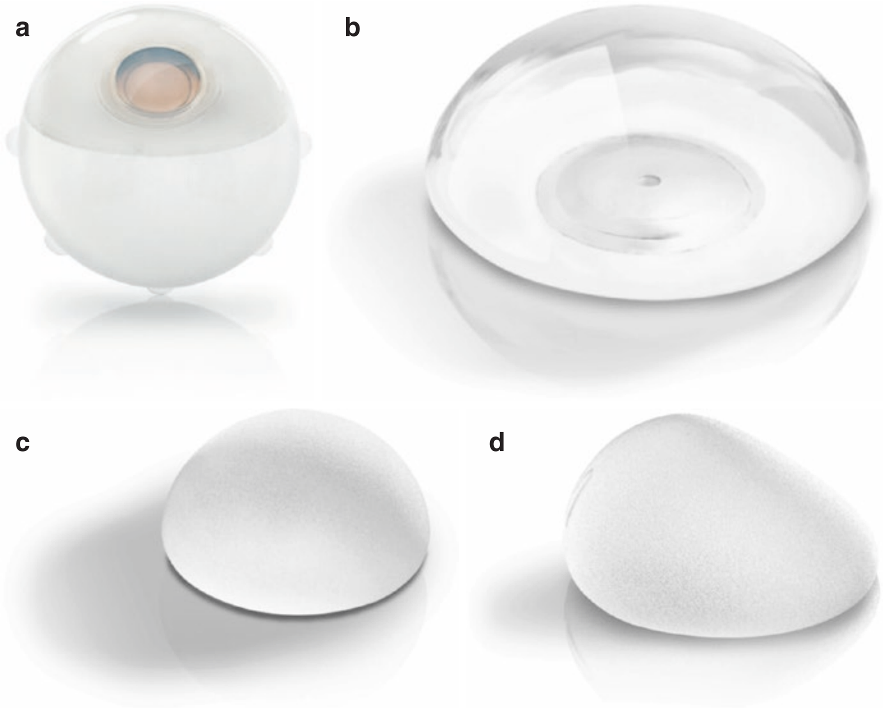


Fig. 27.4 Representative samples of mentor breast tissue expander and implants: (**a**) Artoura tissue expander, (**b**) MemoryGel High Profile smooth round silicone breast implant, (**c**) UltraHigh textured round silicone breast implant, and (**d**) MemoryShape textured anatomic silicone breast implant. (©2018 Mentor Corporation. All rights reserved. Used with permission)

Ensuring that the implant is in a good position, the access capsulotomy is closed with interrupted or running absorbable sutures. The cutaneous layer is closed with 3–0 Monocryl deep dermal sutures and a running 4–0 subcuticular suture. The patient is placed in a compression bra with soft dressings for support. No drains are usually used. Illustrative cases are shown in Figs. 27.5 and 27.6.

Nipple-Areolar Reconstruction

After the breast mounds have achieved symmetry through a breast balancing procedure, the nipple-areolar reconstruction can be initiated. The general categories of nipple-areolar reconstruction include skin flap/skin graft techniques, local flaps combined with staged areolar tattooing, and total nipple-areolar-complex (NAC) tattooing. Tattooing can also be employed to enhance the coloration of a completed surgical reconstruction of the NAC. A popular variant of these local flaps is the CV flap that is relatively easy to execute and has good long-term results [12]. Through

Fig. 27.5 A 55-year-old patient who underwent bilateral immediate reconstruction following skin-sparing mastectomies with subpectoral 450 cc Medium Height Mentor expanders and Flex HD Pliable acellular dermal matrices inserted as an inferior lateral sling. Serial expansion was completed to 425 cc bilaterally. Tissue expander exchange to permanent silicone implants was completed 5 months later. The patient has 450 cc Mentor smooth round high-profile silicone implants in place. Preoperative views (**a**, **b**), and postoperative result at 8 months (**c**); reconstruction is stable 1 year later (**d**)

the various techniques of nipple areolar reconstruction, the loss of projection can be as high as 45–75%, and therefore when planning the reconstruction, the nipple should be overprojected to account for anticipated loss of height [23]. Nipple reconstruction will be covered in further detail in a different chapter.

Surgical Complications and Solutions

Hematoma

Small hematomas can be observed and managed with compressive dressings. Rapidly expanding hematomas that cause compression/ischemia of the overlying mastectomy skin flaps need operative intervention to stop the actively bleeding

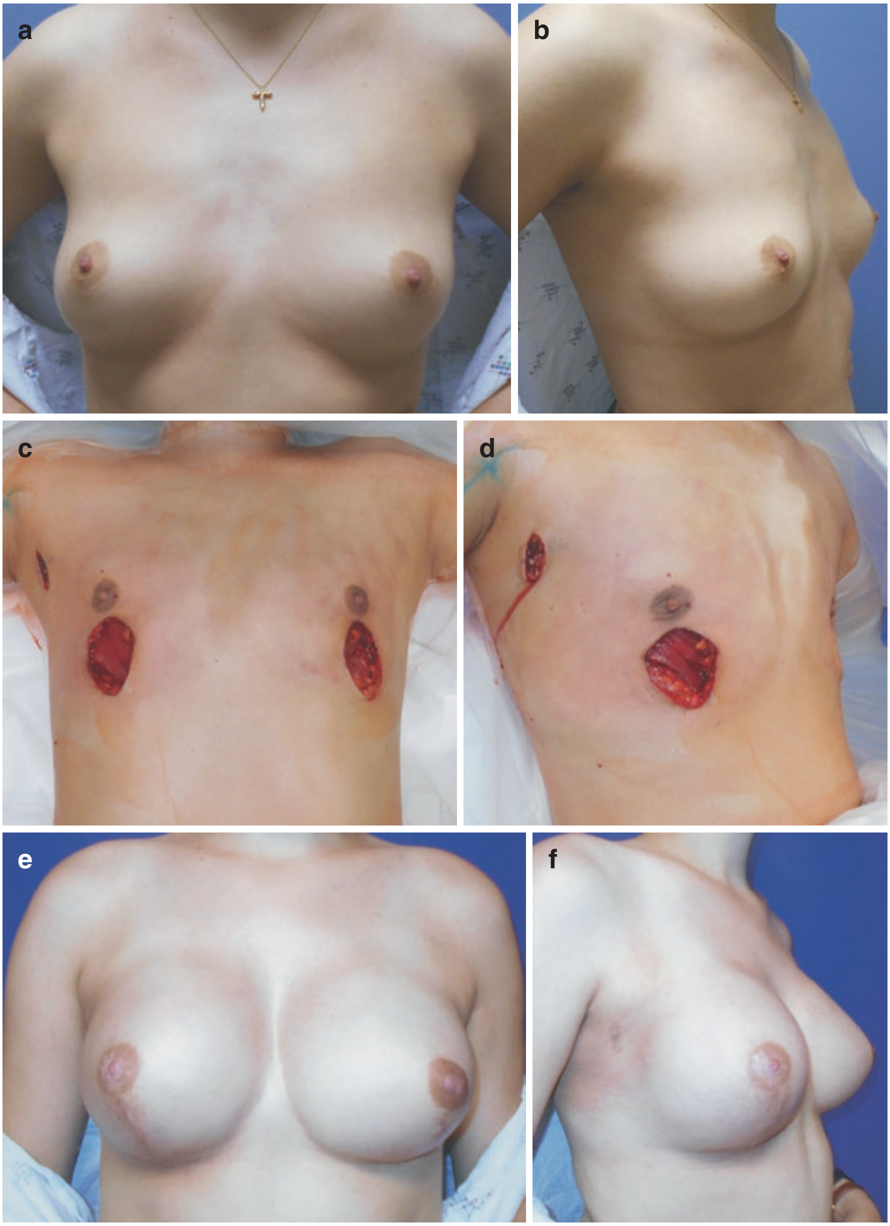


Fig. 27.6 A 25-year-old patient with right breast cancer who underwent bilateral nipple-sparing mastectomy via vertical incision at the inferior meridian between the nipple and inframammary crease. She underwent bilateral immediate reconstruction with insertion of tall-height Mentor tissue expander (350 mL) and acellular dermal matrix at the inferior pole and lateral fold using FlexHD. After completing serial expansion to 460 mL bilaterally, she underwent right breast radiation. Tissue expander exchange to permanent implants was completed 8 months after radiation. Preoperative views (**a**, **b**), intraoperative views (**c**, **d**), postoperative photos taken 4 months postoperatively (**e**, **f**). Reconstruction is stable 1 year later

vessel(s). The best method to deal with this issue is prevention with meticulous hemostasis during the initial operation. Before placing the expander/implant and acellular dermal matrix, time should be taken to take a survey of the hemostasis after the mastectomy, and all bleeding should be controlled meticulously.

Infection

Infection can have a wide range of manifestations. This can range from a low-grade cellulitis that can be cured with a trial of oral antibiotics all the way to a purulent infection around the breast prosthesis necessitating explantation. For patients with systemic manifestations of infection, the patient should be admitted and treatment initiated with broad spectrum intravenous antibiotics. Cellulitis that fails to resolve with intravenous antibiotics may require explantation of the device along with the acellular dermal matrix.

Seroma

Seromas commonly occurs in implant-based breast reconstruction due to multiple factors. A contributing factor is the dead space between the implant pocket and the overlying skin. The use of acellular dermal matrices has been implicated to increase the risk of seroma development. During the tissue expansion process at the completion of a tissue expander fill, the butterfly needle can be withdrawn from the port and into the periprosthetic space, so aspiration of the seroma can then be performed, preferable with the patient in the supine or near-supine position and fluid guided towards the needle using gentle external manual compression. Refractory seromas can be addressed with repeat aspirations in the office, but may require either percutaneous drain placement, operative evacuation, and drain placement, or even explantation.

Mastectomy Skin Flap Necrosis

This can manifest as partial-thickness or full-thickness loss. They both can initially show superficial epidermolysis and blistering. Full-thickness loss presents with further loss of the dermal layer and eventual eschar formation. This can be managed conservatively with partial thickness loss, but if impending exposure of the underlying prosthesis is present in the absence of infection, then excision and closure should be performed promptly.

Red Breast Syndrome

Red breast syndrome (RBS) is a clinical entity described as being a noninfectious erythema that is associated with the use of acellular dermal matrix after postmastectomy reconstruction [25]. The clinical features of pain, skin warmth, fever, and induration are absent in RBS. Differentiating RBS from infectious cellulitis remains a diagnostic challenge.

Results (Literature and Data)

With immediate reconstruction, it has been shown that patients have improved body image with retention of the breast mound [24]. In general, conventional reconstruction with complete muscle coverage has been shown in various studies to achieve a patient satisfaction rate in the 80–90% range or higher [8, 18]. Many studies of nipple-sparing and skin-sparing mastectomy combined with immediate ADM-assisted alloplastic reconstruction are promising with the majority of patients achieving good or excellent results and complication rates being acceptable.

Obesity

Elevated BMI of 25 or greater is associated with increased risks of postoperative complications and reconstructive failure [1]. It has been suggested that elevated BMI acts as a continuous variable that is predictive of complications and has been shown in multivariable logistic regressions to be predictive of seroma, infection, and mastectomy skin flap necrosis [16]. Obesity has been associated with an almost sevenfold increase in reconstructive failure [13]. When using AlloDerm, the reader is warned about the increased odds ratio for infectious complications and mastectomy skin necrosis with increasing BMI. One study showed a threefold increase in cellulitis when comparing patients with a BMI >35 relative to <25 [26].

Acellular Dermal Matrix

According to American Society of Plastic Surgeons (ASPS) guidelines on breast reconstruction with expander and implants, the evidence is conflicting and varied [1]. A recent meta-analysis [9] describes an increased risk of total complications (relative risk 2.05), seroma (relative risk 2.73), infection (relative risk, 2.47), and reconstructive failure (relative risk, 2.80) in patients with acellular dermis. However, another meta-analysis has shown that only the risk of seroma was elevated, while partial mastectomy skin flap necrosis, hematoma, and infection (nonoperative and requiring expander/implant removal) were not significantly different [20]. It has been suggested that as the total surface area of acellular dermal matrix is increased, the rate of complications increases in a stepwise fashion [22].

Radiotherapy

It is well established that radiotherapy is a known risk factor for complications after implant-based reconstruction. In a systematic review assessing the impact of radiation on implant-based breast reconstruction [14], the pooled rate for major complications in patients with prior radiotherapy was 49% and the rate for patients who had postoperative radiotherapy was 39%. However, there are reports that even in the face of anticipated radiation that immediate tissue expander placement can provide reasonably good outcomes in the setting of locally advanced disease [2, 11].

Conclusions

Subpectoral implant-based reconstruction is the most common reconstructive modality following mastectomy and can provide good to excellent aesthetic outcomes in breast reconstruction. The preservation of natural skin followed by immediate filling of the mastectomy space using a permanent implant or tissue expander, stabilized by ADM, allows for reconstruction of the lateral and inframammary folds with a very natural appearance. However, the potential for complications is not negligible and should be minimized by sound patient selection and meticulous operative technique.

Reference Video

- https://youtu.be/4sDK0UHmGuI

References

1. Alderman A, Gutowski K, Ahuja A, Gray D, Postmastectomy Expander Implant Breast Reconstruction Guideline Work, G. ASPS clinical practice guideline summary on breast reconstruction with expanders and implants. Plast Reconstr Surg. 2014;134(4):648e–55e. https://doi.org/10.1097/PRS.0000000000000541.
2. Ayoub Z, Strom EA, Ovalle V, Perkins GH, Woodward WA, Tereffe W, et al. A 10-year experience with mastectomy and tissue expander placement to facilitate subsequent radiation and reconstruction. Ann Surg Oncol. 2017;24(10):2965–71. https://doi.org/10.1245/s10434-017-5956-6.
3. Breuing KH, Warren SM. Immediate bilateral breast reconstruction with implants and inferolateral AlloDerm slings. Ann Plast Surg. 2005;55(3):232–9.
4. Clemens MW, Miranda RN, Butler CE. Breast implant informed consent should include the risk of anaplastic large cell lymphoma. Plast Reconstr Surg. 2016;137(4):1117–22. https://doi.org/10.1097/01.prs.0000481103.45976.b1.
5. Dikmans RE, Negenborn VL, Bouman MB, Winters HA, Twisk JW, Ruhe PQ, et al. Two-stage implant-based breast reconstruction compared with immediate one-stage implant-based breast reconstruction augmented with an acellular dermal matrix: an open-label, phase 4, multicentre,

randomised, controlled trial. Lancet Oncol. 2017;18(2):251–8. https://doi.org/10.1016/S1470-2045(16)30668-4.
6. Doren EL, Miranda RN, Selber JC, Garvey PB, Liu J, Medeiros LJ, et al. U.S. epidemiology of breast implant-associated anaplastic large cell lymphoma. Plast Reconstr Surg. 2017;139(5):1042–50. https://doi.org/10.1097/PRS.0000000000003282.
7. Farhangkhoee H, Matros E, Disa J. Trends and concepts in post-mastectomy breast reconstruction. J Surg Oncol. 2016;113(8):891–4. https://doi.org/10.1002/jso.24201.
8. Gui GP, Tan SM, Faliakou EC, Choy C, A'Hern R, Ward A. Immediate breast reconstruction using biodimensional anatomical permanent expander implants: a prospective analysis of outcome and patient satisfaction. Plast Reconstr Surg. 2003;111(1):125–38; discussion 139–140. https://doi.org/10.1097/01.PRS.0000037752.95854.41.
9. Kim JY, Davila AA, Persing S, Connor CM, Jovanovic B, Khan SA, et al. A meta-analysis of human acellular dermis and submuscular tissue expander breast reconstruction. Plast Reconstr Surg. 2012;129(1):28–41. https://doi.org/10.1097/PRS.0b013e3182361fd6.
10. Kronowitz SJ. Delayed-immediate breast reconstruction: technical and timing considerations. Plast Reconstr Surg. 2010;125(2):463–74. https://doi.org/10.1097/PRS.0b013e3181c82d58.
11. Kronowitz SJ, Lam C, Terefe W, Hunt KK, Kuerer HM, Valero V, et al. 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. 2011;127(6):2154–66. https://doi.org/10.1097/PRS.0b013e3182131b8e.
12. Losken A, Mackay GJ, Bostwick J 3rd. Nipple reconstruction using the C-V flap technique: a long-term evaluation. Plast Reconstr Surg. 2001;108(2):361–9.
13. McCarthy CM, Mehrara BJ, Riedel E, Davidge K, Hinson A, Disa JJ, et al. Predicting complications following expander/implant breast reconstruction: an outcomes analysis based on preoperative clinical risk. Plast Reconstr Surg. 2008;121(6):1886–92. https://doi.org/10.1097/PRS.0b013e31817151c4.
14. Momoh AO, Ahmed R, Kelley BP, Aliu O, Kidwell KM, Kozlow JH, Chung KC. A systematic review of complications of implant-based breast reconstruction with prereconstruction and postreconstruction radiotherapy. Ann Surg Oncol. 2014;21(1):118–24. https://doi.org/10.1245/s10434-013-3284-z.
15. Namnoum JD. Expander/implant reconstruction with AlloDerm: recent experience. Plast Reconstr Surg. 2009;124(2):387–94. https://doi.org/10.1097/PRS.0b013e3181aee95b.
16. Nguyen KT, Hanwright PJ, Smetona JT, Hirsch EM, Seth AK, Kim JY. Body mass index as a continuous predictor of outcomes after expander-implant breast reconstruction. Ann Plast Surg. 2014;73(1):19–24. https://doi.org/10.1097/SAP.0b013e318276d91d.
17. Phillips BT, Fourman MS, Bishawi M, Zegers M, O'Hea BJ, Ganz JC, et al. Are prophylactic postoperative antibiotics necessary for immediate breast reconstruction? Results of a prospective randomized clinical trial. J Am Coll Surg. 2016;222(6):1116–24. https://doi.org/10.1016/j.jamcollsurg.2016.02.018.
18. Ramon Y, Ullmann Y, Moscona R, Ofiram E, Tamir A, Har-Shai Y, et al. Aesthetic results and patient satisfaction with immediate breast reconstruction using tissue expansion: a follow-up study. Plast Reconstr Surg. 1997;99(3):686–91.
19. Salzberg CA, Ashikari AY, Berry C, Hunsicker LM. Acellular dermal matrix-assisted direct-to-implant breast reconstruction and capsular contracture: a 13-year experience. Plast Reconstr Surg. 2016;138(2):329–37. https://doi.org/10.1097/PRS.0000000000002331.
20. Sbitany H, Serletti JM. Acellular dermis-assisted prosthetic breast reconstruction: a systematic and critical review of efficacy and associated morbidity. Plast Reconstr Surg. 2011;128(6):1162–9. https://doi.org/10.1097/PRS.0b013e318230c29e.
21. Scheflan M, Colwell AS. Tissue reinforcement in implant-based breast reconstruction. Plast Reconstr Surg Glob Open. 2014;2(8):e192. https://doi.org/10.1097/GOX.0000000000000140.
22. Selber JC, Wren JH, Garvey PB, Zhang H, Erickson C, Clemens MW, Butler CE. Critical evaluation of risk factors and early complications in 564 consecutive two-stage implant-based breast reconstructions using acellular dermal matrix at a single center. Plast Reconstr Surg. 2015;136(1):10–20. https://doi.org/10.1097/PRS.0000000000001327.

23. Sisti A, Grimaldi L, Tassinari J, Cuomo R, Fortezza L, Bocchiotti MA, et al. Nipple-areola complex reconstruction techniques: A literature review. Eur J Surg Oncol. 2016;42(4):441–65. https://doi.org/10.1016/j.ejso.2016.01.003.
24. Wilkins EG, Cederna PS, Lowery JC, Davis JA, Kim HM, Roth RS, et al. Prospective analysis of psychosocial outcomes in breast reconstruction: one-year postoperative results from the Michigan Breast Reconstruction Outcome Study. Plast Reconstr Surg. 2000;106(5):1014–25; discussion 1026–1017.
25. Wu PS, Winocour S, Jacobson SR. Red breast syndrome: a review of available literature. Aesthet Plast Surg. 2015;39(2):227–30. https://doi.org/10.1007/s00266-014-0444-x.
26. Yuen JC, Coleman CA, Erickson SW. Obesity-related risk factors in implant-based breast reconstruction using AlloDerm. Plast Reconstr Surg Glob Open. 2017;5(2):e1231. https://doi.org/10.1097/GOX.0000000000001231.
27. Zhong T, Hu J, Bagher S, Vo A, O'Neill AC, Butler K, et al. A comparison of psychological response, body image, sexuality, and quality of life between immediate and delayed autologous tissue breast reconstruction: a prospective long-term outcome study. Plast Reconstr Surg. 2016;138(4):772–80. https://doi.org/10.1097/PRS.0000000000002536.
28. Zienowicz RJ, Karacaoglu E. Implant-based breast reconstruction with allograft. Plast Reconstr Surg. 2007;120(2):373–81. https://doi.org/10.1097/01.prs.0000267340.31742.1.

28 Pre-pectoral Implant Breast Reconstruction: The Better Option?

Ashutosh Kothari, Hisham Hamed, and Tibor Kovacs

History

The history of breast reconstruction dates back to 1800 with an attempt to transplant a large lipoma to a mastectomy site [1]. During the Second World War, the Dow Chemical Company commercialised the use of silicone. The first silicone implant for breast augmentation was used in 1962. Over the past few decades, there have been a plethora of different types of silicone breast implants available for both breast augmentation and reconstruction that have allowed for an evolution in techniques of implant-based breast reconstructions.

Cronin and Gerow started the new era of breast reconstruction in 1963 by inserting a silicone implant following a mastectomy [2]. A delayed approach to breast reconstruction dominated until 1971 when the first case of immediate breast reconstruction was reported. Snyderman and Guthrie were first to place silicone implants subcutaneously, directly under the preserved skin envelope following a mastectomy [3].

The initial attempts at implant-based reconstruction involved placing the implants subcutaneously, directly under the skin. These early attempts at subcutaneous implant reconstruction were associated with high rates of surgical complications such as infection, skin necrosis and implant extrusion. Besides, they were frequently associated with poor cosmetic outcomes secondary to rippling, capsular contracture and visibility of implant contours [4].

A. Kothari (✉) · H. Hamed · T. Kovacs
Breast Surgery, Guy's & St. Thomas NHS Foundation Trust, London, UK

King's College, London, UK
e-mail: Ashutosh.Kothari@gstt.nhs.uk; Hisham.Hamed@gstt.nhs.uk; Tibor.Kovacs@gstt.nhs.uk

V. S. Klimberg et al. (eds.), *Oncoplastic Breast Surgery Techniques for the General Surgeon*, https://doi.org/10.1007/978-3-030-40196-2_28

These issues necessitated a change in the surgical technique, which led to placing the implants under the muscles of the chest wall. Sub-muscular implant reconstruction evolved as an alternate and relatively safe technique, providing a healthier, biological tissue bed with the potential of providing neo-vascularisation of the fragile post-mastectomy skin envelope [5].

Radovan was first to report the use of expander implants in the early 1980s [6]. This technique gained popularity for many years. However, it was criticised due to deterioration of cosmetic appearances over time [7]. By the end of the 1970s, a single-stage breast reconstruction was made possible [8]. Subcutaneous/pre-muscular implant reconstruction did not gain popularity initially for fear of wound dehiscence and implant exposure.

Limitations of the Sub-muscular Technique

A sub-muscular implant pocket is perceived as a safe surgical option as it provides a rich vascular bed for the post-mastectomy skin envelope when it is most vulnerable. It compartmentalises the "foreign body" in a vascular, muscle envelope and prevents direct contact between the implant and subcutaneous tissue. Not only does it help with healing, it also allows for a reconstruction to be salvaged in the unfortunate event of partial skin flap necrosis. However, the drawbacks of this technique revolve around the aesthetic outcomes and the fact that due to limitation in the immediate sub-muscular pocket volume, it does not allow for a direct-to-implant approach in a vast majority of cases.

It is relatively straightforward to explain the physics behind the handicaps that are implicit in this technique and that can lead to poorer cosmetic outcomes. In the case of a nipple-sparing mastectomy, there is a glaring discrepancy in the lengths of the skin and sub-muscular envelopes, which can persist even after maximal inflation of the expander. Therefore, even after optimal inflation within a somewhat restrictive sub-muscular pocket, the vector for maximal projection of the implant may not be at the same level as the preserved Nipple-areola complex (NAC). More often than not, due to the nature of the sub-muscular pocket, and the resting tone of the chest-wall muscles, this vector for maximal projection is located superior to the NAC. This leads to more fullness in the upper pole and a downward displacement of the Nipple Aareola Complex, with a relatively underfilled lower pole. Unless the discrepancy between the insertion of the pectoralis major and the Infra-mammary fold (IMF) has been addressed at the time of dissecting the sub-muscular pocket, the post-reconstruction Infra Mammary Fold will also be higher and incongruous with the native IMP as defined by the footprint of the breast. Lastly, due to the contraction of the pectoralis muscle, there is always a tendency for the implant to be displaced superiorly and laterally from its intended location.

The argument that this technique automatically implies two surgical interventions may not be entirely relevant in the present day. Technological advances in implant design and construction have led to the development of what are now commonly referred to as "permanent expander" implants (MemoryGel™ Siltex™

Contour Profile™ 35 Cohesive II™). These are anatomical permanent tissue expanders that do not need to be exchanged and can be left in situ for as long as solid silicone prosthesis.

Soft Tissue Cover Enhancers

The need to restore a patient's body image, attaining good aesthetic outcomes with minimal complications and improving the quality of life, has driven innovations in the practice of immediate implant-based breast reconstructions. These drivers, along with a drastic paradigm shift where "less is more", have led to a radical change in mastectomy techniques. We have evolved from the ablative conventional Halsted mastectomy, toward a more conservative approach, where the skin, areola and nipple are spared (where indicated), without concerns about oncological safety. These conservative mastectomies have facilitated significantly better cosmetic outcomes that have in turn led to greater patient satisfaction.

Towards the tail end of the last century, significant advances in biomechanical engineering delivered medical devices capable of enhancing the coverage of breast implants. These devices or matrices have the unique property of promoting tissue regeneration, integration and repair as opposed to the usual foreign body reaction of inflammation, scarring and fibrosis. They provide a matrix or scaffolding for the host tissue to revascularise and populate with regenerative tissue that in most cases, does not lead to capsular contracture and resulting deformities [9, 10]. There are two distinct types of matrices available for commercial use today, biologic and synthetic. The initial matrices were either rectangular or contoured to be concave superiorly and convex inferiorly. They came as pre-meshed sheets or came as solid sheets without any perforations.

The introduction of these coverage enhancing devices allowed for the creation of a larger and more tailored dual-plane pocket, by extending the length of the pectoralis muscle. One edge of the matrix is sutured to the inferior free end of a detached pectoralis major muscle, and the other edge is sutured at the level of the intended IMF as well as laterally to define the lateral edge of the newly reconstructed breast akin to an internal bra or inferolateral hammock (Fig. 28.1). It follows that the pectoralis major muscle covers the upper pole of the implant while the matrix covers the inferior and lateral aspects of the implant. The dual-plane pocket allowed for one stage direct to immediate implant reconstructions and permitted the use of implants with larger volume and higher projection. The dual-plane technique, due to the resting muscle tone and inherent strength of the matrices, reduced the biomechanical load on the skin envelope, in the direct-to-implant reconstructions, protecting the blood circulation of the skin envelope, which in turn allowed for better healing. In addition, the matrices allowed for the length of the dual-plane pockets to be adjusted, facilitating improved symmetry in the lengths of the external skin—internal the dual-plane envelopes. By overcoming this handicap of the sub-muscular technique, the dual-plane envelope allowed for a more rounded convex lower pole with a degree of ptosis that could be controlled by the surgeons.

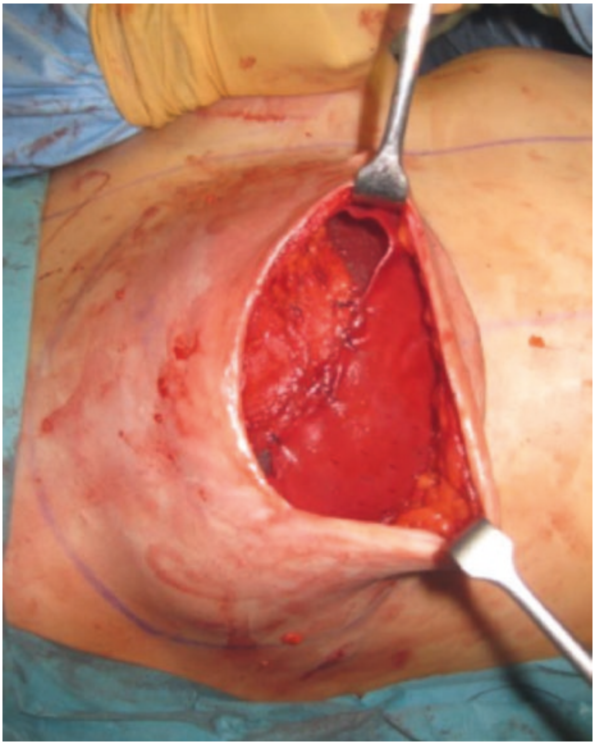


Fig. 28.1 Acellular dermal matrix (ADM) submuscular technique. ADM is inferior and lateral. Pectoralis major is superior and medial, with the implant visible beneath these two anterior covers

The dual-plane approach requires additional dissection of the inferior and inferomedial insertions of the pectoralis major muscle on the anterior chest wall. This not only leads to partial loss of pectoral function but may also result in a longer recovery and increased morbidity in terms of acute pain and chronic pain [11]. There is also the somewhat distressing aspect of “animation deformity” or the superolateral displacement of the implant on the contraction of the ipsilateral pectoralis major muscle. Window shading is another linear crease-like deformity associated with wrinkling of the skin that is created at the interface between a dynamic contracting muscle and a static matrix (Fig. 28.2). These deformities cause significant anguish to patients, although, animation may be temporarily and successfully treated with Botox injections. Some surgeons believe that a higher release (as high as the third rib) of the medial insertions of the pectoralis muscle can do away with the problem of animation altogether.

These advancements along with the desire to negate the perceived drawbacks of the total sub-muscular and dual-plane techniques revived interest in the subcutaneous placement of breast implants. As the safety and efficacy of the dual-plane technique were established, the use of matrices that allowed for total implant cover and thereby providing an additional layer of protection beneath the subcutaneous tissue and skin was the logical next step in the evolution of matrix-enhanced reconstructions. In pre-pectoral reconstruction, the implant is placed in a pocket as defined by

Fig. 28.2 Window shading

the footprint and skin envelope of the breast, preserving the anatomy, the chest wall muscles and their function, thereby negating the perceived drawbacks of the dual-plane breast reconstruction.

Less than 50% of women requiring mastectomy are offered reconstruction, with around 20% of those electing to have immediate reconstruction. Implant-based reconstructions account for 40–60% for all breast reconstructions in the United Kingdom and 75% in the United States [12, 13]. In fact, the rate of implant-based breast reconstructions in the United Kingdom has doubled over the past 15 years, and now 80% of all immediate reconstructions are implant based [14, 15]. Although breast reconstruction has increased in popularity, on account of access to health care resources and expertise, there is wide variation in its uptake.

The emergence of acellular dermal matrix (ADM) has revolutionised reconstruction techniques (Fig. 28.1). ADMs improve aesthetic outcomes [16]; however, they are not without drawbacks. It is an expensive device and has been shown to be associated with increased rates of complications [17]. Therefore, careful patient selection and judicious use are essential.

Patients' Selection and Planning

Meticulous patient selection is pivotal to a successful procedure that delivers good aesthetics and patient satisfaction while minimising complications. This approach should be applied to all implant-based reconstruction techniques. Factors which minimise complications and enhance aesthetic outcomes include low body mass index, small- to medium-size breast (breasts not larger 500 g), first- and second-degree ptosis, and non-smokers [18]. The authors are of the opinion that in patients with a notch-to-nipple distance greater than 25 cm, or grade 3 ptosis, nipple preservation should not be attempted and alternative techniques such as free nipple grafts should be explored to minimise peri-operative flap morbidity.

In general, smokers have a significantly higher risk of complications, and this is particularly relevant in implant-based reconstructions [19]. Patients who undergo risk-reducing mastectomy and implant reconstruction should be counselled to abstain from smoking for a minimum of 3 months prior to surgery. This should not apply to those patients with an established diagnosis of breast cancer, where delaying surgery for any length of time is not advisable. In this group, patients should be encouraged to stop smoking for at least 3 weeks prior to their surgery and the use of tissue expanders should be preferred. In addition, they should be strongly advised against the use of any nicotine alternatives, and this includes nicotine patches or chewing gums as these are equally detrimental.

There is also a dialogue to be had around lifestyle preferences, vocation and particularly participation in certain sports and leisure activities. The lack of disruption of pectoralis major muscle in pre-pectoral implant reconstruction provides a significant advantage by maintaining core upper body strength and reducing morbidity, animation and chronic pain. Therefore, it may be the preferred choice for women who are keen on exercise, swimming, yoga and pilates and those who actively partake in sports activities.

There is some debate on whether the pre-pectoral approach is suitable for particularly slender women. The argument against using this approach revolves around the fact that the lack of subcutaneous fat increases implant visibility, palpability, implant edge definition and visible implant creasing due to thin skin flaps. These patients are usually thin and may not have sufficient fat donor sites for post-surgical fat transfer. Nava et al. presented their breast thickness coverage classification based on digital mammography [20]. They used digital mammography to determine the thickness of breast tissue coverage overlying the breast gland, corresponding to the superficial tissues between the skin and the Cooper ligaments (i.e. the dermis and subcutaneous fat), thus facilitating the planning of the optimal reconstructive technique. They proposed a breast tissue coverage classification (BTCC) according to the thickness of the superficial tissues covering the mammary gland, as measured in centimetres: type 1, poor coverage, < 1 cm; type 2, medium coverage, 1–2 cm; and type 3, good coverage, >2 cm [21]. According to the BTCC, they suggested a two-stage implant-based breast reconstruction with ADM or synthetic meshes followed by autologous fat grafting before the second stage for type 1 patients, 1-stage implant-based breast reconstruction with ADM or synthetic meshes (with or without considering lipomodelling) for type 2 patients, and one-stage implant-based breast reconstruction with ADM or synthetic meshes for type 3 patients.

Pre-pectoral Reconstruction and Chest Wall Radiotherapy

Adjuvant post-mastectomy chest wall radiotherapy (PMRT) has been increasingly used on the basis of the evidence of a reduction in local recurrence and improved survival [22]. It is important to understand that the tissues most at risk of local recurrence, namely the pectoralis muscle and skin flaps, are directly targeted from PMRT. Robust data on subcutaneous implant reconstruction and post-mastectomy radiotherapy are lacking. There has been some concern that subcutaneous/pre-pectoral implant reconstruction may compromise the radiotherapy planning [23].

Some surgeons speculate that placing the implants behind the pectoralis major muscle provides extra protection to the skin flaps during radiotherapy. This is presumably due to neo-vascularisation of the skin from the richly vascular muscle bed and that this would reduce the risk of skin flap-related complications or afford the ability to excise necrotic areas without compromising the integrity of the reconstruction. There is little doubt that this process of neo-vascularisation would at best take between 6 and 10 weeks after surgery to establish and it would possibly take even longer for a more robust supply to establish. So even if we concede this may be true for the two-stage approach, for a cohort of patients who have undergone neoadjuvant chemotherapy, adjuvant chest wall radiotherapy may start as soon as 6 weeks after surgery. This does not allow for sufficiently robust neovascularisation to establish and it follows that it is unlikely that any such protection would be afforded in these cases. A recent comparative study demonstrated that Baker Grade 3 and 4 capsular contractures are three times more likely in sub-pectoral reconstruction when compared to pre-pectoral reconstruction following PMRT [24].

Small clinical case series have demonstrated reduced rates of capsular contracture when using ADM following post-mastectomy radiation [25]. On the basis of these findings, one can speculate that the effects of radiation should be lesser with an ADM that covers all of the anterior surface of the implant. With a sub-muscular or dual-plane implant reconstruction, the radiation and ensuing fibrosis will still affect the pectoralis muscles, even with an inferolateral ADM sling. In contrast, wrapping the expander or implant in an ADM and placing it superficial to the pectoral muscles may eliminate any negative effect of fibrosis and contracture of the pectoralis muscle preventing the upwards and outwards migration of the prosthesis, typically seen with an irradiated completely or partially sub-pectoral implant.

It is crucial to communicate the exact location of the implant to the clinical oncologist during a multidisciplinary discussion as this knowledge is essential to radiation planning. The radiation oncologist needs to consider the chest wall shape and use three-dimensional (3D) conformal planning as they can no longer allow for any cold spots posterior to the implant. Furthermore, for patients with large tumours where a boost to the mastectomy flaps may be indicated, there may be an inability to boost the entire mastectomy flap with electrons, as the anterior aspect of the pectoralis major may be now located under the implant.

The use of the specific types of expanders in patients undergoing PMRT is also an area of debate. Certain radiation oncologists are concerned about the use of expanders with integrated magnetic ports as they believe that these interfere with dose planning and distribution. This is particularly relevant in pre-pectoral reconstructions, as a proportion of the muscle is posterior to the metallic port. To avoid any controversy, it may be advisable to use expanders with remote ports and ensure that these are placed outside the radiotherapy fields in the mid-axillary line.

Surgical Technique

The success of surgery starts with meticulous preoperative planning and patient selection. A thorough and detailed preoperative consultation with the patient is essential. It is essential to establish patient expectations; discuss the type and site of the scar and final breast size and shape; and address all possible complications along with their potential impact on the planned procedure. It is also essential to discuss aspects such as hospital stay, recovery, postoperative care and management of surgical drains. The choice of implant used will depend on the patient's desired outcome. In pre-pectoral reconstructions, it is important to counsel women on the possible requirement of additional lipomodelling procedures to improve the final aesthetic outcome. It is obligatory to discuss breast implant associated anaplastic large cell lymphoma with all patients undergoing implant reconstruction. The likelihood of postsurgery adjuvant therapies and their impact on the proposed reconstruction procedure should also be discussed in detail and documented. Preoperative photographs using either conventional imaging and standardised views or more advanced three-dimensional imaging are also strongly recommended. Some of the newer imaging packages also allow for calculation of breast volumes and suggest implants types and volumes for immediate breast reconstruction.

Preoperative marking is fundamental to the cosmetic outcome. The marking of should always be performed with the patient either sitting upright or standing. The markings should include the midline, the breast meridian, the IMF, the take-off points of the breasts, in addition to the lateral extent of dissection and the entire footprint of the breast. If a skin-reducing mastectomy is planned, then the wise pattern reduction incisions should be marked with the usual care and precautions. If a synchronous free nipple graft is planned with the wise pattern skin reduction, then the position of the new nipple should be discussed with the patient.

During surgery, the use of disposable gowns and double gloving is advisable. Systemic antibiotic use should be limited to either one intraoperative dose of broad-spectrum antibiotic or three individual intravenous doses. There is no evidence that continuation of oral antibiotics to the point of drain removal or even a random period of 5, 7 or 10 days reduces the risk of postoperative surgical site infections [26].

On behalf of the Northwest Breast Surgical Research Collaborative, Barr et al. [26] published recommendations for the prevention of infections in implant-based surgery. They recommended the following: double gloving, preoperative antibiotics that should continue postoperatively in high-risk patients, alcohol solution for skin preparation, limiting the footfall and size of the surgical team in theatres, washing of the implant cavity, changing gloves and drapes after the mastectomy and before inserting the implant and reducing the operative time, to reduce the risk of infections in breast implant surgery.

Incisions

There are several incisions dependent on the type of mastectomy that is planned, the breast volume, degree of ptosis and whether any synchronous axillary surgery is planned. These incisions vary on the amount of breast envelope being preserved and are different for skin sparing, areola sparing and nipple sparing mastectomies. The principle of hidden scars with the least impact on the aesthetic subunits of the breast should be adhered to whenever possible. Scars may need to be varied and improvised if skin over the tumour needs to be excised.

If skin reduction is required, then the standard-wise pattern incision is the preferred approach, with or without a free nipple graft. The authors recommend a lateral hockey stick incision in cases with Grade 1/ 2 ptosis, where a Nipple Sparing Mastectomy is planned. This allows for medial and superior translocation of the NAC and provides excellent access to the entire breast pocket and axilla. In the sitting position, the new nipple position is marked on the breast meridian. The distance of the areolar edge to the base of the nipple is then measured. A mark is made above the neo-nipple position to the site of the new areolar edge. An ellipse is then drawn to connect this new mark starting from the areola at 8 o'clock to 2 o'clock (for the left breast). From 3 o'clock an oblique lateral extension (7 cm long) is drawn, and a V, with its tip pointing to the axilla, is connected to the 2 o'clock peri-areolar marking (Fig. 28.3). The entire area is de-epithelised, with only the superior lateral limb of the "V" incised across its full thickness. Mastectomy and any axillary dissection may be performed through this approach.

Areola Sparing Mastectomy

If the areola is to be preserved and the nipple sacrificed, a lollipop-like is preferred. This involves making a circumferential incision around the base of the nipple which can be extended laterally or obliquely in the form of a lazy "S" to minimise the lateral deviation of the preserved areola. It is also possible to use an oblique scar starting in the lower-inner quadrant going around the base of the nipple and extending superolaterally, if required. A combination of an IMF incision and a circumferential incision around the base of the nipple is also aesthetically very pleasing for areola sparing mastectomies (Fig. 28.4).

At the end of any reconstruction procedure, we strongly recommend a thorough inspection of the wound edges. If they appear discoloured or bruised as a consequence of overzealous retraction during the mastectomy, then they should be excised till fresh bleeding is observed. Wound closure is performed using absorbable monofilament sutures in two layers with a subcuticular final layer. The suture

Fig. 28.3 Hockey stick allows for mastopexy in Grade 1 and 2 ptosis with very good access

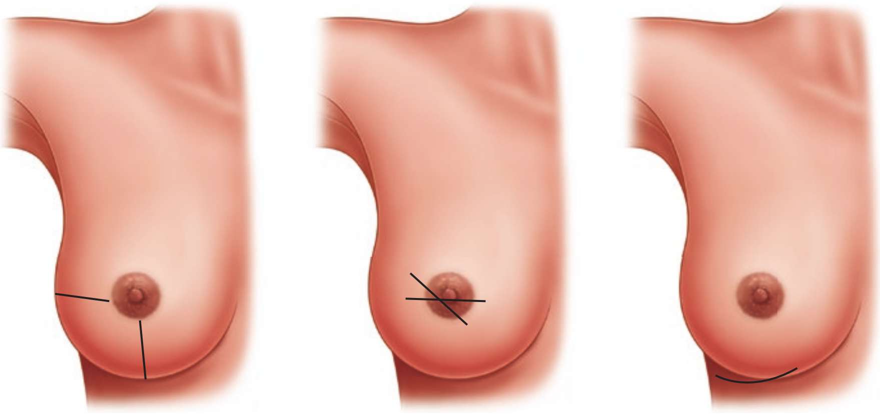


Fig. 28.4 Lollipop, transareolar and IMF + transmammary

line is reinforced and sealed with either steri-strips or Dermabond. We use Tegaderm waterproof dressings and patients are encouraged to shower from post-operative day 1.

Mastectomy Technique

It is essential to remember that a good cosmetic and oncologically safe result in breast reconstructive surgery starts with an adequately and competently performed mastectomy. The preservation of the entire breast skin envelope is technically challenging as the post-mastectomy skin flaps receive blood supply purely from the subdermal plexus. The risk factors for ischaemic complications (previous radiotherapy, smoking etc.) should be thoroughly assessed preoperatively; furthermore, the larger is the skin envelope, the higher is the rate of ischaemic complications.

Careful attention should be paid to the thickness of the mastectomy flaps. The dissection should always be performed between the anterior lamella of the superficial fascia and the subcutaneous tissue. Deliberately leaving thick flaps to ensure good healing is not oncologically safe and the aesthetic outcomes should never take precedence over oncological aspects whether mastectomy is carried out for cancer or risk reduction [26]. Care should be taken not to transgress the IMF, and its integrity should ideally be preserved. Medially, the dissection should be restricted to the footprint, and particular care should be taken to avoid synmastia. In addition, the second and third intercostal perforators supply the skin and NAC, and overzealous medial flap dissection could easily damage them jeopardising flap vascularity. There are similar perforators inferomedially, and inferolaterally that should also be preserved to maintain good all-round skin perfusion. Extending the dissection more laterally and medially than necessary can also sever the lateral and medial branches of the intercostal nerves and reduce skin flap sensation. The dissection should ideally be restricted to the footprint of the breast so that the new envelope is well defined and implant displacement is restricted. Careful haemostasis is vital to prevent troublesome postsurgical haematomas that could lead to re-operations, infections and suboptimal aesthetic outcomes.

Hydro-dissection using diluted adrenaline at a concentration of 1:400,000 injected in the subcutaneous plane can assist by minimising bleeding and consequently enhancing visualisation of the plane between the anterior lamella of the superficial fascia and subcutaneous tissue. Some surgeons discourage the use of diathermy to dissect the skin flaps due to the risk of thermal damage to the delicate subcutaneous vessels and the overlying skin envelope. They advocate the use of sharp dissection with a blade or scissors to get around this issue. In the author's experience, there is no difference between the two methods as long as the dissection is in the appropriate anatomical plane and care is taken to protect the subdermal vasculature with limited skin retraction. If retractors are used, then care should be exercised to limit the amount of traction on the skin flaps and the duration of the retraction, allowing sufficient time for the skin to recover between periods of retraction. Whatever the method of dissection in patients with breast cancer, above all else, the skin and/or nipple sparing mastectomy should respect strict oncological principles.

Once the mastectomy pocket is created, several methods could be utilised to cover the pre-pectoral implant and its subsequent placement.

ADM: Full Implant Cover

Braxon® (Medical Biomaterial Products GmbH, Neustadt-Glewe, Germany, under the license of Decomed S.r.l., Marcon-Venezia, Italy) was the first ADM designed and licensed for pre-pectoral breast reconstruction. Braxon® is a 0.6-mm-thick porcine, acellular dermal matrix that allows for complete implant cover. A composite of the implant with its complete Braxon® wrap is prepared ex vivo and then inserted into the cavity as a single entity. Braxon® is supplied freeze-dried and needs to be hydrated in a saline bath before it can be used. Surgeons add broad-spectrum antibiotics to this bath; however, evidence around this practice is limited. The matrix is a single-shaped sheet; the part of the matrix with the two square windows (to allow for the textured implant to adhere to the pectoral muscle) is the posterior leaf of the matrix. The definitive implant with 6 o'clock correctly aligned is placed over these windows ensuring that its inferior edge is in line with the central seam. The anterior leaf of the matrix is then folded over the anterior surface of the implant. It is then sutured with the posterior leaf with interrupted absorbable sutures all around the edge of the implant, forming a dome-shaped envelope/composite. Surplus ADM can be trimmed around the sutured edges (Fig. 28.5). The composite is then appropriately positioned in the subcutaneous pocket between the pectoral muscle and the skin and anchored to the pectoral muscle with 4–5 interrupted absorbable suture. One final wash after placement is recommended by the authors using either a betadine and saline

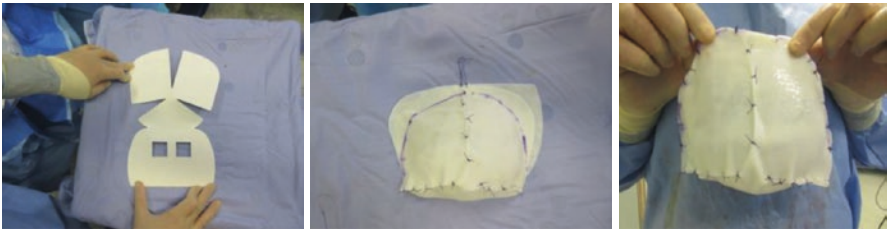


Fig. 28.5 Braxon ADM full implant cover

sequenced washout or then an antibiotic solution. The limitation of this matrix is that it will not accommodate implants larger than 500 cc. If an expander is preferred, then the composite is prepared as described earlier with the expander fully inflated. The implant is then deflated to the desired level in vivo.

Single Flat Sheet Anterior Cover Technique

Given that the pectoralis muscle is well vascularised and not at risk, there is a growing opinion that posterior cover of sub-pectorally placed implants with an ADM may not provide any tangible benefit. Surgeons have consequently innovated with these rectangular ADMs to provide complete anterior implant cover, using the native pectoral muscles to provide a posterior cover for the implant. This technique is relatively cheaper and equally effective.

A sizer is positioned within the newly created mastectomy cavity. The superior and lateral border of the implant is marked on the chest wall. The ADM is washed in a saline/antibiotic bath either for hydration or to wash away any chemical preservatives. If a non-meshed ADM is used, then a few fenestrations with a number 10 blade can be evenly spaced across the length of the matrix. This facilitates free movement of any exudative fluids across the ADM membrane potentially creating one cavity. Ex vivo, the meshed ADM is draped over the sizer lengthwise. After the entire anterior surface of the sizer is covered by the ADM, a mark is made on the matrix at the inferior edge. The surplus length of the ADM below this mark is then cut. The larger single length of ADM is then placed anterolaterally over the sizer and the smaller, newly cut piece, is then stitched to its medial aspect, using a continuous absorbable suture. Total anterior cover by this newly created ADM shape is then reconfirmed using the sizer (Fig. 28.6). The mesh is then secured to the chest wall superiorly at the level of the previous marking, with interrupted absorbable sutures. Medial stitches are secured at the edge of the dissection. After this, the definitive implant is opened, bathed in the antibiotic solution and introduced into the cavity between the pectoral muscle posteriorly and the ADM anteriorly. With the implant in place, the lateral and inferior stitches are taken. These lateral stitches on the chest wall control medialisation of the implant and consequently the new cleavage.

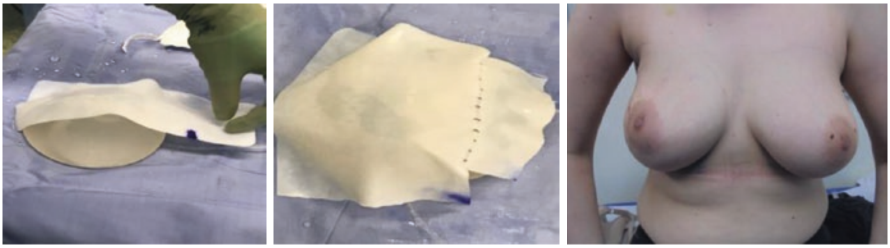


Fig. 28.6 Long sheet is cut at mark and sutured to the medial aspect of the larger sheet providing full anterior implant cover

Fig. 28.7 Meshed ADM, provides anterior cover

The recently introduced SurgiMend® PRS Meshed is an expandable acellular dermal matrix derived from foetal bovine dermis, which provides up to twice the initial coverage once fully hydrated. It claims to be the first Medicines and Healthcare products Regulatory Authority-approved ADM solution for pre-pectoral implant-based reconstruction. It comes pre-meshed and allows for complete anterior coverage, even of large implants. The criticism is that the mesh stretches allowing for parts of the implant surface to come into direct contact with subcutaneous tissue. Therefore, having a generous meshed matrix on the surface of the implant does not provide a homogenous regenerative interface between the implant and subcutaneous tissue (Fig. 28.7).

Tailored Full Cover Technique

Another technique used to achieve complete implant cover involves conjoining lengthwise (using absorbable sutures) two sheets of any rectangular ADM measuring 8 × 16 cm. Two evenly spaced incisions are made on each side of this square. With the sizer in situ, the borders of the sizer are marked with a marking pen. The superior edge of the ADM is secured to the pectoral muscle with three interrupted stitches. The implant is then placed on the pectoral muscle, and the ADM is draped over it. The flaps of ADM on all sides are then folded under the implant, achieving complete coverage. The lateral and medial slips of ADM are sutured to the pectoral muscle with three

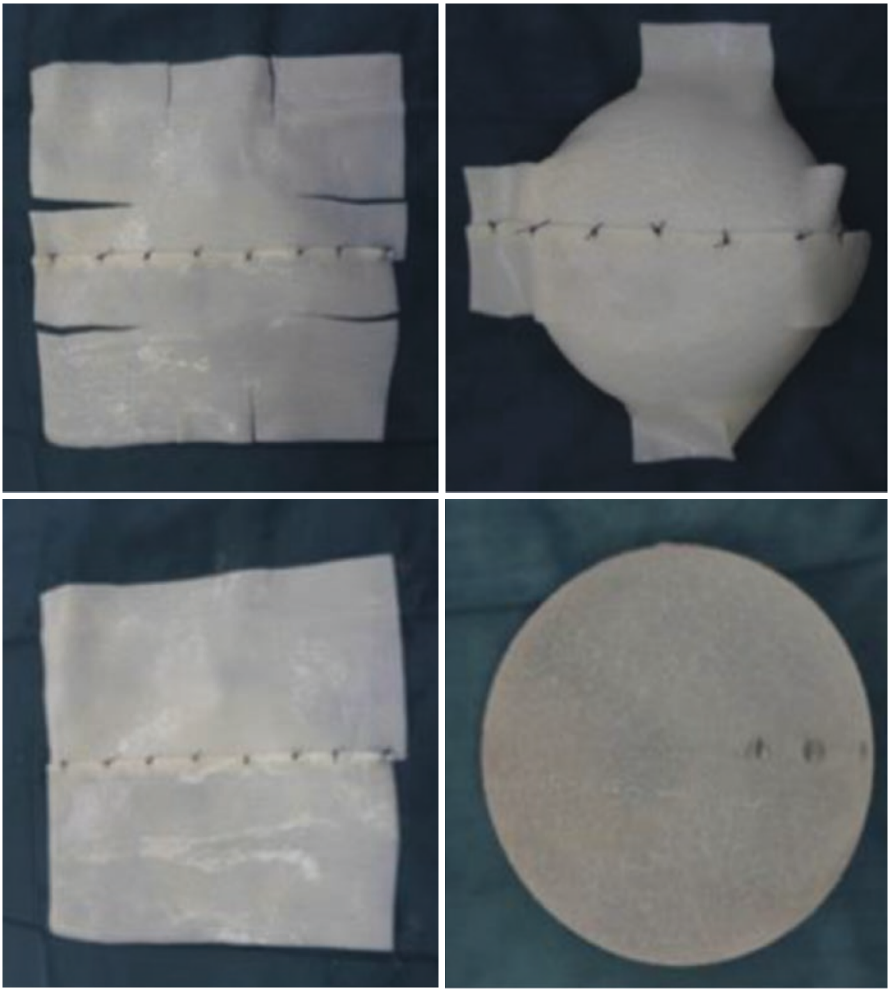


Fig. 28.8 Tailored full mesh cover technique for prepectoral reconstruction from 2 pieces of rectangular mesh

interrupted stitches. The caudal slip of ADM can be used to define the new inframammary fold by stitching it to the muscle at the caudal edge of the implant (Fig. 28.8).

The Hybrid-Sling

If a wise pattern skin-reducing mastectomy (either with or without a free nipple graft) is planned, the usual practice is to de-epithelise the inferior skin flap and use it as a dermal-sling. To place the implant pre-pectorally, rather than suture the superior free edge of the dermal-sling to the pectoralis major muscle, it may be sutured

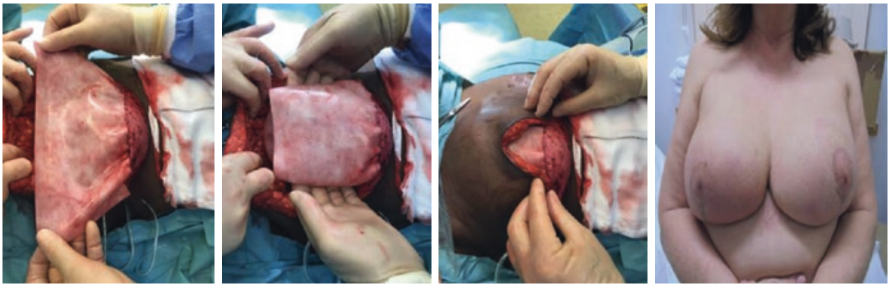


Fig. 28.9 Hybrid inferior dermal sling and ADM—providing anterior cover

to a rectangular matrix instead. This extends the length of the inferior dermal sling, and the new hybrid-sling (dermal flap + ADM/ mesh) is capable of providing complete anterior cover to an implant of any shape or volume. The superior, lateral and medial edges of the matrix are sutured to the underlying muscles to define the pocket over which the skin can be draped. This approach provides all the benefits of a pre-pectoral reconstruction but at the same time protects the most vulnerable portion of the reduced skin envelope (inverted T-junction and adjacent skin flaps). The authors have used this technique with great success in large ptotic breasts (Fig. 28.9).

On completion of the mastectomy, two drains are inserted at the surgical site by tunnelling under the skin; one drain is placed inferiorly in the IMF and one in the lateral gutter in the anterior axillary line.

Several studies failed to demonstrate a significant difference in outcomes or complication rates based purely on the type of matrix used [23]. Having used nearly every matrix on the market, in pre-pectoral reconstruction, the authors share this view. Several studies have emphasised the importance of full-implant cover in the subcutaneous implant-based reconstruction (SIBR) [27, 28]. It is suggested that this technique provides additional protection for the mastectomy flaps and minimises the risk of capsular contracture. There is no evidence that full-implant cover is essential; furthermore, it often requires more than one sheet of ADM, which is more expensive [27].

Complications

Chatterjee A. et al. [29] published a comprehensive literature review and meta-analysis by conducting thorough searches of PubMed®/MEDLINE® to identify studies on pre-pectoral reconstruction. Patient characteristics and outcomes were extracted from the studies and pooled. Linear relationships between complication rates and patient characteristics with pre-pectoral reconstruction were analysed. A meta-analysis compared complication rates between pre-pectoral and dual-plane reconstruction.

Fourteen studies (406 women/654 breasts) were included. The most common complications with pre-pectoral reconstruction were flap necrosis (7.8%), seroma

(6.7%), capsular contracture (5.8%) and explantation (4.6%). No hyperanimation was reported. A significant correlation between previous radiation and flap necrosis, postoperative chemotherapy and infection, hypertension and flap necrosis, diabetes and dehiscence, and smoking and explantation were found. A meta-analysis of four studies comparing pre-pectoral (135 women/219 breasts) and dual-plane (230/408) reconstructions found no significant difference for likelihood of infection (odds ratio, 0.46; 95% confidence interval, 0.16–1.30), explantation (0.83; 0.29–2.38), necrosis (1.61; 0.77–3.36), seroma (1.88; 0.71–5.02), dehiscence (1.84; 0.68–4.95) or capsular contracture (0.14; 0.02–1.14).

Long-term data on capsular contracture rates are not available, with only two studies assessing capsular contracture with a mean follow-up of 0.96 and 2 years. In the meta-analysis, the trend was towards lesser capsular contracture in the pre-pectoral group when compared to dual-plane techniques.

The pooled rates for most complications associated with pre-pectoral reconstruction were low and consistent with rates following ADM-assisted dual plane as reported in the literature. These included 10.9% for flap necrosis, 6.9% for seroma, 5.7% for infection, 5.1% for explantation and 1.3% for haematoma [30]. The Salibian et al. literature review of pre-pectoral reconstruction also demonstrated low pooled complication rates [31]. Nevertheless, the considerable variation in complication rates and follow-up times between individual studies, similar to what was observed here, highlight the need for additional studies in larger populations with consistent reporting and tracking outcomes.

Bernini et al. [32] measured the difference in patient-related outcomes in the dual-plane and pre-pectoral groups. At a median follow-up of 25–26 months, patients who underwent a pre-pectoral reconstruction expressed significantly greater satisfaction with outcomes compared with patients who had undergone a dual-plane reconstruction.

Zhu and colleagues [33] from the Mayo Clinic recently published a study comparing pre-pectoral versus sub-pectoral tissue expander implant (Natrelle-133 MV or MX, Allergan) placement in 29 patients. The pre-pectoral approach, either alone or combined with the use of ADM (Alloderm®) or inferior dermal sling, was associated with no expander loss, while the overall complication rate was 8%. Similarly, no implant losses were reported at a median follow-up of 14.7 months in a study using the inferior dermal sling and ADM (ADM used—Native, MBP, Neustadt-Glewe, Germany) (implants used—Natrelle 410 or Natrelle 150, Allergan) in 27 women after wise-pattern, skin-reducing mastectomy [34].

A recent, non-randomised prospective study compared a total of 73 sub- and pre-pectoral implants with full-implant coverage using a titanium-coated polypropylene mesh [(TCPM), TiLoop®Bra, pfm-medical, Cologne, Germany). There were no significant differences in immediate post-operative complications [35] but at a median follow-up of 25 months the subcutaneous approach was associated with higher explantation rate following severe complications (5.1% vs. 0%) but a lower implant exchange rate for functional and aesthetic reasons (12% vs. 0%) [36].

Another study used a vicryl mesh with or without ADM to completely cover the implant and reported a 7% implant loss rate in 23 cases of pre-pectoral breast reconstruction [37].

Pain Control

For a nipple-sparing mastectomy and pre-pectoral implant reconstruction, the authors' preferred practice is a pre-surgical, ultrasound-guided, thoracic paravertebral block that provides excellent peri-operative pain relief and decreases the need for postoperative opioid requirement. In the absence of this block, an intraoperative infiltration of local anaesthetic under direct vision into the inter-pectoral fascial plane as well as the sub-serratus plane is a suitable alternative.

Studies have demonstrated that pre-pectoral breast reconstruction is associated with less postoperative pain, shorter recovery and faster return to baseline activity [34].

Conclusion

Pre-pectoral implant breast reconstruction is gaining popularity over the sub-muscular method and is now the preferred technique for implant-based Immediate Breast Reconstruction with ADM/mesh. It has several advantages, including improved outcomes, natural ptosis, lack of animation and less pain, and is associated with lower incidence of Baker GIII/IV capsular contracture. Early data are very encouraging as they do not demonstrate a significantly higher risk of complications compared with sub-muscular implant reconstruction. However, it is important to stress that there is still a lack of good-quality data regarding long-term outcomes.

The advances in medical innovations and better surgical techniques support pre-pectoral Immediate Breast Reconstruction (IBR) as the future direction of travel. Whether there is the appetite, the resource or indeed the need for a randomised control trial continues to be debated. The evidence base for pre-pectoral breast reconstruction is limited by small case series from reconstruction specialists, with short follow-up, and heterogeneous study designs, making it difficult to perform meaningful pooled analyses. The incidence of PMRT capsular contracture in pre-pectoral reconstruction is unknown as are the results of revision surgery.

In the absence of conclusive data, we recommend careful patient selection and execution to minimise complications and enhance patient-related outcomes. The surgeons who perform pre-pectoral reconstruction should also be familiar with fat-grafting techniques as these can serve as an important adjunct in enhancing the final aesthetic outcome.

Reference Video

https://youtu.be/JlameV2MpHo

References

1. Czerny V. Plastic replacement of the breast with a lipoma. [in German] Chir Kong Verhandl. 1895;2:216.
2. Cronin TD, Gerow FJ. Augmentation mammaplasty: a new "natural feel" prosthesis. Amsterdam: In Transactions of the Third International Congress of Plastic and Reconstructive Surgery; Excerpta Medica; 1963.
3. Snyderman RK, Guthrie RH. Reconstruction of the female breast following radical mastectomy. Plast Reconstr Surg. 1971;47:565–7.
4. Freeman BS. Subcutaneous mastectomy for benign breast lesions with immediate or delayed prosthetic replacement. Plast Reconstr Surg. 1962;30:667–82.
5. Gruber RP, Kahn RA, Lash H, Maser MR, Apfelber DB, Laub DR. Breast reconstruction following mastectomy: a comparison of submuscular and subcutaneous techniques. Plast Reconstr Surg. 1981;67:312–7.
6. Radovan C. Breast reconstruction after mastectomy using the temporary expander. Plast Reconstr Surg. 1982;69:195–208.
7. Clough KB, O'Donoghue JM, Fitoussi AD, Vlastos G, Falcou MC. Prospective evaluation of late cosmetic results following breast reconstruction: II. Tram flap reconstruction. Plast Reconstr Surg. 2001;107:1710–6.
8. Bostwick J III, Schlefan M. The latissimus dorsi musculocutaneous flap: a one-stage breast reconstruction. Clin Plast Surg. 1980;7:71–8.
9. Terino EO. Alloderm acellular dermal graft: applications in aesthetic soft –tissue augmentation. Clin Plast Surg. 2001;28(1):83–99.
10. Connor J, McQuillan D, Sandor M, et al. Retention of structural and biochemical integrity in a biological mesh supports tissue remodelling, in a primate abdominal wall model. Regen Med. 2009;4(2):185–95.
11. Ducic I, et al. Chronic postoperative breast pain: danger zones for nerve injuries. Plast Reconstr Surg. 2011;127:41–6.
12. Cancer Research UK. Breast cancer statistics. Available at http://www.cancerresearchuk.org/health-professional/cancer-statistics/statistics-by-cancer-type/breast-cancer. Accessed 13 Apr 2016.
13. American Society of Plastic Surgeons. Plastic surgery statistics report 2015. Available at https://www.plasticsurgery.org/news/plastic-surgery-statistics. Accessed 13 Nov 2016.
14. Jeevan R, Cromwell DA, Browne JP, et al. Findings of a national comparative audit of mastectomy and breast reconstruction surgery in England. J Plast Reconstr Aesthet Surg. 2014;67(10):1333e44.
15. Leff DR, Bottle A, Mayer E, et al. Trends in immediate postmastectomy breast reconstruction in the United Kingdom. Plast Reconstr Surg Glob Open. 2015;3:e507.
16. Vardanian AJ, Clayton JL, Roostaeian J, et al. Comparison of implant-based immediate breast reconstruction with and without acellular dermal matrix. Plast Reconstr Surg. 2011;128(5):403ee10e.
17. Lanier ST, Wang ED, Chen JJ, et al. The effect of acellular dermal matrix use on complication rates in tissue expander/−implant breast reconstruction. Ann Plast Surg. 2010;64(5):674e8.
18. Vidya R, Iqbal FM. Guide to prepectoral breast reconstruction: a new dimension to implant-based breast reconstruction. Clin Breast Cancer. 2017;17:266–71.
19. Schnarrs RH, Carman CM, Tobin C, Chase SA, Rossmeier KA. Complication rates with human acellular dermal matrices: retrospective review of 211 consecutive breast reconstructions. Plast Reconstr Surg Glob Open. 2016;4:e1118.

20. Maurizio N, Giuseppe C, Nicola R. How to optimize outcomes in implant based reconstructions. Arch Plast Surg. 2018;45(1):4–13.
21. Rancati A, Angrigiani C, Hammond D, et al. Preoperative digital mammography imaging in conservative mastectomy and immediate reconstruction. Gland Surg. 2016;5:9–14.
22. EBCTCG (Early Breast Cancer Trialists' Collaborative Group), McGale P, Taylor C, Correa C, Cutter D, Duane F, et al. Effect of radiotherapy after mastectomy and axillary surgery on 10-year recurrence and 20-year breast cancer mortality: meta-analysis of individual patient data for 8135 women in 22 randomised trials. Lancet. 2014;383:2127e35.
23. Mitchell MP, Wagner J, Butterworth J Subcutaneous implant-based breast reconstruction, a modern challenge in postmastectomy radiation planning. Pract Radiat Oncol. Accepted date: 5 September 2017.
24. Sinnot C, Persing S, Pronovost M, Hodyl C, McConnel D, Young AO. Impact of postmastectomy radiation therapy in prepectoral versus subpectoral implant based breast reconstruction. Ann Surg Oncol. 2018;25(10):2899–908.
25. Mowlds DS, Salibian AA, Scholz T, Paydar KZ, Wirth GA. Capsular contracture in implant-based breast reconstruction: examining the role of acellular dermal matrix fenestrations. Plast Reconstr Surg. 2015;136(4):629–35.
26. Barr SP, Topps AR, Barnes NLP, Henderson J, Hignett S, Teasdale R, McKenna A, Harvey JR, Kirwan CC. Infection prevention in breast implant surgery – a review of the surgical evidence, guidelines and a checklist. Eur J Surg Oncol. 2016;42(5):591–603.
27. Reitsamer R, Peintinger F. Pre-pectoral implant placement and complete coverage with porcine acellular dermal matrix: a new technique for direct to implant reconstruction after nipple-spraying mastectomy. JPRAS. 2015;68:162–7.
28. Berna G, Cawthorn SJ, Papaccio G, Balestriers N. Evaluation of a novel breast reconstruction technique using the Braxon® acellular dermal matrix: a new muscle-sparing breast reconstruction. ANZ J Surg. 2017;87:493–8.
29. Chatterjee A, Nahabedian MY, Gabriel A, Macarios D, Parekh M, Wang F, Griffin L, Sigalove S. Early assessment of post-surgical outcomes with pre-pectoral breast reconstruction: a literature review and meta-analysis. J Surg Oncol. 2018:1–12.
30. Ho G, Nguyen TJ, Shahabi A, et al. A systematic review and meta- analysis of complications associated with acellular dermal matrix- assisted breast reconstruction. Ann Plast Surg. 2012;68:346–56.
31. Salibian AA, Frey JD, Choi M, Karp NS. Subcutaneous implant-based breast reconstruction with acellular dermal matrix/mesh: a systematic review. Plast Reconstr Surg Glob Open. 2016;4:e1139.
32. Bernini M, Calabrese C, Cecconi L, et al. Subcutaneous direct-to- implant breast reconstruction: surgical, functional, and aesthetic results after long-term follow-up. Plast Reconstr Surg Glob Open. 2015;3:e574.
33. Zhu L, et al. Comparison of subcutaneous versus submuscular expander placement in the first stage of immediate breast reconstruction. J Plast Reconstr Aesthet Surg. 2016;69:e77.
34. Caputo GG, et al. Skin-reduction breast reconstructions with prepectoral implant. Plast Reconstr Surg. 2016;137:1702–5.
35. Casella D, et al. TiLoop(R) Bra mesh used for immediate breast reconstruction: comparison of retro-pectoral and subcutaneous implant placement in a prospective single-institution series. Eur J Plast Surg. 2014;37:599–604.
36. Bernini M, et al. Subcutaneous direct-to-implant breast reconstruction: surgical, functional, and aesthetic results after long-term follow-up. Plast Reconstr Surg Glob Open. 2015;3:e574.
37. Kobraei EM, et al. Avoiding breast animation deformity with pectoralis-sparing subcutaneous direct-to-implant breast reconstruction. Plast Reconstr Surg Glob Open. 2016;4:e708.

TAP, LICAP, SAAP, and AICAP Flaps

29

Elise Mecham, Julie Park, and Linda Phillips

Introduction

Breast conservation therapy (BCT) is defined by the excision of breast cancer with a tumor-free margin followed by breast irradiation to improve local control. BCT has shown this to be oncologically safe with aesthetic and psychological benefits and represents a major shift in the approach to treating breast cancer over the last 20 years [2, 4]. Oncoplastic surgery is a widely accepted integrated set of oncological and plastic surgical techniques that allow for immediate reconstruction, optimize surgical planning with wider margins, and maximize the aesthetic results of cancer resection. The development of this field has extended the role of breast conserving therapy [1]. The use of intrinsic parenchymal breast flaps with breast reduction techniques for defect reconstruction will be discussed in other chapters of this book. This chapter will specifically address the use of pedicled perforator flaps to replace volume in the breast by bringing well-vascularized tissue from adjacent areas into the surgical defect. The advent of perforator flaps in the 1990s has allowed for greater reconstructive options without the morbidity associated with sacrifice of the underlying muscle or motor nerves. The full scope of options cannot be included in this text. Due to the delicate nature of the vessels that supply the tissue, success is dependent upon advanced dissection techniques and vessel handling. Microsurgical training should be completed and appropriate levels of monitoring employed or the reconstruction is at risk for failure.

There are several approaches to deciding what type of flap to use when reconstructing breast defects that depend on the location in the breast [2]. The primary goals of oncoplastic reconstruction include appropriate nipple position, support of

E. Mecham
University of Texas MD Anderson Cancer Center of Houston, Houston, TX, USA

J. Park (✉) · L. Phillips
Utah Surgical Associates, Provo, UT, USA
e-mail: jupark@UTMB.EDU; lphillip@UTMB.EDU

V. S. Klimberg et al. (eds.), *Oncoplastic Breast Surgery Techniques for the General Surgeon*, https://doi.org/10.1007/978-3-030-40196-2_29

nipple perfusion, maintenance of the footprint of the breast, and replacement of lost tissue volume with the ideal ratio of breast volume as 45% above the nipple and 55% below [3]. The breast can be oriented by dividing it into quadrants. Each quadrant can then be individually addressed to create an aesthetic whole. A combination of techniques may be necessary to reconstruct the resulting defects, but this allows for surgical planning and decision making. Each section of the breast has challenges and limitations to reconstruction. The least forgiving area tends to be the superomedial aspect, which often requires parenchymal reshaping due to lack of reconstructive options. The area most amenable to oncoplasty is the upper-outer quadrant of the breast [2]. When deciding how best to reconstruct a defect, the amount of volume needed and the affected quadrant will dictate which pedicled flap is most appropriate (Fig. 29.1). For defects in the lateral quadrants, the lateral intercostal artery perforator flap (LICAP), thoracodorsal artery perforator flap (TAP), muscle-sparing latissimus dorsi flap (MSLD), and serratus anterior artery perforator flap (SAAP) are all options. Medial Inferior defects may be treated using the anterior intercostal artery perforator (AICAP) flap, which is a branch off of the internal mammary arteries. Defects in the upper inner quadrant are best treated with local parenchyma rotation flaps, although some surgeons

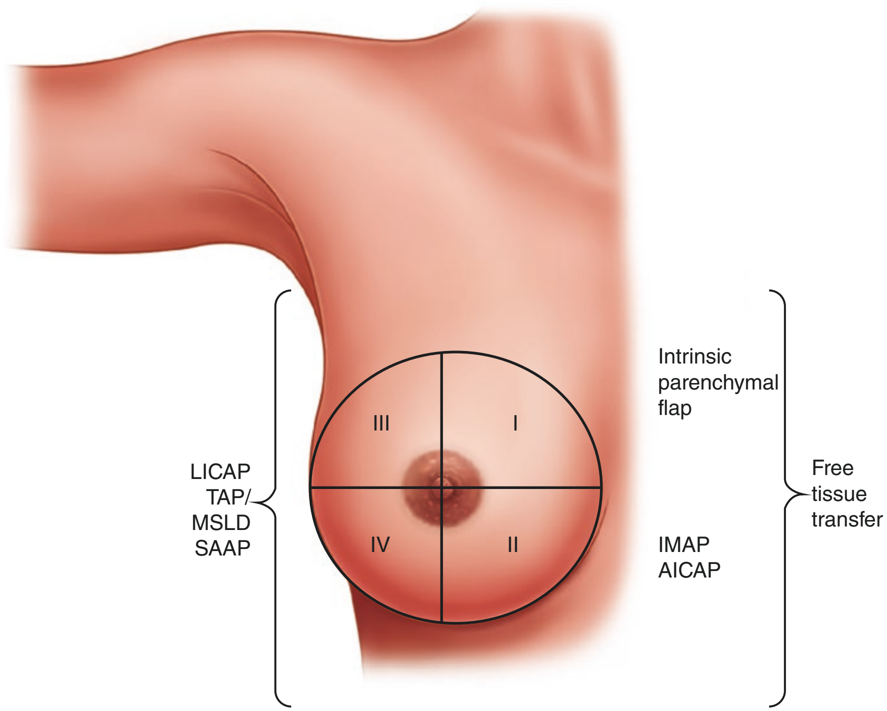


Fig. 29.1 Breast divided into four quadrants. Quadrant 1: upper inner quadrant—Intrinsic breast flap—reduction technique. Quadrant 2: lower inner quadrant—SEAP/ IMAP/ AICAP, MSLD. Quadrants 3 and 4: upper and lower lateral quadrants- LICAP, LTAP, TAP/ MSLD, SAAP

Table 29.1 List of flaps, perforators, locations, and uses of TAP/ MSLD, LICAP, AICAP, SAAP

	Perforating vessel	Location of perforator	Uses
TAP/ MS-LD	Thoracodorsal artery	5 cm posterior to anterior border of LD, 8–13 cm caudal to axillary crease	Lateral, central, and superior portions of breast
LICAP	Posterior intercostal artery—lateral perforating branch	Between 2 and 4 cm from anterior border of latissimus dorsi mm	Lateral and inferior portions of the breast
AICAP	Anterior intercostal artery—off of IMA	Superior aspect of the anterior rectus sheath, 1–3 cm from midline	Inferomedial aspect of breast
SAAP	Serratus anterior branch of the lateral thoracic artery	3–4 cm from anterior border of latissimus dorsi mm	Inferior and central portions of breast

advocate for the use of MSLD and TAP flaps for this region when possible [4–6] (Table 29.1). This chapter will discuss the benefits, anatomy, and harvest of the TAP/MSLD, LICAP, SAAP, and IMAP (AICAP) flaps for use in oncoplastic breast surgery.

A full preoperative evaluation should be performed for each patient that includes assessment of tissue quality and laxity, approximate location of the potential defect, and imaging with CT angiography to assess for the presence and location of the available perforators. Preoperative marking should be done with the patient standing when possible, as this provides the greatest ability to evaluate tissue laxity in potential donor areas such as the lateral axilla, back, or upper abdomen. A Doppler is necessary to identify the exact location of perforating the vessels that each flap will be based on. This is often marked with the patient laying in the planned surgical position. Loupe magnification should be used for dissection of the flap and perforators to minimize the risk of damage to the pedicle.

Thoracodorsal Artery Perforator (TAP) Flap

Breast Indications The thoracodorsal artery perforator flap is useful for the reconstruction of lateral superior and inferior breast defects. It can rarely be used for reconstructing the inferomedial aspect of the breast as well, although this region of the breast is often a challenge to reach using pedicled flaps and is better treated using other reconstructive techniques such as free tissue transfer. TAP flaps can be used in immediate or delayed reconstruction, as well as in salvage procedures. As a perforator flap, it can be harvested with differing amounts of LD muscle due to variable anatomy and is ideal in settings where less muscle bulk is required. The anatomy of the thoracodorsal neurovascular bundle is unique. A portion of the muscle can be harvested based off of the descending branch of the thoracodorsal artery, while the nerve to the remaining latissimus muscle is left intact. This allows preservation of muscle innervation and minimizes donor morbidity [5–7]. When harvested with small segments of muscle, the flap can be classified into three categories based on the amount of muscle harvested.

Anatomy (Fig. 29.2)

Pedicle: Thoracodorsal Vessels: Descending and Transverse Branches
The thoracodorsal artery is a branch off of the subscapular artery. It bifurcates early on into two main divisions that include the serratus anterior branch and the thoracodorsal branch. The vessels then enter the deep side of the latissimus dorsi muscle about 2.5 cm medial to the lateral edge of the muscle and 4 cm distal to the inferior scapular border. They then bifurcate a second time into descending and transverse branches [10]. These branches then give off perforators to the overlying skin that can be utilized in local flap harvest for lateral breast reconstruction. The descending branch gives off 2–3 perforators, the most proximal of which is found about 8 (range of 6–15 cm) cm inferior to the posterior axillary fold and 2–3 cm posterior to the anterior border of the LD muscle. It has an oblique orientation as it pierces the muscle and runs from deep to superficial [8–10]. The next perforator is found 2–4 cm distal to the first. Additional perforators have been noted that travel around the anterior border of the LD rather than piercing through the muscle. This variant simplifies harvest as there is no need for intramuscular dissection, which can be tedious and cause damage to the blood vessels supplying the flap. As noted above, there is also variability in how far the perforators run along the muscle fascial before supplying the subcutaneous tissue. This may lead to misleading Doppler signals preoperatively, so this dissection should be approached carefully with care being taken to dissect with care as perforators are approached.

Marking and Positioning The patient is evaluated preoperatively in a standing position, and then placed in a lateral decubitus position to locate perforators. Tissue

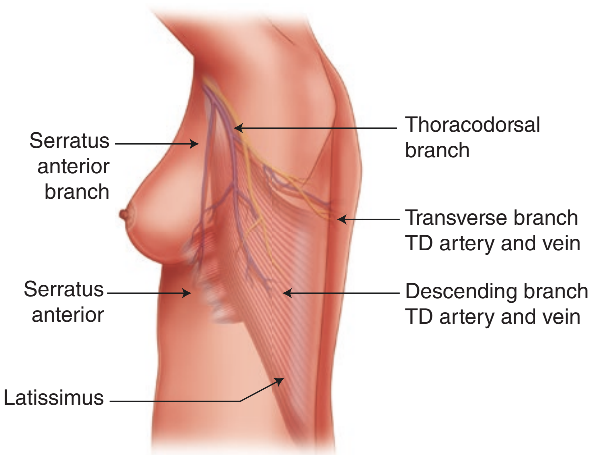


Fig. 29.2 Neuroanatomy—The thoracodorsal nerve and vessels bifurcates into a descending and transverse branch, allowing the muscle to maintain function after partial muscle harvest is performed

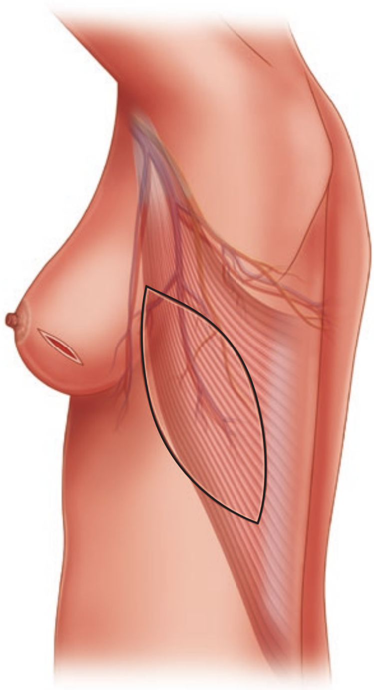


Fig. 29.3 Preoperative markings for tap flap. The markings are made along the anterior border of the latissimus muscle in an oblique fashion running

laxity and thickness of the underlying subcutaneous tissues are evaluated by a skin pinch test with the arm in neutral position. The volume of tissue that can be harvested is limited by what can be closed primarily with minimal tension. The perforators are located using a Doppler probe with the patient in a lateral decubitus position with the arm abducted 90°. Almost all perforators can be found within 5 cm of the anterior border of the LD muscle, and between 7 and 10 cm of the posterior axillary line [11, 12]. The flap should be designed based on the location of the perforators and should extend over the anterior border of the LD muscle to include any paramuscular perforators as previously mentioned. The skin paddle should be designed obliquely in an inferomedial direction [9] (Fig. 29.3). The width and orientation of the flap is determined by the size of the breast defect and by the skin laxity as determined by pinch test if primary closure is preferred. Intraoperatively the patient should be placed in a lateral decubitus position with the arm abducted to 90° with the arm prepped into the sterile field.

Harvest Loupe magnification should be used for the identification and dissection of the perforators. The skin is incised and the subcutaneous dissection is performed with outward beveling down to the muscle fascia to maximize tissue harvest with the flap. The elevation is typically performed from medial to lateral with the identification of the main perforators at the level just above the LD muscle fascia. This allows for the identification of perforators as the flap is elevated. If two perforators are noted to be in line, both may be incorporated into the flap. Do not sacrifice a

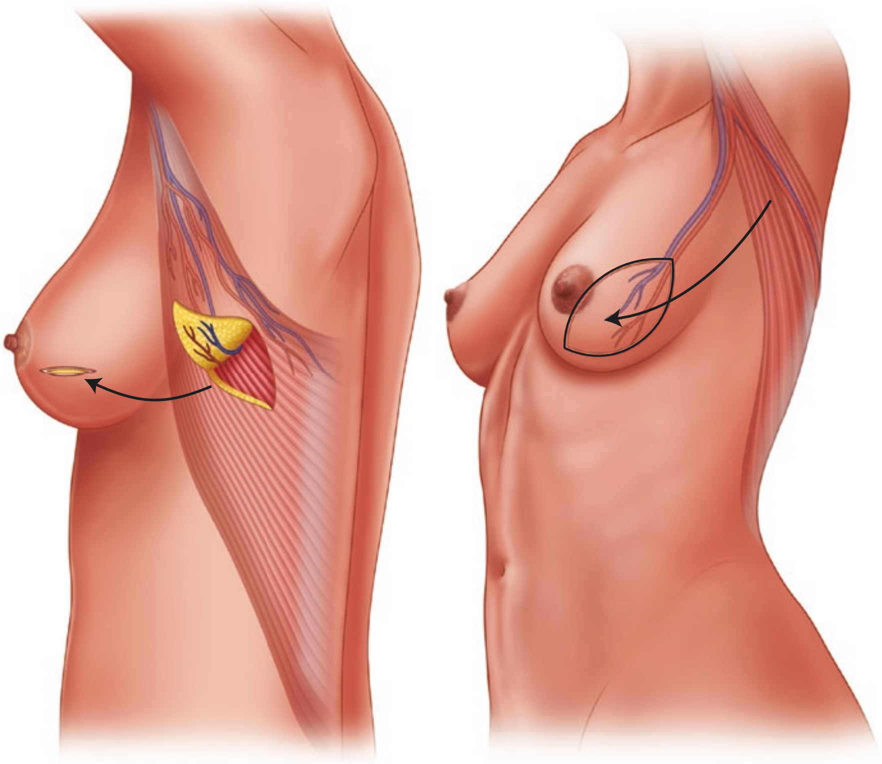
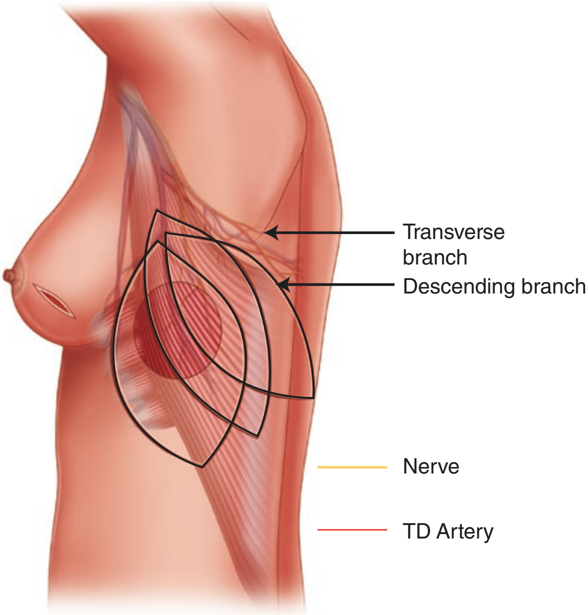


Fig. 29.4 Transposition of TAP flap into breast defect

perforator until one of equal or larger caliber has been identified. Once an appropriate perforator is found, the surgeon should continue dissection of the perforator vessel through the muscle to the descending branch of the thoracodorsal artery and finalize the dimensions of the flap. It is recommended that a small superior portion of the skin paddle remain attached to the patents skin to provide stability and minimize shearing of the pedicle and perforators. During dissection, nerve branches should be protected and preserved to minimize morbidity and preserve the function of the LD muscle. The vessels will dive under the LD muscle and run submuscular plane until joining thoracodorsal pedicle. The SA branch of the vessels can be ligated if additional length is required, and dissection can be carried out to the subscapular vessel if necessary. The surface of the pedicle should be marked to prevent twisting or kinking of the vessels as the flap is passed anteriorly through the LD muscle, subcutaneous tissue of the axilla, and into the breast defect (Fig. 29.4).

In the setting of inadequate perforator size (<0.5 mm and/or non pulsatile), consideration should be given to converting to a MSLD due to risk of avulsion or damage to the perforator. Leaving a small cuff of LD muscle attached to the flap distally provides stability for the perforators. This allows for safer transfer of the flap without the bulk

Fig. 29.5 Muscle Sparing Latissimus (MS-Lat) tram and skin paddle design options



and potential morbidity associated with harvesting the entire LD muscle. The orientation of the skin paddle can be more freely adjusted based on need when a small amount of muscle is also harvested (Fig. 29.5). The risk of seroma formation is lowered through leaving the LD muscle intact, using progressive tension sutures to minimize potential space, and the use of drains. A layered closure should be completed using dissolvable 0-sutures such as PDS or Vicryl in the deep tissues, and a layered skin closure should be performed to minimize tension on the dermis and risk of widened scar.

Lateral Intercostal Artery Perforator (LICAP) Flap

Breast Indications The lateral intercostal artery perforator (LICAP) flap has many uses in reconstruction. It is most commonly used for lateral breast reconstruction as well as for autoaugmentation in the setting of massive weight-loss breast reconstruction [11, 12]. There is redundant soft tissue and skin in the lateral thoracic region, which makes this flap ideal for reconstruction. When this lateral roll is large, it can reconstruct a breast mound. It can be tailored to fit the needs of the patient, whether that includes replacing dermis and underlying tissues, or just the breast volume lost during lumpectomy. This flap can be de-epithelialized or thinned as needed, and does not involve sacrifice of a muscle or major named vessel. It preserves the latissimus dorsi muscle and its blood supply, which may be needed for reconstruction in the face of later recurrence. A full preoperative evaluation is necessary for each patient, which of includes a preoperative CT angiogram to assess for the presence of this perforator and its location.

Anatomy

Pedicle: Posterior Intercostal Vessels—Lateral Cutaneous Branch

Size: Up to 25 × 14 cm (L × W)
The lateral intercostal artery perforator (LICAP) flap is a fasciocutaneous flap based on the posterior intercostal artery. The costal segment of the intercostal artery gives several perforators to the skin through the intercostal, serratus anterior, and latissimus dorsi muscles. The LICAP flap is based off of these perforators. The intercostal arteries arise from the aorta and run in an anterior fashion beneath the inner aspect of the rib to communicate with the anterior intercostal circulation arising from the internal mammary artery. After passing around the angle of the rib, these arteries lie between the internal intercostal muscles and innermost intercostal muscle. They give off multiple myocutaneous perforators at varying intervals along its course. The LICAP flap is based off a main trunk that is at the midaxillary line and gives off a large cutaneous branch with an anterior and posterior division. This branch travels anterior to the latissimus dorsi muscle and is accompanied by sensory nerves. The anterior branch tends to be larger and more robust than the posterior branch. Anatomic studies suggest up to 40% of patients may have a lateral cutaneous branch that divides early with the anterior branch running deep to the external oblique prior to supplying the overlying skin. The perforators tend to be 1–1.5 cm in diameter and often originate from the fifth intercostal space [13, 14], although they can also originate from the 6th, 7th, or 8th intercostal spaces. The perforators are typically found 2.5–3.5 cm from the anterior border of the latissimus dorsi muscle.

The venous drainage of the flap follows the arterial circulation as one or two venae comitantes. The sensory nerve supply follows the perforating arterial branches to the skin as branches of the intercostal arteries.

Marking and Positioning This flap is typically designed with the patient standing. Doppler ultrasound is used to identify the perforator(s) of choice. This preferred perforator is generally closest to the breast, as this allows for the greatest arc of rotation and improved ease of inset. The flap is designed with the posterior border of the skin island starting 5 cm behind the posterior axillary line. This allows for capture of the lateral cutaneous branch of the internal costal artery. The width of the flap is dependent upon skin redundancy and the ability to primarily close the donor site. This is typically about 9–12 cm in the average patient. The anterior border should include the junction of the inframammary fold (IMF) with the anterior axillary line. This allows for closure of the donor site as an extension of the IMF [11, 12] (Fig. 29.6). Intraoperatively, the patient is positioned in the lateral decubitus position with the arm prepped and draped into the field for movement and manipulation during dissection (Fig. 29.7).

Harvest and Inset Loupe magnification is used for the dissection. The posterior incision is made first, with an anterior extension to allow for the identification of

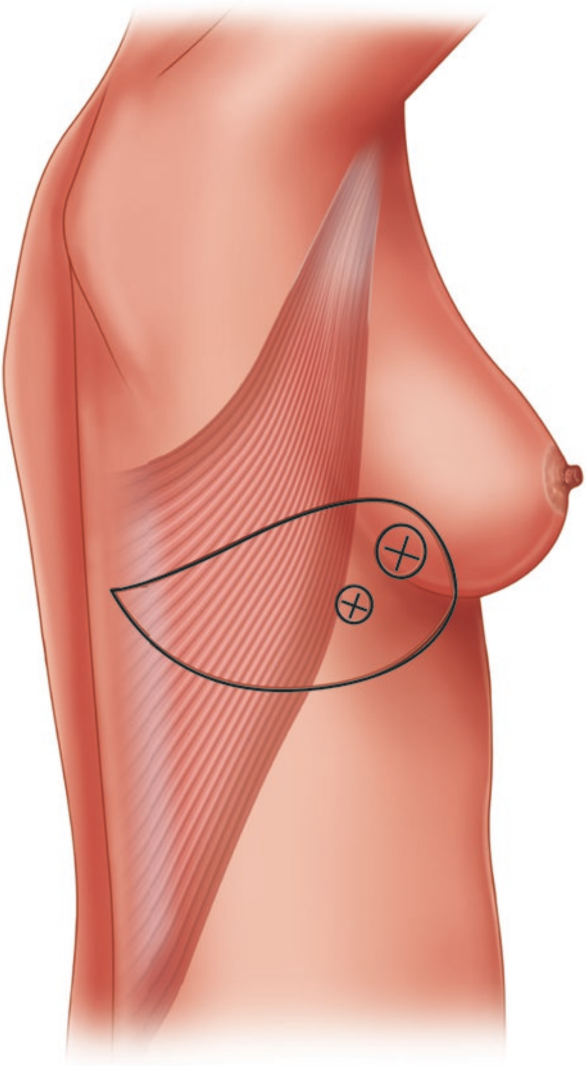


Fig. 29.6 LICAP markings: The perforators are marked using Doppler ultrasound. The amount of tissue that can be harvested is based on what can be easily pinched in a standing position. The incision can be carried to the inframammary fold

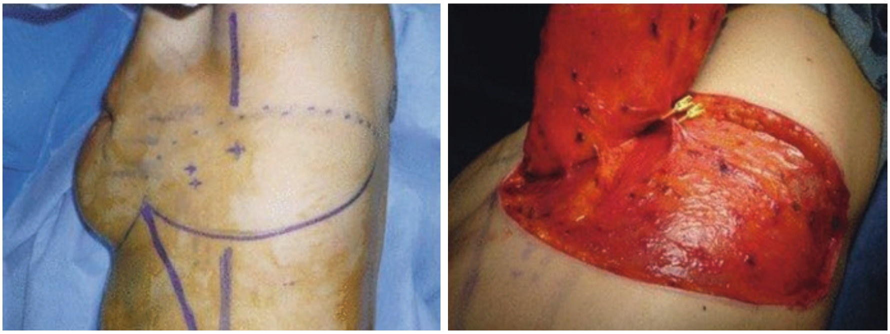


Fig. 29.7 LICAP markings and elevation (Permissions pending)

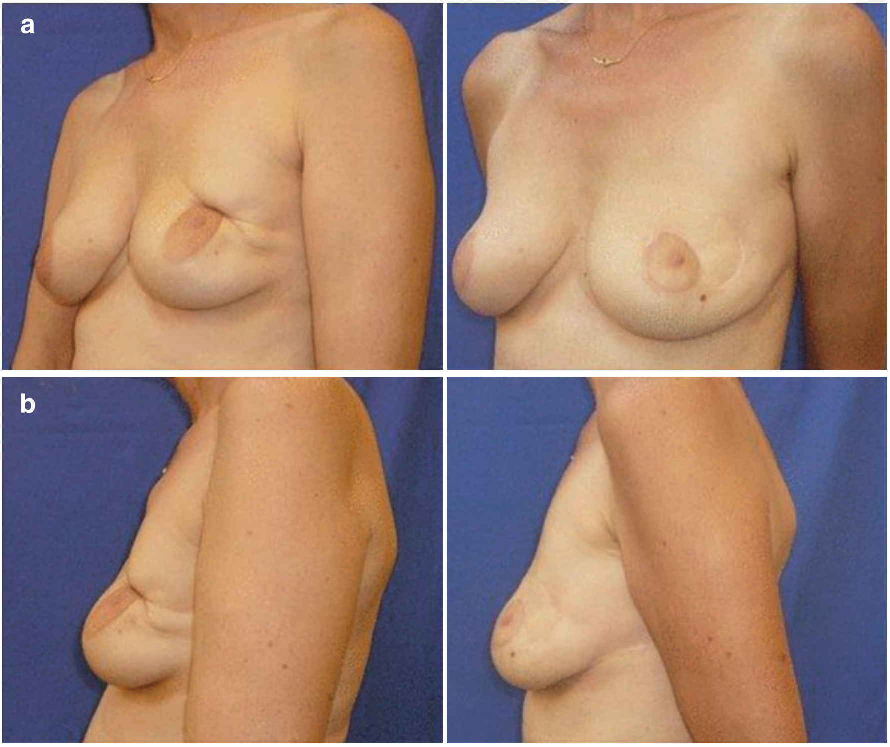


Fig. 29.8 LICAP Breast revision, before and after (**a**) 45 view of post lumpectomy radiation breast contour deformity (left) and revision with LICAP flap (*right*) (**b**) Lateral view of the same post lumpectomy radiation breast contour deformity (*left*) and revision with LICAP flap (*right*) (Permissions pending- owned by Springer)

the vessels. The incision is carried down to the latissimus dorsi (LD) muscle. For breast reconstruction, the harvest is carried out above the level of the LD fascia. The dissection is carried anteriorly until the anterior border of the LD has been reached; the smaller, posterior branch of the lateral cutaneous perforator can be identified. This vessel can be followed to the larger anterior branch of the perforator. The flap is usually designed spanning two or three intercostal spaces, which allows for selection of the largest of any of the lateral cutaneous arteries for primary flap blood supply. The vessels tend to run slightly behind the anterior border of the latissimus dorsi muscle. The latissimus dorsi muscle should be retracted to expose the vessel as it is followed through the serratus anterior or the external oblique muscles. These are divided to trace the vessels into the intercostal space. Additional large perforators may be encountered during dissection. It is recommended that these are not sacrificed until vessels of equal or larger caliber are encountered closer to the pectoralis muscle. The intercostal muscles are freed from the lower border of the rib, exposing the origin of the lateral cutaneous perforator. If additional pedicle length is needed, the posterior intercostal artery can be further traced and mobilized within the costal groove, but this puts the pleura at risk for damage. The remaining skin island is incised around the lateral cutaneous perforator and the flap can then be tunneled or transposed into the breast defect (Fig. 29.8).

Additional Information

Inset should be performed using a two-layer closure. If the flap is to be buried, the tissue can be deepithelialized and shaped as needed prior to inset. The donor site should be closed primarily in a layered fashion. Drains may be necessary. Care should be taken to minimize pressure on the pedicle at all times to prevent vascular compromise.

Anterior Intercostal Artery Perforator (AICAP) Flap

Indications: The anterior intercostal artery perforator flap is a fasciocutaneous flap that can cover medial and inferior breast defects [17]. It can also be used as a tool for autoaugmentation in massive weight loss patients undergoing mastopexy [18]. This flap is similar to the LICAP but with less versatility. It provides volume replacement and soft tissue coverage for the medial and inferior aspects of the breast, which generally cannot be addressed with the LICAP or the TAP flaps. It utilizes the excess skin and fat under the mammary fold. The advantage of this flap is the ability to place the patient in a supine position without additional turning of the patient during harvest. The scar can be placed in the inferior mammary fold with a slight medial extension that hides well in most bathing suits and bras. Disadvantages include the increased medial scar burden, which may be more visible to the patient as it frequently approaches or crosses midline. It can also cause mild abdominal asymmetry.

Anatomy

Pedicle: Anterior Intercostal Artery, Branch of the Internal Mammary Artery

Size: Up to 19 × 8 cm (L × W)

This flap is fed by the anterior intercostal artery perforators, which are branches of the internal mammary artery. The main medial perforator is between 1 and 3 cm lateral to the sternum and typically follows a path through the anterior rectus sheath or the pectoralis major muscle, depending on the location on the chest wall [15, 16]. This necessitates splitting of the muscle for harvest and rotation. There are additional perforators present along the anterior chest wall that can be dissected and used to design variations of this flap as needed. The perforators arising from the lateral third of the tissue tend to be the largest and most consistent. The intercostal perforators are most often found between the fifth to seventh rib spaces. Length can be added by harvesting the internal mammary trunk with elevation of the perforator, but this increases the risk of injury to the pleura. The flap can be sensate if elevated with the intercostal nerve. CT angiography can be utilized to assess the perforators preoperatively.

Marking and Positioning The inframammary fold is marked in an upright position with the proposed flap markings being determined both by the planned resection defect and the amount of tissue available. The excess skin and fat below the inframammary fold (IMF) is evaluated, and the width of the flap is designed based on what can be comfortably closed by pinch test. The patient is then placed in a supine position and the presence of an appropriate perforator is confirmed using Doppler ultrasonography [17, 18]. The superior incision of the flap should follow the IMF to allow transposition of the flap into the breast envelope and reconstruction of the IMF. If simultaneous mastopexy is being performed, the skin and tissue above the IMF that would have been resected can be de-epithelialized and utilized to enhance volume.

Harvest Loupe magnification is used for the dissection. The superior incision is made and the island is dissected in a subfascial plane until appropriate perforators are identified. Intercostal perforators emerging through the pectoralis major, serratus anterior, or rectus abdominis muscles are identified. The anterior intercostal artery perforator flap is based on perforator vessels from the fifth to seventh intercostal spaces. Again, do not sacrifice any perforators until the flap has been appropriately elevated. Depending on blood flow, the lower perforators may be sacrificed to allow superior rotation into the breast defect and minimize tension with primary closure of the donor site. Lateral, smaller perforators may also be sacrificed to allow for improved breast shaping and reach [16, 17]. The flap may then be rotated into the defect and can be secured needed. Wide undermining of the superior abdominal skin may be necessary to facilitate closure of the defect without tension. Resuspension of the IMF with long-lasting sutures may be necessary, but care should be taken to avoid any pressure of tension near the flap pedicle.

Serratus Anterior Artery Perforator Flap (SAAP)

Indications

The serratus anterior artery perforator flap can be harvested as a fascial or fasciocutaneous flap based off of the serratus anterior (SA) branch of the thoracodorsal (TD) vessels. This can be used in lateral breast reconstruction, often for the upper lateral quadrant. This flap has a shorter pedicle and a smaller arc of rotation when compared to the other perforator flaps, but has the advantage of less intramuscular dissection and can be harvested with the patient in a supine position with lateral bump rather than lateral decubitus position. A true SA skin perforator is present only in 18–25% of the population, so this flap should only be chosen when preoperative imaging has been performed confirming the presence of these vessels, or when a composite musculocutaneous flap is planned. This flap has the advantage of ease of dissection, and spares the thoracodorsal system for use in later reconstruction, if necessary [19, 20]. On occasion, a small slip of serratus anterior muscle can be harvested to protect small or fragile perforators.

Blood Supply: The Serratus Anterior Artery, First Branch of the Thoracodorsal Artery

Size: Up to 20 × 15 cm

Anatomy The serratus anterior artery perforator flap can be harvested as a fasciocutaneous flap or as a fascial flap alone, depending on the breast defect and reconstructive needs. The pedicle is an average of 11.3 cm. The SA pedicle is the first branch off of the TD vessels and runs in a course superficial to the serratus anterior muscle. Superiorly it runs below the latissimus dorsi muscle. The long thoracic nerve runs vertically adjacent to the SA artery and care must be taken to preserve this nerve when possible [21] (Fig. 29.9).

Marking and Positioning

Patient should be marked initially in an upright position. The proposed resection defect should be determined and lateral axillary fold, IMF, and the contour of the native breast marked prior to surgery. The proposed flap size is limited to what can be safely closed as determined by the pinch test. This flap has been reported to be up to 20 × 15 cm in larger women, depending on the volume of the lateral axillary fat pad and redundancy of the skin. The perforators to the flap can be Dopplered preoperatively or on the operating table, but preoperative imaging is recommended to verify the presence of perforators of adequate size and positioning. When present, the SA perforator will be identified in front of the anterior border of the LD muscle off

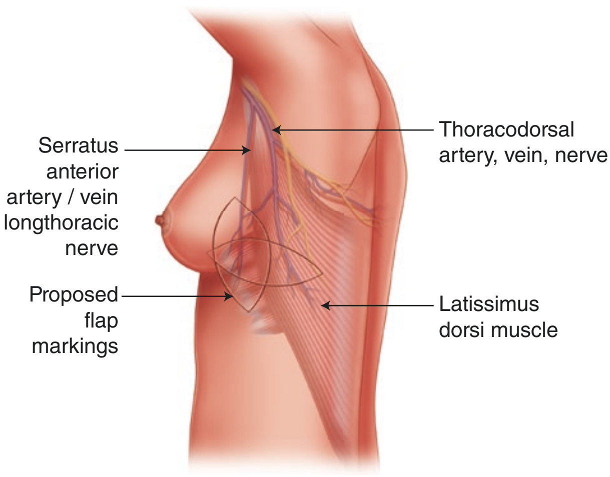


Fig. 29.9 The serratus anterior perforator flap is based off of the serratus anterior artery and vein, which is the first branch off of the thoracodorsal vessels. The serratus anterior vessel is often covered superiorly by the latissimus musculature. Care must be taken to preserve the long thoracic nerve in dissection

of the serratus anterior artery and vein. The flap can then be designed starting behind the posterior border of the breast footprint and the size is based on the axillary skin laxity and fullness. Surgical planning can be altered to include a different regional perforator within the design of the flap so if the SA perforator is found to be inadequate, small changes can still salvage the reconstruction. The patient can be placed in a lateral decubitus position for harvesting with the arm draped into the sterile field for movement as needed with the arm abducted at 90°, or the flap can be harvested with the patient in the supine position and a bean bag under the patient placed as a lateral bump. Loupe magnification should be used for dissection and pedicle isolation.

Harvest

The posterior incision of the flap is made just behind the anterior border of the LD muscle. The lateral edge of the LD muscle is identified and lifted, allowing exposure of the underlying fascia and SA muscle. The TD artery is identified and branches coursing medially to the SA are protected. Dissection is then carried out at the level of the SA muscle fascia with care taken to identify and protect the long thoracic nerve. The perforator should be identified and dissection performed under loupe magnification to protect the vessels. The harvest may require subfascial dissection of the perforators, or even a small cuff of muscle. Ligation of the muscle branches must be performed to free the pedicle. Be sure to mark the superficial surface of the vessels to ensure the they aren’t kinked or rotated with movement of the flap. The anterior incision of the flap is made in an oblique fashion following the posterior curvature of the breast. A small subcutaneous or subparenchymal tunnel may be necessary to deliver the flap into the defect (Fig. 29.10).

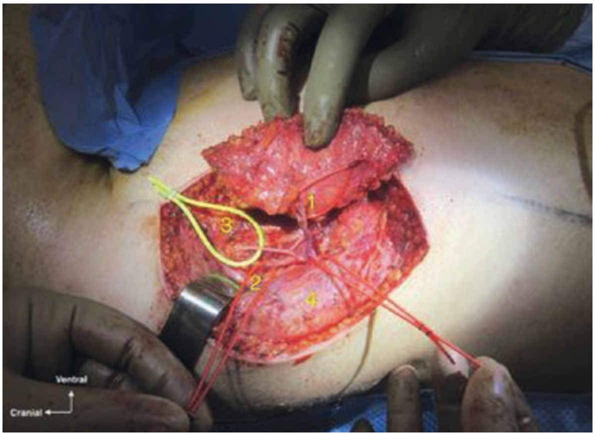


Fig. 29.10 Image of dissected SAAP flap. Reference below. (Image rights owned by Springer-Permissions pending) Intraoperative view. Retrograde dissection of the perforator (*1*) was performed until its origin from the serratus anterior vessels (*2*). The dissection preserved the long thoracic nerve (*3*). The anterior border of latissimus dorsi is retracted (*4*) The vascular branches to the serratus anterior muscle will need to be ligated to rotate the flap into a breast defect

Additional Information When present, this flap can be an excellent alternative to the more tedious intramuscular dissection required of the TAP flap and may have a longer pedicle than the LICAP flap, although it will be shorter than the TAP flap. It reaches the superolateral aspect of the breast with ease and preserves the TAP flap for future use as long as the TD vessels are not divided during dissection. Due to the anatomic variability associated with the SA perforator, the surgeon should obtain preoperative imaging or be prepared to change surgical plans intraoperatively based on the presence of perforators found during dissection [20].

Discussion

With the increasing popularity of the breast conservation therapy, the need for partial breast reconstruction is increasing over time. Perforator flaps require a higher level of skill and experience, but have the added benefits of minimizing donor site morbidity such as weakness and seroma, and the potential for shorter operative times when compared to free tissue transfer. Figure 29.11 shows the relationship of the perforators and pedicles of these various flaps. Given the breadth of options available, the choice of flap can be tailored to meet the needs of the patient and the skill of the surgeon. There are limitations to reconstructing the breast using pedicled and perforator flaps, particularly in the setting of defects of the medial breast or in large volume resections. Listed above are some tools available for breast reconstruction and a potential algorithm for use in the setting of breast conservation therapy.

--

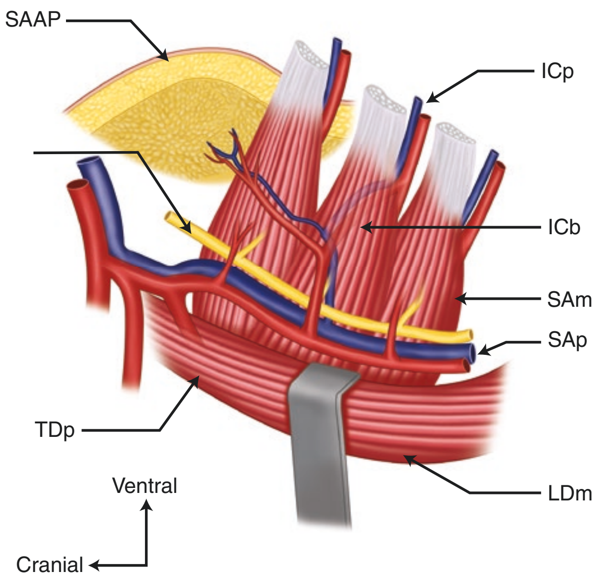


Fig. 29.11 Vascular pattern representation. *SAAP* serratus anterior artery perforator flap, *TDp* thoracodorsal pedicle, *SAp* serratus anterior pedicle, *ICb* communicating intercostal branch, *ICp* intercostal pedicle, *P* perforator vessels, *LDm* latissimus dorsi muscle, *SAm* serratus anterior muscle, *LTn* long thoracic nerve

Reference Video

https://youtu.be/0TCrFc0tpMY
https://youtu.be/T9SEEphN0UY
https://youtu.be/gpQgHqM77-0

References

1. Urban C, Lima R, Schunemann E, Spautz C, Rabinovich I, Anselmi K. Oncoplastic principles in breast conserving surgery. Breast. 2011;20:S92–5.
2. Clough KB, Kaufman GJ, Nos C, Buccimazza I, Sarfati IM. Improving breast cancer surgery: a classification and quadrant per quadrant atlas for oncoplastic surgery. Ann Surg Oncol. 2010;17:1375–91.
3. Mallucci P, Branford OA. Population analysis of the perfect breast: a morphometric analysis. Plas Reconstr Surg. 2014;134:436–47.
4. Weiguang H, Stallard S, Doughty J, Mallon E, Oncological Outcomes RL. Complications after volume replacement oncoplastic breast conservations- the Glasgow experience. Breast Cancer: Basic Clin Res. 2016;10:223–8.
5. Colohan S, Wong C, Lakhiani C, Cheng A, Maia M, Arbique G, Saint-Cyr M. The free descending branch muscle-sparing latissimus dorsi flap: vascular anatomy and clinical applications. Plast Reconstr Surg. 2012;130:776e–87e.
6. Saint-Cyr M, Nagarkar P, Schaverien M, Dauwe P, Wong C, Rohrich RJ. The pedicled descending branch muscle-sparing latissimus dorsi flap for breast reconstruction. Plast Reconstr Surg. 2009;123:13–24.
7. Tobin GR, Schusterman M, Peterson GH, Nichols G, Gland KI. The intramuscular neurovascular anatomy of the latissimus dorsi muscle: the basis for splitting the flap. Plast Reconstr Surg. 1981;67:637–41.
8. Schaverien M, Saint-Cyr M, Arbique G, Brown SA, Rohrich RJ. Three- and four-dimensional arterial and venous anatomies of the thoracodorsal artery perforator flap. Plast Reconstr Surg. 2008;121:1578–87.
9. Spinelli HM, Fink JA, Muzaffar AR. The latissimus dorsi perforator-based fasciocutaneous flap. Ann Plast Surg. 1996;37:500–6.
10. Heitmann C, Guerra A, Metzinger S, Levin LS, Allen RJ. The thoracodorsal artery perforator flap: anatomic basis and clinical application. Ann Plast Surg. 2003;51:23–9.
11. Hamdi M, Van Landuyt K, Blondeel P, Hijjawi J, Roche N, Monstrey S. Autologous breast augmentation with the lateral intercostal artery perforator flap in massive weight loss patients. J Plast Reconstr Aesthet Surg. 2009;62:65e–70e.
12. Hamdi M, Spano A, Van Landuyt K, D'Herde K, Blondeel P, Monstrey S. The lateral intercostal artery perforators: anatomical study and clinical application in breast surgery. Plast Reconstr Surg. 2008;121:389–96.
13. Kim J, EOM JR, Lee JW, Park HY, Yang JD. Utility of two surgical techniques using a lateral intercostal artery perforator flap after breast-conserving surgery: a single- center retrospective study. Plast Reconstr Surg. 2019;143(3):477e–87e.
14. Veber M, Mojallal A. Lateral intercostal artery perforator flap: use in the treatment of breast tumorectomy sequelae. In: Shiffman M, editor. Breast reconstruction. Cham: Springer; 2016.
15. Zang M, Yu S, Xu L, Zhao Z, Zhu S, Ding Q, Liu Y. Intercostal artery propeller flap for reconstruction of trunk defects following sarcoma resection. J Plast Aesthet Surg. 2015;68:822–9.
16. Hamdi M, Van Landuyt K, De Frene B, et al. The versatility of the intercostal artery perforator (ICAP) flaps. J Plast Reconstr Aesthet Surg. 2006;59:644–52.

17. Carrasco-Lopez C, Ibanez JFJ, Vila J, Tomas MAL, Lopez JN, Miguesl IP, Fernandez-Llamazares-Rodriguez J, Higueras-Sune C. Anterior intercostal artery perforator flap in immediate breast reconstruction: anatomical study and clinical application. Microsurgery. 2017;37:603–10.
18. Persichetti P, Tenna S, Brunetti B, Aveta A, Segreto F, Marangi GF. Anterior intercostal artery perforator flap autologous augmentation in bariatric mastopexy. Plast Reconstr Surg. 2012;130:917–25.
19. Munhoz AM, Montag E, Arruda E, et al. Immediate conservation breast surgery reconstruction with perforator flaps: new challenges in the era of partial mastectomy reconstruction? Breast. 2011;20:233–40.
20. Tamburino S, Menez T, Laloze J, et al. Free serratus anterior artery perforator flap: a case report with an anatomic and radiological study. Surg Radiol Anat. 2017;39:837.
21. Pittet B, Mahajan AL, Alizadeh N, et al. The free serratus anterior flap and its cutaneous component for reconstruction of the face: a series of 27 cases. Plast Reconstr Surg. 2006;117:1277–88.

30

Surgical Resection and Utilization of Fasciocutaneous Advancement Flaps for Locally Advanced Breast Cancer: The Closure

Daniela Ochoa and Ronda S. Henry-Tillman

D. Ochoa · R. S. Henry-Tillman (✉)
Department of Surgery, University of Arkansas for Medical Sciences and the Winthrop P. Rockefeller Institute, Little Rock, AR, USA
e-mail: DOchoa@uams.edu; HenryRondaS@uams.edu

V. S. Klimberg et al. (eds.), *Oncoplastic Breast Surgery Techniques for the General Surgeon*, https://doi.org/10.1007/978-3-030-40196-2_30

Introduction

Locally advanced breast cancer (LABC) remains a major problem and a challenging soft tissue cancer to manage. It is estimated to impact nearly 11.4–15% of patients presenting with invasive breast cancer [1]. These include tumors that are greater than 5 cm typically with extensive regional nodal involvement, inflammatory cancers (T4 d), and clinical stage IIIA, B, and C [2].

Patients typically present with a history describing the slow growth and expansion of a large breast tumor, the neglected primary, detailing how it has encompassed their entire lives from its malodorous smell leading to their inability to work secondary to the odor and the persistent bleeding. Our presentation is a patient with a history of rapid growth secondary to the aggressive biology of the breast cancer. In contrast to the dramatic advancement in breast cancer management from early detection through treatment, the locally advanced bulky eroded cancer remains a big challenge. This challenge in detail requires a well-adapted multidisciplinary team and the well-trained breast surgical oncologist to ablate, resect, or de-bulk with the skills to close the huge defect.

Typically, current guideline recommendation for workup and treatment begins with extensive workup to include mammogram, ultrasound (U/S), core needle biopsy (CNB) of breast, and suspicious axillary nodes. Additionally, staging workup may include magnetic resonance imaging (MRI) to evaluate the extent as well as contralateral breast disease, labs (specifically CBC, LFTs, and alkaline phosphatase), computerized axial tomography (CT) scan, and bone scan or positron emission tomography. The treatment in most cases begins with multi-regimen neoadjuvant chemotherapy with plans of converting extensive disease into resectable disease and addressing distant metastases, followed by surgical resection allowing for palliation and wound control, radiation, and endocrine therapy as indicated [3]. There are numerous options and considerations to approach closure of chest wall defects; this chapter describes options for closure utilizing local advancement flaps (fasciocutaneous flaps) and skin grafts.

Considerations and Options

Although there have been many advances in systemic therapies, surgical resection remains an integral component in the treatment of locally advanced disease. Even in the setting of stage IV disease, there may still be a role for surgical resection of the primary for palliative intent. Factors impacting quality of life in terms of local wound care may be greatly impacted. This becomes especially important in the patient whose metastatic disease is otherwise responding well to systemic treatment. The disease course may often be a chronic illness for which quality of life becomes a significant consideration. There is also an arguable benefit in terms of survival that may be achieved; therefore, it is crucial to evaluate each individual patient for candidacy for potential resection and operative options [4, 5].

There are factors one must consider in evaluating the patient with locally advanced disease that may affect our surgical options. Prior treatments such as surgical scars either related to prior breast surgery or abdominal procedures may impact viability of mobilized tissue or be at increased risk of ischemia if anatomy has been altered. In the setting of recurrence, previous radiation may be a consideration as compromised vascularity may impact wound healing potential and resultant fibrosis may hinder mobilization.

Additional considerations that may impact one's surgical approach include the need for adjuvant treatment post-operatively. If chest wall radiation is planned as is often the case, it may be prudent to strive for closure of the wound with full-thickness skin and subcutaneous tissue, perhaps even muscle. Options such as skin grafts may be less desirable in these scenarios given the expectation of post-operative radiation and its effects on the treatment field. The need for continued systemic treatment may as well affect the surgical decision making. Issues such as ischemia, infection, and delayed wound healing complications may negatively impact the ability to resume systemic treatment in a timely fashion post-operatively. Thus, considerations such as donor sites and tissue vascularity are of the upmost importance oncologically, as one does not wish to risk treatment delays from non-healing wounds.

The myocutaneous flap has traditionally also been an option for soft tissue coverage of large defects. When evaluating the options for wound closure, it is important to consider factors such as operative risk, comorbidities, post-operative morbidity, and available resources. Local advancement and rotational flaps of skin and subcutaneous tissue have the advantage of significantly decreased operating room and anesthesia time, decreased blood loss, and shorter hospital stay when compared to myocutaneous flaps equipment not widely available [6]. Patient comorbidities such as cardiac and vascular disease, as well as diabetes, may also affect decisions regarding operative time and donor site wound healing capability. Given one of the primary goals of surgical resection is palliation and improved quality of life, it is especially important to consider risk-benefit profiles and strive for the least morbidity possible post-operatively. It is equally imperative to consider one's available resources, skills, and capabilities as to what works best at one's institution may not be feasible in another. The myocutaneous flap may require additional expertise or equipment not widely available, potentially making the other operative techniques more suitable to a given situation.

Advancement Flaps

Unilateral/Bilateral Advancement Flaps

Advancement flaps are a potential option for wound closure after resection of locally advanced disease. One of the advantages to this approach is that the dissection is limited to the immediately surrounding tissue and there is little to no donor site morbidity. The use of advancement flap techniques allows for full-thickness tissue coverage including skin and subcutaneous tissue that subsequently allows for adjuvant treatment as needed.

The most easily achievable of the advancement flaps that requires the least amount of additional dissection is the use of bilateral advancement flaps. In this technique, the dissection is continued beyond the area of primary resection by undermining in a prefascial dissection plane. The goal is to dissect superficial to the fascia of the underlying musculature that allows for mobilization of the subcutaneous tissue and overlying skin. Often, one is able to achieve sufficient mobilization so as to complete a primary wound closure, especially in cases where there is redundant surrounding soft tissues in the abdominal and lateral axillary regions. The dissection of the flaps cephalad may proceed above the level of the clavicle. Inferiorly, the dissection onto the abdomen may proceed to the level of the umbilicus. This technique has the additional advantage of well vascularized soft tissue coverage without the level of morbidity or complexity of the pedicle or rotational flap. One must consider the level of tension upon wound closure in order to allow for optimal wound healing post-operatively. The positioning of the upper extremity can affect the ease with which the closure is achieved and adduction of the upper extremity is a potential option for facilitating approximation. Other techniques such as mattress sutures may be used to alleviate the degree of tension at the primary suture line as well. Figures 30.1, 30.2, 30.3, 30.4, 30.5, 30.6, 30.7, 30.8, and 30.9 demonstrate two advanced cancers requiring wide reconstruction with a primary closure.

Figures 30.1, 30.2, and 30.3a,b demonstrate preplanning images in a 65 year-old male presenting with a right stage IIIC breast cancer. Figure 30.1 (initial presentation), Fig. 30.2 (neoadjuvant mid treatment), and Fig. 30.3a (4 weeks post neoadjuvant therapy surgical pre planning for unilateral advancement flap).

Figures 30.8 and 30.9 demonstrate a primary breast sarcoma encompassing the majority of the breast is resected with a wide local excision creating a large defect. The edges of the lesion are marked with the dotted line using ultrasound intraoperatively and the solid line delineates ultrasound negative margins and the planned skin incision. Bilateral advancement flaps are created for primary wound closure.

Contralateral Mastectomy with Bilateral Advancement Rotation Flap

Another option for potential soft tissue coverage is the use of a contralateral mastectomy flap. In this technique, one must ensure that appropriate workup has been obtained of the contralateral breast and appears benign. Provided the skin is uninvolved on the contralateral side, the mastectomy flap can be created in a skin sparing technique and the incisions fashioned so as to advance the subcutaneous tissue and skin with slight rotation sufficient for closure of the primary resection site. Thickness of the flap must be considered in these scenarios and care must be taken to strive for sufficient subcutaneous tissue transfer. The dissection plane should not be at the dermal level as this will increase the risk of ischemia post-operatively. This

Fig. 30.1 Initial presentation with locally advanced lesion noted at right chest and axilla

Fig. 30.2 Neoadjuvant (mid-treatment)

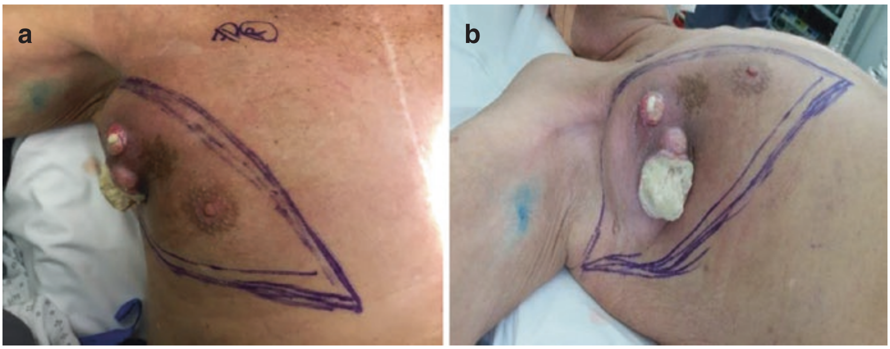


Fig. 30.3 (**a**) Lateral view. (**b**) Anterior view marking denoting oblique elliptical incision to encompass extent of tumor

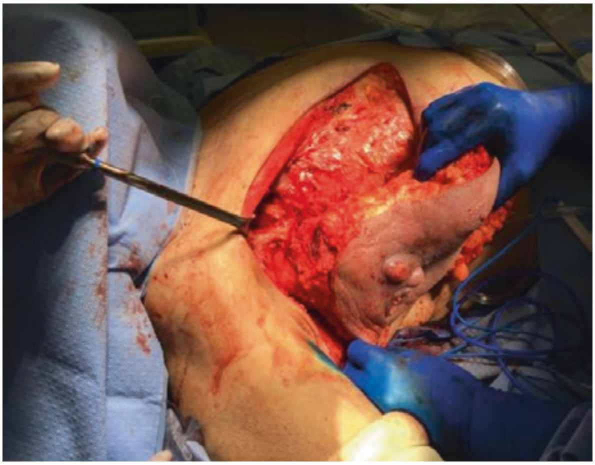


Fig. 30.4 En bloc removal with elevated flaps

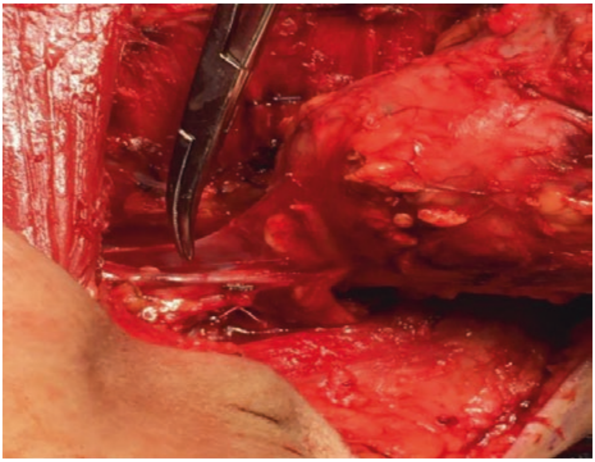


Fig. 30.5 Axillary contents and tumor extent with dissection extending into the deep axillary space Expand the tumor legend eg. what is the burlisher pointing to Take out Expand the tumor legend eg what is the burlisher pointing to. Add in that the Burlisher is pointing to the thoracodorsal bundle

Fig. 30.6 Closure (lateral view)

Fig. 30.7 Closure (anterior view)

Fig. 30.8 Pre-operative markings noting lesion extent by ultrasound evaluation (dotted line) and planned incision with 1cm margins

Fig. 30.9 Post-operative Primary Closure after mobilization of flaps

technique incorporates the contralateral chest with potential associated donor site morbidity; however, it spares the abdomen and does not incorporate musculature that may affect post-operative mobility.

In Figs. 30.10, 30.11, 30.12, and 30.13, the resection of the breast primary was first performed. Subsequently, a mastectomy was performed on the contralateral side using a periareolar incision that then extended superiorly and medially to connect with the open wound on the affected side. Care is taken to preserve the skin and subcutaneous tissue with sufficient thickness so as to minimize risk of ischemia. The flap was then able to be rotated to the affected side, in this case clockwise onto the left chest, for wound closure and tissue coverage. Once approximated, any additional redundant tissue may be excised for improved cosmesis and contour. Mattress sutures may be used for reinforcement and facilitating a tension-free closure. Figure 30.14 depicts the tumor location in-situ. Figure 30.15 illustrates the planned incisions for completion of the bilateral mastectomies with flap preservation on the contralateral side (https://www.youtube.com/watch?v=0ugOs9r7qwo; https://www.youtube.com/watch?v=OMK_iNu3gIE).

A locally advanced breast cancer recurrence in a previously radiated breast is resected. The contralateral mastectomy flap is then advanced across midline for wound closure.

Thoracoabdominal Flap

The abdominal skin and subcutaneous tissue are also an option for available tissue coverage. The redundancy of the abdominal tissue lends itself well to rotational flaps that may be advanced over the chest wall for aid in wound closure. There are options for the laterality of the pedicle and direction of the flap rotation. These may be evaluated based on tumor location and where the greatest tissue defect and coverage needs are located [7].

The thoracoabdominal flap is one such available option. Described in 1975 by Brown et al., it is a laterally based flap in terms of its pedicle and blood supply [7]. An incision

Fig. 30.10 Pre-operative

Fig. 30.11 Pre-operative

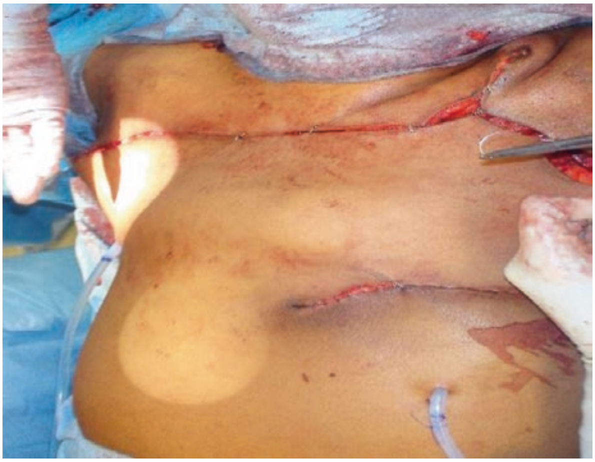


Fig. 30.12 Intra-operative mobilization of contralateral flap for closure

is made extending from the chest wall defect caudally at the midline to approximately the level of the umbilicus. The dissection proceeds at a prefascial level anterior and superficial to the underlying musculature of the abdominal wall. The skin and subcutaneous tissue are then able to be rotated superolaterally for coverage of the defect. This

Fig. 30.13 Resultant Closure and Post-operative Outcome

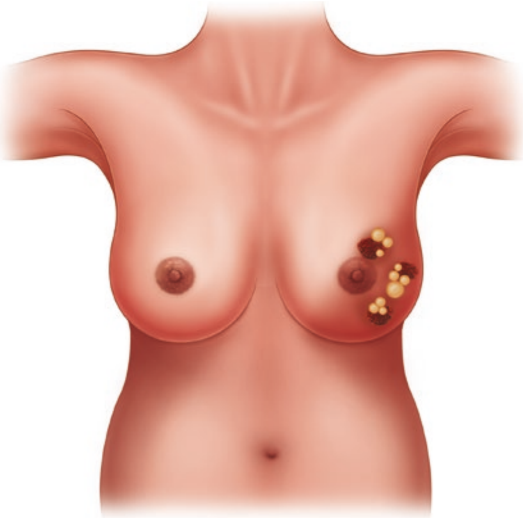


Fig. 30.14 Pre-operative tumor in-situ

closure results in a vertical midline scar post-operatively and may be better suited for medially located tumors as it allows for a greater degree of medial advancement.

Thoracoepigastric

The thoracoepigastric advancement flap is a medially based option. It has also been referred to as a "medially based thoracoabdominal flap." Figure 30.16 shows the area to be resected and Fig. 30.17 illustrates the planned incisions for the flap that is to be rotated for coverage. For this flap option, the incision is created laterally extending from the chest wall defect along the anterior or mid-axillary line. Figures 30.18 and 30.19 show the wound closure upon completion in the operating room and 6 weeks post-operatively. Again, the dissection proceeds as mentioned previously in a

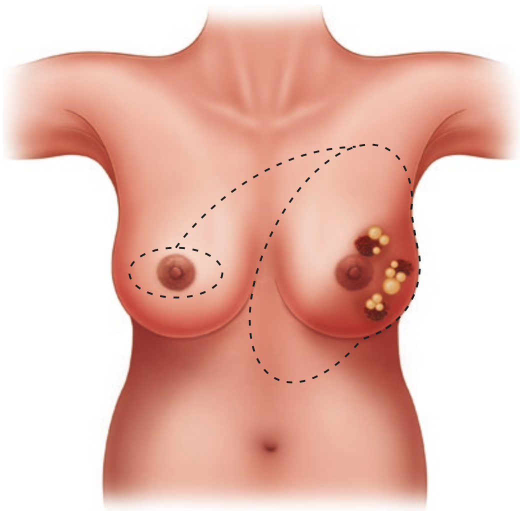


Fig. 30.15 Planned incision marked

Fig. 30.16 Fungating chest wall mass

prefascial plane. The flap is then able to be advanced in a superomedial direction, making this a potential better option for lateral tumor locations where a greater amount of tissue coverage is needed on the lateral aspect of the chest wall [8].

When primary closure is not possible because of an exceedingly large defect, or if the defect is very limiting, a combination of skin graft and advancement flap is a viable option to cover the chest wall defect. The defect is measured and the donor site is chosen. Typically, a skin graft tolerates radiation fairly well and should contain epithelium and variable amounts of dermis. The donor site heals spontaneously by epithelialization; the thigh, buttocks, and trunk are all examples of donor sites. In this patient, the anterior thigh was chosen and a dermatome was used to harvest the split thickness skin graft (STSG). Grafts in general are placed over the prepared wound bed and secured with a bolster dressing for 5–7 days to ensure contact with the recipient bed.

Figures 30.20, 30.21, 30.22, 30.23, and 30.24 demonstrate the process of resection and STSG in a 51 years/old AA with L recurrent breast cancer eroding through

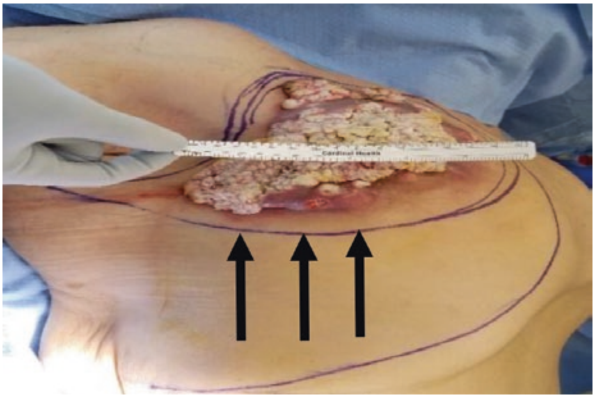


Fig. 30.17 Anterior mid axillary line (denoted by the arrows)

Fig. 30.18 Advanced flap

Fig. 30.19 Six weeks post-operatively (immediately post-operative)

Fig. 30.20 Ulcerated tumor

Fig. 30.21 Poor candidate for primary closure

Fig. 30.22 Anterior view— skin graft

Fig. 30.23 Lateral view—skin graft

Fig. 30.24 Left leg —donor site

the skin. The patient is s/p left lumpectomy, ALND on 8-16-2011. Pathology revealed: Infiltrating mammary carcinoma, no special type, grade 3, high grade DCIS, 2 of 14 axillary nodes positive for metastatic mammary carcinoma. Patient declined adjuvant therapy with chemo/radiation. Patient presented after 2 years of persistent growth of the tumor, malodorous with ulceration and bleeding requiring immediate surgery. A thoracoabdominal rotational advancement flap was used, utilizing blood supply from the lateral intercostal and subcostals. The rotational flap covered the majority of the defect but secondary to the limited rotation of the flap superiorly, a skin graft was placed to complete the closure.

Conclusion

Patients presenting with locally advanced disease require a multi-modal treatment approach and often require surgery for local control. It is worth noting that the options for tissue coverage may result in what some might consider cosmetically displeasing results. These patients, however, suffer such costly consequences in terms of quality of life related to wound care that resection of the primary with tissue coverage accomplishes their goals for palliation and allows them the opportunity to continue systemic treatment.

Video References

https://www.youtube.com/watch?v=0ugOs9r7qwo
https://www.youtube.com/watch?v=OMK_iNu3gIE

References

1. NCDB National Cancer Database. https://www.facs.org/quality-programs/cancer/ncdb.
2. Simos D, Clemons M, Ginsburg OM, Jacobs C. Definition and consequences of locally advanced breast cancer. Curr Opin Support Palliat Care. 2014;8(1):33–8. https://doi.org/10.1097/SPC.0000000000000020.
3. Khan SA, Stewart AK, Morrow M. Does aggressive local therapy improve survival in metastatic breast cancer? Surgery. 2002;132(4):620–6; discussion 626–7.
4. Quinn EM, Kealy R, O'Meara S, Whelan M, Ennis R, Malone C, et al. Is there a role for locoregional surgery in stage IV breast cancer? Breast (Edinburgh, Scotland). 2015;24(1):32–7. https://doi.org/10.1016/j.breast.2014.10.009.
5. Deo SV, Purkayastha J, Shukla NK, Asthana S. Myocutaneous versus thoraco-abdominal flap cover for soft tissue defects following surgery for locally advanced and recurrent breast cancer. J Surg Oncol. 2003;83(1):31–5. https://doi.org/10.1002/jso.10236.
6. Park JS, Ahn SH, Son BH, Kim EK. Using local flaps in a chest wall reconstruction after mastectomy for locally advanced breast cancer. Arch Plast Surg. 2015;42(3):288–94. https://doi.org/10.5999/aps.2015.42.3.288.
7. Brown RG, Vasconez LO, Jurkiewicz MJ. Transverse abdominal flaps and the deep epigastric arcade. Plast Reconstr Surg. 1975;55(4):416–21.
8. Breastsurgeonsweb.Thoracoabdominal Flap for Inflammatory Breast Cancer. May 7, 2017. https://www.youtube.com/watch?v=OMK_iNu3gIE.

31 Surgery Following Primary Systemic Therapy: How to Increase Breast Conservation Rate

Rosa Di Micco and Oreste Davide Gentilini

Introduction

A major benefit of primary systemic therapy (PST) in breast cancer is its potential to increase the rate of breast conservation, thus having less morbidity and improved body image compared with mastectomy [1]. Numerous randomized and non-randomized prospective studies have demonstrated that PST can allow breast-conserving surgery (BCS) in some patients for whom mastectomy was initially the first option [2–9]. The application of PST, historically used in an effort to improve prognosis in patients presenting with inoperable or locally advanced breast cancer, may now be used to downstage tumor size for eligibility of BCS [11, 12].

The first issue to address when considering BCS after PST is the fear that breast conservation yields a higher risk of locoregional recurrence (LRR). This is an old belief that is still object of debate [13]. Past studies on PST showed a statistically significantly higher risk of LRR (6% in absolute terms) [14–16]. Despite being high-quality data, including randomized controlled trials and meta-analysis, they included heterogenous studies. First of all, they refer to patients treated from 1980s and new advancement in drug discovery and response to new agents cannot be compared with results achievable 30 years ago, as shown by pCR (patological Complete Response) rates reported (i.e., <20%, [17, 18]). Second, the increase in LRR was greatly reduced when studies of patients who were treated by radiotherapy only and no surgery following PST were excluded. Third, no increase in overall survival (OS)

R. Di Micco (✉)
Breast Unit, San Raffaele University and Research Hospital, Milan, Italy

Department of Clinical Medicine and Surgery, University of Naples Federico II, Naples, Italy
e-mail: dimicco.rosa@hsr.it

O. D. Gentilini
Breast Unit, San Raffaele University and Research Hospital, Milan, Italy
e-mail: gentilini.oreste@hsr.it

V. S. Klimberg et al. (eds.), *Oncoplastic Breast Surgery Techniques for the General Surgeon*, https://doi.org/10.1007/978-3-030-40196-2_31

and disease-free survival (DFS) was associated with the higher LRR rate. Therefore, notwithstanding the "potential" risk of higher LRR, no meaningful conclusion can be driven on the basis of old chemotherapy regimen in a pre-trastuzumab era with non-homogenous treatment considered. In fact, the Early Breast Cancer Trialists' Collaborative Group in the same meta-analysis showing increased LRR after BCS argued that if the higher LRR was due to the de-escalation of surgery from mastectomy to BCS, the local recurrence should be greatest in women for whom mastectomy was originally planned; however, the difference in the event rate ratio between women initially planned for mastectomy and women planned for BCS since the diagnosis was not statistically significant ($p = 0.07$) [16]. Even more recent data are in contrast, maybe due to the differences in patient selection criteria and differences in therapeutic approaches. Chen et al. [19] reporting M.D. Anderson experience that could be used as a reference point showed 5-year actuarial rates of LRR-free and IBTR (Ipsilateral Breast Tumor Recurrence)-free survival of 91% and 95%, being comparable with those of patients undergoing upfront BCS. A recent meta-analysis of 16 trials on PST in locally advanced breast cancer having a good response showed no significant difference in LRR but a lower distant recurrence and a higher rate of DFS and OS in the BCS groups compared with mastectomy group [20]. Hence, past data have not been confirmed by more recent studies showing no increase in LRR after BCS following PST or even a better trend for BCS, as it happens for upfront surgery [10, 12, 19, 21, 22, 61].

As a result of the safety of breast conservation after PST, a meta-analysis of 14 prospective randomized trials of neoadjuvant versus adjuvant chemotherapy in a total of 5500 patients with breast cancer demonstrated that PST was associated with an absolute decrease in the mastectomy rate of 16.6% (95% CI: 15.1–18.1%) [15]. However, this percentage is actually an underestimation of the potential benefit of PST in increasing BCS rate, as many of the patients were already candidates to upfront BCS. Despite the increasing rate of pCR in trials with the most recent drugs, the breast conservation rate does not seem to increase in parallel. In the National Surgical Adjuvant Breast and bowel Project (NSABP) B-18 trial [9] and the European Organization for Research and Treatment of Cancer (EORTC) 10,901 trial [23], the rates of BCS after four cycles of anthracycline-based PST in patients deemed to have required mastectomy if surgery had been initial treatment were 27% and 23%, respectively. More recently, in the NSABP B-27 trial, the addition of docetaxel to doxorubicin and cyclophosphamide increased the pCR rate from 13.7% to 26.1% ($P < 0.001$), but the rates of BCS were not significantly different between the two groups (61.6% versus 63.7%; $P = 0.33$). Similarly, in the Neoadjuvant Lapatinib and/or Trastuzumab Treatment Optimization (NeoALTTO) [24] trial in patients with Her2-overexpressing tumors, which compared chemotherapy plus either lapatinib or trastuzumab, rates of pCR differed considerably: 51.3% with dual blockade; 29.5% with trastuzumab; and 24.7% with lapatinib alone while breast conservation rate after PST were 26.4%, 27.7%, and 26.4%, respectively. Failure to translate increased pCR rates into a higher rate of BCS has been also observed in GeparQuinto GBG44 trial [25]with lapatinib versus trastuzumab in addition to epirubicin, cyclophosphamide, and docetaxel (pCR rate: 30.2% versus 44.6%, BCS rate: 59% versus 64%) and CHER-LOB trial with lapatinib, trastuzumab and both, in association with paclitaxel and FEC (pCR rate 25%, 26%, and 47%; BCS rate 67%, 58%, and 69%). This trend is maybe due to the surgical issues that PST determines: difficulty in evaluating the extent of residual disease, surgeons' resistance in sparing from resection part of the breast tissue originally occupied by the tumor, disagreement in the definition of pCR, which could include residual intraductal component precluding BCS, and patients' preference [26] for mastectomy.

Indications

BCS should always be considered as the first option in early breast cancer treatment both in primary surgery and in post-PST setting. When BCS is considered challenging or impossible at first instance, PST could be a good solution to enable BCS and give the patient the opportunity to avoid mastectomy or a poor aesthetic outcome. Both anatomical and biological factors are useful in selecting patients with breast cancer for whom tumor downstaging is expected after PST. In general, patients with high-grade breast tumors being estrogen-receptor negative and/or Her2-positive have a higher likelihood of pCR to PST, in particular the pCR rate could reach up to 65% in Her2-positive [24, 25, 27–31] and up to 55% in triple negative breast cancer [32–41]. However, besides pCR provides important prognostic information for long-term survival [32, 42], BCS can be achieved even though the tumor does not disappear completely, it could shrink and enable a reduced surgical resection. Provided that for a given patient with operable breast cancer, the order of surgery and chemotherapy will not affect either distant or local recurrence risk; PST may be safely used to reduce tumor size and allow for BCS when mastectomy was indicated, or a smaller lumpectomy when BCS was already feasible. In the pivotal NSABP-B18 trial, BCS rate for patients with T3 tumors initially was significantly higher after PST than for patients with primary surgery (22% versus 3%) [9]. In a meta-analysis of 14 studies by Mieog et al. [40] 17% of patients who initially were candidates for mastectomy could be converted to BCS with PST. These data are supported by the finding that 52% of the patients with stage 2 or 3 disease were downstaged by PST to pathological stage 0 or 1 [43]. The conversion rate for patients with stage 2 or 3 triple-negative BC from mastectomy to BCS by PST was 42% [44]. As a result, the indications to BCS after PST should be very clear at the first surgical visit, planning which kind of surgery is to be offered as primary treatment and which surgery is expected to offer after PST if a good response occurs.

However, for some subgroups of patients primary surgery remains preferable. Considering that the extension of ductal carcinoma in situ could not be reduced and invasive lobular carcinoma is unlikely to respond significantly, PST is not supposed to increase the likelihood of BCS in patients with such tumor characteristics [45]. However, more recent studies have shown that although the extent of microcalcifications did not decrease following PST, they are unreliable indicator of response, as not all residual calcifications represented carcinoma [46] and even in presence of intraductal component in the diagnostic biopsy, pCR could be achieved at final pathology [47].

Preoperative Evaluation and Planning

Surgery after PST should be based on the breast and axillary status at the post-PST preoperative visit, only taking into account the eventual inflammatory presentation or extensive skin ulceration at diagnosis that contraindicates BCS. Current standards recommend repeating imaging after PST to provide an accurate assessment of residual tumor burden for surgical decision-making [48–50]. A reliable local re-staging after PST, accurately reflecting the extent of residual disease, is crucial for an optimal surgery. However, the currently available options including physical examination, ultrasound (US), mammography, and magnetic resonance imaging (MRI) do not fully satisfy, particularly in prediction of pCR [51–54]. The accuracy of physical examination, ultrasound, and mammography in predicting a residual size of ±1 cm after PST was found to be respectively 66%, 75%, and 70%; furthermore, the size estimation by each method poorly correlated with the final pathological residual tumor size (correlation < 50%) [51]. In a recent meta-analysis extracted from 19 studies comparing the utility of various methods for predicting residual tumor size, MRI appeared to overestimate pathological size, similar to ultrasound [55]. However, due to the high sensibility and low specificity of MRI, not all abnormalities detected at diagnosis may reflect invasive cancer deposits and ideally should be confirmed by core biopsy before PST. Predicting pCR by imaging, including MRI and minimally invasive biopsy, remains unsatisfactory, with false-negative rates of about 25–30% [54, 56]. Fibrosis and scarring resulting from PST make residual tumor difficult to accurately assess [57], in particular microcalcifications represent a real issue in surgical planning, as they are often not representative of viable tumor [58–62]. The extent of suspicious microcalcifications should be evaluated before and after PST. On one side, if their extension contraindicates BCS at diagnosis, there is no advantage in suggesting PST. On the other side, calcifications appearing after PST should be evaluated together with the whole clinical picture, considering that they are not always a sign of residual disease, core biopsy could be indicated and their complete excision could be not necessary to achieve curative surgical resection [63]. Before surgery all suspicious microcalcifications should be marked (see next paragraph) and removed. Finally, although its effect is modest at best, MRI remains the best imaging modality at predicting a pCR, with a sensitivity of 56–70%, compared with mammography and US, MRI is the preferred imaging modality for monitoring residual tumor size post-PST [55, 59, 64]. Multiple studies have demonstrated that MRI is superior to other imaging modalities at identifying residual disease, with higher accuracy and positive predictive value [57, 65, 66].

Surgical Technique

BCS after PST follows the same technical principles of primary BCS, including oncoplastic and reconstructive technique repertoire (Figs. 31.1, 31.2, 31.3, 31.4, and 31.5). According to the St.Gallen International Expert Consensus Conference on the Primary Therapy of Early Breast Cancer 2017 the recommendation is that after PST full resection of the initial tumor bed is not necessary and the "no ink on tumor" standard for surgical margins is favored. However, in cases of multifocal or "scattered" residual disease more "generous" margins are preferable. This so called

Fig. 31.1 Clinical case 1 medical history, preoperative view on the left, 6-month view on the right. A 50 year-old patient with a 6 cm breast lump (invasive ductal carcinoma grade 2, ER90% PgR80% ki67 18% Her2 negative) with extensive microcalcifications at the right upper outer quadrants. After PST (FEC for 4 cycles followed by 12 cycles of weekly paclitaxel) the patient she still had a 4 cm mass including both residual tumor and microcalcifications on imaging. She underwent ROLL-guided wide local excision within lateral mammoplasty

Fig. 31.2 Clinical case 2 medical history, preoperative view on the left, 3-month view on the right. A 40-year-old patient with a 3.5 cm breast lump at the left lower inner quadrant (invasive ductal carcinoma grade 3 HR negative ki67: 43% Her2 3+) and 1-cm papillomas with atypia at the right and left upper outer quadrant. After PST (FEC for 4 cycles followed by 12 cycles of weekly paclitaxel and trastuzumab), the residual tumor was 9 mm on imaging. All lesions were localized with ultrasound-guided ROLL and then she underwent bilateral round block mammoplasty

Fig. 31.3 Clinical case 3 medical history, preoperative view on the left, 3-month view on the right. A 50-year-old patient with a 2 cm breast tumor of the left lower quadrant retracting the skin (invasive ductal carcinoma grade ER80% PgR0% Ki-67:32% HER-2 negative) and 3.5 cm tumor with microcalcifications of the right inner quadrant (invasive and in situ ductal carcinoma ER80% PgR neg Ki-67:54% HER-2:3+). After PST (FEC for 4 cycles followed by 12 cycles of weekly paclitaxel and trastuzumab) the residual tumors were 18 mm on the left and a 2 cm area of microcalcifications on the right. Right microcalcifications were localized with mammography-guided ROLL. The patient underwent round block mammoplasty on the right and vertical mammoplasty on the left

Fig. 31.4 Clinical case 4 medical history, preoperative view on the left, 6-month view on the right. A 53-year-old patient with a 4 cm breast tumor of the left central quadrant (invasive ductal carcinoma grade2 ER100% PgR80% Ki-67:30% HER-2 negative) with a 10 cm area of microcalcifications around. Due to a synchronous lung tumor, she required lung surgery first and started neoadjuvant hormonal therapy with tamoxifen and decapeptyl. After 6 months. she still had a 4 cm palpable lump and underwent mammogram-guided mapping of microcalcifications. Wide local excision of left central quadrant was performed within a bilateral breast reduction pattern, and an inferior pedicle was harvested to vascularize nipple-areola complex on the right and simulate a new areola on the left

"Swiss cheese "pattern of response has been shown to predict an increased risk of local recurrence [19]. The surgical excision includes residual tumor or part of the initial tumor bed around the clip to be placed before PST. For non-palpable lesions and to delineate the area of microcalcifications, all techniques of tumor localization utilized for primary surgery could be used to guide resection (photos or examples of which technique you used and how to do it…) bracketing wires, iodine seeds, ROLL (Radio-guided Occult Lesion Localization), ultrasound-guided

Fig. 31.5 Clinical case 5 medical history, preoperative view on the left, 3-month view on the right. A 63-year-old patient with a 6 cm breast tumor (invasive ductal carcinoma grade 3 ER90% PgR60% Ki-67:31% HER-2 negative) of the left lower outer quadrant and 8 mm breast tumor (invasive ductal carcinoma grade 2 ER90% PgR90% Ki-67:12% HER-2 negative) of the right lower outer quadrant. After PST (FEC for 4 cycles followed by 12 cycles of weekly paclitaxel) the patient still had a 4 cm breast tumor on the left and a 3 mm residual tumor on the right. She underwent preoperative ultrasound-guided ROLL on the right and then bilateral wide local excision within a breast reduction pattern with a bilateral superomedial pedicle to vascularize nipple-areola complexes and a bilateral advancement dermoglandular flap from lower inner quadrant to fill in the defect at the lower outer quadrant

surgery Intraoperative pathologic, and radiologic evaluation could help the surgeon identify tumor bed and achieve negative margins. However, BCS after PST remains technically more challenging than primary surgery, where the surgeon's fingers could often feel tumor edges. The lack of clearly palpable margins of the softer and diffuse remnant tumor after PST can reduce surgical precision and a negative margin more difficult to achieve in case of partial response. Once that tumor is no longer a contiguous structure but instead consists of multiple viable tumor islands scattered throughout the original volume of tumor tissue. In these cases, BCS surgery could be difficult even if a good response, in terms of tumor burden, has been achieved as the same initial tumor bed needs to be excised [13].

Surgical Complications and Solutions

Surgical complications after PST are the same of ordinary breast surgery [67]. The potential increased risk of surgical complications after PST is not supported by the available data. In a study including 3696 patients with breast cancer who underwent PST no increase in 30-day morbidity was observed compared to more than 60,000 women undergoing upfront surgery [68]. The most important complication is failing in achieving negative margins, considering that removing the clip marker when clinical complete (or almost complete) response occurs, means removing only a part of the whole tumor bed and the clip is not necessarily placed in the precise point where the residual tumor remains. In this setting, the great experience of M.D. Anderson Cancer Center with PST could be helpful. At the University of Texas Boughey et al. [21] choose a different timing to mark the tumor according to the initial size. In T1 tumor the marking is performed under US guidance, if visible, at the diagnosis. A complex marker that attaches to the tissue is used, which has a decreased migration rate. Patients with larger tumors are followed clinically throughout PST; they are monthly evaluated by the surgeon and medical oncologist. If the tumor shows a significant decrease in size or is less than 2 cm, a marker will be placed at that time. During the surgery, the tissue surrounding the marker as well as anything that is abnormal by palpation or imaging should be excised. All breast specimens should be evaluated intraoperatively for margin assessment to allow additional excision of any close or concerning margins through the pathologist and the radiologist's evaluation, thus keeping re-excision rates as low as possible [21].

Results

BCS is a safe alternative to mastectomy for patients who are treated with PST. The apparent paradox of higher pCR rates with no increase in BCS rate might be explained by both surgeon and patient related variables. The main issues to address in order to increase the BCS rate after PST are as follows.

Patient Selection

An appropriate patient selection is of paramount importance to optimize PST benefit on surgery. Ideal candidates to increase BCS rate are women with high grade, triple negative, or Her2-positive large tumor for whom upfront mastectomy would be indicated. Women who are candidates for breast conservation with PST may have a decrease in the volume of surgical resection and/or axillary surgery. Women with multicentric cancer (explain how oncoplastic can help and add some photos) or diffuse suspicious microcalcifications throughout the breast will likely require mastectomy regardless of PST. Women who prefer a mastectomy for personal reasons or high genetic risk are unlikely to have the surgical choice changed by PST. The conversion to BCS candidates is not always certain, above all for lobular, multifocal, low-grade, Her2 negative, ER positive disease, similarly for those with extensive intraductal component [69]. Initial staging is fundamental to assess that can be expected from a primary systemic treatment, one thing is the conversion from mastectomy to BCS, for which a great response is necessary; another thing is to reduce the volume to be excised in order to improve aesthetic outcome. For the last purpose of allowing a smaller resection to obtain better cosmetic results, even a partial response could be helpful, as well as a neoadjuvant endocrine treatment, mainly in post-menopausal women, could be considered too [70]. Boughey et al. [21] showed that preoperative chemotherapy in T1 tumors does not reduce the volume of tissue resected. On the contrary, PST reduces the volume to be excised in T2–3 tumor downstaging their size. So, patients with T2–3 tumors have a greater benefit than T1 from PST in terms of less tissue removed and then of higher rate of conversion to BCT. This suggests that the proper use of PST may lead to a better overall cosmetic outcome and patient satisfaction [71].

Accurate Pre- and Post-PST Staging

Mammogram, ultrasound, and breast MRI should be performed at diagnosis to stage initial disease, establish which is the surgical indication, and decide the proper indications to PST according to the expectations. In order to facilitate the surgical procedure, a clip should be placed to mark the primary tumor site and at the end of the PST breast imaging should be repeated preferably with the same modalities used at the onset of treatment. Residual disease, suspicious calcifications, and the marker clip should be localized for resection. The surgical specimen should be oriented and inked. Intraoperative specimen X-ray or US as well as pathological examination could grant more accuracy. The surgeon should be guided by intraoperative exams for eventual further excision in order to achieve negative margins.

Surgeon-Related Factors

According to results from NeoALTTO trial patients who are initially planned for mastectomy or are considered ineligible for resection at diagnosis are less likely to undergo BCS compared with patients who are initially planned for BCS, regardless of response to PST [72]. It seems that surgeons' perception and risk of recurrence are not in line with the response and outcomes seen in the modern era. Surgeon's preference and characteristics have been demonstrated to have a significant influence on patient's treatment choice. Each surgeon should be well informed on the most updated results from literature in order to offer the patients the widest range of surgical options according to contemporary data and, in case of downstaging, to be ready to review eligibility for BCS according to post-PST status [73].

Tumor-Related factors

Large tumor size, multicentric breast cancer, lymphovascular invasion, diffuse microcalcifications, and the presence of lobular carcinoma have a significant impact on mastectomy rates [74, 75]. However, evidence now shows that recurrence is a function of tumor biology rather than surgical choice, so tumor size in itself is no longer considered an absolute contraindication to BCS [12, 76].

Patient-Related factors

The fear of recurrence and perceived survival benefit are the main drivers in patient's preference for mastectomy over BCS. Patients counseling and decision aids based on contemporary data could be a key component in the surgical decision making. Clinicians should always explain the equivalent survival rates regardless of surgery type and also discuss issues regarding body image and quality of life to support the safety and feasibility of BCS [71, 73].

Conclusions

PST provides the opportunity to tailor the extent of locoregional therapy of breast cancer based on the preoperative treatment response. An improved understanding of the optimal negative margin width and of the equivalence of BCS and mastectomy in terms of recurrence and survival, as well as the evidence of better aesthetic outcomes and quality of life after breast conservation should encourage surgeons to offer, being convincing, BCS to more and more breast cancer patients after PST.

References

1. Kiebert GM, de Haes JC, van de Velde CJ. The impact of breast-conserving treatment and mastectomy on the quality of life of early-stage breast cancer patients: a review. J Clin Oncol. 1991;9(6):1059–70.
2. Kling KM, Ostrzega N, Schmit P. Breast conservation after induction chemotherapy for locally advanced breast cancer. Am Surg. 1997;63(10):861–4.
3. Schwartz GF, Birchansky CA, Komarnicky LT, Mansfield CM, Cantor RI, Biermann WA, et al. Induction chemotherapy followed by breast conservation for locally advanced carcinoma of the breast. Cancer. 1994;73(2):362–9.
4. Makris A, Powles TJ, Ashley SE, Chang J, Hickish T, Tidy VA, et al. A reduction in the requirements for mastectomy in a randomized trial of neoadjuvant chemoendocrine therapy in primary breast cancer. Ann Oncol. 1998;9(11):1179–84.
5. Bélembaogo E, Feillel V, Chollet P, Curé H, Verrelle P, Kwiatkowski F, et al. Neoadjuvant chemotherapy in 126 operable breast cancers. Eur J Cancer. 1992;28A(4–5):896–900.
6. Scholl SM, Fourquet A, Asselain B, Pierga JY, Vilcoq JR, Durand JC, et al. Neoadjuvant versus adjuvant chemotherapy in premenopausal patients with tumours considered too large for breast conserving surgery: preliminary results of a randomised trial: S6. Eur J Cancer. 1994;30A(5):645–52.
7. Smith IE, Jones AL, O'Brien ME, McKinna JA, Sacks N, Baum M. Primary medical (neo-adjuvant) chemotherapy for operable breast cancer. Eur J Cancer. 1993;29A(12):1796–9.
8. Singletary SE, McNeese MD, Hortobagyi GN. Feasibility of breast-conservation surgery after induction chemotherapy for locally advanced breast carcinoma. Cancer. 1992;69(11):2849–52.
9. Fisher B, Brown A, Mamounas E, Wieand S, Robidoux A, Margolese RG, et al. Effect of preoperative chemotherapy on local-regional disease in women with operable breast cancer: findings from National Surgical Adjuvant Breast and Bowel Project B-18. J Clin Oncol. 1997;15(7):2483–93.
10. Bleicher RJ, Ruth K, Sigurdson ER, Daly JM, Boraas M, Anderson PR, et al. Breast conservation versus mastectomy for patients with T3 primary tumors (>5 cm): a review of 5685 medicare patients. Cancer. 2016;122(1):42–9.

11. Redden MH, Fuhrman GM. Neoadjuvant chemotherapy in the treatment of breast cancer. Surg Clin North Am. 2013;93(2):493–9.
12. King TA, Morrow M. Surgical issues in patients with breast cancer receiving neoadjuvant chemotherapy. Nat Rev Clin Oncol. 2015;12(6):335–43.
13. Vaidya JS, Massarut S, Vaidya HJ, Alexander EC, Richards T, Caris JA, et al. Rethinking neoadjuvant chemotherapy for breast cancer. BMJ. 2018;360:j5913.
14. Mauri D, Pavlidis N, Ioannidis JP. Neoadjuvant versus adjuvant systemic treatment in breast cancer: a meta-analysis. J Natl Cancer Inst. 2005;97(3):188–94.
15. Mieog JS, van der Hage JA, van de Velde CJ. Neoadjuvant chemotherapy for operable breast cancer. Br J Surg. 2007;94(10):1189–200.
16. (EBCTCG) EBCTCG. Long-term outcomes for neoadjuvant versus adjuvant chemotherapy in early breast cancer: meta-analysis of individual patient data from ten randomised trials. Lancet Oncol. 2018;19(1):27–39.
17. Bear HD, Anderson S, Brown A, Smith R, Mamounas EP, Fisher B, et al. The effect on tumor response of adding sequential preoperative docetaxel to preoperative doxorubicin and cyclophosphamide: preliminary results from National Surgical Adjuvant Breast and Bowel Project Protocol B-27. J Clin Oncol. 2003;21(22):4165–74.
18. Jackisch C, von Minckwitz G, Eidtmann H, Costa SD, Raab G, Blohmer JU, et al. Dose-dense biweekly doxorubicin/docetaxel versus sequential neoadjuvant chemotherapy with doxorubicin/cyclophosphamide/docetaxel in operable breast cancer: second interim analysis. Clin Breast Cancer. 2002;3(4):276–80.
19. Chen AM, Meric-Bernstam F, Hunt KK, Thames HD, Oswald MJ, Outlaw ED, et al. Breast conservation after neoadjuvant chemotherapy: the MD Anderson cancer center experience. J Clin Oncol. 2004;22(12):2303–12.
20. Sun Y, Liao M, He L, Zhu C. Comparison of breast-conserving surgery with mastectomy in locally advanced breast cancer after good response to neoadjuvant chemotherapy: a PRISMA-compliant systematic review and meta-analysis. Medicine (Baltimore). 2017;96(43):e8367.
21. Boughey JC, Peintinger F, Meric-Bernstam F, Perry AC, Hunt KK, Babiera GV, et al. Impact of preoperative versus postoperative chemotherapy on the extent and number of surgical procedures in patients treated in randomized clinical trials for breast cancer. Ann Surg. 2006;244(3):464–70.
22. Botteri E, Veronesi P, Vila J, Rotmensz N, Galimberti V, Thomazini MV, et al. Improved prognosis of young patients with breast cancer undergoing breast-conserving surgery. Br J Surg. 2017;104(13):1802–10.
23. van der Hage JA, van de Velde CJ, Julien JP, Tubiana-Hulin M, Vandervelden C, Duchateau L. Preoperative chemotherapy in primary operable breast cancer: results from the European Organization for Research and Treatment of Cancer trial 10902. J Clin Oncol. 2001;19(22):4224–37.
24. Baselga J, Bradbury I, Eidtmann H, Di Cosimo S, de Azambuja E, Aura C, et al. Lapatinib with trastuzumab for HER2-positive early breast cancer (NeoALTTO): a randomised, open-label, multicentre, phase 3 trial. Lancet. 2012;379(9816):633–40.
25. Untch M, Loibl S, Bischoff J, Eidtmann H, Kaufmann M, Blohmer JU, et al. Lapatinib versus trastuzumab in combination with neoadjuvant anthracycline-taxane-based chemotherapy (GeparQuinto, GBG 44): a randomised phase 3 trial. Lancet Oncol. 2012;13(2):135–44.
26. Katz SJ, Lantz PM, Janz NK, Fagerlin A, Schwartz K, Liu L, et al. Patient involvement in surgery treatment decisions for breast cancer. J Clin Oncol. 2005;23(24):5526–33.
27. Gianni L, Eiermann W, Semiglazov V, Manikhas A, Lluch A, Tjulandin S, et al. Neoadjuvant chemotherapy with trastuzumab followed by adjuvant trastuzumab versus neoadjuvant chemotherapy alone, in patients with HER2-positive locally advanced breast cancer (the NOAH trial): a randomised controlled superiority trial with a parallel HER2-negative cohort. Lancet. 2010;375(9712):377–84.
28. Gianni L, Pienkowski T, Im YH, Roman L, Tseng LM, Liu MC, et al. Efficacy and safety of neoadjuvant pertuzumab and trastuzumab in women with locally advanced, inflammatory, or early HER2-positive breast cancer (NeoSphere): a randomised multicentre, open-label, phase 2 trial. Lancet Oncol. 2012;13(1):25–32.

29. Untch M, Fasching PA, Konecny GE, Hasmüller S, Lebeau A, Kreienberg R, et al. Pathologic complete response after neoadjuvant chemotherapy plus trastuzumab predicts favorable survival in human epidermal growth factor receptor 2-overexpressing breast cancer: results from the TECHNO trial of the AGO and GBG study groups. J Clin Oncol. 2011;29(25):3351–7.
30. von Minckwitz G, Darb-Esfahani S, Loibl S, Huober J, Tesch H, Solbach C, et al. Responsiveness of adjacent ductal carcinoma in situ and changes in HER2 status after neoadjuvant chemotherapy/trastuzumab treatment in early breast cancer--results from the GeparQuattro study (GBG 40). Breast Cancer Res Treat. 2012;132(3):863–70.
31. Schneeweiss A, Chia S, Hickish T, Harvey V, Eniu A, Hegg R, et al. Pertuzumab plus trastuzumab in combination with standard neoadjuvant anthracycline-containing and anthracycline-free chemotherapy regimens in patients with HER2-positive early breast cancer: a randomized phase II cardiac safety study (TRYPHAENA). Ann Oncol. 2013;24(9):2278–84.
32. Liedtke C, Mazouni C, Hess KR, André F, Tordai A, Mejia JA, et al. Response to neoadjuvant therapy and long-term survival in patients with triple-negative breast cancer. J Clin Oncol. 2008;26(8):1275–81.
33. von Minckwitz G, Schneeweiss A, Loibl S, Salat C, Denkert C, Rezai M, et al. Neoadjuvant carboplatin in patients with triple-negative and HER2-positive early breast cancer (GeparSixto; GBG 66): a randomised phase 2 trial. Lancet Oncol. 2014;15(7):747–56.
34. Silver DP, Richardson AL, Eklund AC, Wang ZC, Szallasi Z, Li Q, et al. Efficacy of neoadjuvant cisplatin in triple-negative breast cancer. J Clin Oncol. 2010;28(7):1145–53.
35. Byrski T, Gronwald J, Huzarski T, Grzybowska E, Budryk M, Stawicka M, et al. Pathologic complete response rates in young women with BRCA1-positive breast cancers after neoadjuvant chemotherapy. J Clin Oncol. 2010;28(3):375–9.
36. Chen XS, Nie XQ, Chen CM, Wu JY, Wu J, Lu JS, et al. Weekly paclitaxel plus carboplatin is an effective nonanthracycline-containing regimen as neoadjuvant chemotherapy for breast cancer. Ann Oncol. 2010;21(5):961–7.
37. Chang HR, Glaspy J, Allison MA, Kass FC, Elashoff R, Chung DU, et al. Differential response of triple-negative breast cancer to a docetaxel and carboplatin-based neoadjuvant treatment. Cancer. 2010;116(18):4227–37.
38. Untch M, Jackisch C, Schneeweiss A, Conrad B, Aktas B, Denkert C, et al. Nab-paclitaxel versus solvent-based paclitaxel in neoadjuvant chemotherapy for early breast cancer (GeparSepto-GBG 69): a randomised, phase 3 trial. Lancet Oncol. 2016;17(3):345–56.
39. Cortazar P, Zhang L, Untch M, Mehta K, Costantino JP, Wolmark N, et al. Pathological complete response and long-term clinical benefit in breast cancer: the CTNeoBC pooled analysis. Lancet. 2014;384(9938):164–72.
40. Mieog JS, van der Hage JA, van de Velde CJ. Preoperative chemotherapy for women with operable breast cancer. Cochrane Database Syst Rev. 2007;2:CD005002.
41. von Minckwitz G, Untch M, Nüesch E, Loibl S, Kaufmann M, Kümmel S, et al. Impact of treatment characteristics on response of different breast cancer phenotypes: pooled analysis of the German neo-adjuvant chemotherapy trials. Breast Cancer Res Treat. 2011;125(1):145–56.
42. von Minckwitz G, Untch M, Blohmer JU, Costa SD, Eidtmann H, Fasching PA, et al. Definition and impact of pathologic complete response on prognosis after neoadjuvant chemotherapy in various intrinsic breast cancer subtypes. J Clin Oncol. 2012;30(15):1796–804.
43. Mittendorf EA, Buchholz TA, Tucker SL, Meric-Bernstam F, Kuerer HM, Gonzalez-Angulo AM, et al. Impact of chemotherapy sequencing on local-regional failure risk in breast cancer patients undergoing breast-conserving therapy. Ann Surg. 2013;257(2):173–9.
44. Golshan M, Cirrincione CT, Sikov WM, Carey LA, Berry DA, Overmoyer B, et al. Impact of neoadjuvant therapy on eligibility for and frequency of breast conservation in stage II-III HER2-positive breast cancer: surgical results of CALGB 40601 (Alliance). Breast Cancer Res Treat. 2016;160(2):297–304.
45. Smith BL. Neoadjuvant versus adjuvant systemic therapy for operable breast cancer: equivalent outcomes? Ann Surg. 2013;257(2):180–1.

46. Adrada BE, Huo L, Lane DL, Arribas EM, Resetkova E, Yang W. Histopathologic correlation of residual mammographic microcalcifications after neoadjuvant chemotherapy for locally advanced breast cancer. Ann Surg Oncol. 2015;22(4):1111–7.
47. Goldberg H, Zandbank J, Kent V, Leonov-Polak M, Livoff A, Chernihovsky A, et al. Chemotherapy may eradicate ductal carcinoma in situ (DCIS) but not the associated microcalcifications. Eur J Surg Oncol. 2017;43(8):1415–20.
48. Kaufmann M, von Minckwitz G, Bear HD, Buzdar A, McGale P, Bonnefoi H, et al. Recommendations from an international expert panel on the use of neoadjuvant (primary) systemic treatment of operable breast cancer: new perspectives 2006. Ann Oncol. 2007;18(12):1927–34.
49. Keune JD, Jeffe DB, Schootman M, Hoffman A, Gillanders WE, Aft RL. Accuracy of ultrasonography and mammography in predicting pathologic response after neoadjuvant chemotherapy for breast cancer. Am J Surg. 2010;199(4):477–84.
50. Eisenhauer EA, Therasse P, Bogaerts J, Schwartz LH, Sargent D, Ford R, et al. New response evaluation criteria in solid tumours: revised RECIST guideline (version 1.1). Eur J Cancer. 2009;45(2):228–47.
51. Chagpar AB, Middleton LP, Sahin AA, Dempsey P, Buzdar AU, Mirza AN, et al. Accuracy of physical examination, ultrasonography, and mammography in predicting residual pathologic tumor size in patients treated with neoadjuvant chemotherapy. Ann Surg. 2006;243(2):257–64.
52. Fukuda T, Horii R, Gomi N, Miyagi Y, Takahashi S, Ito Y, et al. Accuracy of magnetic resonance imaging for predicting pathological complete response of breast cancer after neoadjuvant chemotherapy: association with breast cancer subtype. Springerplus. 2016;5:152.
53. Straver ME, Loo CE, Rutgers EJ, Oldenburg HS, Wesseling J, Vrancken Peeters MJ, et al. MRI-model to guide the surgical treatment in breast cancer patients after neoadjuvant chemotherapy. Ann Surg. 2010;251(4):701–7.
54. Schaefgen B, Mati M, Sinn HP, Golatta M, Stieber A, Rauch G, et al. Can routine imaging after neoadjuvant chemotherapy in breast Cancer predict pathologic complete response? Ann Surg Oncol. 2016;23(3):789–95.
55. Marinovich ML, Macaskill P, Irwig L, Sardanelli F, von Minckwitz G, Mamounas E, et al. Meta-analysis of agreement between MRI and pathologic breast tumour size after neoadjuvant chemotherapy. Br J Cancer. 2013;109(6):1528–36.
56. Heil J, Kümmel S, Schaefgen B, Paepke S, Thomssen C, Rauch G, et al. Diagnosis of pathological complete response to neoadjuvant chemotherapy in breast cancer by minimal invasive biopsy techniques. Br J Cancer. 2015;113(11):1565–70.
57. Prati R, Minami CA, Gornbein JA, Debruhl N, Chung D, Chang HR. Accuracy of clinical evaluation of locally advanced breast cancer in patients receiving neoadjuvant chemotherapy. Cancer. 2009;115(6):1194–202.
58. Kwong MS, Chung GG, Horvath LJ, Ward BA, Hsu AD, Carter D, et al. Postchemotherapy MRI overestimates residual disease compared with histopathology in responders to neoadjuvant therapy for locally advanced breast cancer. Cancer J. 2006;12(3):212–21.
59. Yuan Y, Chen XS, Liu SY, Shen KW. Accuracy of MRI in prediction of pathologic complete remission in breast cancer after preoperative therapy: a meta-analysis. AJR Am J Roentgenol. 2010;195(1):260–8.
60. Esserman LE, d'Almeida M, Da Costa D, Gerson DM, Poppiti RJ. Mammographic appearance of microcalcifications: can they change after neoadjuvant chemotherapy? Breast J. 2006;12(1):86–7.
61. Moskovic EC, Mansi JL, King DM, Murch CR, Smith IE. Mammography in the assessment of response to medical treatment of large primary breast cancer. Clin Radiol. 1993;47(5):339–44.
62. Li JJ, Chen C, Gu Y, Di G, Wu J, Liu G, et al. The role of mammographic calcification in the neoadjuvant therapy of breast cancer imaging evaluation. PLoS One. 2014;9(2):e88853.
63. Weiss A, Lee KC, Romero Y, Ward E, Kim Y, Ojeda-Fournier H, et al. Calcifications on mammogram do not correlate with tumor size after neoadjuvant chemotherapy. Ann Surg Oncol. 2014;21(10):3310–6.

64. Marinovich ML, Houssami N, Macaskill P, Sardanelli F, Irwig L, Mamounas EP, et al. Meta-analysis of magnetic resonance imaging in detecting residual breast cancer after neoadjuvant therapy. J Natl Cancer Inst. 2013;105(5):321–33.
65. Rosen EL, Blackwell KL, Baker JA, Soo MS, Bentley RC, Yu D, et al. Accuracy of MRI in the detection of residual breast cancer after neoadjuvant chemotherapy. AJR Am J Roentgenol. 2003;181(5):1275–82.
66. Weatherall PT, Evans GF, Metzger GJ, Saborrian MH, Leitch AM. MRI vs. histologic measurement of breast cancer following chemotherapy: comparison with x-ray mammography and palpation. J Magn Reson Imaging. 2001;13(6):868–75.
67. Marszalek D, Noël JC, Simon P. [Post operative complications after neoadjuvant systemic therapy in primary breast cancer treatment – case-control study]. Rev Med Brux. 2016;37(6):469–75.
68. Abt NB, Flores JM, Baltodano PA, Sarhane KA, Abreu FM, Cooney CM, et al. Neoadjuvant chemotherapy and short-term morbidity in patients undergoing mastectomy with and without breast reconstruction. JAMA Surg. 2014;149(10):1068–76.
69. Boughey JC, McCall LM, Ballman KV, Mittendorf EA, Ahrendt GM, Wilke LG, et al. Tumor biology correlates with rates of breast-conserving surgery and pathologic complete response after neoadjuvant chemotherapy for breast cancer: findings from the ACOSOG Z1071 (Alliance) Prospective Multicenter Clinical Trial. Ann Surg. 2014;260(4):608–14; discussion 14–6.
70. Chiba A, Hoskin TL, Heins CN, Hunt KK, Habermann EB, Boughey JC. Trends in neoadjuvant endocrine therapy use and impact on rates of breast conservation in hormone receptor-positive breast Cancer: a National Cancer Data Base Study. Ann Surg Oncol. 2017;24(2):418–24.
71. Criscitiello C, Curigliano G, Burstein HJ, Wong S, Esposito A, Viale G, et al. Breast conservation following neoadjuvant therapy for breast cancer in the modern era: are we losing the opportunity? Eur J Surg Oncol. 2016;42(12):1780–6.
72. Criscitiello C, Azim HA, Agbor-tarh D, de Azambuja E, Piccart M, Baselga J, et al. Factors associated with surgical management following neoadjuvant therapy in patients with primary HER2-positive breast cancer: results from the NeoALTTO phase III trial. Ann Oncol. 2013;24(8):1980–5.
73. Tan MP. Is there an ideal breast conservation rate for the treatment of breast cancer? Ann Surg Oncol. 2016;23(9):2825–31.
74. McGuire KP, Santillan AA, Kaur P, Meade T, Parbhoo J, Mathias M, et al. Are mastectomies on the rise? A 13-year trend analysis of the selection of mastectomy versus breast conservation therapy in 5865 patients. Ann Surg Oncol. 2009;16(10):2682–90.
75. Feigelson HS, James TA, Single RM, Onitilo AA, Aiello Bowles EJ, Barney T, et al. Factors associated with the frequency of initial total mastectomy: results of a multi-institutional study. J Am Coll Surg. 2013;216(5):966–75.
76. Morrow M, Harris JR, Schnitt SJ. Surgical margins in lumpectomy for breast cancer – bigger is not better. N Engl J Med. 2012;367(1):79–82.

32 Using Oncoplastic Techniques to Salvage Poor Outcomes of Breast Conservation

Maurizio Bruno Nava, Giuseppe Catanuto,
and Nicola Rocco

Introduction

Breast-conserving surgery (BCS) followed by radiation therapy represents the gold standard for the surgical treatment of early-stage breast cancer, achieving comparable results in terms of overall survival to those of mastectomy as demonstrated by the historical randomized trials of Veronesi and Fisher, with the consequent impact on patient's quality of life [1, 2].

However, the aesthetic results of breast-conserving surgery are not always acceptable, resulting in breast shape distortion and deformities in up to 30% of cases, 5% being a severe distortion [3–8].

The aesthetic result depends on several factors, in particular the location and size of the tumor to be excised and the breast size excisions of no more than 10–15% of the breast volume will determine acceptable results [9].

The impact of post-breast-conserving surgery radiotherapy on residual breast tissues makes the surgical correction of deformities really challenging.

M. B. Nava
School of Plastic Surgery, University of Milan, Milan, Italy

Group for Reconstructive and Therapeutic Advancements, G.RE.T.A, Milan, Naples, Catania, Italy

G. Catanuto
Group for Reconstructive and Therapeutic Advancements, G.RE.T.A, Milan, Naples, Catania, Italy

Multidisciplinary Breast Unit, Azienda Ospedaliera Cannizzaro, Catania, Italy

N. Rocco (✉)
Group for Reconstructive and Therapeutic Advancements, G.RE.T.A, Milan, Naples, Catania, Italy

Department of Clinical Medicine and Surgery, University of Naples "Federico II", Naples, Italy

V. S. Klimberg et al. (eds.), *Oncoplastic Breast Surgery Techniques for the General Surgeon*, https://doi.org/10.1007/978-3-030-40196-2_32

This is why preventing poor results with oncoplastic breast surgery techniques remains mandatory.

Berrino and colleagues proposed four-level classification for sequelae after BCS [10, 11].

Clough and colleagues suggested a three-level system, with type I involving symmetrizing surgery to the contralateral breast and type III involving mastectomy with immediate reconstruction. All other deformities have been categorized as type II defects [12].

Classification of Deformities

Deformities could be classified in radiotherapy damage and fibrosis, anatomical malpositions, parenchymal defects, and asymmetries.

Fitoussi and colleagues suggest a classification of the severity of the deformity in five grades:

- Grade I. Minimal deformities not affecting the shape or the volume of the breast, with the possibility of improving results with scar revision and autologous fat transfer.
- Grade II. Asymmetry due to the bigger volume or higher degree of ptosis of the untreated breast without significant alteration of treated breast shape or volume, with the possibility of improving the results with a contralateral breast symmetrization.
- Grade III. The shape of the treated breast is not acceptable, with a dislocation of the nipple-areola complex (NAC). In these cases, a NAC repositioning is necessary with a remodeling of breast parenchyma to restore an acceptable shape.
- Sometimes the residual breast volume after BCT is so little that an implant-based augmentation is required with contralateral symmetrization with different volume implants.
- Grade IV. The shape of the breast is severely compromised with a residual breast tissue localized volume defect, with the need of flap transfer to recover volume and healthy skin coverage. Intercostal artery perforator (ICAP) flaps could be used with good cosmetic results.
- Grade V. Severe deformity of the entire breast as a consequence of both surgery and radiotherapy, with the only option of mastectomy and immediate autologous tissues reconstruction (free muscle-sparing flaps).

Contralateral symmetrization could be required in the treatment of grade III, IV, and V deformities.

Outcomes Following BCS Deformities Surgery

Surgery for deformities after BCS is challenging due to the previous damage to soft tissue due to the effect of radiotherapy. Clough reports 14.2% of overall complications (20/141) delayed wound healing and cutaneous necrosis with need for re-intervention in 5.7% (8/141) [13]. The authors report reduced complication rates in the grade II deformities correction, as surgery is performed on non-radiotreated tissues and higher complication rates in grade IV and V deformities.

Clough and colleagues report not long-lasting aesthetic outcomes due to the long-term "stigmata" of radiotherapy. More stable results are reported in grade IV–V deformities corrected with autologous tissue flaps. The authors report a need for further revisional surgery in 19.1% (27/141) and 6.4% required a third procedure. The rate of additional surgery increased with the grade of deformity [13].

Discussion

The widespread use of oncoplastic breast techniques is reducing poor aesthetic outcomes following breast-conserving surgery. However, we still treat post-BCT deformities.

We are firmly convinced that an algorithmic and standardized approach remains the only way to succeed, obtaining long-term satisfactory aesthetic results.

Patients must be carefully informed about the increased incidence of complications and possibility of further procedures to optimize aesthetic outcomes or revise further asymmetries.

As delayed repair appears mostly unsatisfactory, it is clear that prevention of significant deformities must be always attempted with the use of primary oncoplastic techniques. The most frequent factors motivating a patient to ask for reconstruction after standard BCS are (1) volume difference of more than 20%, (2) contour deformity, and (3) nipple malposition.

The most common causes of unfavorable results in standard BCT include:

1. Removal of more than 15–20% of the breast parenchyma in a small volume breast or more than 30% in a larger breast;
2. Removal of tissue in an aesthetically sensitive area, as the cleavage area. Contour deformities could become more severe if the defect results in adherence of the skin to the pectoralis fascia or muscle and this is a potential occurrence when less than 1–2 cm of subcutaneous tissue is left on the skin flap. This defect could be evident later in the postoperative course as the seroma will be reabsorbed over time. All these deformities will be enhanced by the effects of radiation therapy;
3. Removal of even a small amount of skin adjacent the NAC could result in nipple malposition and this defect is difficult to hide. This deformity could be frequently evident after a transverse excision in the lower pole of the breast resulting in a severe nipple malposition [14].

The parameters that most significantly affect the aesthetic outcome following a standard BCT are the extent and location of the tumor and volume of resection, degree of ptosis, breast volume, and the ratio between tumor volume and breast size. The estimation of the impact of radiotherapy will also be thoroughly considered when planning a BCT [15].

In Table 32.1, we present our oncoplastic breast surgery approach to improve the poor aesthetic outcomes of standard breast-conserving surgery, with a growing level of complexity in relation with the entity of the initial post-BCS deformity (Figs. 32.1, 32.2, 32.3, 32.4, 32.5, 32.6, 32.7, and 32.8).

Table 32.1 Post-BCT deformity classification and possible approach to correct the defect

Grade of deformity	How to correct the defect
Grade I	Fat transfer or scar revision
Grade II	Contralateral symmetrizations
Grade III	NAC repositioning and parenchymal redistribution—bilateral augmentation with different volume implants if possible
Grade IV	Localized volume defect—> latissimus dorsi flap, perforator flaps
Grade V	Whole breast deformity—> D.I.E.P.

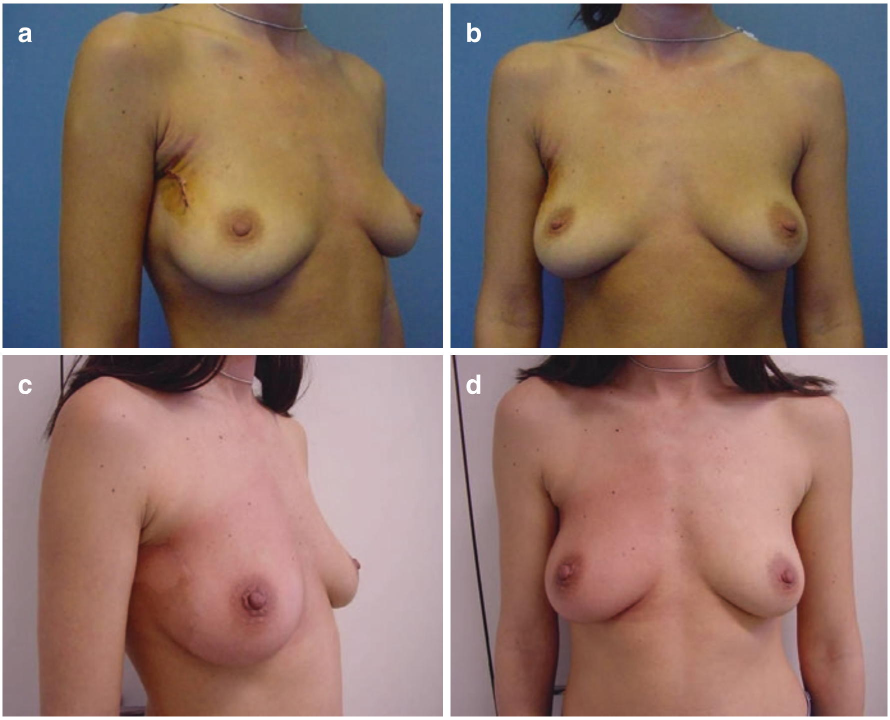


Fig. 32.1 (**a, b**) Grade I post-BCT deformity. (**c**, **d**) Z-plasty of the surgical scar post-RT

Fig. 32.2 (**a, b**) Grade I post-BCT deformity; (**c, d**) postoperative result following fat grafting

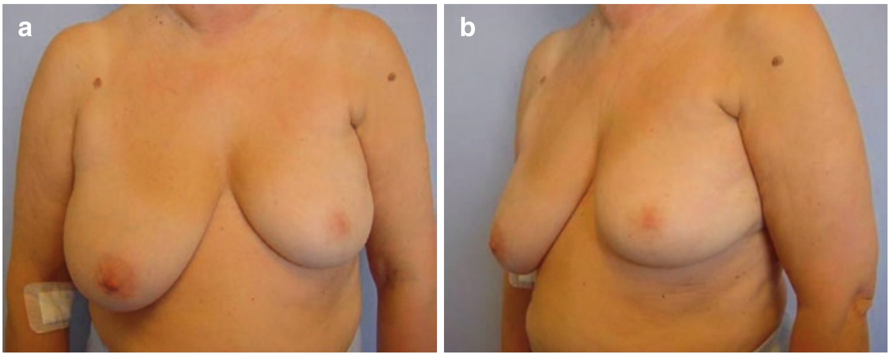


Fig. 32.3 (**a, b**) Grade II post-BCT deformity. (**c, d**) Wise pattern mastopexy right symmetrization - Immediate postoperative result; (**e**, **f**) 10-year postoperative result

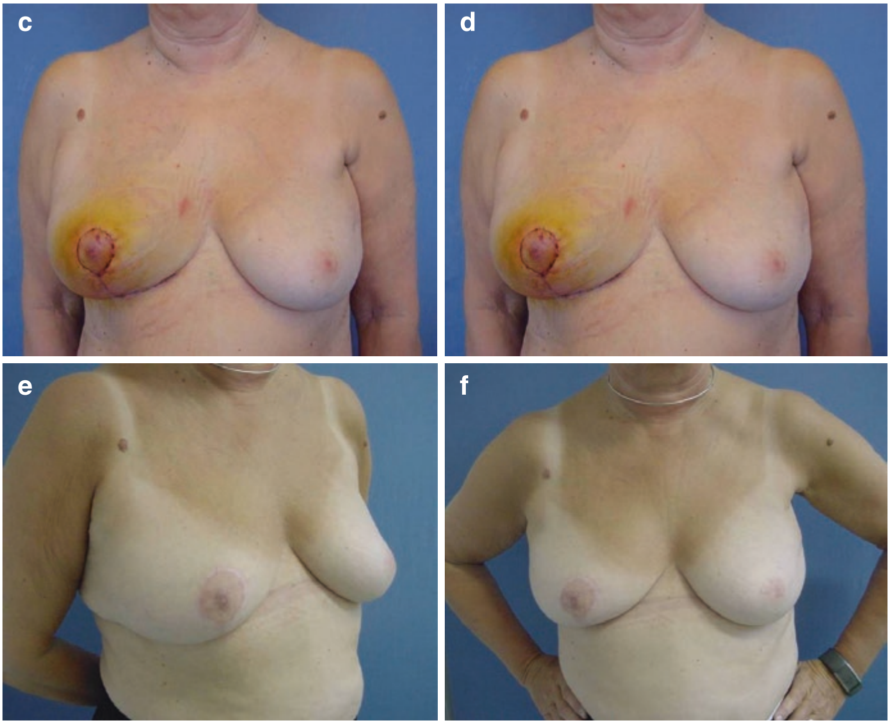


Fig. 32.3 (continued)

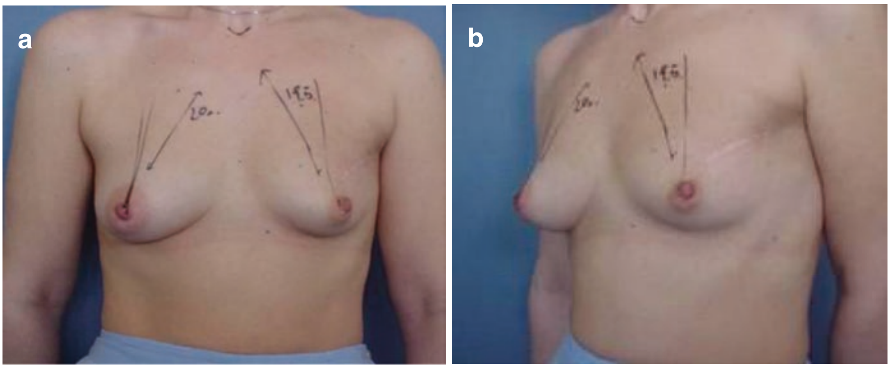


Fig. 32.4 (**a**, **b**) Post-BCT Grade IV deformity; (**c**, **d**) preoperative markings; (**e**) horizontal latissimus dorsi surgical project; (**f**, **g**) 5-year postoperative follow-up

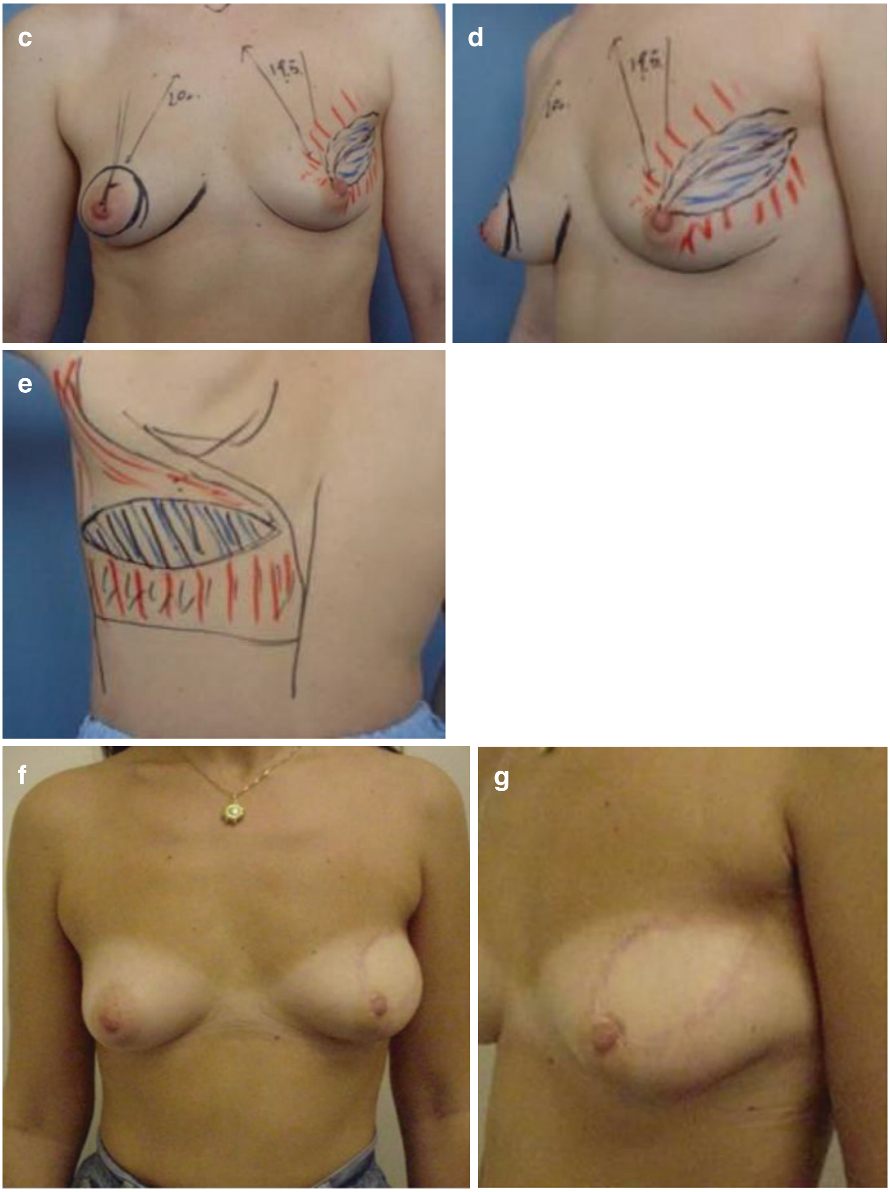


Fig. 32.4 (continued)

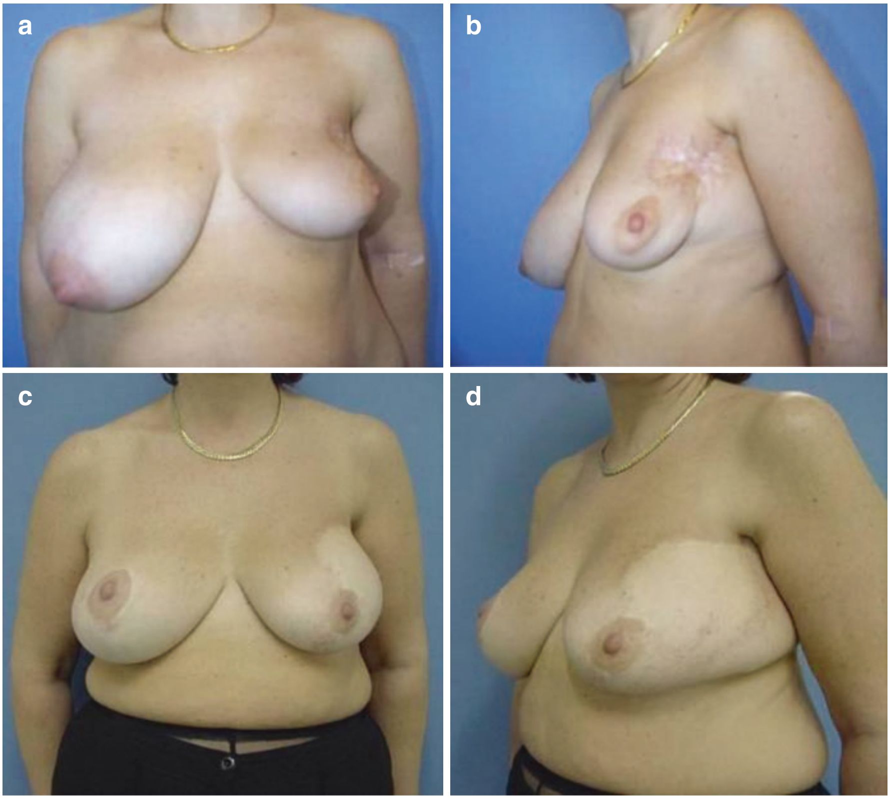


Fig. 32.5 (**a**, **b**) Post-BCT Grade IV deformity; (**c**, **d**) postoperative follow-up following a left latissimus dorsi flap and a right Wise pattern mastopexy

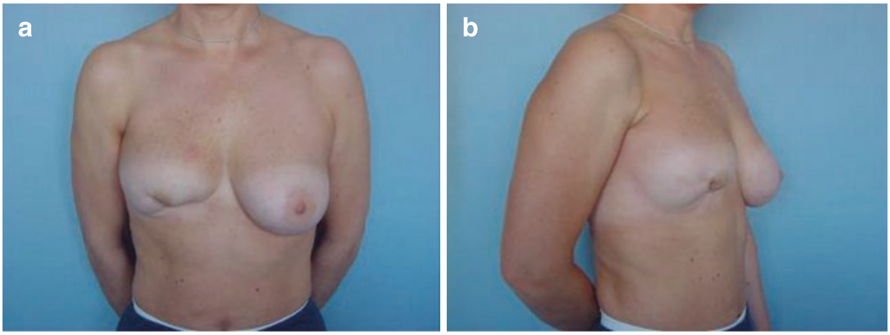


Fig. 32.6 (**a, b**) Post-BCT Grade IV deformity; (**c**, **d**) 5-year postoperative follow-up following a latissimus dorsi flap plus implant

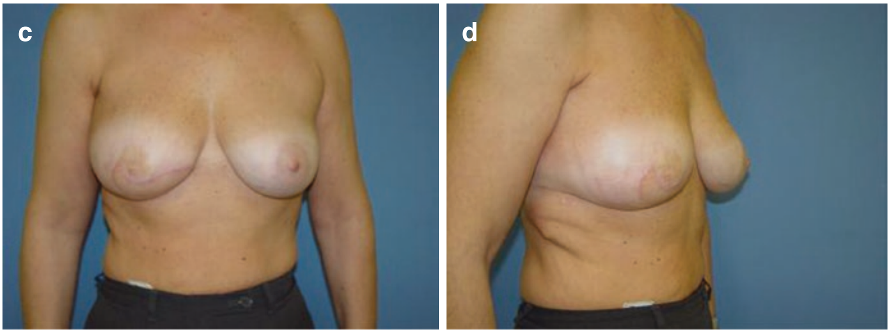


Fig. 32.6 (continued)

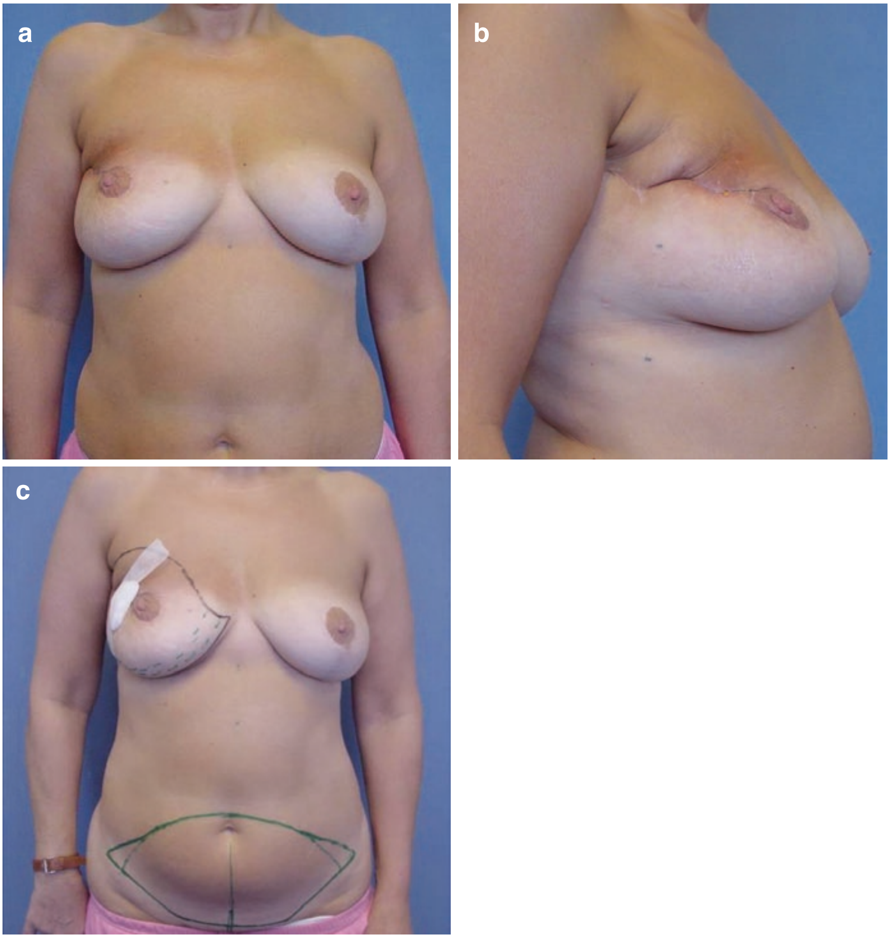


Fig. 32.7 (**a**, **b**) Post-BCT Grade V deformity; (**c**) preoperative markings for a DIEP flap; (**d**, **e**) 4-year postoperative follow-up

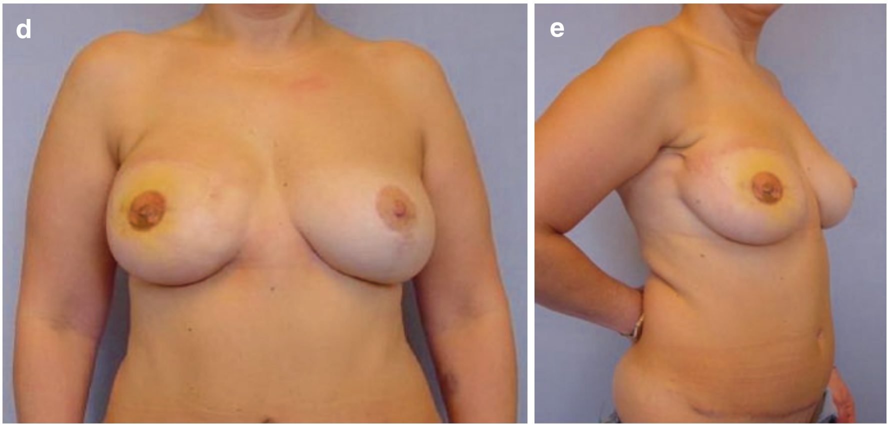


Fig. 32.7 (continued)

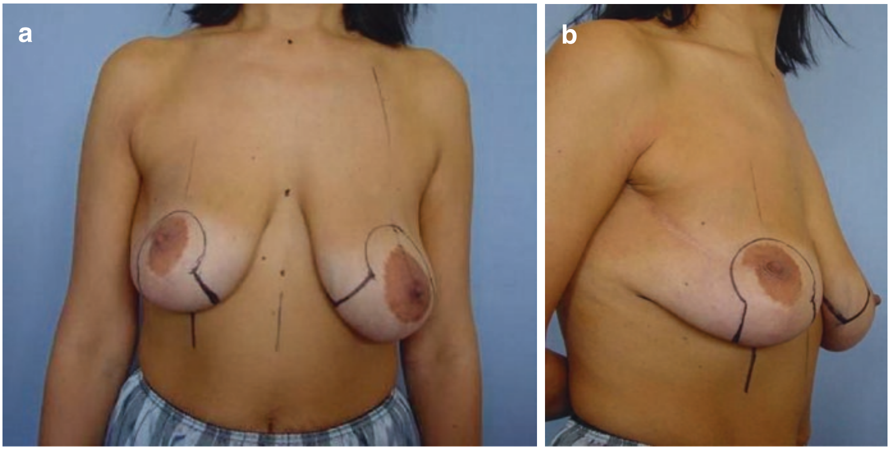


Fig. 32.8 Grade II post-BCT deformity. Symmetrization post right upper-outer quadrant standard BCS through a Wise pattern mastopexy. (**a**, **b**) Preoperative markings; (**c**) surgical tips: it is advisable to prepare thick flaps and to preserve all the perforators to deal with the effects of radiotherapy; (**d**) immediate postoperative follow-up; (**e**) 8-year postoperative follow-up

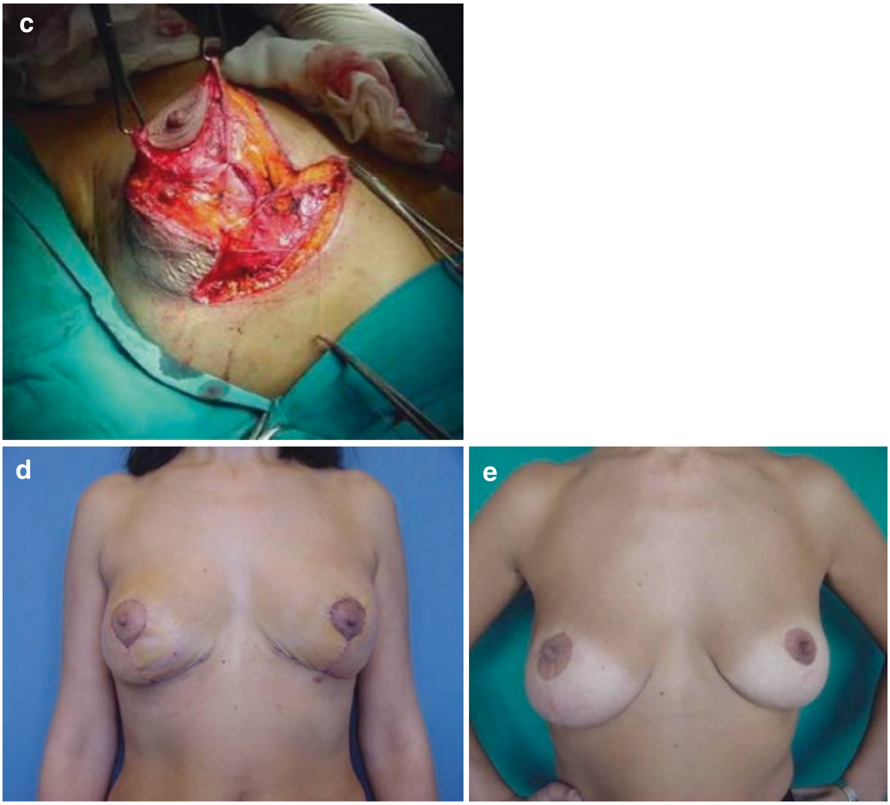


Fig. 32.8 (continued)

References

1. Fisher B, Anderson S, Bryant J, et al. 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. 2002;347:1233–41.
2. Veronesi U, Cascinelli N, Mariani L, et al. Twenty-year follow-up of a randomised study comparing breast-conserving surgery with radical mastectomy for early breast cancer. N Engl J Med. 2002;347:1227–32.
3. Chan SWW, Chueng PSY, Lam SH. Cosmetic outcome and percentage of breast volume excision in oncoplastic breast conserving surgery. World J Surg. 2010;34:1447–52.
4. Fujishiro S, Mitsumori M, Kokubo M, Nagata Y, Sasai K, Mise K, Kodama H, Hiroka M. Cosmetic results and complications after breast conserving therapy for early breast cancer. Breast Cancer. 2000;7:57–63.
5. Semprini G, Cattin F, Vaienti L, Brizzolari M, Cedolini C, Parodi PC. Oncoplastic surgery and cancer relapses: cosmetic and oncological results in 489 patients. Breast. 2013;22:946–51.
6. Olivotto IA, Rose MA, Osteen R, et al. Late cosmetic outcome after conservative surgery and radiotherapy: analysis of causes of cosmetic failure. Int J Radiat Oncol Biol Phys. 1989;17:747–53.

7. Moro G, Ciambellotti E. Evaluation of the aesthetic results of conservative treatment of breast cancer. Tumori. 1993;79:258–61.
8. Clough KB, Cuminet J, Fitoussi A, Nos C, Mosseri V. Cosmetic sequelae after conservative treatment for breast cancer: classification and results of surgical treatment. Ann Plast Surg. 1998;41:471–81.
9. Cochrane RA, Valasiadou P, Wilson AR, Al-Ghazal SK, Macmillan RD. Cosmesis and satisfaction after breast-conserving surgery correlates with the percentage of breast volume excised. Br J Surg. 2003;90:1505–9.
10. Berrino P, Campora E, Santi P. Postquadrantectomy breast deformities: classification and techniques of surgical correction. Plast Reconstr Surg. 1987;79:567–72.
11. Berrino P, Campora E, Leone S, Santi P. Correction of type II breast deformities following conservative cancer surgery. Plast Reconstr Surg. 1992;90:846–53.
12. Clough KB, Thomas SS, Fitoussi AD, Courturaud B, Reyal F, Falcou M-C. Reconstruction after conservative treatment for breast cancer: cosmetic sequelae classification revisited. Plast Reconstr Surg. 2004;114:1743–53.
13. Fitoussi AD, Berry MG, Couturaud B, Falcou MC, Salmon RJ. Management of the post-breast-conserving therapy defect: extended follow-up and reclassification. Plast Reconstr Surg. 2010;125(3):783–91.
14. Nahabedian M. Oncoplastic surgery of the breast. St. Louis: Saunders Elsevier; 2009.
15. Petit JY, Rrigaut L, Zekri A, et al. Poor esthetic results after conservative treatment of breast cancer: technics of partial breast reconstruction. Ann Chir Plast Esthet. 1989;34(2):103–8.

33 Oncological Outcomes and Safety of Oncoplastic Breast Conservation

Laszlo Romics and Esther Jennifer Campbell

Introduction

Breast conservation treatment (BCT) defined as breast conservation surgery (BCS) with whole breast irradiation is the standard of care in the management of early breast cancer. The goal of standard BCT (sBCS) is tumour-free resection margins and good local control. An important secondary goal is a satisfactory cosmetic outcome as this is associated with both patient satisfaction and improved quality of life [1]. Poor cosmetic outcomes can affect up to 40% of patients undergoing BCT [2]. There are many factors influencing the ultimate cosmetic outcome, including host factors, adjuvant therapy administered and tumour location in breast; however, the percentage of breast volume excised is the single most important factor influencing cosmetic outcome [1]. How the breast looks after treatment is so important because of the correlation between cosmetic outcome and the patients' anxiety and depression score, body image, sexuality and self-esteem [3].

In the last decade BCT has evolved to ensure both adequate oncological resection and good cosmetic outcome for patients even with larger tumours. There is increasing utilisation of neoadjuvant chemotherapy or endocrine therapy to enable tumour shrinkage [4]. However, response to neoadjuvant treatment is variable and some invasive cancers are associated with widespread malignant calcifications; subsequently even if the invasive tumour response to treatment is successful, a large surgical excision of the tumour "footprint" may be required. Oncoplastic

L. Romics (✉)
Department of Surgery, New Victoria Hospital, Glasgow, UK

Department of Academic Surgery, University of Glasgow, Glasgow, UK
e-mail: Laszlo.Romics@glasgow.ac.uk

E. J. Campbell
Department of Surgery, University Hospital Crosshouse, Crosshouse, Kilmarnock, UK

V. S. Klimberg et al. (eds.), *Oncoplastic Breast Surgery Techniques for the General Surgeon*, https://doi.org/10.1007/978-3-030-40196-2_33

breast conservation surgery (OBC) with or without neoadjuvant therapy facilitates tumour excision with a wide margin of resection followed by immediate reconstruction of the defect (partial breast reconstruction), thus preserving a natural breast shape. The aim of OBC is to maintain quality of life with an acceptable breast appearance without compromising on oncological effectiveness. The oncological effectiveness is always the priority in treatment; however, avoiding poor aesthetic outcome has quality-of-life benefits for patients in which long-term, disease-free survival is the goal.

OBC has become widely accepted and adopted into routine clinical practice. Accurate national data on current utilisation and practice of OBC is limited [5]. A 2010 French national survey of breast cancer referrals led by Clough et al. demonstrated that of the 13,762 patients evaluated, 71% had breast conservation. Of these 13.9% received level 2 OPBC, either upfront or after neoadjuvant chemotherapy [6]. A study from the MD Anderson Cancer Centre in the USA demonstrated that OBC had a nearly fourfold increase in the percentage of all breast cancer surgeries performed (from 4% to 15%) between 2007 and 2014. In 2014 OBC accounted for over 33% of all breast conservation surgeries [7]. The techniques of OBC previously required either specialist oncoplastic training for breast surgeons or a combined approach between breast oncological surgeon and plastic surgeons. In the UK, competency in mammoplasty techniques and involvement in pedicled flaps is now a certificate of completion of training requirement for all general surgeons with a breast sub-speciality interest; subsequently, all newly appointed consultant breast surgeons in the UK will be trained in the techniques of mammoplasty.

Despite the widespread adoption of OBC, there is limited high-quality evidence to support the oncological safety of this approach [2, 5, 8, 9]. OBC utilises the principles of sBCS; however, the landmark prospective randomised trials that established the safety and efficacy of BCT mostly included patients with small tumours [10, 11]. Patients who are treated with OBC often have larger tumours; in studies over half the patients treated with OBC had T2–T3 cancers [12–22]. Randomised trials comparing OBC to sBCS or mastectomy +/− immediate reconstruction (IR) are unlikely to happen given the complex ethical issues. However, it is increasingly recognised that oncological safety is more strongly associated with factors inherent to the patient and tumour biology than the surgical technique used concerns regarding the oncological safety of OBC exist [23]. Most published OBC studies are single centre, observational or comparative studies (level III or IV evidence). Many studies are limited in patient numbers and length of follow-up. Systematic review and meta-analysis have been performed but conclusions often limited due to heterogeneous reporting between studies and limited follow-up time [2, 8, 9, 24]. In this chapter, which includes a literature review of the best current available evidence, the key issues regarding oncological safety in OBC will be discussed including: preoperative planning; tumour resection margins and re-excision rates; local recurrence and patient outcome; postoperative complications, adjuvant therapy delivery and postoperative surveillance.

Preoperative Planning

Indications for OBC include: anticipated poor cosmetic outcome with sBCS, large tumours that do not require neoadjuvant treatment (e.g. ductal carcinoma in situ (DCIS)), invasive carcinoma with extensive DCIS, large tumours that do not respond well to neoadjuvant therapy or multifocal/multicentric tumours. Breast reduction is increasingly performed at the time of oncological resection, even for very small tumours in patients with macromastia. This is a reasonable option for such woman wishing a reduction as this can prevent complications associated with irradiation of large breasted woman such as lymphoedema, fibrosis and chronic pain, as well as achieve a quality-of-life benefit [8, 25]. Additionally, OBC is increasingly being utilised as an alternative to mastectomy +/− immediate reconstruction; this approach may offer a lower complication rate compared with mastectomy and reconstruction, particularly if radiotherapy is being given in the adjuvant setting [5, 7, 26]. Other potential benefits of this approach include improved patient satisfaction, quality of life, as well as decreased health care costs compared to full breast reconstruction [27]. For many women OBC offers the best, simplest, lowest risk and sometimes only option for a good aesthetic and practical outcome of breast cancer surgery [25].

The ‘rules’ of OBC were established almost two decades ago [14]: OBC should be compatible with multidisciplinary treatment, cause no delay in postoperative treatments; have comparable results in terms of local recurrence, survival, and have better cosmetic outcome results than patients treated with standard lumpectomy. These guidelines are still largely applicable and considered general principles in OBC. However, patient reported outcomes should be considered more valuable evidence than cosmetic outcome as judged by panel surgeons, or preferably both considered in conjunction. Additionally, OBC is increasingly being used as an alternative to mastectomy +/− immediate reconstruction (IR); therefore, outcomes should also be compared to mastectomy patients [21]. When the histopathological features of patients treated with OBC, sBCS and mastectomy +/− IR in 1000 consecutive operable breast cancer patients were compared, tumour size, grade, nodal status and hormone receptor expression were all significantly less favourable in the OBC cohort compared to sBCS [21]. The striking similarities between OBC and mastectomy patient’s histopathology results suggest that when analysing recurrence rates and survival this should be compared to both mastectomy and sBCS patients.

There is a large repertoire of oncoplastic procedures varying in complexity. Expert centres in Europe have published guidelines to aide patient selection and optimal surgical procedure for patients requiring OBC [28]. As surgeons treating breast cancer patients, increasingly we find ourselves explaining options to our patients. In general, when different options are available, the simplest is preferable and many women are accepting of small indentations and asymmetries. Given the wide range of procedures and techniques described the experience of the surgeon is important for both planning and execution of techniques. It is very possible to minimise complications with careful planning and patient selection. It is vital that a surgeon has minimal complications with standard mammoplasty techniques before applying them to the cancer setting [25]. The surgeon needs to review the patient preoperatively for surgical planning and discuss the case within a multidisciplinary team considering the patient, the tumour burden (stage of disease), the tumour biology (including neoadjuvant options and likely adjuvant treatment) along with decision regarding whether breast conservation is feasible based on radiological and clinical assessment of the patient. Patients with co-morbidities should avoid more complex procedures due to longer operation times, with attention to single incision lines to avoid the vulnerable T junction whilst considering their cosmetic and functional well-being. There is no consensus on symmetrising contralateral surgery. It is the authors' opinion that an aim of OBC is one procedure if possible and there is rarely any benefit in delaying a symmetrising procedure if the patient desires, as it will leave the patient with significant asymmetry for variable periods of time. Advocates of delayed symmetrising procedures argue that poor cosmetic results occur as a result of posttreatment radiotherapy change in the treated breast.

Resection Margins

The principle of breast cancer ablative surgery is complete removal of the cancer with an adequate resection margin. Involved resection margins are one of the most important factors associated with local recurrence after BCS, and standard surgical practice is to obtain clear margins even if this requires a further surgical procedure. The evidence base for surgical margins following breast conservation is continuously evolving and there is no universal consensus on what defines a positive margin.

Involved surgical margin occurs in 20–40% of all standard BCS, and one in five BCS patients undergoes a reoperation (including re-excision or completion mastectomy) [2, 29]. OBC allows wider oncological resections; although wider negative margins are not associated with lower recurrence rates, advocates of OBC argue that wider resections reduce positive margin rate and result in less reoperations compared to standard BCS [30, 31]. Additional procedures have the potential for a delay to adjuvant treatment, further surgical complications and potentially compromise cosmetic outcome. Additionally, a further operation causes stress for patients and their families, patient discomfort and increased health care costs.

Most comparative studies that compare OBC patients with a control group (sBCS or quadrantectomy) report a significant benefit in terms of negative margins and/ or reoperation rate [7, 16, 32–36]. The largest of these was a retrospective cohort study which included 1177 patients treated with OBC [7]. The control arms included patients treated with sBCS ($n = 3559$), mastectomy only ($n = 3263$) and mastectomy plus immediate reconstruction ($n = 2608$). In terms of margin status, patients who underwent OBC had significantly less positive or close margins (5.8%) compared to sBCS (8.3%, $p = 0.04$); the study did not report on re-excisions or reoperation rates. Chakravorty et al. reported significantly less re-excision rates in OBC patients ($n = 150$) compared to sBCS ($n = 440$) [33]. In the OBC group a repeat surgical procedure was required 6.6% versus 14.5% in the sBCS ($p < 0.01$). Losken et al. compared OBC ($n = 83$) to sBCS ($n = 139$) and found similar results [36]. Despite the OBC group being younger patients with more advanced stage cancer, the incidence of positive margins was significantly less, 24% versus 41% in the OBC compared to the sBCS respectively. Approximately half as many patients in the OBC required re-excision (12% vs 26%, $p = 0.01$). Crown et al. compared re-excision rates before and after the adaption to OBC [36]. In the sBCS group ($n = 425$) the average re-excision rate was 32% versus 18% in the OBC group ($n = 387$) ($p < 0.001$) [37].

Other comparative studies have not demonstrated a significant benefit in terms of reducing incomplete excisions and reoperations, however, importantly have not demonstrated an unfavourable difference between OBC and sBCS [7, 16, 17, 21, 32–35, 38–40]. Mazouni et al. compared OBC ($n = 45$) with sBCS ($n = 214$) after neoadjuvant chemotherapy [17]. There was no difference between the two groups, in terms of margin involvement or re-excisions despite the median tumour size following chemotherapy being significantly larger in the OBC group. The European Institute of Oncology reported a large series of OBC ($n = 454$) with a sBCS control group ($n = 908$) that was matched in terms of clinicopathological features and reported no difference in the rate of involved/ close margins, approximately 10% in each group [40]. We previously reported similar rates of incomplete excision (13.4% vs 13.2%) in OBC ($n = 119$) to sBCS ($n = 600$); however, within the OBC group, tumours were significantly larger and higher grade [21].

The Paris Breast Center reported their early 5-year series of patients treated using level 2 OBC techniques ($n = 175$); 13% of patients had involved margins defined as absence of tumour cells at cut edge ('no ink on tumour') [41]. Most (73%) patients with involved margins went on to have a completion mastectomy and 13% a re-excision. The rate of involved margins was associated with histological subtype. In a recent, larger Paris Breast Center series of patients treated with oncoplastic reduction surgery ($n = 350$), the overall incidence of involved surgical margins was similar at 12.6%; similarly, involved margins varied with histological subtype [42]. Involved margins ($n = 44$) were treated with re-excision (27%), completion mastectomy (63%) and radiotherapy alone (9%).

Meta-analysis comparing OBC (including volume displacement/reduction, $n = 1773$, and volume replacement/flap, $n = 1396$) with sBCS ($n = 5994$) demonstrated that the positive margin rate was significantly lower in the OBC group (12% vs 21%, $p < 0.001$), despite the OBC group having larger tumour sizes [24]. Re-excision was more common in the sBCS group (14.6% vs 4%, $p < 0.001$); however, completion mastectomy was more common in the OBC group (6.5% vs. 3.5%, $p < 0.001$). A recent systematic review collectively evaluated over 6000 patients with T1–T2 breast cancer treated with OBC reported a weighted average positive margin rate of 10.8%, re-excision rate 6.0% and conversion to mastectomy rate 6.2% [43]. These support that the positive margin rate and subsequent reoperation rate are lower than sBCS. Other systematic reviews have failed to conclude on benefit of tumour free margins and lower re-excision rates in OBC given the diverse and heterogeneous study reporting with variation in the frequency of margin involvement ranging between 0% and 36% of patients [2, 8, 9]. Additionally, in patients with positive margins the subsequent management varied with re-excision rates of 11–75%, completion mastectomy rates of 8–100%, no further treatment or radiotherapy boost to tumour bed in some studies [8].

Despite the generous resections that are undertaken, it is clear there is a subgroup of patients who still have positive margins. Clough et al. reported on the risk factors for positive margins in OBC patients [6]. Factors significantly influencing positive margins are grade, histological subtype (invasive lobular carcinoma 27.8%; DCIS 14.1% and invasive ductal 8.0%), tumour size (T3 42.9%, T2 16% and T1 5.1%). Neoadjuvant chemotherapy was not associated with positive margins. In multivariate analysis invasive lobular carcinoma remained independently associated with risk of involved margins. A recent review of oncoplastic reductions (n = 353) demonstrated that resections over 1000 g are associated with a higher incidence of positive margins and may increase the risk for completion mastectomy [44]. Invasive lobular carcinoma and DCIS are associated with higher rate of completion mastectomy following OBC [45]. In a study including only DCIS patients treated with oncoplastic reductions (n = 28), young patients with DCIS had a 25% risk of requiring a completion mastectomy [46]. In this series, almost 50% of patients with high-grade DCIS required completion mastectomy.

Improved preoperative planning is required for patients who are considered for OBC, especially patients with invasive lobular or DCIS. The role of preoperative magnetic resonance imaging (MRI) is controversial [47]. Many centres including our own are now routinely undertaking preoperative MRI for invasive lobular carcinoma when breast conservation surgery is being considered. For patients with DCIS, mammography is the primary tool for detection; however, MRI may give a more accurate assessment of size, although its value in preoperative planning remains controversial and under evaluation [48]. Intra-operative frozen section analysis (FSA) has been reported to reduce positive margins in OBC; it has a sensitivity and specificity of 65–78% and 98–100%, respectively [49, 50]. The disadvantage of the technique, however, is that operation time prolonged and the use of FSA may compromise the accurate assessment of permanent pathology by the pathologist and subsequently FSA is not routinely undertaken in most centres.

It is clear from the current literature that the wider resections undertaken with OBC do not obviate positive tumour margins. Patients should be fully informed of this possibility. The management of involved margins is not standardised. Oncoplastic volume displacement procedures are the most commonly employed OBC procedure, and this can result in displacement of the mammary tissue and hamper subsequent re-excision of the tumour bed necessitating completion mastectomy. Although technically challenging, a second BCS after OPBC is feasible if the breast volume allows this [6]. Tumour bed marker clips are essential at the original operation, and the original oncoplastic breast surgeon should be available to perform the re-excision in a timely manner. Whenever a mastectomy is the most suitable choice, immediate breast reconstruction may still be offered. The mastectomy incision may be a concern, especially if an inverted T, J or V mammoplasty has been used and these scars may preclude immediate reconstruction with implants due to the high risk of post-mastectomy skin necrosis; however, flap reconstructions can be performed [6].

Local and Distant Recurrence and Patient Survival

The diagnosis of breast cancer includes ductal carcinoma in situ (DCIS), early breast cancer and advanced breast cancer: stages of disease that differ markedly in terms of tumour burden (or anatomical extend of disease) and differ markedly in terms of outcome and treatment strategy (Table 33.1). For patients with operable breast cancer (non-metastatic), the treatment goal is cure. The estimated 5-year survival for operable breast cancer is in the range of 70–100%. It is no longer tenable to consider breast cancer a single disease, and classification by stage does not take into consideration the heterogeneous biological nature of breast cancer. The recognition of the molecular intrinsic subtypes (luminal A/B, HER-2 enriched, basal type) which differ markedly in biological behaviour and response to therapy has been demonstrated in numerous independent datasets to correlate with prognosis. Loco-regional recurrence has historically been perceived as a failure of adequate local control; however, in the modern era there is increasing recognition that local–regional recurrence is influenced by tumour biology. Meta-analysis has demonstrated local recurrence after BCT for non-triple negative breast cancer has approximately half the risk of local relapse compared to triple negative breast cancer, and breast cancer subtype affects the number of locoregional events [51, 52]. Additionally, systemic therapy has a major impact on both local regional recurrence and distant recurrence [53]. Subsequently when discussing outcome of patients with operable breast cancer, both disease burden and disease biology should be considered.

Table 33.1 Five-year breast cancer outcome by stage

Stage	Description	Estimated 5 year survival[a]
0 non-invasive	Non-invasive breast cancer	Nearly 100%
I early breast cancer	Invasive breast cancer	Nearly 100%
IA	$T < 2$ cm	
IB	$T < 2$ m and micrometer	
II early breast cancer		About 93%
IIA	$T < 2$ cm and 1–3 node positive *or* T 2–5 cm and node negative	
IIB	$T < 5$ cm and 1–3 node positive *or* $T > 5$ cm and node negative	
III locally advanced breast cancer		About 72%
IIIA	$T > 5$ cm & 1–3 node positive	
IIIB	T any size with ulceration or >3 nodes + or inflammatory breast cancer	
IIIC	Any size/ skin and >10 nodes or supraclavicular or internal mammary nodes	
IV metastatic	Visceral and/or bone metastases	About 22%

[a]Estimates based on National Cancer Institute SEER database 2007–2013

In the landmark randomised studies that established breast conservation treatment, the 5-year local recurrence rate after breast conservation varied from 0.5% to 12% [10, 11, 54]. Recent prospective randomised trials have reported local recurrence rates as low as 1.5% at 5 years after sBCS and radiotherapy [55, 56]. Bosma et al. showed in their large retrospective analysis of more than 8000 patients that the cumulative 5-year local recurrence incidence was 2% [57]. Low local recurrence rates with equivalent survival to mastectomy support the use of breast conservation as the routine approach for all small cancers.

Large tumour size is a poor prognostic marker and may be a marker of time in situ or accelerated tumour growth and biological aggressiveness. Larger tumours have traditionally been managed with mastectomy +/− immediate reconstruction. OBC allows extensive resections and subsequently extends the possibilities of breast conservation to larger tumours that would otherwise be treated by mastectomy. Numerous studies have been published in which over half the patients treated with OBC had T2–T3 cancers [12–22]. The evidence that cancers of these sizes can be safely treated with breast conservation is not robust in the classic prospective randomised trials. Only 599 patients with T2 cancers were randomised into the arm of breast conservation with radiotherapy in three trials published by van Dongen et al., Poggi et al. and Fisher et al., although the later one randomised only up to 4 cm cancer size [54, 58, 59]. Only patients with T1 (<2 cm) cancers were randomised by Veronesi et al. and Arriagada [60, 61]. Hence, the classic randomised controlled trials do not provide sufficient evidence that breast conservation is safe in T2 cancers and above. There is lack of high-level evidence supporting the oncological safety of OBC in terms of local, distant recurrence, patient disease-free survival (DFS), overall survival (OS) and breast cancer-specific survival (BCSS). Prospective randomised trials are unlikely to ever be undertaken given the complex ethical considerations. The current evidence available detailing the oncological safety in terms of patient outcome are level 3 or 4 studies; many are limited in terms of patient numbers and length of follow-up.

In patients with large cancers treated by OBC short and intermediate term (up to 4.5 years), follow-up results are good with reported local recurrence rates between 0% and 4% [17, 33, 62, 63]. A retrospective series ($n = 79$) of patients treated by reduction mammoplasty, which included stage 0 (15%), stage I (12%), stage II (35%), stage III (19%) and stage IV (2%), reported that almost 30% of tumours within this cohort were >4 cm [63]. At a median follow-up of 39 months, they reported a local recurrence rate of 2.3%. In another series ($n = 66$) of multifocal, multicentric or locally advanced tumours, a median tumour size was 62 mm (mean 77 mm) treated with OBC, at 24 months, one patient (1.5%) experienced a local recurrence [62]. Chakravorty et al. reported equivalent safety in a retrospective comparative study that compared OBC with sBCS [33]. The OBC group included significantly larger tumours, higher grade, and more patients had received neoadjuvant chemotherapy. However, the OBC also included a significant greater number of patients with non-invasive breast cancer. There was no difference in the adjuvant treatment therapy given and no significant difference in local recurrence rates (OBC

2.7% vs sBCS 2.2%) or distant recurrence rates (1.3% OBC vs 7.5% sBCS) at median follow-up of 28 months.

Mazouni et al. compared sBCS with OBC after primary chemotherapy in a retrospective study with median follow-up of 46 months [17]. The median tumour size was 40 mm in both groups; local relapse (OBC group 4%) and distant relapse rates (OBC group 14%) were similar in both groups. The groups were equivalent in terms of tumour size, grade, nodal disease; however, the OBC had significantly less HER-2-positive patients, more ER positive suggesting better breast cancer subtypes. Gulcelik et al. performed a prospective study comparing quadrantectomy to therapeutic mammoplasty (average tumour size 2.7 cm) with a median follow-up of 33 months and reported no difference in local recurrence (<1% in the OBC group) [38]. Between the groups there was no significant difference in tumour size, ER status, HER-2 status and adjuvant treatment given. However, the study failed to detail tumour grade and nodal involvement in the two groups.

The largest comparative study is a retrospective single-institution study that included 9861 consecutive patients diagnosed between 2007 and 2014 with a median follow-up of 3.4 years [7]. Four groups were included: sBCS (n = 3559), OBC (n = 1177), mastectomy only (Mx) (n = 3263) and mastectomy plus immediate reconstruction (Mx + IR) (n = 2608). Compared to sBCS (n = 3559) patients undergoing OBC (n = 1177) had more aggressive disease. There was no difference in the proportion of hormone receptor positive or triple negative patients in the OBC group; however, they were significantly younger in age, had larger tumours, more advanced disease stage, higher tumour grade, higher incidence of multifocality, node positivity, lymphovascular invasion, more HER-2 positivity, more adjuvant chemotherapy administered and surprisingly less adjuvant hormonal therapy and adjuvant radiotherapy. Despite the marked differences in the clinic-pathological features between sBCS and OBC groups, there was no difference in 3-year recurrence free survival (94.6% OBC vs 96.1% sBCS). Actual local recurrence rates were not documented. Comparing patients undergoing Mx + IR (n = 2608) with OBC, non-invasive breast cancer and stage 0 was statistically more frequent in the Mx + IR group, although there was no difference between Mx + IR and OBC in nodal stage or triple negative breast cancer. Mx + IR invasive cancer patients compared to OBC did have higher-grade tumours, higher incidence of multifocality, higher lymphovascular invasion, lower proportion of hormone receptor positivity and higher number of HER2 positive tumours. More Mx + IR patients received adjuvant chemotherapy. Patients undergoing Mx + IR had significantly better 3-year recurrence-free survival (96.6% Mx + IR vs. 94.6% OBC, p = 0.01). The authors accounted this difference in outcome to the larger proportion of patients with in-situ or stage 0 disease in the Mx + IR group. The authors did not perform a direct statistical analysis comparing demographics of OBC to Mx (n = 3263), although Mx patients had the most advanced stage disease in the cohort, including 5% with metastatic disease. Unsurprisingly, the Mx had the worst patient outcome of all the groups. In multivariate analysis when comparing surgical procedures only Mx was significantly different from OBC, with a hazard ratio over two times that of OBC for death or recurrence. The authors concluded that OBC does not disadvantage patients in terms of short-term outcomes when compared to sBCS or Mx. Whilst this is the largest comparative study performed, the follow-up period in this study is too short to be truly meaningful in terms of local/distant recurrence or survival, especially given the heterogeneous tumour pathology between the unmatched groups.

Meta-analysis comparing OBC (including volume displacement/reduction $n = 1773$ and volume replacement/flap $n = 1396$) with sBCS ($n = 5994$) rates of locoregional recurrence (LRR) was significantly lower in OBC compared to sBCS (4% vs 7% $p < 0.0001$); the authors cautioned that because the average follow-up interval was shorter in the oncoplastic group (37 months) than in the sBCS group (64 months), accurate comparisons were difficult to make conclusions on [24]. However, they concluded that recurrence rates do not seem to be higher in patients undergoing oncoplastic surgery despite often including patients with larger tumours, but longer follow-up is necessary to determine if the oncoplastic approach truly broadens the indications for BCT with equivalent recurrence rates.

Longer follow-up is becoming available. There are 13 published studies detailing recurrence rates (including local and distant) after OBC based on at least 55 months' follow-up (Table 33.2) [13–15, 22, 36, 40, 42, 45, 64–70]. The Paris Breast Center recently published their 10-year follow-up of patients treated by reduction mammoplasty ($n = 350$) [42]. The mean pathological tumour size was 26 mm; almost 30% of the series received neoadjuvant chemotherapy. The median follow-up was 55 months, and the cumulative 5-year incidences of local, regional and distant recurrences were 2.2%, 1.1% and 14.4% respectively and the 5-year OS was 95.1% and DFS 84.8%. The European Institute of Oncology review of 149 OBC cases reported a median tumour size of 22 mm (range 3–100), and during a median follow-up of 74 months the local recurrence rate was 3% and distant recurrence rate was 13% [15]. We reported similar local recurrence rate in a consecutive series of patients treated with oncoplastic reductions ($n = 65$), 64% of patients had stage II or III disease, the mean tumour size was 29 mm and at median follow-up of 72 months, 2% local and 6% distant recurrences were detected, while the BCSS was 96% [68]. Other studies in patients with large/locally advanced breast cancers treated with OBC have demonstrated higher recurrence rates. In a prospective study of patients with locally advanced stage III breast cancer ($n = 60$), 70% received neoadjuvant chemotherapy and all were treated with OBC followed by radiotherapy [66]. At a mean follow-up of 86 months the local recurrence rate was 10% and 5-year OS was 61.7%. Within this series young age was significantly associated with risk for LRR [66]. Fitoussi et al. reported on a series of 540 OBC cases, the median tumour size was 29 mm (range 4–100), true median follow-up was 49 months and the cumulative 5-year local recurrence rate was 6.8%. The 5-year OS was 92.9% and distant DFS was 87.9% [65]. Clough et al. reported a prospective series of 101 OBC with a mean tumour size of 32 mm (range 10–70), true median follow-up of 46 months, 5-year local recurrence rate of 9.4%, OS of 95.7% and distant DFS 82.8% [13].

We analysed 5-year local recurrence and distant recurrence rates in our cohort of consecutively treated operable breast cancer patients [22]. The true median follow-up was 56 months. Patients were treated with OBC ($n = 104$), sBCS ($n = 558$) and

Table 33.2 Published local and distant recurrence rates during long-term follow-up (at least 55 months) after oncoplastic breast conservation

First author	Year	Country/institution	No. of OBC cases	Tumour size	Tumour stage	Surgical technique	Median follow up (months)	Recurrence (%)	
								LR	DR
Nos et al.	1998	France/Institut Curie	50	Tis-T4	0-IIIb	VD	60[a]	7[a]	19[a]
Clough et al.	2003	France/Institut Curie	101	Tis-T4	0-IIIb	VD	60[b]	9.4[b]	17.2[b]
Rietjens et al.	2007	Italy/European Institute of Oncology	148	Tis-T3	n/r	VD and VR	74	3	13
Caruso et al.	2008	Italy/Humanitas Cento Catanese	61	T1a-T4	n/r	VD	68	1.5	9.8
Fitoussi et al.	2010	France/Institut Curie	540	Tis-T3	0-IIIc	VD	68[c]	6.8[c]	12.1[c]
Eaton et al.	2014	USA/Emory University, Atlanta	86	Tis-T4	0-IIIb	VD	60[d]	7[d]	9[d]
Bogusevicius et al.	2014	Lithuania/University Health Sciences	60	Tis-T4	IIIa-IIIc	VD and VR	86	10	38.3
Ren et al.	2014	China, Jiangsu Cancer Hospital	91	Tis-T2	n/r	n/r	87[e]	7[e]	9[e]
Rezai et al.	2015	Germany/Dusseldorf Luisenkrankenhaus	944	Nd	n/r	VD and VR	62	4	5.1
De Lorenzi et al.	2016	Italy/European Institut of Oncology	454	T1-T4	n/r	VD and VR	86	6.7[f]	12.7[f]
Kabir et al.	2016	Glasgow/Victoria Infirmary	50	Tis-T3	0-IIIa	VD	72	2	6
Mansell et al.	2017	Glasgow/Victoria Infirmary	104	Tis-T3	n/r	VD and VR	60[g]	2[g]	7.5[g]
Clough et al.	2017	France/L'Institut du Sein -Paris Breast Center	350	Tis-T3	n/r	VD	55	2.2[h]	12.4[h]
Zaha et al.	2017	Japan/Nakayami Hospital	200	Tis-T3	n/r	VR	90	1	n/r
Emiroglu et al.	2017	Turkey/Tepecik Research Hospital	82	T1-T2	I-II	VR	121	8.7[i]	20.7[i]

VD, volume displacement; VR, volume replacement; n/r not reported; LR, local recurrence; DR, distal recurrence.
[a]Actuarial recurrence rates—true median follow-up of 48 months
[b]Actuarial recurrence rates—true median follow-up of 46 months
[c]Actuarial recurrence rates—true median follow-up of 49 months
[d]Actuarial recurrence rates—true median follow-up of 54 months
[e]Actuarial recurrence rates—true median follow-up of 83 months
[f]Actuarial rates at 10 years
[g]Actuarial recurrence- true median follow-up of 56 months
[h]Actuarial rates at 5 years
[i]At median 87 months

Mx +/– IR (n = 318). Within the OBC group, patients were younger, and tumour size, grade, nodal status and hormone receptor expression were all significantly different from sBCS, being less favourable in all aspects in the OBC group. The histological results (and adjuvant therapy application) were similar in patients treated with Mx +/– IR and OBC. There was no statistical difference in 5-year local recurrence rates between the three groups (2% OBC, 3.4% sBCS, 2.6% Mx +/– IR). In terms of distant recurrence, rates were significantly higher after Mx +/– IR and OBC (13.1% Mx +/– IR, 7.5% OBC, 3.3% sBCS, $p < 0.001$) (Fig. 33.1a, b). The higher rates of distant recurrence after OBC compared to sBCS most likely reflect the more advanced cancer pathology and biological aggressiveness in this group and do not indicate that OBC is unsafe oncologically; rather it needs to be compared to patients who undergo surgery for similar tumour pathology; hence, distant recurrence rates after mastectomy and OBC were more alike. Interestingly, in terms of DFS and BCSS, 5-year DFS after OBC was 90.7% and 93.2% after WLE compared

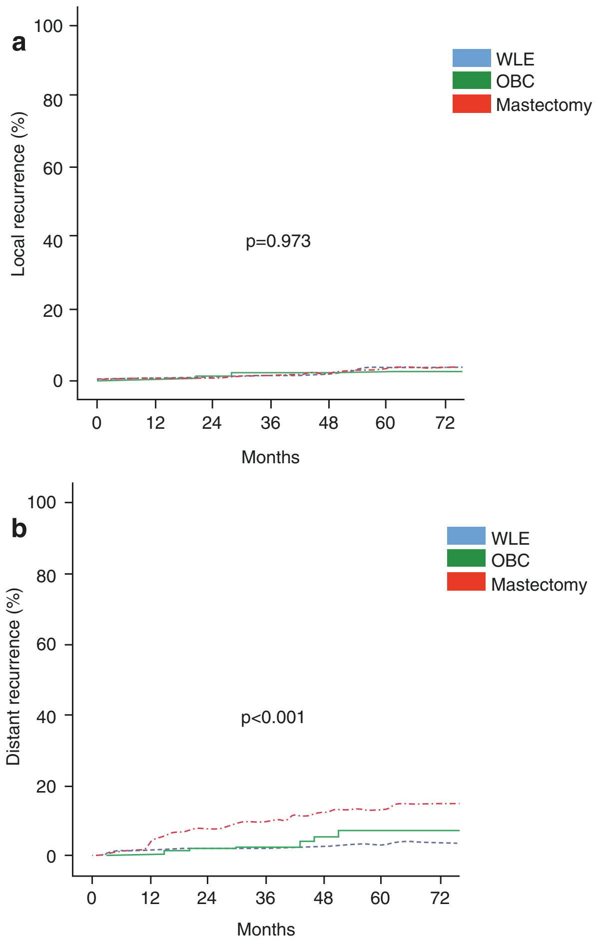


Fig. 33.1 Local recurrence (**a**) and distant recurrence (**b**) rates of patients treated with OBC, WLE and mastectomy with or without immediate reconstruction. *OBC* oncoplastic breast conservation, *WLE* wide local excision

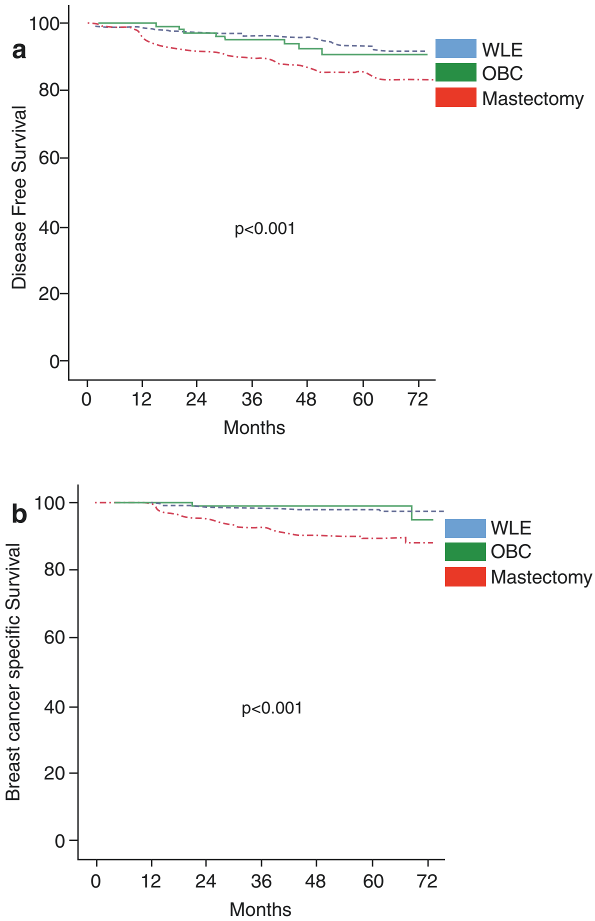


Fig. 33.2 Disease-free survival rates (**b**) and breast cancer specific survival (**b**) of patients treated with OBC, WLE and mastectomy with or without immediate reonstruction. OBC – oncoplastic breast conservation; WLE – wide local excision

to Mx +/– IR (85.6%) ($p < 0.001$), and 5-year BCSS was better after OBC (99%) and WLE (97.6%) than mastectomy (89.4%) ($p < 0.001$) (Fig. 33.2a, b).

A weakness of many comparative studies is that the control groups are not matched and it is therefore difficult to make conclusions on oncological safety and patient outcome given the heterogeneous tumour pathology. The European Institute of Oncology published two case matched studies comparing OBC to sBCS and mastectomy respectively for primary invasive breast cancer patients diagnosed between 2000 and 2008 [40, 71]. In the first study OBC ($n = 454$) was compared with sBCS ($n = 908$). Age at surgery, year of surgery and tumour size (including T1–T4) were the variables used for matching. In terms of clinic-pathological features between the two groups there was no significant differences in tumour histological type, grade, lymph node status, surgical margin involvement, tumour subtype (luminal A, B, ER+/HER+, HER2 enriched and triple negative), presence of perivascular invasion and adjuvant systemic therapy administered. The OBC group had significantly more patients with multifocal disease. The median follow-up was

7.2 years. The OS was similar (91.4% OBC vs 91.3% sBCS at 10 years). The incidence of local recurrence was slightly higher on the OBC group (3.2% vs 1.8% at 5 years; 6.7% vs 4.4% at 10 years), but this was not statistically significant, and regional and distant events were similar between the groups. In the second study, OBC ($n = 193$) was compared with mastectomy ($n = 386$) in patients with T2 invasive breast cancers. Over 90% of mastectomy patients had immediate reconstruction performed. Cases were matched using age at surgery, year of surgery and tumour subtype. In the mastectomy group, tumour multifocality was more frequent and tumours were significantly larger than in the oncoplastic group. For all other clinic-pathological features not used in the matching algorithm the two groups were well balanced. The median follow-up was 7.4 years. There was no significant difference in OS 87.3% (OBC) and 87.1% (Mx) at 10 years. DFS was similar in both groups: 60.9% (OBC) and 56.3% (Mx) at 10 years. The incidence of local events was slightly higher in the OBC group (7.3 vs 3% at 10 years), whereas the incidence of regional events was slightly higher in the mastectomy group. These differences were not statistically significant. The oncoplastic procedures described in both these studies were quite heterogeneous involving advancement of glandular flaps which suggests level 1 oncoplastic surgery. Nevertheless, these two retrospective studies, which include longer follow-up of a large series of patients compared to matched control groups, provide the best available evidence that OBC is a safe treatment option in early breast cancer.

Postoperative Complications, Delivery of Adjuvant Therapy and Surveillance

Depending on the technique of OBC applied, procedures can be complicated and lengthy, and usually involve long scars. Complications associated with surgery are therefore expected, and the surgeon should be aware of this. Along with patient discomfort, complications may require surgical intervention and can potentially delay adjuvant treatment which is a major concern for oncological safety. Leading centres in Europe which have reported on large numbers of OBC populations have complication rate of 8.9–16.3% [15, 40–42, 65]. Fitoussi et al. reported a large series ($n = 540$) of patients treated by volume displacement, 46% of patients had a contralateral symmetrisation procedure, and detailed the complications into early and late [65]. Overall the complication rate was 16.3%, most complications were early and occurred on the therapeutic side, 3% of cases required surgical intervention and <2% had a delay to adjuvant treatment. Similar rates of complications with reduction mammoplasty have been reported in other large series [44]. Reduction mammoplasty with more complex reshaping (utilising secondary dermoglandular pedicles) leads to higher complication rates, and selection of optimal mammoplasty technique can lower complications [42]. Concerns regarding complications of the donor site are unique to the volume displacement techniques. We reported a series of volume replacement OBC ($n = 30$) (including thoraco-epigastric flaps, lateral intercostal artery perforator (LICAP) flaps, thoraco-dorsal artery perforator (TDAP) flaps, lateral thoracic artery perforator (LTAP) flap, crescent flap volume replacement surgery and matrix rotations); no donor site morbidity was recorded [72]. However, partial flap failure was reported in 6.6% which subsequently required debridement.

A recent systematic review evaluating 6011 patients treated with OBC reported overall postoperative complications occurred in 14.3% of patients [43]. Wise pattern mastopexy was the most commonly utilised technique (35.4% of patients), followed by round block (14.8%) and latissimus dorsi volume replacement (9.5%). Complications included liponecrosis (3.3%), skin necrosis (0.5%), haematoma (2.5%), seroma (1.0%), delayed wound healing (2.2%), nipple necrosis (0.4%) and/or infection (1.9%). The rates of complications reported were similar to a study that compared complications between OBC and sBCS [39]. Tenofsky et al. demonstrated no statistically significant difference in the incidence of postoperative seromas, haematomas, infection, nipple necrosis and wound dehiscence between OBC and sBCS [39]. However, a higher incidence of non-healing wounds was reported in the OBC compared to sBCS (8.6% vs 1.2%), although this did not delay time to adjuvant radiotherapy. Other studies comparing OBC with sBCS report no difference in surgical complications between the groups [34, 35]. Carter et al. compared complication rates in 9861 patients treated with sBCS, OBC, mastectomy only (Mx) and mastectomy plus immediate reconstruction (Mx + IR) [7]. OBC had a significantly lower seroma rate than sBCS but wound-related complications (4.8%) were statistically higher in OBC. OBC and sBCS had similar haematoma (2%) and surgical site infection (4.5%). Compared to Mx + IR, OBC had significantly lower wound complications, surgical site infections and haematomas. A meta-analysis comparing OBC with sBCS demonstrated a significantly lower rate of complications in the OBC patients compared to sBCS, OBC reduction (16%), flap (14%) and sBCS (26%) [24]. However, the severity of complications in OBC is different with a reported need for surgical intervention in 3% in OBC.

Radiotherapy is an essential component of breast conservation treatment, and delaying radiotherapy beyond 8 weeks has been demonstrated to have a detrimental effect on local recurrence [73]. There is also evidence that delaying chemotherapy beyond 3 months following surgery may have a detrimental outcome in older patients [74]. Most OBC series report no delays to adjuvant treatments despite complications reported [12, 15, 19, 40, 46, 75–79]. A meta-analysis by Losken et al. reported no delay in timely adjuvant treatments in OBC [24]. We compared time to adjuvant chemotherapy in patients treated with OBC, sBCS or Mx +/– IR and found no significant differences [80]. However, a few studies have reported adjuvant treatment delays; delays reported in <2–4.6% of patients treated with OBC [8, 42, 65, 81]. Nevertheless, authors agree that even if some delay occurs, it is unlikely to influence prognosis.

Complications resulting from complex lengthy surgery are to be expected, and unlikely to have a negative impact on patients from an oncological safety standpoint. Appropriate technique and patient selection are required to minimise morbidity with this approach. Aggressive treatment of complications, which in a small number of patients will require surgical intervention, is appropriate, and delays to adjuvant treatments can be minimised.

Concern regarding accurate delivery of radiotherapy boosts to the tumour bed given the breast parenchymal rearrangement inherent to the majority of displacement OBC has been raised. No studies have reported cases where the tumour bed could not be localised for boost therapy. Tumour bed marking with clips is underreported in studies, but clips and good communication between oncoplastic breast surgeon and radiotherapist are essential to aid accurate tumour bed boost [82]. In cases where the clips are displaced outside the original tumour quadrant, it has been recommended the preoperative tumour quadrant should be targeted for the RT boost dose as this is the site of most ipsilateral breast local recurrences should they arise [36].

Another concern that has been raised is the potential impact OBC has on cancer surveillance. It has been reported that mammographic stabilisation in displacement techniques is longer than sBCS; however, the sensitivity and overall mammographic findings were similar [83]. We have previously reported an increased need for ultrasound and subsequent biopsies most likely related to fat necrosis in OBC compared to sBCS, but no difference was found in surveillance mammographic findings in between the two groups [84]. Piper et al. reported no increased incidence of mammographic abnormalities or biopsy despite substantial tissue rearrangement inherent to volume displacement [85]. Mele et al. studied volume replacement patients (LD miniflap) and found that mammographic surveillance was not compromised [86]. It is important that all members of the multidisciplinary team communicate well to understand what procedure has been performed and its potential implications on adjuvant treatment. It is also important that all glandular and skin flaps are as vascularised as possible, not only to better tolerate radiotherapy but also to minimise potential fat necrosis [44].

Conclusions

Oncoplastic breast surgery has rightly become an integral part of routine breast cancer surgery. Women who are treated with OBCS would have had a poor aesthetic outcome with sBCS or have been recommended a mastectomy. Oncological safety is more strongly associated with factors inherent to the patient and tumour biology than surgical approach so preoperative planning within a multidisciplinary setting considering tumour burden, tumour biology and patient selection for selected OBCS technique is required to optimise patient outcomes. OBCS enables extensive resections and subsequently the incidence of positive margins is likely reduced but not ablated. Long-term local and distant recurrence highlights the importance of comparing ‘like with like’, and based on the current evidence OBCS is a safe oncological approach even for patients with larger tumours. OBCS involves often more complex and lengthy procedures, and complications are to be expected; however, in most cases, this does not result in delays to adjuvant therapy. Postoperative surveillance does not appear to be affected, although higher rates of biopsy may be expected. Accepting the limitations of the evidence available, OBCS is an oncological safe option for patients. Randomised trials are unlikely to be undertaken given the ethical considerations; however, prospective data collection of large, preferably nationwide cohorts will significantly contribute to the generation of higher-level evidence supporting the oncological safety.

References

1. Cochrane RA, Valasiadou P, Wilson AR, Al-Ghazal SK, Macmillan RD. Cosmesis and satisfaction after breast-conserving surgery correlates with the percentage of breast volume excised. Br J Surg. 2003;90(12):1505–9.
2. Haloua MH, Krekel NM, Winters HA, Rietveld DH, Meijer S, Bloemers FW, et al. A systematic review of oncoplastic breast-conserving surgery: current weaknesses and future prospects. Ann Surg. 2013;257(4):609–20.
3. Al-Ghazal SK, Blamey RW. Cosmetic assessment of breast-conserving surgery for primary breast cancer. Breast. 1999;8(4):162–8.
4. Buchholz TA, Lehman CD, Harris JR, Pockaj BA, Khouri N, Hylton NF, et al. Statement of the science concerning locoregional treatments after preoperative chemotherapy for breast cancer: a National Cancer Institute conference. J Clin Oncol: Off J Am Soc Clin Oncol. 2008;26(5):791–7.
5. Baker E, Kim B, Rattay T, Williams K, Ives C, Remoundos D, et al. The TeaM (Therapeutic Mammaplasty) study: protocol for a prospective multi-Centre cohort study to evaluate the practice and outcomes of therapeutic mammaplasty. Int J Surg Protoc. 2016;1:3–10.
6. Clough KB, Gouveia PF, Benyahi D, Massey EJ, Russ E, Sarfati I, et al. Positive margins after oncoplastic surgery for breast cancer. Ann Surg Oncol. 2015;22(13):4247–53.
7. Carter SA, Lyons GR, Kuerer HM, Bassett RL Jr, Oates S, Thompson A, et al. Operative and oncologic outcomes in 9861 patients with operable breast cancer: single-institution analysis of breast conservation with oncoplastic reconstruction. Ann Surg Oncol. 2016;23(10):3190–8.
8. McIntosh J, O'Donoghue JM. Therapeutic mammaplasty – a systematic review of the evidence. Eur J Surg Oncol. 2012;38(3):196–202.
9. Yiannakopoulou EC, Mathelin C. Oncoplastic breast conserving surgery and oncological outcome: systematic review. Eur J Surg Oncol. 2016;42(5):625–30.
10. Veronesi U, Cascinelli N, Mariani L, Greco M, Saccozzi R, Luini A, et al. Twenty-year follow-up of a randomized study comparing breast-conserving surgery with radical mastectomy for early breast cancer. N Engl J Med. 2002;347(16):1227–32.
11. Fisher B, Anderson S, Bryant J, Margolese RG, Deutsch M, Fisher ER, et al. 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. 2002;347(16):1233–41.
12. McCulley SJ, Macmillan RD. Therapeutic mammaplasty – analysis of 50 consecutive cases. Br J Plast Surg. 2005;58(7):902–7.
13. Clough KB, Lewis JS, Couturaud B, Fitoussi A, Nos C, Falcou MC. Oncoplastic techniques allow extensive resections for breast-conserving therapy of breast carcinomas. Ann Surg. 2003;237(1):26–34.
14. Nos C, Fitoussi A, Bourgeois D, Fourquet A, Salmon RJ, Clough KB. Conservative treatment of lower pole breast cancers by bilateral mammoplasty and radiotherapy. Eur J Surg Oncol. 1998;24(6):508–14.
15. Rietjens M, Urban CA, Rey PC, Mazzarol G, Maisonneuve P, Garusi C, et al. Long-term oncological results of breast conservative treatment with oncoplastic surgery. Breast. 2007;16(4):387–95.

16. Giacalone PL, Roger P, Dubon O, El Gareh N, Rihaoui S, Taourel P, et al. Comparative study of the accuracy of breast resection in oncoplastic surgery and quadrantectomy in breast cancer. Ann Surg Oncol. 2007;14(2):605–14.
17. Mazouni C, Naveau A, Kane A, Dunant A, Garbay JR, Leymarie N, et al. The role of oncoplastic breast surgery in the management of breast cancer treated with primary chemotherapy. Breast. 2013;22(6):1189–93.
18. Veiga DF, Veiga-Filho J, Ribeiro LM, Archangelo-Junior I, Mendes DA, Andrade VO, et al. Evaluations of aesthetic outcomes of oncoplastic surgery by surgeons of different gender and specialty: a prospective controlled study. Breast. 2011;20(5):407–12.
19. Thornton BP, Stewart DH, McGrath PC, Pu LL. Breast reduction as an alternative treatment option for early breast cancer in women with macromastia. Ann Plast Surg. 2006;56(1):26–30.
20. Stolier A, Allen R, Linares L. Breast conservation therapy with concomitant breast reduction in large-breasted women. Breast J. 2003;9(4):269–71.
21. Mansell J, Weiler-Mithoff E, Martin J, Khan A, Stallard S, Doughty JC, et al. How to compare the oncological safety of oncoplastic breast conservation surgery - to wide local excision or mastectomy? Breast. 2015;24(4):497–501.
22. Mansell J, Weiler-Mithoff E, Stallard S, Doughty JC, Mallon E, Romics L. Oncoplastic breast conservation surgery is oncologically safe when compared to wide local excision and mastectomy. Breast. 2017;32:179–85.
23. Maishman T, Cutress RI, Hernandez A, Gerty S, Copson ER, Durcan L, et al. Local recurrence and breast oncological surgery in young women with breast cancer: the POSH Observational Cohort Study. Ann Surg. 2017;266(1):165–72.
24. Losken A, Dugal CS, Styblo TM, Carlson GWA. Meta-analysis comparing breast conservation therapy alone to the oncoplastic technique. Ann Plast Surg. 2013;72(2):145–9.
25. Macmillan RD, McCulley SJ. Oncoplastic breast surgery: what, when and for whom? Curr Breast Cancer Rep. 2016;8:112–7.
26. Tong WM, Baumann DP, Villa MT, Mittendorf EA, Liu J, Robb GL, et al. Obese women experience fewer complications after oncoplastic breast repair following partial mastectomy than after immediate total breast reconstruction. Plast Reconstr Surg. 2016;137(3):777–91.
27. Winters ZE, Afzal M, Balta V, Freeman J, Llewellyn-Bennett R, Rayter Z, et al. Patient-reported outcomes and their predictors at 2- and 3-year follow-up after immediate latissimus dorsi breast reconstruction and adjuvant treatment. Br J Surg. 2016;103(5):524–36.
28. Clough KB, Kaufman GJ, Nos C, Buccimazza I, Sarfati IM. Improving breast cancer surgery: a classification and quadrant per quadrant atlas for oncoplastic surgery. Ann Surg Oncol. 2010;17(5):1375–91.
29. Jeevan R, Cromwell DA, Trivella M, Lawrence G, Kearins O, Pereira J, et al. Reoperation rates after breast conserving surgery for breast cancer among women in England: retrospective study of hospital episode statistics. BMJ (Clin Res ed). 2012;345:e4505.
30. Singletary SE. Surgical margins in patients with early-stage breast cancer treated with breast conservation therapy. Am J Surg. 2002;184(5):383–93.
31. Houssami N, Macaskill P, Marinovich ML, Dixon JM, Irwig L, Brennan ME, et al. Meta-analysis of the impact of surgical margins on local recurrence in women with early-stage invasive breast cancer treated with breast-conserving therapy. Eur J Cancer (Oxford England : 1990). 2010;46(18):3219–32.
32. Kaur N, Petit JY, Rietjens M, Maffini F, Luini A, Gatti G, et al. Comparative study of surgical margins in oncoplastic surgery and quadrantectomy in breast cancer. Ann Surg Oncol. 2005;12(7):539–45.
33. Chakravorty A, Shrestha AK, Sanmugalingam N, Rapisarda F, Roche N, Querci Della Rovere G, et al. How safe is oncoplastic breast conservation? Comparative analysis with standard breast conserving surgery. Eur J Surg Oncol. 2012;38(5):395–8.
34. Down SK, Jha PK, Burger A, Hussien MI. Oncological advantages of oncoplastic breast-conserving surgery in treatment of early breast cancer. Breast J. 2013;19(1):56–63.

35. Chauhan A, Sharma MM, Kumar K. Evaluation of surgical outcomes of oncoplasty breast surgery in locally advanced breast cancer and comparison with conventional breast conservation surgery. Indian J Surg Oncol. 2016;7(4):413–9.
36. Eaton BR, Losken A, Okwan-Duodu D, Schuster DM, Switchenko JM, Mister D, et al. Local recurrence patterns in breast cancer patients treated with oncoplastic reduction mammaplasty and radiotherapy. Ann Surg Oncol. 2014;21(1):93–9.
37. Crown A, Wechter DG, Grumley JW. Oncoplastic breast-conserving surgery reduces mastectomy and postoperative re-excision rates. Ann Surg Oncol. 2015;22(10):3363–8.
38. Gulcelik MA, Dogan L, Yuksel M, Camlibel M, Ozaslan C, Reis E. Comparison of outcomes of standard and oncoplastic breast-conserving surgery. J Breast Cancer. 2013;16(2):193–7.
39. Tenofsky PL, Dowell P, Topalovski T, Helmer SD. Surgical, oncologic, and cosmetic differences between oncoplastic and nononcoplastic breast conserving surgery in breast cancer patients. Am J Surg. 2014;207(3):398–402; discussion.
40. De Lorenzi F, Hubner G, Rotmensz N, Bagnardi V, Loschi P, Maisonneuve P, et al. Oncological results of oncoplastic breast-conserving surgery: long term follow-up of a large series at a single institution: a matched-cohort analysis. Eur J Surg Oncol. 2016;42(1):71–7.
41. Clough KB, Ihrai T, Oden S, Kaufman G, Massey E, Nos C. Oncoplastic surgery for breast cancer based on tumour location and a quadrant-per-quadrant atlas. Br J Surg. 2012;99(10):1389–95.
42. Clough KB, van la Parra RFD, Thygesen HH, Levy E, Russ E, Halabi NM, et al. Long-term results after oncoplastic surgery for breast cancer: a 10-year follow-up. Ann Surg. 2018;268(1):165–71.
43. De La Cruz L, Blankenship SA, Chatterjee A, Geha R, Nocera N, Czerniecki BJ, et al. Outcomes after oncoplastic breast-conserving surgery in breast cancer patients: a systematic literature review. Ann Surg Oncol. 2016;23(10):3247–58.
44. Losken A, Hart AM, Broecker JS, Styblo TM, Carlson GW. Oncoplastic breast reduction technique and outcomes: an evolution over 20 years. Plast Reconstr Surg. 2017;139(4):824e–33e.
45. Rezai M, Knispel S, Kellersmann S, Lax H, Kimmig R, Kern P. Systematization of oncoplastic surgery: selection of surgical techniques and patient-reported outcome in a cohort of 1,035 patients. Ann Surg Oncol. 2015;22(11):3730–7.
46. Song HM, Styblo TM, Carlson GW, Losken A. The use of oncoplastic reduction techniques to reconstruct partial mastectomy defects in women with ductal carcinoma in situ. Breast J. 2010;16(2):141–6.
47. Turnbull L, Brown S, Harvey I, Olivier C, Drew P, Napp V, et al. Comparative effectiveness of MRI in breast cancer (COMICE) trial: a randomised controlled trial. Lancet. 2010;375(9714):563–71.
48. Proulx F, Correa JA, Ferre R, Omeroglu A, Aldis A, Meterissian S, et al. Value of pre-operative breast MRI for the size assessment of ductal carcinoma in situ. Br J Radiol. 2016;89(1058):20150543.
49. Rusby JE, Paramanathan N, Laws SA, Rainsbury RM. Immediate latissimus dorsi miniflap volume replacement for partial mastectomy: use of intra-operative frozen sections to confirm negative margins. Am J Surg. 2008;196(4):512–8.
50. Olson TP, Harter J, Munoz A, Mahvi DM, Breslin T. Frozen section analysis for intraoperative margin assessment during breast-conserving surgery results in low rates of re-excision and local recurrence. Ann Surg Oncol. 2007;14(10):2953–60.
51. Cancello G, Maisonneuve P, Rotmensz N, Viale G, Mastropasqua MG, Pruneri G, et al. Prognosis in women with small (T1mic,T1a,T1b) node-negative operable breast cancer by immunohistochemically selected subtypes. Breast Cancer Res Treat. 2011;127(3):713–20.
52. Lowery AJ, Kell MR, Glynn RW, Kerin MJ, Sweeney KJ. Locoregional recurrence after breast cancer surgery: a systematic review by receptor phenotype. Breast Cancer Res Treat. 2012;133(3):831–41.
53. Darby S, McGale P, Correa C, Taylor C, Arriagada R, Clarke M, et al. Effect of radiotherapy after breast-conserving surgery on 10-year recurrence and 15-year breast cancer death: meta-analysis of individual patient data for 10,801 women in 17 randomised trials. Lancet. 2011;378(9804):1707–16.

54. van Dongen JA, Voogd AC, Fentiman IS, Legrand C, Sylvester RJ, Tong D, et al. Long-term results of a randomized trial comparing breast-conserving therapy with mastectomy: European Organization for Research and Treatment of Cancer 10801 trial. J Natl Cancer Inst. 2000;92(14):1143–50.
55. Vaidya JS, Wenz F, Bulsara M, Tobias JS, Joseph DJ, Keshtgar M, et al. Risk-adapted targeted intraoperative radiotherapy versus whole-breast radiotherapy for breast cancer: 5-year results for local control and overall survival from the TARGIT-A randomised trial. Lancet. 2014;383(9917):603–13.
56. Veronesi U, Orecchia R, Maisonneuve P, Viale G, Rotmensz N, Sangalli C, et al. Intraoperative radiotherapy versus external radiotherapy for early breast cancer (ELIOT): a randomised controlled equivalence trial. Lancet Oncol. 2013;14(13):1269–77.
57. Bosma SC, van der Leij F, van Werkhoven E, Bartelink H, Wesseling J, Linn S, et al. Very low local recurrence rates after breast-conserving therapy: analysis of 8485 patients treated over a 28-year period. Breast Cancer Res Treat. 2016;156(2):391–400.
58. Poggi MM, Danforth DN, Sciuto LC, Smith SL, Steinberg SM, Liewehr DJ, et al. Eighteen-year results in the treatment of early breast carcinoma with mastectomy versus breast conservation therapy: the National Cancer Institute Randomized Trial. Cancer. 2003;98(4):697–702.
59. Fisher B, Bauer M, Margolese R, Poisson R, Pilch Y, Redmond C, et al. 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. 1985;312(11):665–73.
60. Veronesi U, Saccozzi R, Del Vecchio M, Banfi A, Clemente C, De Lena M, et al. Comparing radical mastectomy with quadrantectomy, axillary dissection, and radiotherapy in patients with small cancers of the breast. N Engl J Med. 1981;305(1):6–11.
61. Arriagada R, Le MG, Rochard F, Contesso G. Conservative treatment versus mastectomy in early breast cancer: patterns of failure with 15 years of follow-up data. Institut Gustave-Roussy Breast Cancer Group. J Clin Oncol. 1996;14(5):1558–64.
62. Silverstein MJ, Mai T, Savalia N, Vaince F, Guerra L. Oncoplastic breast conservation surgery: the new paradigm. J Surg Oncol. 2014;110(1):82–9.
63. Chang EI, Peled AW, Foster RD, Lin C, Zeidler KR, Ewing CA, et al. Evaluating the feasibility of extended partial mastectomy and immediate reduction mammoplasty reconstruction as an alternative to mastectomy. Ann Surg. 2012;255(6):1151–7.
64. Caruso F, Catanuto G, De Meo L, Ferrara M, Gallodoro A, Petrolito E, et al. Outcomes of bilateral mammoplasty for early stage breast cancer. Eur J Surg Oncol. 2008;34(10):1143–7.
65. Fitoussi AD, Berry MG, Fama F, Falcou MC, Curnier A, Couturaud B, et al. Oncoplastic breast surgery for cancer: analysis of 540 consecutive cases [outcomes article]. Plast Reconstr Surg. 2010;125(2):454–62.
66. Bogusevicius A, Cepuliene D, Sepetauskiene E. The integrated evaluation of the results of oncoplastic surgery for locally advanced breast cancer. Breast J. 2014;20(1):53–60.
67. Ren ZJ, Li XJ, Xu XY, Xia L, Tang JH. Oncoplastic breast conserving surgery with nipple-areolar preservation for centrally located breast cancer: a retrospective cohort study. Asian Pac J Cancer Prev. 2014;15(12):4847–9.
68. Kabir SA, Stallard S, Weiler-Mithoff E, Mansell J, Mallon E, Doughty JC, et al. Six-year follow-up of patients treated with oncoplastic reduction mammoplasty: a cohort study. Int J Surg (London, England). 2016;26:38–42.
69. Zaha H, Abe N, Sagawa N, Unesoko M. Oncoplastic surgery with omental flap reconstruction: a study of 200 cases. Breast Cancer Res Treat. 2017;162(2):267–74.
70. Emiroglu M, Salimoglu S, Karaali C, Sert I, Gungor O, Sert F, et al. Oncoplastic reduction mammoplasty for breast cancer in women with macromastia: oncological long-term outcomes. Asian J Surg. 2017;40(1):41–7.
71. De Lorenzi F, Loschi P, Bagnardi V, Rotmensz N, Hubner G, Mazzarol G, et al. Oncoplastic breast-conserving surgery for tumors larger than 2 centimeters: is it oncologically safe? A matched-cohort analysis. Ann Surg Oncol. 2016;23(6):1852–9.

72. Ho W, Stallard S, Doughty J, Mallon E, Romics L. Oncological outcomes and complications after volume replacement oncoplastic breast conservations-the Glasgow experience. Breast Cancer: Basic Clin Res. 2016;10:223–8.
73. Punglia RS, Saito AM, Neville BA, Earle CC, Weeks JC. Impact of interval from breast conserving surgery to radiotherapy on local recurrence in older women with breast cancer: retrospective cohort analysis. BMJ (Clin Res ed). 2010;c845:340.
74. Hershman DL, Wang X, McBride R, Jacobson JS, Grann VR, Neugut AI. Delay of adjuvant chemotherapy initiation following breast cancer surgery among elderly women. Breast Cancer Res Treat. 2006;99(3):313–21.
75. Munhoz AM, Montag E, Arruda EG, Aldrighi C, Gemperli R, Aldrighi JM, et al. Critical analysis of reduction mammaplasty techniques in combination with conservative breast surgery for early breast cancer treatment. Plast Reconstr Surg. 2006;117(4):1091–103; discussion 104–7.
76. Losken A, Styblo TM, Carlson GW, Jones GE, Amerson BJ. Management algorithm and outcome evaluation of partial mastectomy defects treated using reduction or mastopexy techniques. Ann Plast Surg. 2007;59(3):235–42.
77. Kronowitz SJ, Hunt KK, Kuerer HM, Strom EA, Buchholz TA, Ensor JE, et al. Practical guidelines for repair of partial mastectomy defects using the breast reduction technique in patients undergoing breast conservation therapy. Plast Reconstr Surg. 2007;120(7):1755–68.
78. Losken A, Elwood ET, Styblo TM, Bostwick J 3rd. The role of reduction mammaplasty in reconstructing partial mastectomy defects. Plast Reconstr Surg. 2002;109(3):968–75; discussion 76–7.
79. Spear SL, Pelletiere CV, Wolfe AJ, Tsangaris TN, Pennanen MF. Experience with reduction mammaplasty combined with breast conservation therapy in the treatment of breast cancer. Plast Reconstr Surg. 2003;111(3):1102–9.
80. Khan J, Barrett S, Forte C, Stallard S, Weiler-Mithoff E, Doughty JC, et al. Oncoplastic breast conservation does not lead to a delay in the commencement of adjuvant chemotherapy in breast cancer patients. Eur J Surg Oncol. 2013;39(8):887–91.
81. Meretoja TJ, Svarvar C, Jahkola TA. Outcome of oncoplastic breast surgery in 90 prospective patients. Am J Surg. 2010;200(2):224–8.
82. Schaverien MV, Doughty JC, Stallard S. Quality of information reporting in studies of standard and oncoplastic breast-conserving surgery. Breast. 2014;23(2):104–11.
83. Losken A, Schaefer TG, Newell M, Styblo TM. The impact of partial breast reconstruction using reduction techniques on postoperative cancer surveillance. Plast Reconstr Surg. 2009;124(1):9–17.
84. Dolan R, Patel M, Weiler-Mithoff E, Mansell J, Stallard S, Doughty JC, et al. Imaging results following oncoplastic and standard breast conserving surgery. Breast Care (Basel, Switzerland). 2015;10(5):325–9.
85. Piper M, Peled AW, Sbitany H, Foster RD, Esserman LJ, Price ER. Comparison of mammographic findings following oncoplastic mammoplasty and lumpectomy without reconstruction. Ann Surg Oncol. 2016;23(1):65–71.
86. Mele S, Wright D, Paramanathan N, Laws S, Peiris L, Rainsbury R. Long-term effect of oncoplastic breast-conserving surgery using latissimus dorsi miniflaps on mammographic surveillance and the detection of local recurrence. J Plast Reconstr Aesthet Surg: JPRAS. 2017;70(9):1203–9.

Treating Complications of Oncoplastic Breast Surgery

34

Maurizio Bruno Nava, Giuseppe Catanuto, and Nicola Rocco

Treatment of Complications Following Oncoplastic Breast-Conserving Surgery

The major concern for complications of oncoplastic techniques is not interfering with the timing of adjuvant therapies.

A meta-analysis comparing oncoplastic and standard breast-conserving surgery showed that early complication rates in the oncoplastic surgery group did not delay the initiation of adjuvant therapies [1].

Some large series of volume displacement techniques report a 3–15% delayed wound healing, 3–10% fat necrosis, and 1–5% infection rates [2, 3].

Overall complications following volume replacement techniques are slightly higher (2–77%), due to the addition of donor-site complications and flap loss [4–6].

M. B. Nava
School of Plastic Surgery, University of Milan, Milan, Italy

Group for Reconstructive and Therapeutic Advancements, G.RE.T.A, Milan, Naples, Catania, Italy

G. Catanuto
Group for Reconstructive and Therapeutic Advancements, G.RE.T.A, Milan, Naples, Catania, Italy

Multidisciplinary Breast Unit, Azienda Ospedaliera Cannizzaro, Catania, Italy

N. Rocco (✉)
Group for Reconstructive and Therapeutic Advancements, G.RE.T.A, Milan, Naples, Catania, Italy

Department of Clinical Medicine and Surgery, University of Naples "Federico II", Naples, Italy

V. S. Klimberg et al. (eds.), *Oncoplastic Breast Surgery Techniques for the General Surgeon*, https://doi.org/10.1007/978-3-030-40196-2_34

However, although complications could occur, they are often managed conservatively without delaying the initiation of adjuvant treatments.

In a reduction series of 353 patients, the authors report a 16% complication rate, only 5% requiring reoperation [7].

Some studies reported fewer complications in obese women and women with macromastia following oncoplastic reduction compared with mastectomy and immediate reconstruction: 3.8% versus 28% complications requiring additional surgery and 0.8% versus 14% complications delaying adjuvant therapies in the oncoplastic group for obese patients [8].

Oncoplastic surgery has been demonstrated to be safe for large tumors treatment too, without significant differences in terms of positive margin rates (22.6% versus 18%), re-excision rates, or complications between oncoplastic resection and lumpectomy alone [9].

A National Surgical Quality Improvement Program evaluation comparing 75,972 breast-conserving surgery patients with soft-tissue transfer showed no increased risk of complication in the oncoplastic group despite longer duration of operation [10].

A systematic review on therapeutic mammaplasties reported complication rates ranging from 10% to 90%. Complications included skin necrosis, delayed wound healing, wound infection, abscess formation, nipple-areola complex (NAC) necrosis, fat necrosis, hematoma, and seroma formation. Complications were reported to be more common in patients who underwent therapeutic mammaplasty following radiotherapy with rates of 33% versus 18%. Seven studies reported no delays in the adjuvant treatments due to complications and five studies reported delays of between 1.9% and 6% of patients [11–16].

Seroma

Seroma formation within any closed space resulting from breast oncoplastic surgery could be associated with the rich lymphatic drainage from the intramammary lymphatics to the axillary, supraclavicular, and internal mammary lymph nodes. The low fibrinogen levels and fibrinolytic activity in the lymphatic fluid collection determine seroma formation.

After wide local excisions, a collection of fluid in the surgical cavity may appear generating discomfort or pain. We generally manage this situation conservatively with pain relievers if symptoms are well tolerated. Percutaneous evacuation of fluids is performed only for persistent symptomatic conditions. When the collection recurs after several conservative attempts, there may be an indication for surgical evacuation and vacuum drainage.

After unilateral comma-shaped or vertical mammaplasties, we use the same criteria of standard wide local excisions. However, if the collection generates tension on skin sutures or if it compromises the blood supply to the nipple-areola complex, we may proceed earlier with evacuation and drainage (either percutaneous at the first attempt of surgical with positioning of vacuum drains).

After bilateral or unilateral mammaplasties with Wise pattern incisions, accumulation of fluids may become painful due to more extended scars. Generally a vacuum drain is placed intraoperatively and kept in place until daily collection reaches 40 mL/24 h. If collection persists after drain removal, we perform percutaneous evacuation first and then surgical evacuation and placement of a second drain.

Antibiotics are not indicated in the conservative management of seromas. We do not prescribe antibiotics for percutaneous drainage. A short term preoperative prophylaxis (1 dose?) is prescribed before surgical evacuation.

Hematoma

Low-volume hematomas following oncoplastic breast-conserving surgery determine low morbidity only leading to a more extensive ecchymosis because of the hematoma absorption by the adjacent soft tissues. Large hematomas could be painful because of the rapid expansion through the wound space. Surgical evacuation, with wound irrigation and re-closure to optimize the aesthetic result, is recommended.

Hematoma may occur in the early postoperative period of breast-conserving surgery. Normally this condition is very painful and requires surgery with hemostasis and evacuation of the blood collection and placement of a drain. We treat hematomas conservatively only when blood collection has clearly stopped and the patient is asymptomatic. We do not recommend percutaneous evacuation of hematomas because it does not allow hemostasis. In case of wide local excisions, comma shaped or vertical scar mammaplasties without intraoperative positioining of a vacuum drain showing a postoperative hematoma, we use to place a drainage for 24–48 h to confirm that the bleeding has stopped. After bilateral or unilateral reductions with Wise pattern incisions, the vacuum drain may evacuate part of the blood; if bleeding persists, the tube may become clotted and the blood may collect quite soon creating a hematoma. In these conditions, surgical evacuation, careful hemostasis with identification of the bleeding source is recommended. We do not use regularly fibrin sealant or any other device after wound revisions, a new drain should be left in place before closing. Wound compression after evacuation of the hematoma may be painful and uncomfortable and therefore should be avoided. No antibiotics are regularly used unless there are clear signs of infection. In case of conservative management the hematoma may present as a solid lump for a long-term period and scarring may occur. No surgical treatment is advisable in these conditions as the symptoms may resolve spontaneously. Patients should be advised that the residual nodularity may last for 6–18 months.

Necrosis and Wound Dehiscence

Skin necrosis after wide local excision is very uncommon and treated conservatively with wound dressing. We do not use antibiotics unless clear signs of infection are evident. A complete dehiscence of the wound mandates re-excision of the skin margins and new closure (Fig. 34.1). In complex therapeutic mammaplasties

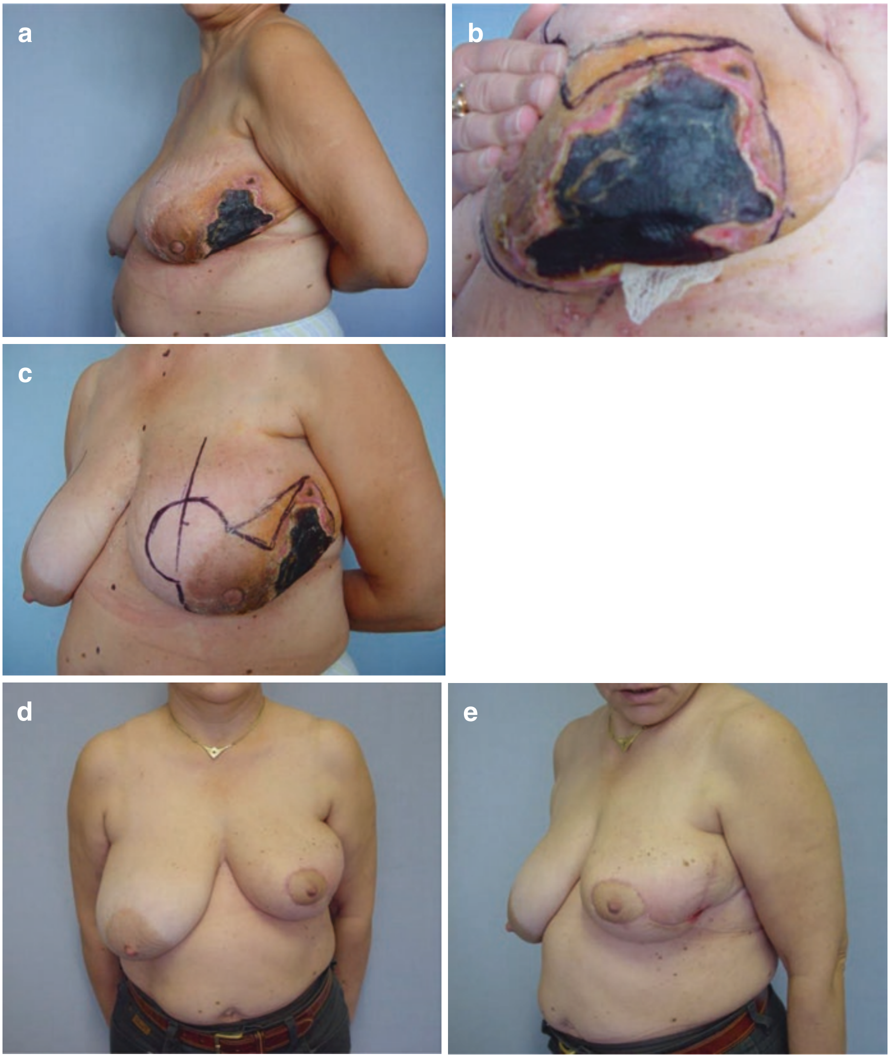


Fig. 34.1 (**a**, **b**) Skin flap necrosis at the left outer quadrants following breast-conserving surgery. (**c**) Surgical planning for a reshaping of the breast with skin necrosis debridement and NAC repositioning. (**d**, **e**) Six-month postoperative result

as Wise pattern skin incision, an attempt to conservative approach is the first option to preserve as much as possible the cosmetic results. In case of failure, we proceed with a re-excision of the necrotic area through healthy and well-vascularized tissue. Necrosis of the T junction can be treated easier if a subcutaneous layer of de-epithelialized skin is left when performing an inferior pedicle mastopexy. Same considerations could be extended to augmentation mastopexies. After culturing the wound, antibiotics may be helpful in assisting the healing process.

Nipple ischemia or necrosis may require a more complex management. In the presence of congestion, observation for about 24 hours is considered; if ischemia is persistent, we release some stitches in order to improve the blood flow. No negative wound pressure devices or hyperbaric therapy are advised in this setting. After demarcation of the necrotic area, we proceed with progressive debridement. Partial necrosis of the epidermal layers may heal with minor changes in the skin color; after complete recovery of the area, the skin can be tattooed . More advanced ischemia may compromise the distal end of the nipple, that has to be removed to assist the healing process. In case of complete loss of the nipple-areola complex, we proceed with a complete removal of the involved area and subsequent reconstruction with skin flaps according to the amount of lost tissue (See Nipple Reconstruction Chap. 25).

Infection

Staphylococcal organisms coming from the skin flora are usually implicated in postoperative infections following oncoplastic breast-conserving surgery. Some of the most relevant risk factors for breast wound infections are obesity, age, and diabetes mellitus. Smoking also plays a significant role in wound infection, with a significant increase in the risk of infection following breast surgery.

The use of preoperative antibiotics has been studied in multiple retrospective and prospective trials reporting conflicting results: many authors demonstrated that a single dose of preoperative antibiotic (usually a cephalosporin 30 min before surgery) could effectively reduce the infection rate by 40% or more [17]. Other authors found no effect with perioperative cephalosporin versus placebo concluding that perioperative antibiotics are unnecessary in elective breast surgery [18].

According to these conflicting evidences, many surgeons limit antibiotic prophylaxis to high-risk patients and to implant-based breast surgery.

Mild incisional cellulitis could be treated with oral antibiotics, while nonresponding or extensive soft tissue infection require intravenous therapy. Some breast wound infections could progress to abscesses, with the typical clinical signs of a fluctuant and tender mass becoming usually apparent 1–2 weeks postoperatively. Ultrasound imaging could be helpful in diagnosing postoperative breast abscesses, even though the ultrasonographic characteristics of a breast abscess could overlap with those of a seroma or hematoma. Aspiration could confirm the diagnosis.

The management of an abscess is managed by placing an ultrasound-guided percutaneous drainage as the best initial treatment. Close follow-up is necessary because if the pus re-accumulates, incision, debridement and drainage by reopening the surgical wound and leaving the cavity open to heal by secondary intention is required.

In case of infections of skin and subcutaneous tissue, with or without hyperpyrexia after breast-conserving surgery, broad spectrum antibiotics should be administered. In case of persistent clinical signs of infection with creation of an abscess, we suggest surgical evacuation of the cavity and culture test with further therapy with targeted antibiotics. After evacuation of an abscess, we leave a drain in place, and in selected case we also leave the cavity open for secondary wound closure. During the healing process, we wash the cavity with saline and keep it open until completion of the granulation process. No other specific device (such as local vacuum therapy or hyperbaric oxygen therapy) are used.

The management of infections after more complex oncoplastic procedures with bilateral operation or after replacement techniques (latissimus dorsi flaps, Intercostal Artery Perforators Flaps (LICAP, ICAP)) does not differ significantly as long as the evacuation of the abscess cavity does not alter the final results of the reconstruction.

Chronic Pain

The etiology of chronic pain remains unknown, but it is assumed to be neuropathic. It could last from several months to years being debilitating and refractory to standard analgesics. The risk factors for chronic pain include older age, larger tumors, radiation therapy, chemotherapy, depression, and poor coping mechanisms. Chronic pain has been recently managed with the use of serotonin uptake inhibitors [19] .

Treatment of Acute Complications Following Implant-Based Breast Reconstruction

The Role of Bacterial Biofilm in Implant-Associated Infection, Capsular Contracture, Late Seromas, and BIA-ALCL

Breast implants are placed in a potentially contaminated pocket, bacteria being present in breast ducts and glandular parenchyma [20, 21].

Several in vitro studies demonstrated how bacteria could bind to breast implants' surface despite the type of surface [22].

These bacteria could form a biofilm that is a combination of glycoprotein and latent bacteria binding to the breast implant silicone envelope. When forming a biofilm, bacteria are resistant to antibiotics [23].

When overcoming the local host defenses, the biofilm will continue proliferating leading to local inflammation and fibrosis, causing capsular contracture [24].

An experimental model in pigs was presented by Hu and colleagues in 2015 [25], showing that capsular contracture Baker grade is directly linked to the number of bacteria for increasing and a threshold of bacterial biofilm exists above which host responses lead to capsular contracture, due to an inflammatory response leading to fibrosis.

A great T-cell response to the presence of bacteria has been described by Hu and colleagues, particularly in textured implants when compared with smooth implants, texturization representing a more ideal surface for biofilm formation. However, the infectious hypothesis does not necessary mean that textured implants will be associated with higher contracture rates, as the threshold over which local inflammation is initiated remains determinant the threshold of infection above which local inflammation is initiated.

Chronic biofilm infection of breast implants and the predominant T-cell lymphocytic infiltrate could acquire a particular importance in the etiopathogenesis of late seromas and breast-implant associated Anaplastic Large Cell Lymphoma (BIA-ALCL) as well.

Chronic bacterial infection has been shown to be associated with the development of lymphomas [26] and similarly chronically infected breast implants could be extremely rarely linked with inflammatory processes leading to T-cell lymphoma development. Obviously this will be a multistep process with fundamental impact of patient genotypes and immunomediated factors contributing to BIA-ALCL development.

Treatment of Capsular Contracture

The only possible treatment of a capsular contracture is the surgical removal of the implant together with a total capsulectomy. Due to the formation of bacterial biofilms that are extremely hard to remove from the silicone elastomer of the implant envelope, a new implant must be used in the affected breast when treating a capsular contracture. In the surgical management of capsular contracture, a site change of the implant could be considered, in particular if the implant is in the subglandular position, with a dual-plane position. Some authors consider a precapsular dissection, leaving the existing capsule in place and inserting the new implant between the anterior capsule and the posterior surface of the muscle, when submuscular placement was done before. No reliable and high-evidenced data about this option are available from literature; however, in relation with the etiopathogenesis of capsular contracture, leaving a portion of the capsule may be not safe.

Many other nonsurgical attempts to treat capsular contracture have been reported in the literature, from the mechanical implant displacement, to the use of several antibiotics, vitamin E, steroids, nonsteroidal anti-inflammatory drugs (NSAIDs), chemotherapeutics, and leukotriene inhibitors, with only a level of evidence IV-V. In particular, leukotriene receptors antagonists (LTRAs) have been used by several authors in the last years (zafirlukast and montelukast) both as a prevention and for treatment of capsular contracture, but again, data are extremely low-evidenced [27, 28].

However, preventing capsular contracture remains the most effective way to avoid this complication, so minimizing implant contamination when positioning an implant and following an accurate technique remain mandatory. We suggest to strictly follow the 14 clinical recommendations proposed by Deva and Adams when positioning a breast implant in order to minimize bacterial biofilm formation, avoiding periareolar incisions and dissection of the breast parenchyma, performing atraumatic dissection and minimizing devascularized tissues, performing pocket irrigation with antibiotics or betadine, minimizing implant handling, and performing intravenous antibiotic prophylaxis at anesthetic induction [24, 29].

Treatment of Double Capsules

Many authors reported about double capsule formation around textured breast implants [30].

Double capsule could be defined as two distinct capsular layers around a breast implant with an intercapsular space: the inner layer adheres to the implant envelope and the outer one to the breast tissue. Between the two capsular layers, the presence of seroma-fluid like has been described. Double capsules could be partial or complete. When complete, double capsules could be linked to rotation of the implant due to the interface between the inner and the outer layers. In these cases, the tissue in-growth into the textured surface could not prevent rotation, textured implants acting as smooth ones, due to the intercapsular space, where synovial metaplasia has been described.

The etiopathogenesis of double capsules is controversial with four main hypotheses. The first theory is based on movement of the implant within an oversized pocket, where adhesion of the implant with the surrounding tissues is precluded [31].

The second hypothesis proposes a mechanical etiology: the detachment of the implant from the capsule would be determined by shear stresses applied to the implant-capsule complex, leading to the creation of a new inner layer of capsule over the implant, from seeding of cells coming from the seroma-like fluid accumulating between the implant and the original capsule [32].

The third hypothesis is based on seroma formation around the implant (from an infectious, allergic, or hemorrhagic origin), subsequently leading to the development of a new inner capsule [33].

The fourth hypothesis also proposes a mechanical etiology with shear forces causing detachment of the implant-capsule complex from the surrounding breast tissue, with a new capsular layer developing outside the original capsule [34].

A recent study by Giot and colleagues [35] observed that bacterial load and biofilm presence within the intercapsular space was lower or absent, while bacteria could always be seen in the prosthesis interface, so the two spaces do not share the same initial fluid, as necessarily would be in the case of the first three hypotheses.

Moreover, the histological findings reported in the same studies confirmed a layered appearance of the inner capsule and delamination at the more solicited locations of the capsule (outer breast quadrants), supporting the fourth hypothesis.

The clinical consequence of a double capsule could be a delayed seroma, capsular contracture or nothing clinically evident, many patients may be completely asymptomatic and the evidence of a double capsule being an incidental finding at implant exchange for other reasons.

Treatment of Late Seromas

Late seroma is defined as a periprosthetic fluid collection occurring more than 1 year following breast augmentation.

The management of late seromas could span from a simple conservative aspiration to a complete capsulectomy and implant exchange. Many Breast Implant

Associated Anaplastic Large Cell Lymphoma (BIA-ALCL) patients have disease confined to the capsule, so it is possible that some patients could be treated with capsulectomy for a late seroma without receiving a prior diagnosis. This is why a pathological evaluation of the removed capsule should always be performed.

Treatment of Breast Implant-Associated Anaplastic Large Cell Lymphoma

Late periprosthetic fluid collections in patients with breast implants have also been reported in association with Breast Implant Associated Anaplastic Large Cell Lymphoma (BIA-ALCL).

This is why a correct diagnostic pathway should always be followed when dealing with late seromas. Late seroma does not represent a direct precursor of BIA-ALCL, but all late seromas should be thoroughly investigated with cytological examination through fine-needle aspiration, flow cytometry, and CD30 IHC of effusion.

Two-thirds of BIA-ALCL patients present as a malignant effusion associated with the fibrous capsule surrounding an implant occurring on average 8–10 years after implantation.

Therefore, any seroma occurring greater than 1 year after implantation not readily explainable by infection or trauma should be considered suspicious for disease. One-third of patients present with a mass which may indicate a more aggressive clinical course [36].

Any aspiration of peri-prosthetic fluid should be sent to pathology for cytologic evaluation and include a clinical history with the aim to “rule out BIA-ALCL”. Diagnosis by hematoxylin and eosin staining alone is nearly impossible: BIA-ALCL will demonstrate strong and uniform membranous expression of CD30 immunohistochemistry [37].

Ultrasound examination may help defining the extent of an effusion and identifying associated capsule masses. Clinical examination should include evaluation of regional lymph nodes. BIA-ALCL effusions are typically more viscous than a benign seroma due to the higher protein content and cellularity. The surrounding capsule may be thickened and fibrous or may be completely normal in appearance.

If a mass is present, it can protrude into the implant creating a mass effect distortion on imaging or the mass may protrude outward into the soft tissue [38].

Patients with biopsy-proven BI-ALCL must be referred to a lymphoma oncologist ideally prior to any surgical intervention to allow for proper oncologic evaluation. Surgical treatment of BI-ALCL includes removal of the implant, complete removal of any disease mass with negative margins and total capsulectomy. Because an implant capsule may drain to multiple regional lymph node basins, there does not appear to be a role for sentinel lymph node biopsy in the treatment of BI-ALCL. Core biopsy previous to surgery of any suspicious lymph nodes should be performed [39].

BIA-ALCL is distinct from primary breast lymphoma that is a disease of the breast parenchyma and is predominantly a B-cell lymphoma (65–90%) [40].

BIA-ALCL is a T-cell lymphoma arising either in an effusion surrounding the implant or in the scar capsule surrounding a breast implant. It is ALK negative and expresses the CD30 cell surface protein [39].

Most cases are diagnosed during implant revision surgery performed for a late onset (>1 year), persistent seroma and may be associated with symptoms of pain, breast lumps, swelling, or breast asymmetry.

An incomplete local surgical control could lead to recurrence or to the need for adjuvant treatments including chemotherapy and radiation therapy, when complete surgical resection could represent the definitive treatment in most cases. Surgery should be performed with accurate oncologic technique, considering specimen orientation and placement of surgical clips in the tumor bed and considering changing surgical implants when performing contralateral implant removal.

BIA-ALCL most commonly follows an indolent course when adequate surgical removal of the implant and surrounding capsule is performed, without any systemic therapy, but aggressive cases experiencing disease progression and death have been reported.

Treatment of Implant Rupture and Silicone Migration

Rupture is a long-recognized complication of all breast implants. Breast implants are not lifetime devices.

Implant rupture could be also be associated with silicone migration to regional lymph nodes with the occurrence of silicone lymphadenopathy and siliconomas (silicone granulomas). The management of implant rupture consists in the surgical removal of ruptured implants together with a total capsulectomy, but the management of silicone lymphadenopathy remains debated; some authors considering not strictly necessary the removal of all enlarged lymph nodes containing silicone, with the consequent potential complications linked with impaired lymphatic drainage [41, 42].

Treatment of Implant Exposure

The management of implant exposure depends on the conditions of local tissues, the severity of exposure, the presence of concomitant infection, and the wishes of the patient. The safest strategy to manage implant exposure and concomitant bacterial growth is implant removal and delayed re-positioning after several months, following targeted antibiotic therapy [43].

Some authors report good results with a short-time implant repositioning following implant removal for implant exposure and concomitant bacterial growth thanks to the use of negative pressure wound therapy [44] (Figs. 34.2 and 34.3).

Other authors present the possibility to save the exposed implant with the use of intercostal perforator flaps to cover the lack of tissue, avoiding implant

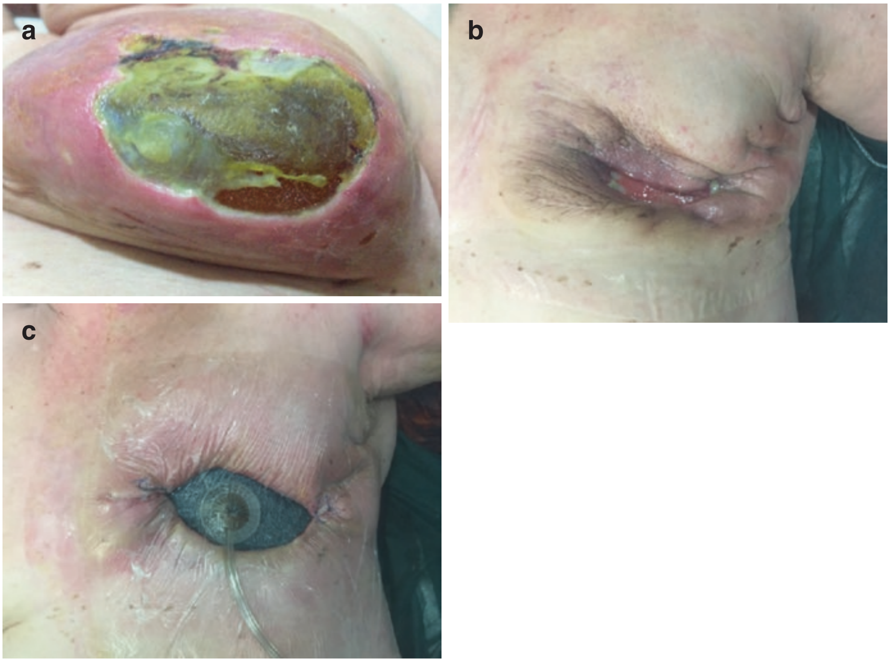


Fig. 34.2 (**a**) Tissue expander's exposure following skin-sparing mastectomy flap necrosis. (**b**) Tissue expander's extrusion. (**c**) V.A.C. Therapy positioning following wound margin debridement and total capsulectomy

removal even in the presence of synthetic meshes. An optimal management of the wound could exclude the risk of infection even in exposed implants/meshes [45] (Figs. 34.4, 34.5, and 34.6).

Treatment of Complications Related with ADMs and Synthetic Meshes in Reconstructive Breast Surgery

The introduction of acellular dermal matrices (ADMs) and synthetic meshes in implant-based breast reconstruction leads to good surgical outcomes and improves the possibility of direct-to-implant reconstructions.

As any other surgical procedure involving breast implants, the use of ADMs could be associated with several complications with the chance of implant loss, including infection, seroma, hematoma, skin flap necrosis, wound dehiscence, capsular contracture, and implant exposure and some other specific complications as the red breast syndrome (RBS).

Mistakes in dealing with the first clinical signs of an implant-associated adverse event could lead to implant loss. Some protocols have been developed to help reducing complication rates and manage adverse events in the most appropriate way through standardized decision-making [43, 46, 47].

Fig. 34.3 (**a**) Hematoma following NAC-sparing mastectomy and ADM-assisted direct-to-implant reconstruction. (**b**) Partial flap necrosis. (**c**) Implant exposition

Red Breast Syndrome

Red breast syndrome (RBS) is a self-limited erythema overlying the ADM following mastectomy and breast reconstruction. RBS represents a poorly recognized complication and it could be challenging to discriminate between infection and RBS, with a consequent psychological distress for the patient.

RBS incidence remains still unknown, with a variable reported rate ranging from 5% to 10%. RBS must be differentiated from infectious cellulitis through the absence of fever and laboratory abnormalities and its self-limiting course. Some

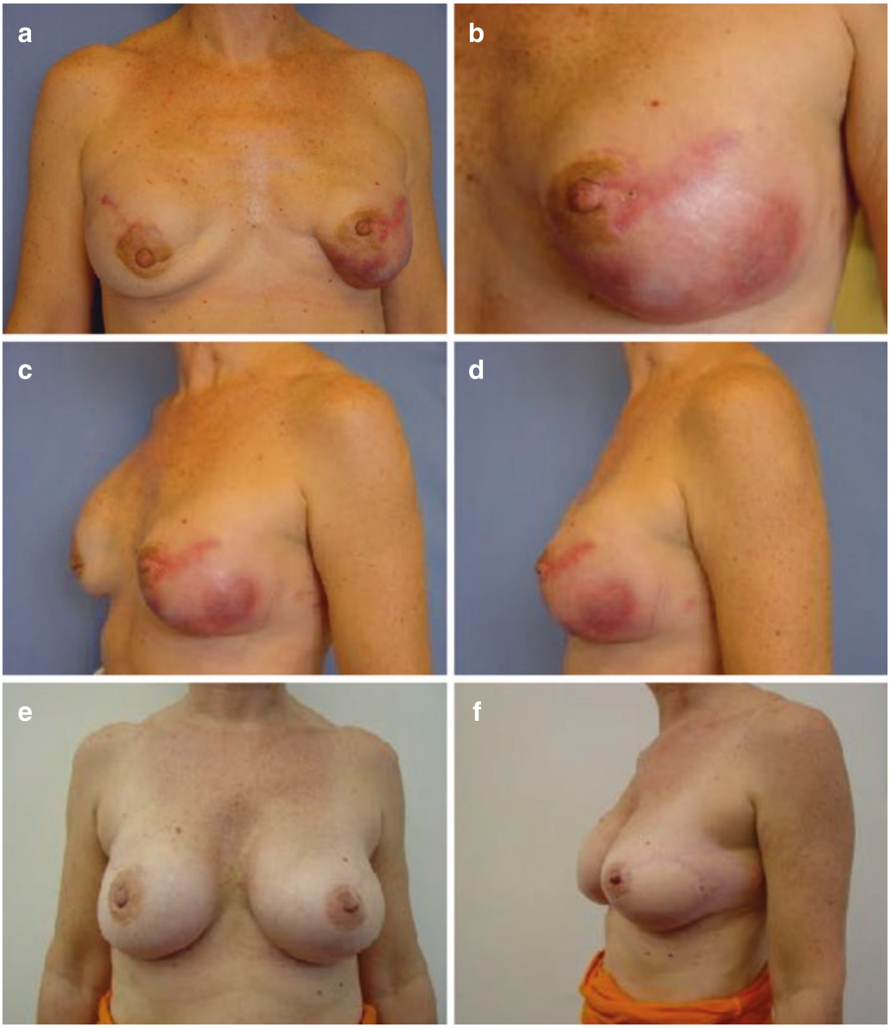


Fig. 34.4 (**a**–**d**) Complication following a NAC-sparing mastectomy and tissue expander positioning with a decubitus of the expander on the mastectomy flaps. (**e**, **f**) Seven-year postoperative follow-up following tissue expander removal and immediate breast reconstruction with latissimus dorsi flap plus implant

authors tried to explain RBS as a consequence of the ADM processing; some others speculating that RBS could be triggered by histamine release as an immunological response to the graft.

This condition is usually self-limiting, but it is important to recognize this clinical entity in order to correctly advice the patient [48].

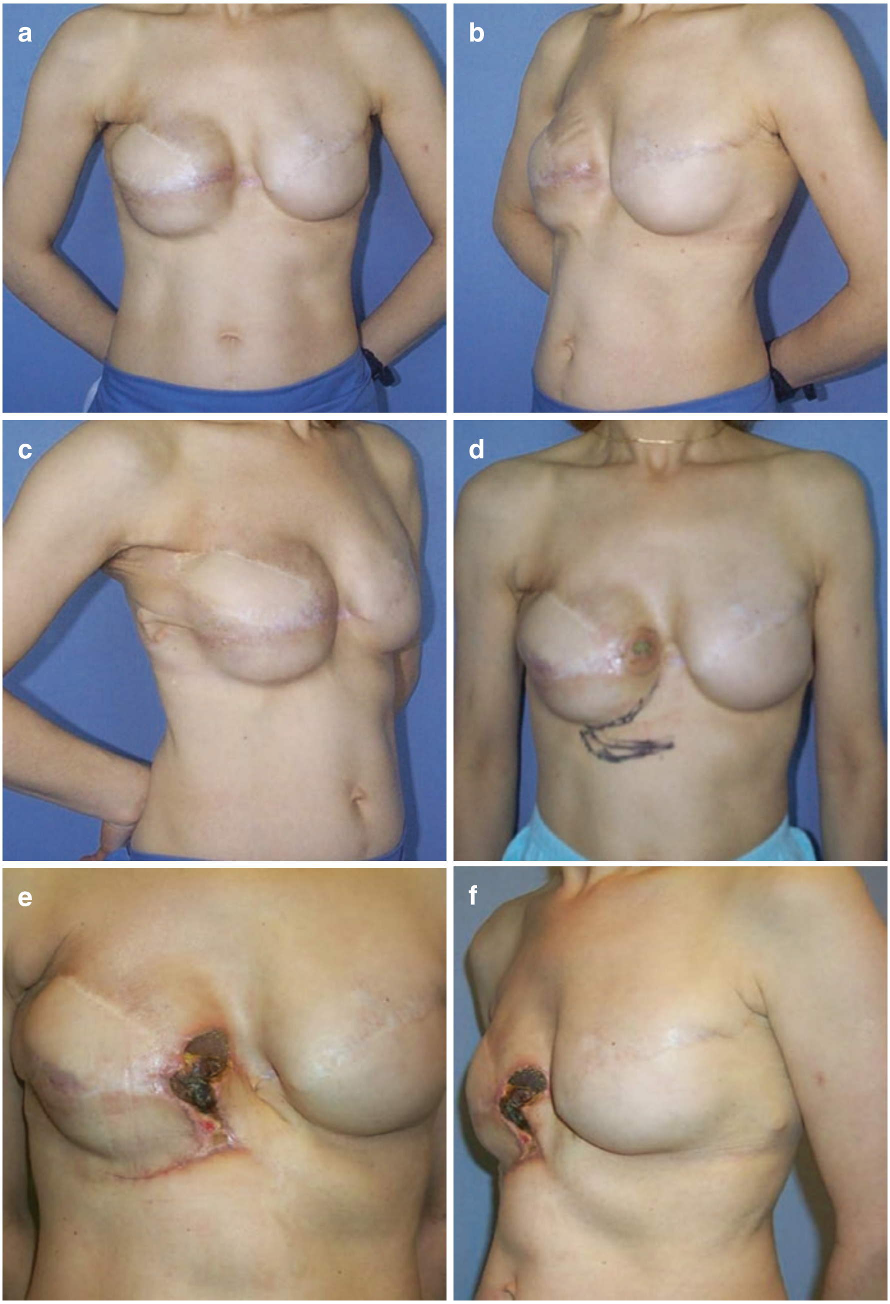


Fig. 34.5 (**a**–**c**) Right latissimus dorsi flap plus implant breast reconstruction following mastectomy for breast cancer in a radio treated patient. (**d**) The flap does not allow a complete coverage of the implant at the right inner quadrants: we tried to solve with a flap based on the rectus abdominis perforators. (**e**, **f**) Skin necrosis is visible at the tip of the flap. The patient is now waiting for a DIEP flap

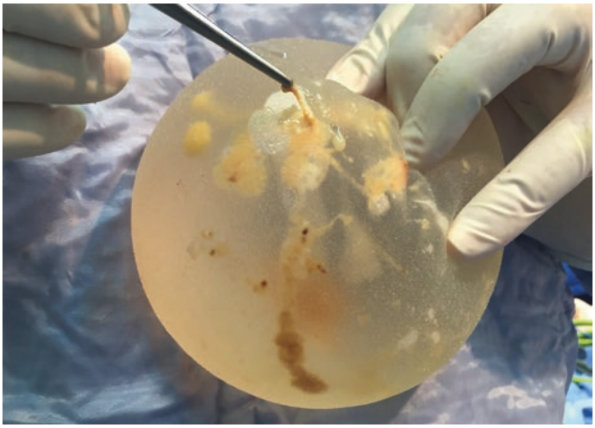


Fig. 34.6 Fat grafting "inside" a silicone implant

References

1. Losken A, Dugal CS, Styblo TM, et al. A meta-analysis comparing breast conservation therapy alone to the oncoplastic technique. Ann Plast Surg. 2014;72:145–9.
2. Kronowitz SJ, Feledy JA, Hunt KK, et al. Determining the optimal approach to breast reconstruction after partial mastectomy. Plast Reconstr Surg. 2006;117:1–11; discussion 12.
3. Munhoz AM, Montag E, Arruda EG, et al. Critical analysis of reduction mammaplasty techniques in combination with conservative breast surgery for early breast cancer treatment. Plast Reconstr Surg. 2006;117(4):1091–103; discussion 1104–7.
4. Munhoz AM, Montag E, Fels KW, et al. Outcome analysis of breast-conservation surgery and immediate latissimus dorsi ap reconstruction in patients with T1 to T2 breast cancer. Plast Reconstr Surg. 2005;116:741–52.
5. Hamdi M, Van Landuyt K, de Frene B, et al. The versatility of the intercostal artery perforator (ICAP) flaps. J Plast Reconstr Aesthet Surg. 2006;59:644–52.
6. Hamdi M, Van Landuyt K, Monstrey S, et al. Pedicled perforator flaps in breast reconstruction: a new concept. Br J Plast Surg. 2004;57:531–9.
7. Losken A, Hart AM, Broecker JS, et al. Oncoplastic breast reduction technique and outcomes: an evolution over 20 years. Plast Reconstr Surg. 2017;139:824e–33e.
8. Tong WM, Baumann DP, Villa MT, et al. Obese women experience fewer complications after oncoplastic breast repair following partial mastectomy than after immediate total breast reconstruction. Plast Reconstr Surg. 2016;137:777–91.
9. Wijgman DJ, Ten Wolde B, van Groesen NR, et al. Short term safety of oncoplastic breast conserving surgery for larger tumors. Eur J Surg Oncol. 2017;43:665–71.
10. Cil TD, Cordeiro E. Complications of oncoplastic breast surgery involving soft tissue transfer versus breast-conserving surgery: an analysis of the NSQIP database. Ann Surg Oncol. 2016;23:3266–71.
11. McIntosh J, O'Donoghue JM. Therapeutic mammaplasty – a systematic review of the evidence. EJSO. 2012;38:196–202.
12. Giacalone PL, Roger P, Dubon O, et al. Comparative study of the accuracy of breast resection in oncoplastic surgery and quadrantectomy in breast cancer. Ann Surg Oncol. 2007;14:605–14.
13. Kronowitz SJ, Hunt KK, Kuerer HM, et al. Practical guidelines for repair of partial mastectomy defects using the breast reduction technique in patients undergoing breast conservation therapy. Plast Reconstr Surg. 2007;120:1755–68.
14. Nos C, Fitoussi A, Bourgeois D, et al. Conservative treatment of lower pole breast cancers by bilateral mammoplasty and radiotherapy. Eur J Surg Oncol. 1998;508(14):24.

15. Caruso F, Catanuto G, De Meo L, et al. Outcomes of bilateral mammoplasty for early stage breast cancer. Eur J Surg Oncol. 2008;34:1143–7.
16. Fitoussi AD, Berry MG, Fama F, et al. Oncoplastic breast surgery for cancer: analysis of 540 consecutive cases [outcomes article]. Plast Reconstr Surg. 2010;125:454–62.
17. Platt R, Zucker JR, Zaleznik DF, Hopkins CC, Dellinger EP, Karchmer AW, Bryan CS, Burke JF, Wikler MA, Marino SK, et al. J Antimicrob Chemother. 1993;31(Suppl B):43–8.
18. Gupta R, Sinnett D, Carpenter R, Preece PE, Royle GT. Antibiotic prophylaxis for post-operative wound infection in clean elective breast surgery. Eur J Surg Oncol. 2000;26(4):363–6.
19. Bishop SR, Warr D. Coping, catastrophizing and chronic pain in breast cancer. J Behav Med. 2003;26(3):265–81.
20. Bartsich S, Ascherman JA, Whittier S, Yao CA, Rohde C. The breast: a clean-contaminated surgical site. Aesthet Surg J. 2011;31:802–6.
21. Thornton JW, Argenta LC, McClatchey KD, Marks MW. Studies on the endogenous flora of the human breast. Ann Plast Surg. 1988;20:39–42.
22. Jennings DA, Morykwas MJ, Burns WW, Crook ME, Hudson WP, Argenta LC. In vitro adhesion of endogenous skin microorganisms to breast prostheses. Ann Plast Surg. 1991;27:216–20.
23. Donlan RM. Role of biofilms in antimicrobial resistance. ASAIO J. 2000;46:S47–52.
24. Deva AK, Adams WP Jr, Vickery K. The role of bacterial biofilms in device associated infection. Plast Reconstr Surg. 2013;132:1319–28.
25. Hu H, Jacombs A, Vickery K, Merten SL, Pennington DG, Deva AK. Chronic biofilm infection in breast implants is associated with an increased T-cell lymphocytic infiltrate: implications for breast implant-associated lymphoma. Plast Reconstr Surg. 2015;135(2):319–29.
26. Szczepanik M. Interplay between helicobacter pylori and the immune system: clinical implications. J Physiol Pharmacol. 2006;57(Suppl 3):15–27.
27. Scuderi N, Mazzocchi M, Rubino C. Effects of zafirlukast on capsular contracture: controlled study measuring the mammary compliance. Int J Immunopathol Pharmacol. 2007;20:577.
28. Adams WP Jr, Rios JL, Smith SJ. Enhancing patient outcomes in aesthetic and reconstructive breast surgery using triple antibiotic breast irrigation: six-year prospective clinical study. Plast Reconstr Surg. 2006;118(Suppl):46S–52S.
29. Craft RO, Damjanovic B, Colwell AS. Evidence-based protocol for infection control in immediate implant-based breast reconstruction. Ann Plast Surg. 2012;69(4):446–50.
30. Hall-Findlay EJ. Breast implant complication review: double capsules and late seromas. Plast Reconstr Surg. 2011;127:56–66.
31. Goes JCS, Landecker A. Optimizing outcomes in breast augmentation: seven years of experience with the subfascial plane. Aesthetic Plast Surg. 2003;27:178–84.
32. Pinchuk V, Tymofii O. Seroma as a late complication after breast augmentation. Aesthet Plast Surg. 2011;35:303–14.
33. Pandya AN, Dickson MG. Capsule within a capsule: an unusual entity. Br J Plast Surg. 2002;55:455–6.
34. Robinson HN. Breast implant complication review: double capsules and late seromas. Plast Reconstr Surg. 2011;128:818.author reply 818–819
35. Giot JP, Paek LS, Nizard N, El-Diwany M, Gaboury LA, Nelea M, Bou-Merhi JS, Harris PG, Danino MA. The double capsules in macro-textured breast implants. Biomaterials. 2015;67:65–72.
36. Clemens MW, Miranda RN. Coming of age: breast implant-associated anaplastic large cell lymphoma after 18 years of investigation. Clin Plast Surg. 2015;42(4):605–13.
37. Hart AM, Lechowicz MJ, Peters KK, Holden J, Carlson GW. Breast implant-associated anaplastic large cell lymphoma: report of 2 cases and review of the literature. Aesthet Surg J. 2014;34(6):884–94.
38. Brody GS, Deapen D, Taylor CR, Pinter-Brown L, House-Lightner SR, Andersen JS, Carlson G, Lechner MG, Epstein AL. Anaplastic large cell lymphoma occurring in women with breast implants: analysis of 173 cases. Plast Reconstr Surg. 2015;135(3):695–705.

39. Clemens MW, Medeiros LJ, Butler CE, Hunt KK, Fanale MA, Horwitz S, Weisenburger DD, Liu J, Morgan EA, Kanagal-Shamanna R, Parkash V, Ning J, Sohani AR, Ferry JA, Mehta-Shah N, Dogan A, Liu H, Thormann N, Di Napoli A, Lade S, Piccolini J, Reyes R, Williams T, McCarthy CM, Hanson SE, Nastoupil LJ, Gaur R, Oki Y, Young KH, Miranda RN. Complete surgical excision is essential for the management of patients with breast implant-associated anaplastic large-cell lymphoma. J Clin Oncol. 2016;34(2):160–8. https://doi.org/10.1200/JCO.2015.63.3412. Epub 2015 Nov 30. Erratum in: J Clin Oncol. 2016;34(8):888. DiNapoli, Arianna [corrected to Di Napoli, Arianna].
40. Gholam D, Bibeau F, El Weshi A. Primary breast lymphoma. Leuk Lymphoma. 2003;44(7):1173–8.
41. Accurso A, Rocco N, Feleppa C, Palumbo A, D'Andrea F. Spread of silicone to axillary lymph nodes after high cohesive gel silicone implant rupture. Plast Reconstr Surg. 2008;122(6):221e–2e.
42. Rocco N, Rispoli C, Moja L, Amato B, Iannone L, Testa S, Spano A, Catanuto G, Accurso A, Nava MB. Different types of implants for reconstructive breast surgery. Cochrane Database Syst Rev. 2016;(5):CD010895.
43. Spear SL, Howard MA, Boehmler JH, Ducic I, Low M, Abbruzzese MR. The infected or exposed breast implant: management and treatment strategies. Plast Reconstr Surg. 2004;113(6):1634–44.
44. Accurso A, Rocco N, Accardo G, Reale P, Salerno C, Mattera E, D'Andrea F. Innovative management of implant exposure in ADM/implant-based breast reconstruction with negative pressure wound therapy. Aesthet Plast Surg. 2016; https://doi.org/10.1007/s00266-016-0739-1.
45. De Riggi MA, Rocco N, Gherardini G, Esposito E, D'Aiuto M. Management of implant re-exposure in one-stage breast reconstruction using titanium-coated polypropylene mesh: sub-mammary intercostal perforator flap. Aesthet Plast Surg. 2016;40(6):896–900.
46. Citron I, Dower R, Ho-Asjoe M. Protocol for the prevention and management of complications related to ADM implant-based breast reconstructions. GMS Interdiscip Plast Reconstr Surg DGPW. 2016;5:Doc06. https://doi.org/10.3205/iprs000085.
47. Liao EC, Breuing KH. Breast mound salvage using vacuum-assisted closure device as bridge to reconstruction with inferolateral AlloDerm hammock. Ann Plast Surg. 2007;59(2):218–24.
48. Wu PS, Winocour S, Jacobson SR. Red breast syndrome: a review of available literature. Aesthet Plast Surg. 2015;39(2):227–30.

Check for updates

Education and Training in Oncoplastic Breast Surgery

35

Gustavo Zucca-Matthes

We are what we repeatedly do.
Excelence [sic], then, is not an act, but a habit

Aristoteles

Introduction

The high level of responsibility in various vocations draws special attention to the educational programs required for competence. To be an aircraft pilot or naval commander, it is critically necessary to have a great number of hours spent at a simulator.

During medical school, future doctors deal with different models of training. They start with cadaveric dissection and animal labs and finally arrive at clinical training guided by an experienced surgeon. To be a surgeon, it is necessary to spend many hours studying and practicing manual skills. Why not train in some kind of surgical simulator as well? In fact, this type of training already exists and is commonly used for minimally invasive surgeries in laparoscopy and robotic procedures. The main point of these devices is to closely mimic reality, simulate real clinical scenarios, and test and rate performance.

With respect to breast surgery, finding the optimal physical material to simulate a real breast is not easy. Investigators have mentioned the use of foam models trying to simulate human tissues. However, the expected level of realism was not achieved. This made it necessary to find more anatomical models to facilitate surgical training to allow surgeons to develop their skills and practice new techniques without risk to a real patient.

G. Zucca-Matthes (✉)
Head of Breast and Reconstruction Surgery Department, Breast Unit Barretos – Barretos Cancer Hospital, Barretos, SP, Brazil

V. S. Klimberg et al. (eds.), *Oncoplastic Breast Surgery Techniques for the General Surgeon*, https://doi.org/10.1007/978-3-030-40196-2_35

Types of Surgical Training (Table 35.2)

Cadaver Lab

Cadaveric dissection is broadly used for specialty laboratory training. Recently, it has been used for breast aesthetic and reconstruction training. However, this practice is hampered by the costs involved in the preparation of cadavers and laboratory, not to mention the many ethical issues that make this practice difficult in some countries. (Fig. 35.1).

Training Programs

Over time, the apprenticeship method has become the gold standard for surgical training. The paradigm of "see one, do one, teach one" clearly reveals the basic tenets of this method. It is a time-honored approach in which a skillful tutor provides practical demonstrations and shares theoretical knowledge with the trainee. Therefore, surgery is learned by example and repetition. This model of training demands a very large number and variety of cases to train a new surgeon. By the end of the 1800s, William Osler and William Halsted were responsible for pioneering and popularizing this method. They also established a more formal and structured system involving a team of trainees and mentors. In fact, the organization of residency training currently employed in the majority of medical schools derives mostly from their work. Surgical rotations and close relationships between masters and novices help the trainee gain competence, optimizing and

Fig. 35.1 Cadaveric surgical mentoring by an expert

amplifying the learning curve. Finally, on completion of the residency program, residents must demonstrate their proficiency through board examinations to be fully certified.

Although the current apprenticeship system of training has a proven track record of success, restrictions in resident work hours, financial pressures, patient safety issues, heated debates about early specialization, duration of training, and the search for a better quality of life have led some renowned surgeons to propose more efficient alternatives to this teaching method. Furthermore, technological advances, such as computer-based simulators, have allowed young surgeons to gain surgical experience in a protected environment with no risk to the patient and to quickly improve their skills.

The breast is an important symbol of femininity and so today we see an increased number of cosmetic surgeries. In addition, breast cancer has spread around the world and each country has their own set of customs for the specialties involved in breast reconstruction. However, all of them have in common the realization that breast cancer surgery is changing and must adapt in order to provide current, safe, and refined treatment for women.

Over the last few decades, surgical techniques have advanced to the point where breast-conserving surgery (BCS) has become the standard of care for the treatment of early stage breast carcinomas [1, 2]. By the early 1990s, some authors suggested the integration of plastic surgery techniques with BCS in the treatment of breast cancer [3]. Conceptually, this approach, referred to as "oncoplastic surgery," aims at providing safe oncologic treatment through careful preoperative planning with the incorporation of plastic surgery techniques in order to obtain good oncologic control with favorable immediate cosmetic results. Moreover, oncoplastic surgery very often offers improved overall aesthetic outcomes and seeks to optimize contralateral breast symmetry.

In 2003 Rainsbury [4] wrote about future training and skills for breast surgeons in the new millennium. He commented that breast surgery was becoming more specialized as a result of fellowship training, greater patient demand for specialists, increasing trainee expectations, and new skills learned by existing breast surgeons. As a result, modern training programs need to recognize these requirements by supporting interprofessional cross-training initiatives and encouraging professional development.In the United Kingdom, the oncoplastic concept has made the breast subspeciality a more popular and attractive career option to a new generation of surgical trainees. The general surgery programs do not offer adequate numbers of breast cancer cases for residents to adequately train, so residents go on to breast surgery or surgical oncology fellowships. Oncoplastic fellowships must train specialists who have an active role in the comprehensive management of breast cancer patients, capable of providing the most appropriate cancer surgery with the best cosmetic results. Robertson et al. proved that trained breast-surgeon specialists perform implant-based immediate breast reconstructions with a satisfactory outcome when evaluated by subjective and objective analyses [5].

This leads to the evolution of breast surgery with improvement in surgical techniques looking for better results, especially regarding breast reconstruction and

Fig. 35.2 Guided preoperative drawings

aesthetic procedures. It is important to mention that for good immediate results, breast reconstruction with implants require a skillfully performed mastectomy.

The goal is to provide education for surgeons with large practices in breast surgery, but without oncoplastic or reconstructive surgery experience (Figs. 35.2 and 35.3). Also of importance, is the structure of postgraduate training courses and the level of activity of the breast reconstruction training unit. Breast cancer centers with high volume should be certified as training programs. The Oncoplastic Training Center based at Barretos Cancer Hospital was a successful example [6]. Since 2009 this oncological center had been focused on preparing surgeons in oncoplastic breast surgery procedures and it was responsible to spread knowledge to different parts of Brazil.

With increased subspecialization as exemplified by the growing number of physicians solely devoted to breast surgery, surgeons are required to develop more sophistication in a relatively shorter period of time. However, the apprenticeship-based method relies on an extended period of time to provide the trainee with sufficient experience.

Oncoplastic Training Center—Barretos Cancer Hospital

A training course in oncoplastic was established with an initial class of up to 12 surgeons. The course was divided into 21 modules taught to the surgeons one

Fig. 35.3 Training in the surgical theater

weekend per month. Each module focuses on a different aspect of oncoplastic procedures (Table 35.1). Up to now five courses have been made.

An expert is also invited to lecture, and also a practical procedure is performed. The experts were selected by their clinical approved experience in oncoplastic surgery. They are composed of breast surgeons with oncoplastic experience and open-minded plastic surgeons.

Cases were selected related to the surgery to be discussed and the need to improve the trainees' abilities. Patients are chosen ahead of time and informed consent obtained for participation in the course. The treatment was provided at no cost to the selected patients. The surgeries were supported by the Brazilian Health System (BHS—SUS) and the hospital's private foundation.

All the lessons and surgeries are recorded and a DVD is provided to the trainees in the next class, containing the procedures and the themes previously discussed. The postoperative results of the surgeries are showed and assessed in the following module.

Simulators

The development and use of newly created simulators in residency or continuing medical educational programs has promoted a shift in surgical education [7]. Through an unlimited number of repeated exercises and in a calm, stress free environment, surgeons can theoretically gain extensive experience in a brief duration of

Table 35.1 Scientific Program of Oncoplastic Training Center—BCH

Scientific program			
Module	Lesson	Surgical procedures	Cases report discussion
1	Introduction: Oncoplastic history/presenting basic concepts	Yes	No
2	General oncoplastic points of view/breast types/ Oncoplastic perspective from plastic surgeon and breast surgeon	Yes	Yes
3	Medical photography/oncoplastic legal aspect	Yes	Yes
4	Oncoplastic training and bioethics	Yes	Yes
5	Superior quadrants approach and symmetrization	Yes	Yes
6	Inferior quadrants approach and symmetrization	Yes	Yes
7	Lateral quadrants approach and symmetrization	Yes	Yes
8	Medial quadrants approach and symmetrization	Yes	Yes
9	Central quadrant approach and symmetrization	Yes	Yes
10	Evolution of mastectomies and new perspectives on breast-conserving treatment/ radiotherapy in oncoplastic	Yes	Yes
11	Skin sparing mastectomy and nipple sparing mastectomy	Yes	Yes
12	Breast reconstruction with implants	Yes	Yes
13	Breast reconstruction with latissimus dorsi	Yes	Yes
14	Breast reconstruction with transverse rectus abdominis myocutaneous (TRAM)	Yes	Yes
15	Closure techniques after great dissections	Yes	Yes
16	Correcting breast asymmetries	Yes	Yes
17	Principles and bases of fat grafting	Yes	Yes
18	How the pathology deals with oncoplastic/wounds and dressings	Yes	Yes
19	Nipple areolar complex (NAC) reconstruction/the radiology and oncoplastic	Yes	Yes
20	Principles of microsurgery—deep inferior epigastric perfurators (DIEP)	Yes	Yes
21	Oncoplastic spreads around the world	Yes	Yes
	Conclusion: Overview Delivery of surgical log book		–

time. The creation of an optimal simulator model as an adjunct to breast and plastic surgery education can improve the training process for both specialties and allow for more rapid attainment of competency [8, 9]. Different kinds of simulators or teaching techniques have been employed and have revealed good results in different aspects of training [10]. The use of foam models allows for a three dimensional structure compared to the standard two dimensional reconstructed breast surface used when teaching local flap techniques. It illustrates, for example, how the flap is harvested and how the nipple is fashioned in nipple areolar complex reconstruction. The use of tissue-like phantoms is widely used to calibrate and compare imaging systems and to train surgeons to operate under image guidance [11]. There are also breast examination models being used to teach breast exams, to improve a doctor's skill of palpation, and to increase the effectiveness of this examination to allow the physician to become less anxious with this interaction and more comfortable with this skill. Training models could be very realistic. Most of them have been developed with varying densities and sizes and physical relationships with underlying rib and muscle structures in breast. They also can come with adjustable breast lumps [12].

Mastotrainer

The Neoderm model [7, 13] called Mastotrainer is a simulator specific for breast surgery training. It was created with a focus on breast aesthetics and reconstruction.

For this model, it was necessary to create differing planes of dissection, for example, subcutaneous tissues, breast, muscles, and ribs. The "Mastotrainer" relies on this lifelike recreation of the organ and falls into a new class of simulators: "R.E.S.T. (Realistic Endo Surgical Trainer) simulators" [7]. This technology was introduced in 42 countries and includes such specialties as neurosurgery, urology, gynecology, and general surgery among others. It makes use of a type of moldable rubber that, together with a group of polymers, allows for more than 60 types of consistencies ranging from mucoid secretions to cartilage. It allows for different colorations, which help in creating a vast variety of different anatomical tissue planes as well as lesions. The combination of these components stimulates the formation of cysts, solid tumors, masses of different consistency, including ones with calcifications and the formation of cleavage planes. The Neoderma is used in a customized manner that corresponds with the variable pathologies that can be chosen before the training process. These simulators are placed on a fiberglass base that allows for the manipulation and practice on the body part of interest. The used anatomical part is discarded after the practice surgery and the fiberglass base is now ready for another surgical unit and training run. Manufacturers offer Neoderma technology that mimics closely the color, consistency, feel, elasticity, and resilience of human tissues. More advanced technologies allow for bleeding inside body cavities. There are tissues that can be cut by an ultrasonic scalpel and laser as well. When practicing suturing, it can provide the appropriate resistance to the specific tissues being worked on in addition to the type of sutures being used and maneuvers being performed. These advanced teaching techniques decrease the learning curve for new professionals when learning to perform procedures for the first time.

The "Mastotrainer" [9, 12] was introduced as a new concept of simulators for use in surgical training. The Mastotrainer has proved to be very useful in training various surgical techniques. There are four generations of Mastotrainers (Fig. 35.4). The first version of the simulator being focused on breast augmentation and implant

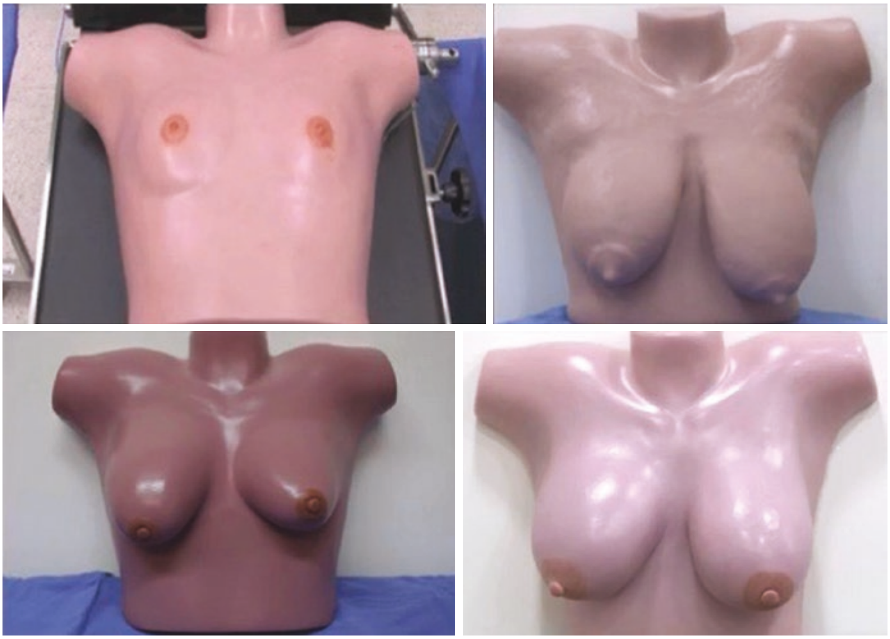


Fig. 35.4 Mastotrainer generations

reconstruction following mastectomy. The second and fourth versions of the Mastotrainer, are foused on larger and ptotic breasts providing hands-on training for preoperative markings, various mammaplasty or mastopexy techniques, including breastconserving surgery, reconstructive lumpectomy, and oncoplastic procedures. The third version is medium, ptotic, and asymmetric breasts, allows to perform mastopexies, vertical mammaplasty, in addition to performe different breastconserving techniques and sparing mastectomies dealing with breast reconstruction and implants. Recently it was used for fat-grafting training. A biological model (porcine parts) was used in parallel for fat harvesting. The potential of these simulators for training in breast surgeries is incredible (Fig. 35.4). It is valuable for training oncologic, aesthetic, and/or reconstructive breast surgeries.

This training model allows beginning surgeons to gain experience with fundamental surgical skills and principles such as making incisions, suturing, and identifying surgical planes that will diminish the risk of future preventable mistakes that can occur in the practice of surgery (Fig. 35.5). There are an enormous list of factors that contribute to error prevention such as adequate experience, familiarity with the surgical field, and immediate recognition and successful solution of prior critical problems. All errors are discussed after the exercises are completed and this is crucial to the surgeon's learning experience and ability to prevent real future morbidity for their patients.

Multiple virtual challenging clinical scenarios can be simulated by this program, and the surgeon's performance under stress situations can be evaluated. These

Fig. 35.5 Mastotrainer simulator for training in oncoplastic breast surgery: feasibility and potential

tutorials focus on improving surgeon performance using both basic and more advanced modules (Table 35.2).

Results

Changing paradigms is always difficult and often slow as well noted by Veronesi and Fisher in relation to their advocacy of breast-conserving surgery [15]. Various questions concerning oncoplastic techniques have been raised. Who is qualified to do it? Who does it better? What are the limits? Are there any? Those questions concerning oncoplastic surgery can be answered but time may be needed to accept the concepts.

Table 35.2 Main characteristics of oncoplastic breast surgery training courses

Programs	Cadaver lab	Mastotrainer	Training center (live surgeries)
Level of expertise	Variable	Variable	Variable
Duration	2 days	Variable	21 months
[a]OBS procedures	Level I to IV	Level I to III	Level I to IV
Content	Practical—50%	Practical—75%	Practical—90%
	Theoretical—50%	Theoretical—25%	Theoretical—10%
Realistic experience	★★	★	★★★
Cost	$$	$	$$$

[a]Classification for OBS procedures [14]:

Level 1: Monolateral breast reconstruction techniques such as aesthetic skin incisions, de-epithelization of the areolar margins, glandular mobilization, and re-shaping techniques, purse string sutures for central quadrant reconstruction, and immediate breast reconstruction with temporary expanders

Level 2: Bilateral procedures such as lipofilling, breast augmentation, breast reduction, mastopexy, Grisotti flap, and nipple and areola reconstruction

Level 3: Immediate and delayed breast reconstruction with implants or a combination of techniques

Level 4: More complex monolateral or bilateral procedures involving autologous flaps (pedicled or free flaps)

The routine practice of oncoplastic surgery depends on the geographical, social, and economical aspects of the region involved. Oncoplastic surgery in the developed world is associated mainly with the reconstruction aspects of early breast cancer, while in the developing countries it includes repairing the surgical defect created by local advanced tumors. Not every breast surgeon will have the time, inclination, or opportunity to learn breast reconstruction and the pattern of practice will depend on local circumstances and available expertise. Options for oncoplastic activities include: (1) the breast surgeon performing the mastectomy and the plastic surgeon performing a reconstruction separately, (2) the breast and plastic surgeons working together to perform the mastectomy and reconstruction at same time, (3) the oncoplastic surgeon or plastic surgeon, improving their skills, they can perform both procedures, oncologic and reconstructive ones, alone by itself and still being part of a multidisciplinary team [4], or to add could be mentioned, and (4) the plastic surgeon obtaining the oncological knowledge and also performing both procedures.

In 2003, Rainsbury wrote about future training and skills for breast surgeons in the new millennium [4]. He commented that breast surgery was becoming more specialized as a result of fellowship training, greater patient demand for specialists, increasing trainee expectations, and new skills learned by existing breast surgeons. As a result, modern training programs need to recognize these requirements by supporting interprofessional cross-training initiatives and encouraging professional development. Examples of these ideas are found in Great Britain [4], Australia [16], France [17], Germany [18], Italy [19], Portugal [20, 21], Spain [22], and Brazil [6]. Nowadays, the American Society of Breast Surgeons and American Society of Breast Diseases are promoting these ideals of oncoplastic surgery in the United States [23, 24].

In United Kingdom, the oncoplastic surgery concept has made the breast subspecialty a more popular and attractive perspective to new generation of surgical trainees [25]. The general surgical programs do not offer adequate numbers of breast cancer cases to residents to adequately train, so residents go on to the breast surgery or surgical oncology fellowship [26]. Oncoplastic surgery fellowships must train specialists who have an active role in the global management of breast cancer patients, capable of providing the most appropriate cancer surgery with the best cosmetic results [25].

More recently, Robertson et al. proved that trained breast surgeons specialists perform implant-based immediate breast reconstructions with a satisfactory outcome when evaluated by subjective and objective analyses [27]. This emphasizes the importance of the oncoplastic surgery training.

The problem is to provide education for surgeons with large practices in breast surgery but without oncoplastic surgery experience.

In aviation, pilot experience is recognized to be invaluable, and this is gained in simulation programs and tutoring before they fly a plane. They are therefore required to undergo yearly training with new technology in different crisis simulators. Why not surgeons too?

Medical mistakes are, and will always be, inevitable in the practice of medicine. The goal here would be to give the novice surgeon experience with difficult operative challenges on a simulator before he is forced with a similar situation in a live patient.

The continuing evolution of surgical education in breast disease is a complex process that has been affected by several variables. During the last decade, many factors, such as an increasing demand for subspecialty care by patients and referring physicians, have forced some changes to the current method of training. In fact, breast and plastic surgeons have been pushed to develop their surgical skills in a relatively shorter period of time. Surgical training in breast reconstruction has some specific requirements. A unique set of instruments is required, as is a practice model that closely resembles the different tissue types with which a breast surgeon will be faced.

Despite the ability of cadaveric models to provide excellent lifelike simulation of multiple varied reconstructive procedures, the access, ethical issues, safety, and cost-effectiveness of this strategy have impaired the widespread use of such models.

Another non-surgical issue but perhaps equally important role for training centers is to teach the surgeons the value of really listening to their patients. Very often aesthetic results are poor from the viewpoint of the surgeon but the patient is content, mainly because she was treated for cancer and still has an acceptable breast shape. Of course, aesthetic results are important; however, for a breast specialist the results cannot be evaluated in isolation but must take into account the goals, motivations, desires, and psyche of the woman that is being treated. The oncoplastic philosophy is very similar to a Swiss army knife. The more experience the surgeon acquires, the more surgical options he has to offer a safe cancer treatment to his patient. In the twenty-first century, treatment of breast cancer has become more and more individualized, on both the molecular level and on the level of the whole human being, respecting the wishes and expectations of the patient in front of you. In addition, patients have become more demanding, with the increased expectations of their treating physicians pushing us to continuously refine our surgical techniques. The communication between breast surgeons and plastic surgeons is certainly important for this improvement in the standard of care regardless of the specific roles of each surgeon.

Another issue to be discussed is the reasons for the lack of interest from part of great majority of plastic surgeons in breast reconstruction [28–30]. Probably, performing aesthetic procedures is more profitable, economically saying. Another point is the impossibility to provide a high percentage of good or excellent results. Sometimes the surgeon who performs oncoplastic techniques must accept the results despite their limited aesthetic pursuit of excellence. Reconstructive surgeries are through procedures and can never be assured about the final result. Dealing with uncertain outcomes, despite all the expertise used, greater surgical time and uncertain financial compensation might have been responsible for the non-participation of plastic surgeons from the fight against breast cancer. This gap encouraged others surgeons to obtain related training to complete the treatment of breast cancer and help patients to regain their dignity [6].

Before the first oncoplastic training center group at Barretos, 75.0% of attendees were able to perform any kind of level I procedure and none were able to perform procedures at level II-III. All the specialists expected the course to improve their surgical skills to help their patients. Most part of them (91.7%) were used to working with a plastic surgeon as a partnership in a private clinic. However, only 16.7% never had problems with this relationship, another 41.7% mentioned their desires to work together with the plastic surgeon, but usually they were not available on request. After the first course, the assessment survey confirmed that 75.0% of the specialists developed their skills and became capable to perform procedures by themselves at up to level III. The trainees' initial feedback was very positive [6].

Critically important to teaching oncoplastic surgery is the use of a variety of methods including demonstrations of the relevant anatomy for breast reconstruction, small group tutorials, implant workshops, and experience with anatomical dissection. Students should perform cadaver-based or simulator-based procedures reinforced by teaching videos and live operative demonstrations. The training centers should provide comprehensive oncological and reconstructive training with structured educational supervision, assessment, and feedback.

Conclusions

A well-organized educational program in oncoplastic breast surgery can elevate the current standard of care.

Organized oncoplastic training centers can provide knowledge necessary for surgeons to achieve oncoplastic skills and continue to help patients. The knowledge gained from cancer surgery associated with plastic surgery skills is an essential weapon for the ideal treatment. We strongly believe that surgical simulators will provide a critical experience in the training of future oncoplastic surgeons to ensure the safe transition to surgery on live patients. Regardless of the origin of the surgeon, well trained, he will be able to make a difference anywhere.

References

1. Fisher B, Anderson S, Bryant J, Margolese RG, Deutsch M, Fisher ER, Jeong JH, Wolmark N. 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. 2002;347(16):1233–41. https://doi.org/10.1056/NEJMoa022152.
2. Veronesi U, Cascinelli N, Mariani L, Greco M, Saccozzi R, Luini A, Aguilar M, Marubini E. Twenty-year follow-up of a randomized study comparing breast-conserving surgery with radical mastectomy for early breast cancer. N Engl J Med. 2002;347(16):1227–32. https://doi.org/10.1056/NEJMoa020989.
3. Audretsch WRM, Kolotas C, et al. Tumor-specific immediate reconstruction in breast cancer patients. Perspect Plast Surg. 1998;11:71–100.
4. Rainsbury RM. Training and skills for breast surgeons in the new millennium. ANZ J Surg. 2003;73(7):511–6.
5. Baildam A, Bishop H, Boland G, Dalglish M, Davies L, Fatah F, Gooch H, Harcourt D, Martin L, Rainsbury D, Rayter Z, Sheppard C, Smith J, Weiler-Mithoff E, Winstanley J, Church J. Oncoplastic breast surgery – a guide to good practice. Eur J Surg Oncol. 2007;33 Suppl 1:S1–23. https://doi.org/10.1016/j.ejso.2007.04.014.
6. Matthes AG, Viera RA, Michelli RA, Ribeiro GH, Bailao A Jr, Haikel RL, Matthes AD. The development of an Oncoplastic Training Center – OTC. Int J Surg. 2012;10(5):265–9. https://doi.org/10.1016/j.ijsu.2012.03.009.
7. Filho FV, Coelho G, Cavalheiro S, Lyra M, Zymberg ST. Quality assessment of a new surgical simulator for neuroendoscopic training. Neurosurg Focus. 2011;30(4):E17. https://doi.org/10.3171/2011.2.FOCUS10321.
8. Stefanidis D. Optimal acquisition and assessment of proficiency on simulators in surgery. Surg Clin North Am. 2010;90(3):475–89. https://doi.org/10.1016/j.suc.2010.02.010.
9. Matthes AG, Perin LF, Rancati A, da Fonseca L, Lyra M. Mastotrainer: new training project for breast aesthetic and reconstructive surgery. Plast Reconstr Surg. 2012;130(3):502e–4e. https://doi.org/10.1097/PRS.0b013e31825dc5fa.
10. Naylor RA, Hollett LA, Valentine RJ, Mitchell IC, Bowling MW, Ma AM, Dineen SP, Bruns BR, Scott DJ. Can medical students achieve skills proficiency through simulation training? Am J Surg. 2009;198(2):277–82. https://doi.org/10.1016/j.amjsurg.2008.11.036.
11. De Grand AM, Lomnes SJ, Lee DS, Pietrzykowski M, Ohnishi S, Morgan TG, Gogbashian A, Laurence RG, Frangioni JV. Tissue-like phantoms for near-infrared fluorescence imaging system assessment and the training of surgeons. J Biomed Opt. 2006;11(1):014007. https://doi.org/10.1117/1.2170579.
12. Zucca-Matthes G, Lebovic G, Lyra M. Mastotrainer new version: realistic simulator for training in breast surgery. Breast. 2016;31:82–4. https://doi.org/10.1016/j.breast.2016.08.009.
13. Zymberg S, Vaz-Guimaraes Filho F, Lyra M. Neuroendoscopic training: presentation of a new real simulator. Minim Invasive Neurosurg. 2010;53(1):44–6. https://doi.org/10.1055/s-0029-1246169.
14. Urban CA. New classification for oncoplastic procedures in surgical practice. Breast. 2008;17(4):321–2. https://doi.org/10.1016/j.breast.2007.11.032.

15. Veronesi U, Banfi A, Salvadori B, Luini A, Saccozzi R, Zucali R, Marubini E, Del Vecchio M, Boracchi P, Marchini S, et al. Breast conservation is the treatment of choice in small breast cancer: long-term results of a randomized trial. Eur J Cancer. 1990;26(6):668–70.
16. Rainsbury D. Training in breast reconstruction: a new chapter in breast surgery. Hosp Med. 2003;64(12):700–1.
17. Clough KB, Lewis JS, Couturaud B, Fitoussi A, Nos C, Falcou M-C. Oncoplastic techiniques allow extensive resections for breast-conserving therapy of breast carcinomas. Ann Surg. 2003;237(1):9.
18. 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. Proceedings of Second European Congress on Senology, Breast Diseases, pp. 139–57.
19. Petit JY, De Lorenzi F, Rietjens M, Intra M, Martella S, Garusi C, Rey PC, Matthes AG. Technical tricks to improve the cosmetic results of breast-conserving treatment. Breast. 2007;16(1):13–6. https://doi.org/10.1016/j.breast.2006.08.004.
20. Cardoso MJ, Macmillan RD, Merck B, Munhoz AM, Rainsbury R. Training in oncoplastic surgery: an international consensus. The 7th Portuguese Senology congress, Vilamoura, 2009. Breast. 2010;19(6):538–40. https://doi.org/10.1016/j.breast.2010.03.030.
21. Cardoso MJ, Cardoso JS, Vrieling C, Macmillan D, Rainsbury D, Heil J, Hau E, Keshtgar M. Recommendations for the aesthetic evaluation of breast cancer conservative treatment. Breast Cancer Res Treat. 2012;135(3):629–37. https://doi.org/10.1007/s10549-012-1978-8.
22. Toro EM, Oliveras PC, Usategui TM, Rodríguez AM. Formación en reconstrucción mamaria y cirugía oncoplástica. Cir Esp. 2008;84(2):1.
23. Anderson BO, Masetti R, Silverstein MJ. Oncoplastic approaches to partial mastectomy: an overview of volume-displacement techniques. Lancet Oncol. 2005;6(3):145–57. https://doi.org/10.1016/S1470-2045(05)01765-1.
24. Lebovic GS. Oncoplastic surgery: a creative approach to breast cancer management. Surg Oncol Clin N Am. 2010;19(3):567–80. https://doi.org/10.1016/j.soc.2010.04.003.
25. Audisio RA, Chagla LS. Oncoplastic fellowship: can we do better? Breast. 2007;16(1):11–2. https://doi.org/10.1016/j.breast.2006.07.001.
26. Bailey L. Challenges and economics of private breast cancer surgery practice. Breast. 2010;19(4):297–302. https://doi.org/10.1016/j.breast.2010.03.012.
27. Robertson S, Wengstrom Y, Eriksen C, Sandelin K. Breast surgeons performing immediate breast reconstruction with implants – assessment of resource-use and patient-reported outcome measures. Breast. 2012. https://doi.org/10.1016/j.breast.2012.01.003.
28. Urban CA. Oncoplastic in a pre-paradigm era: a Brazilian perspective in an American problem. Plast Reconstr Surg. 2010;125(6):1839–41; author reply 1841-1833. https://doi.org/10.1097/PRS.0b013e3181cb61d5.
29. Losken A, Nahabedian MY. Oncoplastic breast surgery: past, present, and future directions in the United States. Plast Reconstr Surg. 2009;124(3):969–72. https://doi.org/10.1097/PRS.0b013e3181b038ec.
30. Losken A. Oncoplastic in a pre-paradigm era: a Brazilian perspective in an American problem. Plast Reconstr Surg. 2010;125(6):1839–41; author reply 1842-1833. https://doi.org/10.1097/PRS.0b013e3181cb61d5.

Oncoplastic Breast Surgery Techniques for the General Surgeon

36

Gustavo Zucca-Matthes

Introduction

Over time the evolution of surgical treatment has consecrated conservative therapy for breast cancer. Initially, mastectomy technique described by Halsted [1] in 1894, employed until the mid-second half of the ninth century, progressively gave way to lumpectomy (1981), suggested by Fisher et al. [2] and Veronesi [3]. The purpose of breast-conserving treatment for early cancers is to preserve the mammary gland guaranteeing a satisfactory outcome of the preserved breast, providing a similar chance of cure compared with mastectomy. In 1998 Audrescht et al. [4] suggested an incorporation of plastic surgery techniques to provide new possibilities to the surgeon to treat breast cancer with safe and refined outcomes. It was born the oncoplastic breast surgery (OBS) that it was stepping forward to become the gold standard surgical treatment for breast cancer patients.

Oncoplastic breast surgery (OBS) represents the use of techniques in plastic surgery, conceptually allowing breast symmetrization through reductive or additive mammoplasty techniques, simultaneously with oncological treatment [5]. It also allows a reduction in scars and asymmetries caused by lumpectomies in patients treated for breast cancer [6]. In addition, breast reconstruction was incorporated to the concept of OBS. The evolution of mastectomies allows the skin conservation facilitating immediate breast reconstruction, which is now considered oncoplastic or conservative mastectomies [7].

Another topic must be highlighted. Nowadays, expectations regarding outcomes have changed and patients are worried about the quality of scars and the shape of the breast even if they underwent oncological treatment [8].

Oncoplastic breast surgery has become a reality, but many breast surgeons need to be fit in this context. These techniques are not fully incorporated; consequently, training for

G. Zucca-Matthes (✉)
Head of Breast and Reconstruction Surgery Department, Breast Unit Barretos – Barretos Cancer Hospital, Barretos, SP, Brazil

V. S. Klimberg et al. (eds.), *Oncoplastic Breast Surgery Techniques for the General Surgeon*, https://doi.org/10.1007/978-3-030-40196-2_36

Table 36.1 New classification for oncoplastic procedures in surgical practice

Class 1	Class 2	Class 3	Class 4
Monolateral approach	Bilateral approach	Implants	Muscular flaps
Monolateral breast reconstruction Aesthetic skin incisions De-epithelization of the areolar margins, glandular mobilization, and reshaping techniques Purse string sutures for central quadrant reconstruction *Specific competence in plastic surgery is not required at this point*	Lipofilling Breast reduction Mastopexy Grisotti flap Nipple and areola reconstruction *Specific competence in plastic surgery techniques of the breast is required to achieve better symmetry*	Immediate breast reconstruction with temporary expanders Bilateral procedures such as immediate and delayed breast reconstruction with implants Breast augmentation *Specific competence in plastic surgery techniques of the breast is required to achieve better symmetry*	More complex monolateral or bilateral procedures involving autologous flaps (pedicled or free flaps) or a combination of techniques *A higher standard in plastic surgery techniques is required*

the new surgeon needs to be remodeled for OBS to be part of their daily activities. This refinement requires time and training to be incorporated into practice [9–11].

Indications

There are different kinds of techniques and four levels of oncoplastic breast surgeries (Table 36.1) [12]. Depending on the surgeon skills and training, the range of indications can be adapted.

Even if you do not have specific training in plastic surgery, there are several surgical tricks for general surgeons to improve the final cosmetic result of breast-conserving treatment.

Preoperative Evaluation and Planning

Several issues are necessary to perform a surgery. The indication of an oncoplastic breast surgery for conserving treatment demands and additional attention to:

- Breast volume
- Ptosis
- Tumor size
- Tumor site
- Symmetry
- Desire of patient

Based on those characteristics, surgeons can find the best technique to each case related to the oncological safety. For each technique, different surgical markings can be used.

For example: a patient with ptotic, large volume breast, small tumor at union of lower quadrants and patient desire symmetry should be perfectly treated with a mammoplasty as a superior pedicle technique by Wise pattern markings including incisions to resect the tumor and reduce the breast providing oncological safety treatment and refined outcome. On the other hand, if the same patient does not want symmetry, a classic lumpectomy could be performed. Another condition is the indication of a mastectomy that is described in places with lack of radiotherapy and it becomes the first choice even if possible a breast conserving treatment the mastectomy becomes the first choice [13].

In other words, different options exist to figure out the same situation. A range of indications must be considered to find out the best individualized solution.

However, the planning and preoperative decisions must be done before surgery. It is necessary to take on account the possibilities and variable conditions of each case. Keep in mind your "plan A," but never forget other second options.

It is necessary a previously discussion about the patient before preoperative drawings.

Patient must be positioneted in standing up any existing asymmetry of shape, position or size should be noticed (congenital or acquired asymmetries caused by increased breast volume due to the tumor, previous scars or residual edema or hematoma after previous biopsies). Take pictures before and after preoperative markings. It is important for your feedback. Start markings from the tumor site respecting the borders of the breast. Try to involve the best technique to resect the tumor reshaping gland and define the final location of the scars looking for oncological safety and good outcome.

In that moment reinforce with patient aspects regarding bad results. It is important to underestimate expectations of the patient. Any outcome could be better than a previous underestimated self-image.

In every patient, the midline should be drawn between the two breasts and the inframammary fold. These markings will be important in the operating theater for checking the final symmetry.

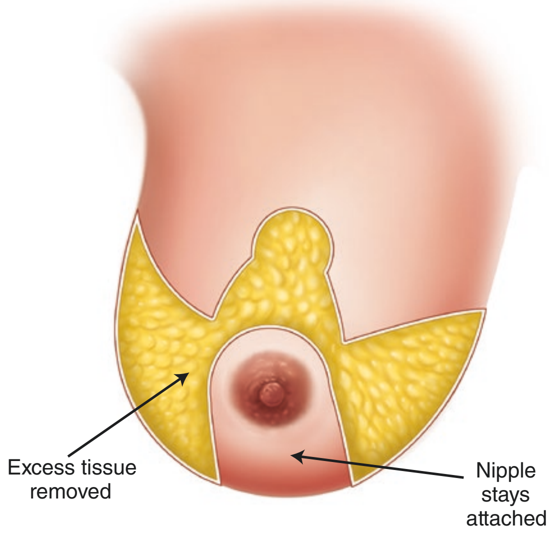
Surgical Techniques

There are three OBS techniques (Table 36.2) that are able to figure out more than 90% of your cases. Pedicle superior (Fig. 36.1) (means that bloody supply comes from the upper part of breast) is indicated for tumors in lower quadrants. Inferior

Table 36.2 The most common OBS techniques

	Breast volume	Tumor site	Ptosis
Superior pedicle	Medium/large	Lower	Y/N
Inferior pedicle	Medium/large	Upper	Y/N
Round block	Any	Close to areola	Y/N

Fig. 36.1 Inferior pedicle example



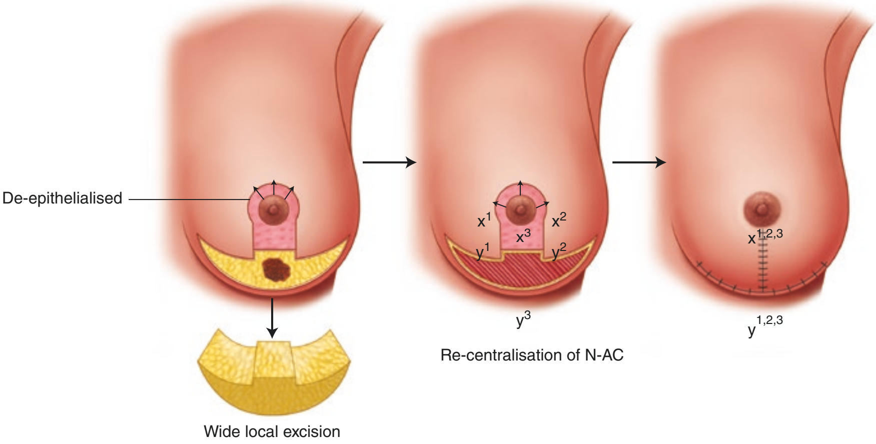


Fig. 36.2 Superior pedicle example

pedicle (Fig. 36.2) (means that bloody supply comes from the lower part of breast) is indicated for tumors at upper quadrants. The third is round-block or periareolar incision (Fig. 36.3) that provides good results if the tumor is located close to the areola; otherwise the extended skin undermining can leave disabling skin retractions.

The two breasts should be included in the operative field even if no procedure on the healthy breast is scheduled.

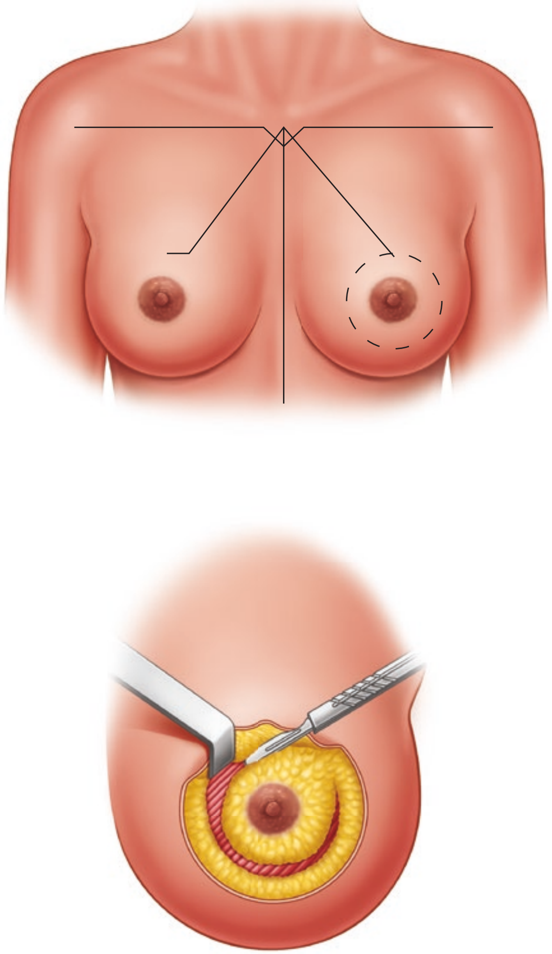
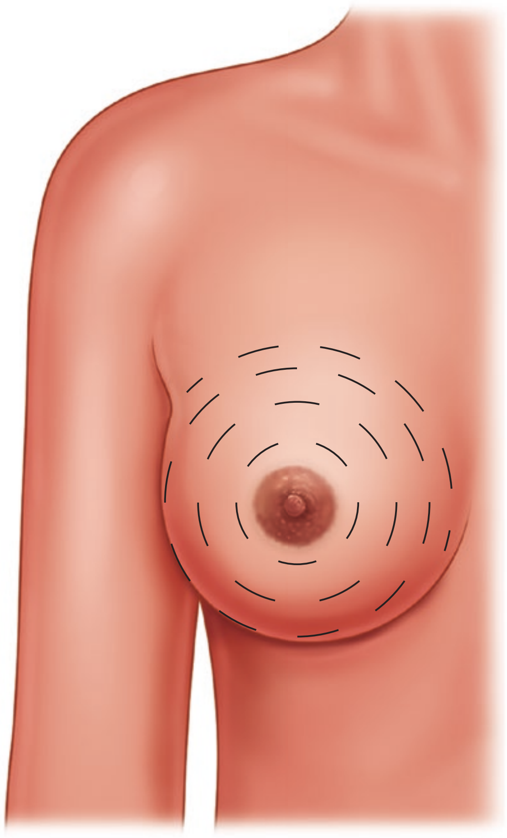


Fig. 36.3 Periareolar incision

For classic breast-conserving treatment, there is a general agreement following the Langer lines (Fig. 36.4) performing radial incisions in the lower mid part of the breast and circumareolar ones in the upper mid part. In fact, a circumareolar incision in the inferior quadrants could create a disabling crease between the areola and the inframammary fold (“double bubble” profile). On the contrary, a radial incision in the upper part of the breast may be too visible above the décolleté line. When the tumor is located in the upper outer quadrant, a radial incision allows good exposure of the tumor site and it can be prolonged forward to the axilla for lymph node dissection. The skin removal depends on the relationship between superficially located tumors and the dermis. Incisions in natural creases are good possibilities when tumors are located deeply in the breast. However, using natural pleats to make incisions could be a very good solution to perform simple and effective surgical treatments.

Fig. 36.4 Langer lines



Dermoglandular flaps could be very feasible for general surgeons. The rationale lies on the conic shape of breast. A partial mastectomy could be well done performed and the defect reshaped by rotating part of the breast to fill the original defect and maintain the conic shape of the breast. The idea is quite similar to the correction of a wound with a Z plasty. Usually those techniques do not need symmetry. The negative point is the large scars that could be previously discussed with patient (Figs. 36.5, 36.6, 36.7, 36.8, and 36.9).

Surgical Complications and Solutions

Several issues could be responsible cause nipple and areola malpositioning, different sizes or positions of the two breasts. The nipple and areola complex is the identity of the breast and hence it is important to maintain its real positioning. Nipple and areola centralization can be obtained by an asymmetrical periareolar

Fig. 36.5 Dermoglandular flap preop (UOQ)

Fig. 36.6 Dermoglandular flap posop (UOQ)

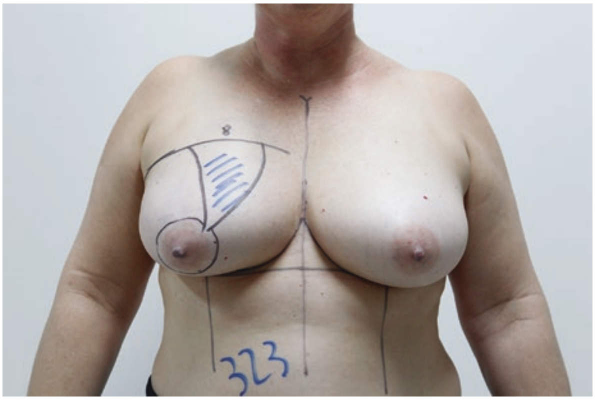


Fig. 36.7 Dermoglandular flap preop (UIQ)

Fig. 36.8 Dermoglandular flap posop (UIQ)

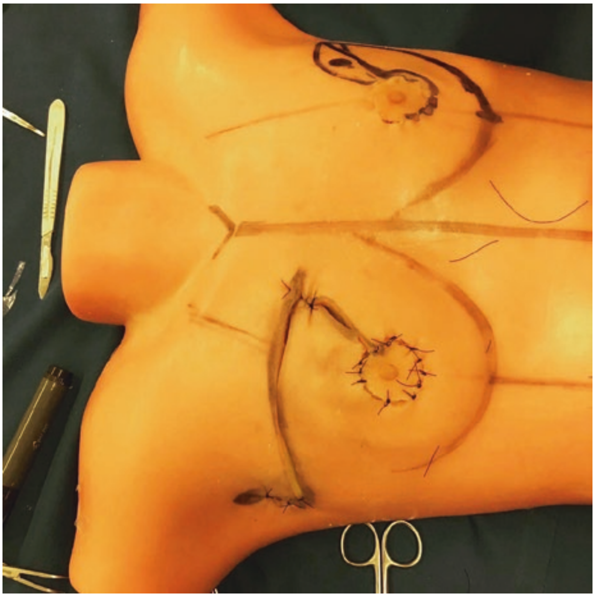


Fig. 36.9 Simulating dermoglandular flap techniques with Mastotrainer

de-epithelialization. A periareolar symmetrical de-epithelialization is recommended to correct a mild ptosis since the reduction in the skin envelope provides a certain degree of mastopexy. However, this procedure may cause a flattening of the breast due to the tension in the areolar region.

When the asymmetry results from an upper outer lumpectomy performed with an oblique incision, it is possible to improve the symmetry with the "mirror lumpectomy" technique. The "symmetry procedure" on the healthy breast is the opportunity to check the glandular tissue. When the lack of symmetry is due to the different position and volume of the two breasts, the improvement generally requires the training skills for reduction in mammoplasty. Any suspicious glandular area should be removed and sent to the pathologist.

The use of metallic clips is very important due to two main reasons: First, driving the radiation oncologist to the best planning for therapy and second to mark the tumor bed. Sometimes pathological assessment could be asked for the radicalization of margins. Those clips can remind the surgeon where the reshaping of glandular tissue was performed. Breast-conserving treatment should be performed with at least no-ink on tumor margins. OBS usually allows large safety margins [14].

Glandular resection should go straight down to the pectoralis fascia. The histological analysis of the specimen will be more accurate if the margins have a straight cut. Never forget to orientate margins to help pathologist to assess the specimen.

Several authors have suggested leaving it open. This increases the risk of hematoma or seroma even mention skin retractions, which will be visible progressively under the skin compromising the outcome. In my point of view, closing the glandular defect is really important. It is usually performed by simple approximation of the glandular pillars. Undermine the glandular tissue before starting the resection. It will help you to resect tumor and then to reshape the gland. At the end, it is also suggested to undermine at least 1 cm glandular tissue above the pectoralis fascia.

Results

Oncoplastic breast surgery has gained widespread use around the world. It becomes a special weapon to fight against breast cancer. It allows the combination of oncological procedure and plastic surgery techniques to achieve safe treatment with refined outcomes.

There are different methods of training programs for general surgeons to improve their skills [15–18]. OBS is more than just learning surgical techniques. It is a philosophical way of treatment that demands on willing of the surgeon to leave his comfort zone and changing his mind through a different aspect of dealing with tumors. When a general surgeon starts learning the potential of OBS, he will open his mind for new incisions possibilities, he will become able to approach bigger tumors getting free margins, he will optimize the radiation treatment reducing the total volume of the breast, and obviously he will respect, if possible, the desire of his patient. It is a consensus that the systemic treatment is important for the disease overall survival. However a well done surgical and reconstructive treatment is responsible to provides strengh and self-steem to the patient to face the adjuvant treatment. The potential of breast cancer surgeries could not be underestimated, a refined and safe outcome allows patients to bargain and face with their fears.

The approach of general surgeons to OBS is increasing, although discreetly. In Turkey, 208 surgeons answered a survey and 53.8% of them emphasized that general surgeons should carry out OBS themselves [19]. Another interesting point must be highlighted. In Great Britain, a comparison between survey over past 5 years showed that the most part of breast surgeons are still interested in further training in oncoplastic techniques, On the other hand, the additional interest of plastic surgeons in OBS training has dropped from 62% to 27%. Furthermore, the specific concerns about OBS have decreased between 2010 and 2015 [20]. Despite a small percentage of participants, a survey in USA revealed that partial breast reconstruction following lumpectomy was limited in almost 70% of general surgeons practice, while 50% of plastic surgeons demonstrated that it was limited because surgeons were not getting the referrals [21].

Conclusions

There are different kinds of techniques from the simplest to more complex that could help surgeons to provide their best to their patients.

Over the last years, discussions regarding who is the surgeon to perform OBS have been largely done. They depend on several topics, different realities, experiences, and possibilities. The point of agreement must be that a well-trained surgeon is able to do his best. Sometimes the best is to perform surgeries using the team approach.

We cannot accept that surgeons anymore – be breast surgeon, plastic surgeon, or general surgeon – they do not expose refined treatment choices for any patient. Breast cancer patients from every where deserve to receive the best approach to each case respecting the oncological limits.

References

1. Halsted WS. I. 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. 1894;20(5):497–555.
2. Fisher B, Anderson S, Bryant J, Margolese RG, Deutsch M, Fisher ER, Jeong JH, Wolmark N. 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. 2002;347(16):1233–41. https://doi.org/10.1056/NEJMoa022152.
3. Veronesi U, Cascinelli N, Mariani L, Greco M, Saccozzi R, Luini A, Aguilar M, Marubini E. Twenty-year follow-up of a randomized study comparing breast-conserving surgery with radical mastectomy for early breast cancer. N Engl J Med. 2002;347(16):1227–32. https://doi.org/10.1056/NEJMoa020989.
4. Audretsch WRM, Kolotas C, et al. Tumor-specific immediate reconstruction in breast cancer patients. Perspect Plast Surg. 1998;11:71–100.
5. Clough KB, Lewis JS, Couturaud B, Fitoussi A, Nos C, Falcou MC. Oncoplastic techniques allow extensive resections for breast-conserving therapy of breast carcinomas. Ann Surg. 2003;237(1):26–34. https://doi.org/10.1097/01.SLA.0000041230.77663.22.
6. Petit JY, De Lorenzi F, Rietjens M, Intra M, Martella S, Garusi C, Rey PC, Matthes AG. Technical tricks to improve the cosmetic results of breast-conserving treatment. Breast. 2007;16(1):13–6. S0960-9776(06)00165-2 [pii]. https://doi.org/10.1016/j.breast.2006.08.004.
7. Zucca-Matthes G, Manconi A, Viera RAC, Michelli RAD, Matthes ACS. The evolution of mastectomies in the oncoplastic breast surgery era. Gland Surg. 2013;2(2):102–6.
8. Zucca-Matthes G, Vieira RA. The value of patients' expectation on breast oncoplastic surgery. Breast J. 2014;20(6):676–8. https://doi.org/10.1111/tbj.12344.
9. Rainsbury D. Training in breast reconstruction: a new chapter in breast surgery. Hosp Med. 2003;64(12):700–1.

10. Vieira RAC, Zucca-Matthes AG, Michelli RAD, Ribeiro GFP, Mendonça MLH, Bailão A Jr, Haikel RL, Matthes ACS. Oncoplastic surgery and breast surgeon training. Rev Bras Mast. 2010;20:5.
11. Matthes AG, Viera RA, Michelli RA, Ribeiro GH, Bailao A Jr, Haikel RL, Matthes AD. The development of an Oncoplastic Training Center – OTC. Int J Surg. 2012;10(5):265–9. https://doi.org/10.1016/j.ijsu.2012.03.009.
12. Urban CA. New classification for oncoplastic procedures in surgical practice. Breast. 2008;17(4):321–2. https://doi.org/10.1016/j.breast.2007.11.032.
13. Zucca-Matthes G, Martin D, Fregnani JH, Callegaro-Filho D, de Carvalho IT, Soares L, Talo AF, Com J, Marques R, Cintra G, Chulam T, Coelho R, Baker E, Lopez M, Lorenzini C, Schmeler K. Oncoplastic breast surgery without radiotherapy in Mozambique. Breast J. 2017;23(2):243–5. https://doi.org/10.1111/tbj.12721.
14. Kaur N, Petit JY, Rietjens M, Maffini F, Luini A, Gatti G, Rey PC, Urban C, De Lorenzi F. Comparative study of surgical margins in oncoplastic surgery and quadrantectomy in breast cancer. Ann Surg Oncol. 2005;12(7):539–45. https://doi.org/10.1245/ASO.2005.12.046.
15. Kollias J, Rainsbury R. Surgical trainees' attitudes to specialization in breast surgery. ANZ J Surg. 2003;73(7):489–92.
16. Malycha PL, Gough IR, Margaritoni M, Deo SV, Sandelin K, Buccimazza I, Agarwal G. Oncoplastic breast surgery: a global perspective on practice, availability, and training. World J Surg. 2008;32(12):2570–7. https://doi.org/10.1007/s00268-008-9635-4.
17. Cardoso MJ, Macmillan RD, Merck B, Munhoz AM, Rainsbury R. Training in oncoplastic surgery: an international consensus. The 7th Portuguese Senology congress, Vilamoura, 2009. Breast. 2010;19(6):538–40. https://doi.org/10.1016/j.breast.2010.03.030.
18. Matthes AG, Perin LF, Rancati A, da Fonseca L, Lyra M. Mastotrainer: new training project for breast aesthetic and reconstructive surgery. Plast Reconstr Surg. 2012;130(3):502e–4e. https://doi.org/10.1097/PRS.0b013e31825dc5fa.
19. Emiroglu M, Sert I, Inal A, Karaali C, Peker K, Ilhan E, Gulcelik M, Erol V, Gungor H, Can D, Aydin C. The approach of general surgeons to oncoplastic and reconstructive breast surgery in Turkey: a survey of practice patterns. Balkan Med J. 2014;31(4):307–12. https://doi.org/10.5152/balkanmedj.2014.13230.
20. Challoner T, Skillman J, Wallis K, Vourvachis M, Whisker L, Hardwicke J. Oncoplastic techniques: attitudes and changing practice amongst breast and plastic surgeons in Great Britain. Breast. 2017;34:58–64. https://doi.org/10.1016/j.breast.2017.04.010.
21. Losken A, Kapadia S, Egro FM, Baecher KM, Styblo TM, Carlson GW. Current opinion on the oncoplastic approach in the USA. Breast J. 2016;22(4):437–41. https://doi.org/10.1111/tbj.12592.

Index

V. S. Klimberg et al. (eds.), *Oncoplastic Breast Surgery Techniques for the General Surgeon*, https://doi.org/10.1007/978-3-030-40196-2