36 Expander/Implant Breast Reconstruction Before Radiotherapy

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36.1 Introduction

Today reconstruction after mastectomy is available for many patients with breast cancer. When performed in the same surgical session as mastectomy, breast reconstruction avails of the following options: placing a temporary tissue expander which will be later replaced with a permanent implant; inserting the permanent implant although only in selected cases; using autologous tissues alone or with a prosthesis [1]. Choice is conditional on the patient's physical characteristics and preference, feasibility and the surgeon's expertise, bearing in mind that reconstruction with expander/prosthesis was associated with a higher complication rate [2–8].

Immediate breast reconstruction undoubtedly offers advantages that are not found if it is delayed for months or even years, despite a higher complication rate [9–14]. Since the supple and elastic breast skin and subcutaneous soft tissue have not yet been exposed to radiotherapy (RT), expansion to the appropriate reconstructed breast volume and shape is easier and more rapid, with better aesthetic results. Patients have the chance to maintain their body image, with no triggering of psychological trauma due to breast mutilation and thus their quality of life remains relatively unperturbed. Finally, a costly and risky second major operation is avoided, the success of which may be jeopardized because the breast tissue has been irradiated.

Post-mastectomy RT (PMRT) aims at eliminating residual tumor foci, reducing the risk of loco-regional relapse and improving overall survival [15]. Since the role of biological subtypes as risk factors for loco-regional relapse has not yet been investigated in depth [16, 17], PMRT is administered mainly according to disease stage. It is recommended for high risk patients, i.e. those with locally advanced disease or with four or more metastatic axillary lymph nodes in early stage disease (T1-2) [18–22]. When 1–3 axillary lymph nodes are positive, evidence is generally insufficient to recommend PMRT but the National Comprehensive Cancer Network (NCCN) Guidelines suggest strongly considering it even though the evidence level is only 2B [20]. Other guidelines [18, 22] propose taking into account risk factors like youth, tumor size >3.5–4 cm, negative hormone receptors, lymphovascular invasion, high grade, nodal ratio >20–25 % [18, 23–28]. The results of the latest Early

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Breast Cancer Trialists' Collaborative Group (EBCTCG) metanalysis [29], which assessed the effect of RT on outcomes after mastectomy and axillary surgery in patients with 1–3 positive nodes, may impact upon current recommendations as it suggested RT reduced disease recurrence and mortality.

Target volumes for PMRT are the chest wall and the supra- infraclavicular nodes [19–22]. There is no indication for RT to the resected part of the axilla if there is no residual disease after surgery [18, 22]. RT to the internal mammary nodes is still controversial [18–22], as the evidence level is low [20] and conflicting results have emerged from recent studies [30–33]. Despite all the advantages it offers PMRT was, however, associated with more complications than were observed in non-irradiated patients [7–9, 34–46] (Table 36.1). These have the potential to impact negatively upon cosmetic outcome and upon the patient's quality of life.

36.2 Concerns About Immediate Breast Reconstruction

Immediate breast reconstruction was, in the past, penalized by the view that medical adjuvant treatments could be delayed because of RT-related toxicity. However, it was shown that adjuvant systemic treatments were administered at the same times whether women underwent it or not [47–51]. Even though immediate breast reconstruction was feared to mask local relapse and delay its diagnosis, it was not associated with a higher incidence of recurrences and worse survival [51–56]. Indeed, a retrospective matched cohort study with a median follow-up of 11.5 years, analyzed the clinical outcome in 600 patients after mastectomy, 300 of whom received immediate breast reconstruction while 300 controls did not. About one-third of patients in each group received PMRT. The incidence of distant metastases, breast cancer and all-cause mortality were signifi-

Table 36.1 Expander/implant breast reconstructions. Complication rates in patients receiving PMRT and in controls

Author	PMRT	No PMRT	P	Follow-up (months)
Berry et al. [7]	58.8	26.7	<0.001	–
Barry et al. [8]			no PMRT vs PMRT OR : 4.2; 95 % CI, 2.4–7.2	–
Spear et al. [9]	52.5	10	0.00005	Mean PMRT group: 28 No PMRT group: 30
Barreau-Pouhaer et al. [34]			0.0002	–
Evans et al. [35]	43	12	0.0001	Median: 37
Vandeweyer et al. [36]	100	3.4	<0.001	Mean PMRT group: 64.5 No PMRT group: 65
Krueger et al. [37]	68	31	0.006	Median: 31
Tallet et al. [38]	51	14	0.006	Median: 25
McCarthy et al. [39]	59	40		Median: 23.5
Ascherman et al. [40]	40.7	16.7	≤0.01	–
Cordeiro et al. [41][a]	50.7	10.3		Mean: 36.7
Behranwala et al. [42][a]	38.6	14.1	≤0.001	Median: 48
Benediktsson et al. [43][a]	41.7	14.5	0.01	Median: 60
Lee et al. [44]	47.46	23.16	<0.001	Median PMRT group: 63.6 No PMRT group: 56.8
Christante et al. [45]			OR: 3.3; $p<0.001$	Median: 31
Brooks et al. [46]	58.8	27.6		Mean: 40.8

Abbreviations: *PMRT* post-mastectomy radiotherapy, *OD* odds ratio
[a]Baker III–IV capsular contracture

cantly higher in controls [57]. The higher percentage of receptor positive tumors in the reconstructed group may account for these results but when the statistical analysis was corrected for hormonal receptor status, the inter-group difference in breast cancer mortality was no longer significant. Since the authors did not describe their correction model one might hypothesize that a stratification was performed so the sample size in each subgroup was too low to reach significance.

Another obstacle to immediate breast reconstruction was that it created technical difficulties for PMRT delivery. In patients with expanders and/or prostheses the large rigid reconstructed breast volume creates steep slopes in medial and apical contours. Standard three-dimensional conformal RT techniques become arduous if the chest wall, the supra-infraclavicular, and particularly the internal mammary nodes have to be irradiated [58–60]. Chest wall and regional coverage may be impaired, raising the risk of relapse. The dose to the heart and lungs may be increased and consequently, more treatment-related toxicity might be expected to occur. For example, when an anterior electron field was used to treat the internal mammary nodes, the field junction between them and the non-uniform chest wall was imprecise and coverage was impaired because of under-dosage across the electron field [58–60]. Arthur et al. [61] compared RT techniques after breast conserving surgery with the aim of selecting the most suitable. The partially wide tangent fields avoided junction problems and, as it irradiated only the internal mammary nodes in the first three intercostal spaces, it spared the organs at risk of toxicity. This technique can be translated to the immediately reconstructed breast.

More advanced RT techniques like intensity modulated RT (IMRT) and tomotherapy were evaluated for delivering PMRT after reconstruction [62–64]. When available, they are generally reserved for patients in whom conformal three dimensional RT does not adequately cover target volumes or does not spare organs at risk. Both improved target volume irradiation, eliminated the field junction problem and delivered lower doses to organs at risk. Furthermore, tomotherapy treated only the tissue anterior to a submuscular implant, thus sparing it [64]. This is worth noting because irradiation may harden or alter the colour of some expander/prosthesis models [65]. However with IMRT and tomotherapy more healthy tissues received low-dose irradiation, which needs to be weighed up against their benefits. Figures 36.1 and 36.2 illustrate dosimetric results with these techniques. Proton therapy, which is at present offered by very few RT Centres because of costs, was proposed for some highly-selected patients with unfavorable anatomy [66, 67]. Protons provided full, homogeneous dose delivery to target volumes, completely sparing organs at risk. However, the following issues have emerged: uncertainties in dose deposition, skin dose and the impact of chancing set-up and respiratory motion on treatment delivery. Furthermore, since expanders with metal ports introduced dose uncertainty, patients with them had to be excluded [66]. With photon PMRT, on the other hand, metal ports did not interfere significantly with treatment planning as they caused only a slight variation in dose distribution to the surrounding area [68–70]. In any case, specific algorithms for the metal material and high energy photons (~15 MV) were proposed [70, 71].

36.3 Complications After Expander/Implant Breast Reconstruction and PMRT

Short- and long-term RT-related complications may mitigate the benefits of reconstruction. Even though up to 68 % of patients were reported to develop them [3, 4, 7, 37, 38, 40, 44–46, 72–77] inter-study comparisons are difficult and a definitive picture is hard to obtain. Retrospective studies reported complications in diverse ways such as incidence or probability at different time–points e.g. 2 or 5 years and provided low-level evidence because they were limited by biases, confounding variables and lack of selection criteria and long-term follow-ups. They usually had relatively small cohorts of negatively selected patients who were ineligible for autologous procedures because of contraindications. There were

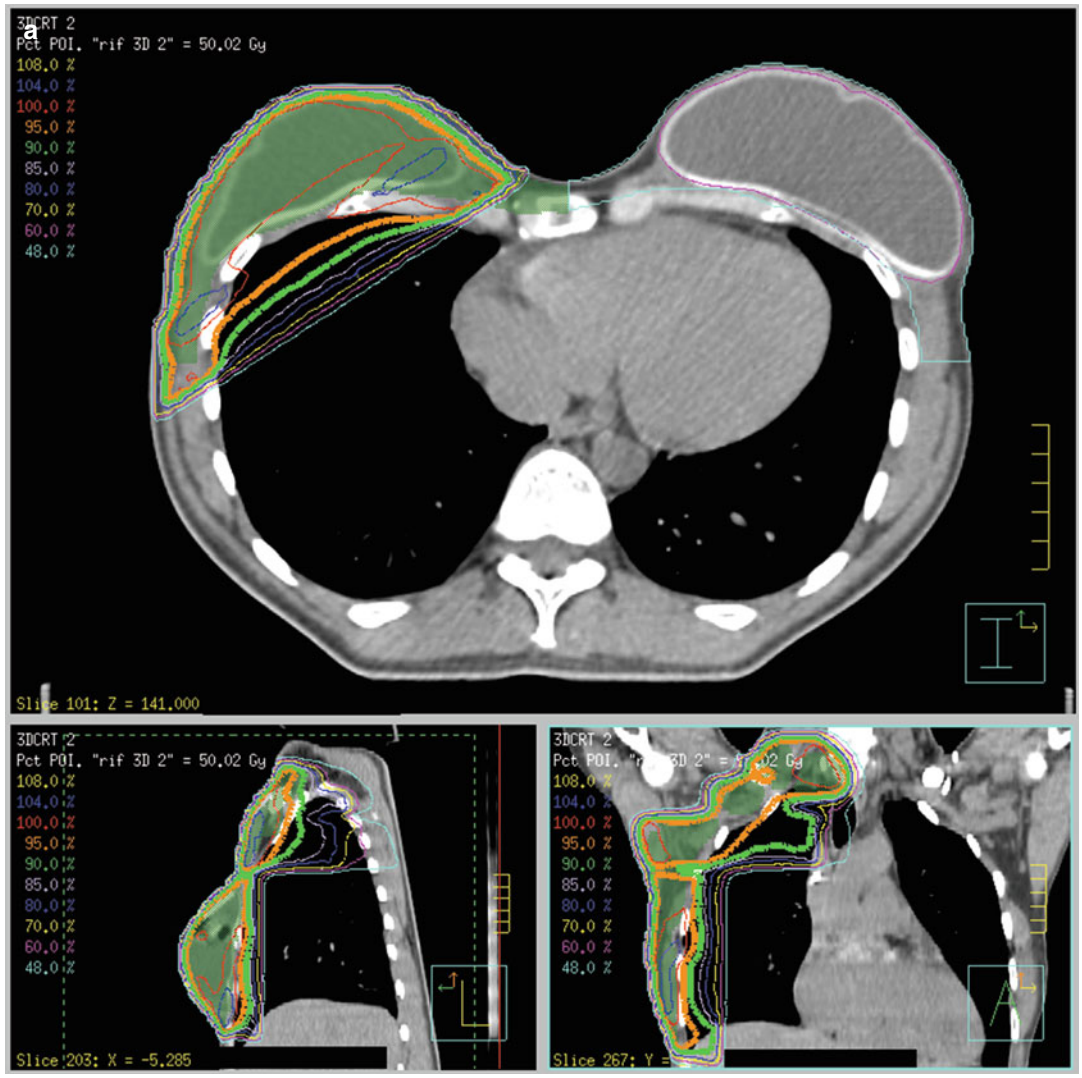
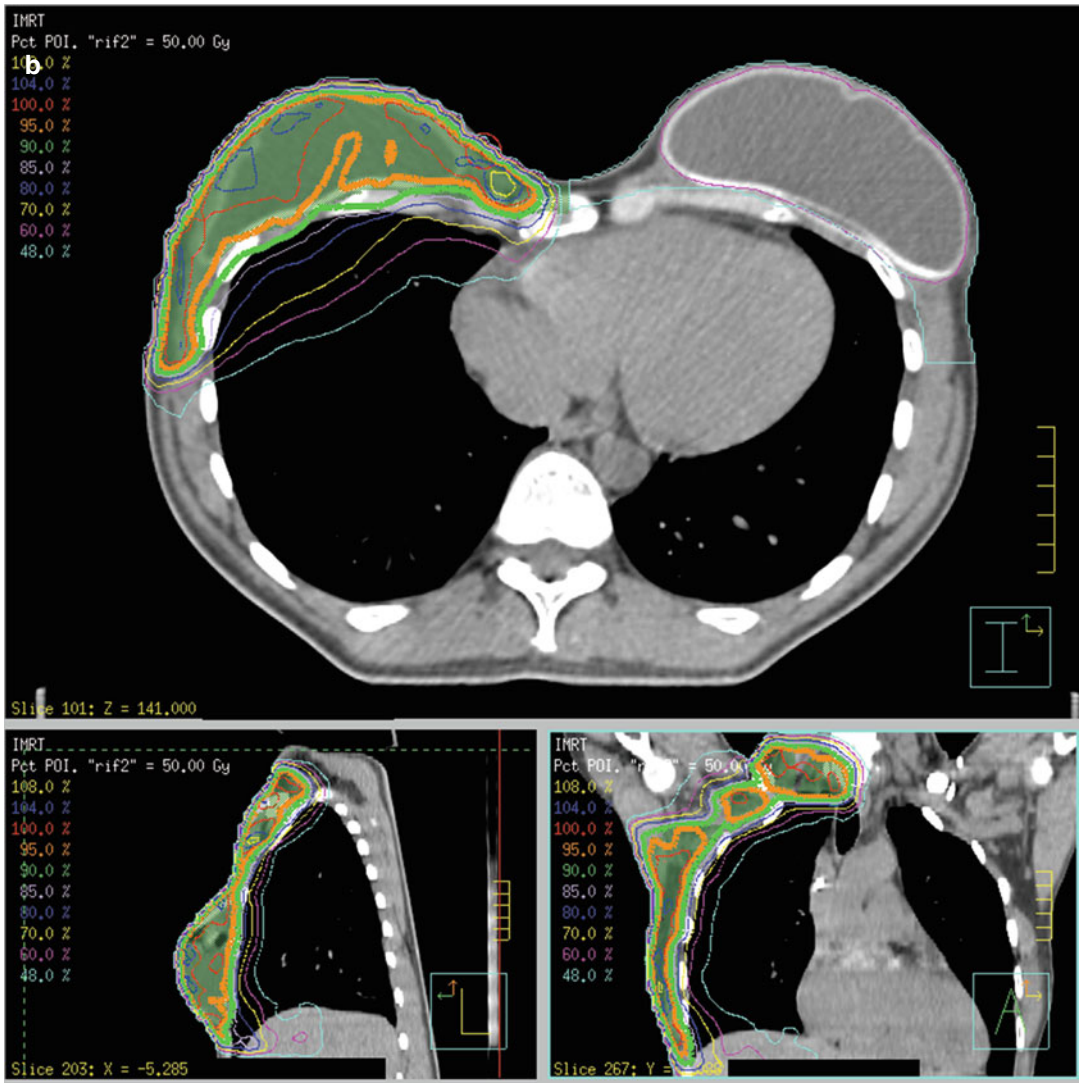


Fig. 36.1 Dose distribution to a right reconstructed breast and omolateral supra-infraclavicular nodes and dose volume histograms. Dose distribution: In panels (**a**–**c**) images are axial, sagittal and coronal. Panel (**a**) 3DRT, panel (**b**) IMRT, panel (**c**) tomotherapy. Dose volume histograms: panel (**d**) 3D and IMRT, panel (**e**) tomotherapy



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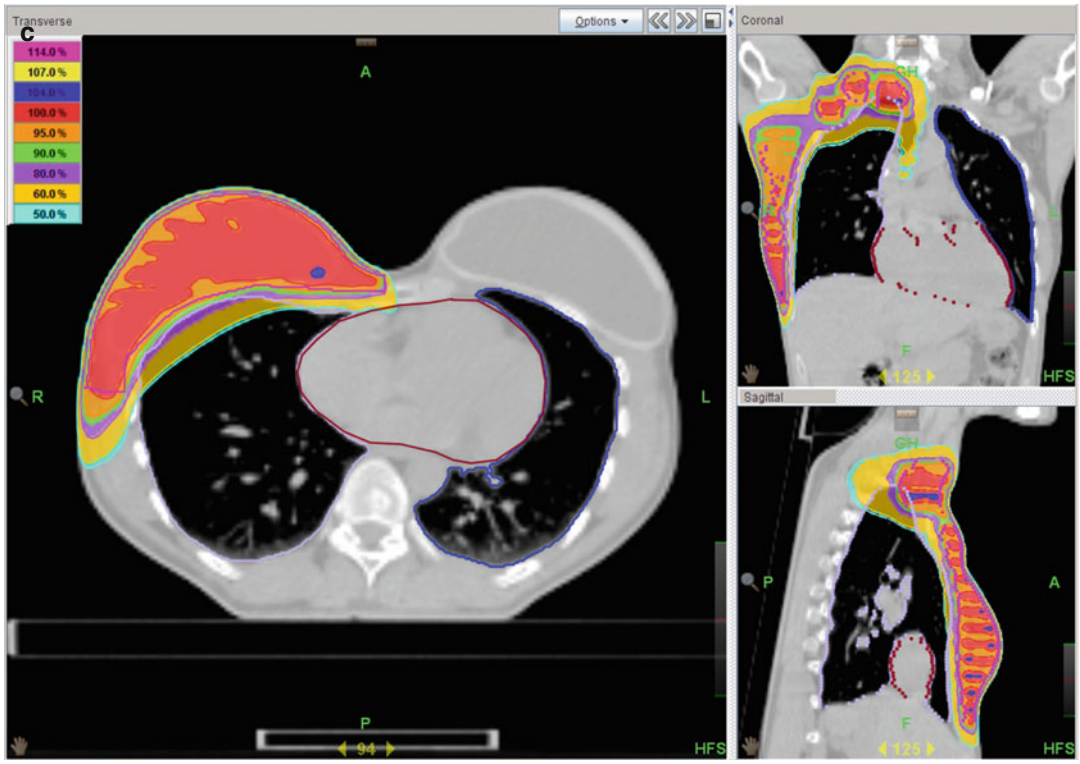

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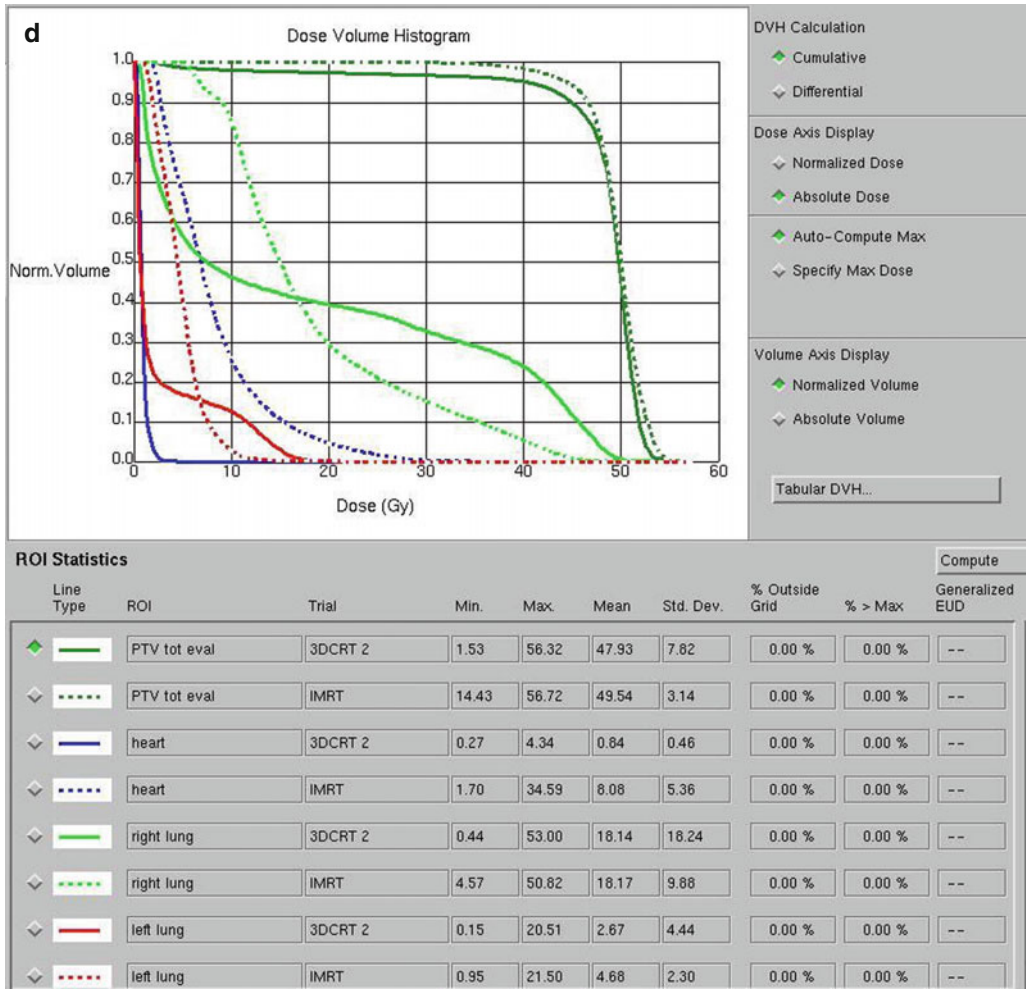

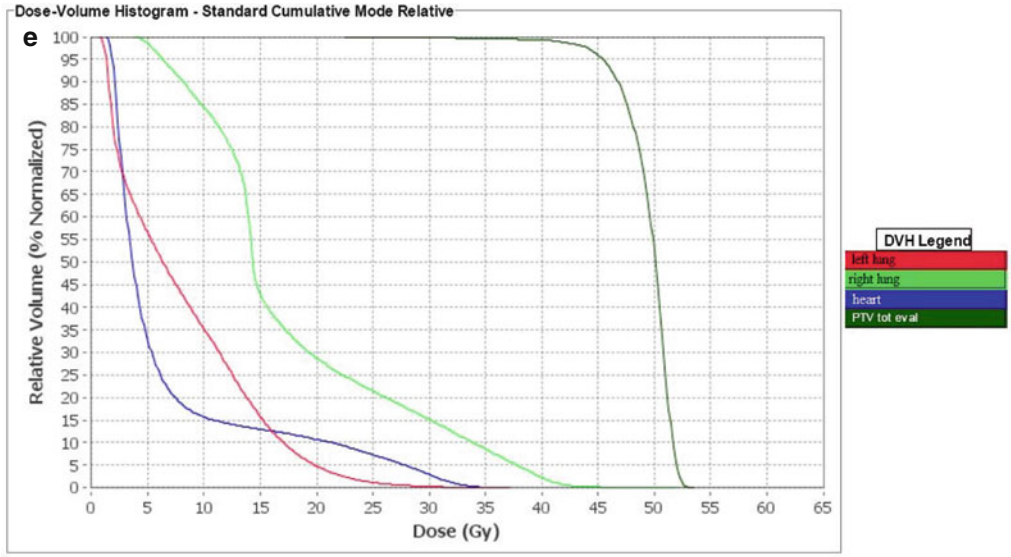

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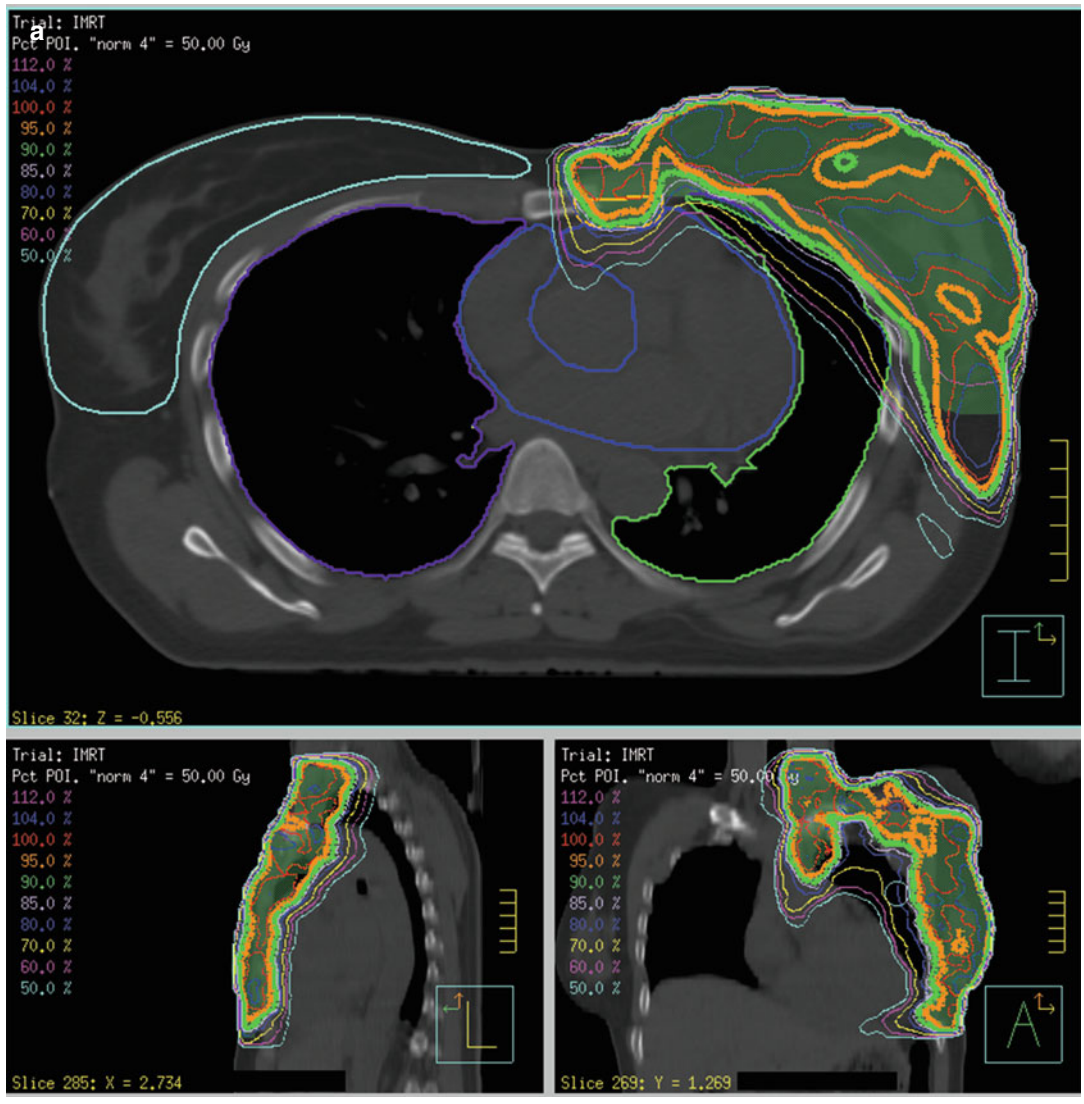
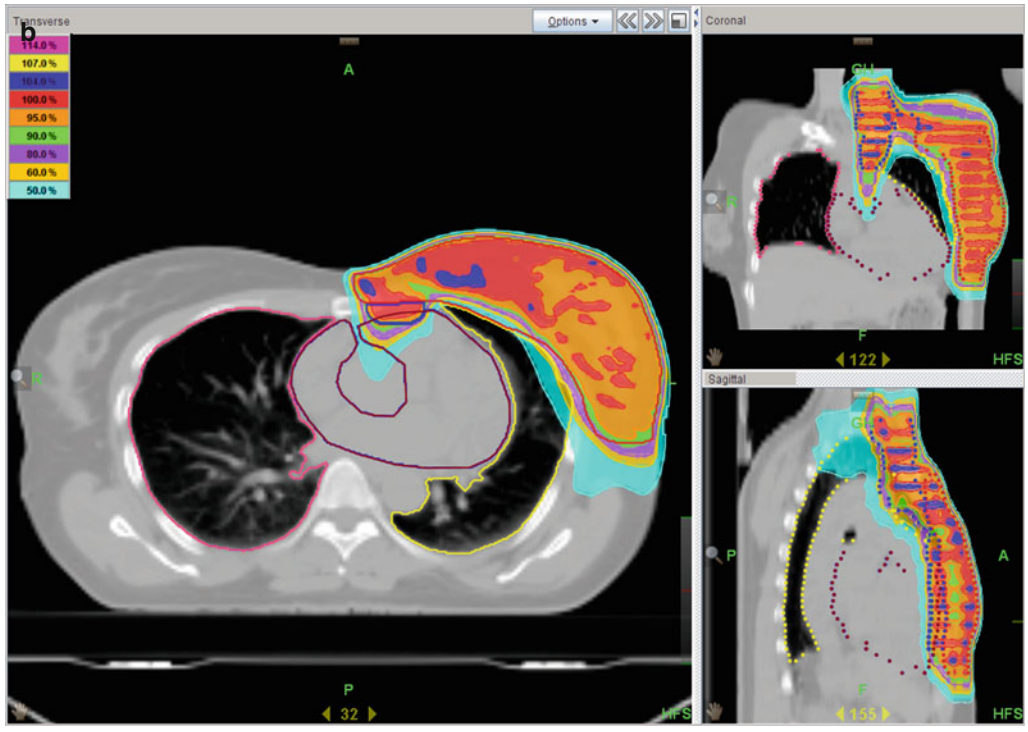
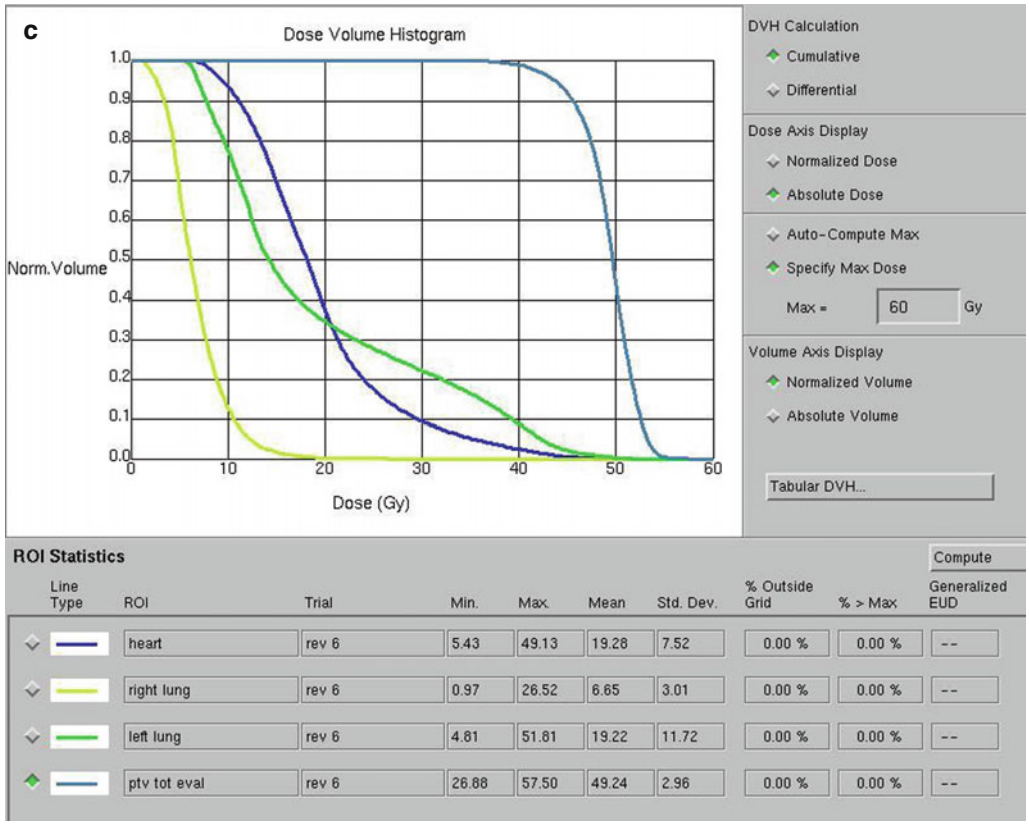


Fig. 36.2 Dose distribution to a left reconstructed breast, omolateral supra-infraclavicular and internal mammary nodes and dose volume histograms. Dose distribution: In panels (**a**) and (**b**) images are axial, sagittal and coronal. Panel (**a**) IMRT, panel (**b**) tomotherapy. Dose volume histograms: panel (**c**) IMRT, panel (**d**) tomotherapy





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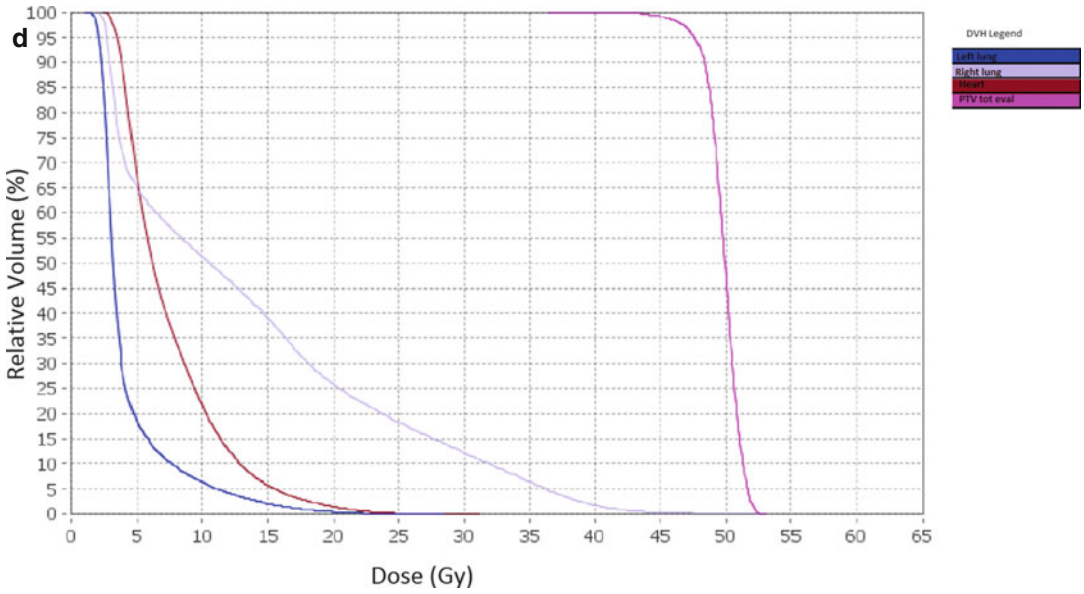

Fig. 36.2 (continued)

often no separate analyses of the different types of reconstruction (expander alone, prosthesis, autologous reconstructive procedure with expander). The few available prospective studies also provided little definitive evidence because patient cohorts were relatively small and they were not randomized. It is worth noting that randomized studies will never be performed in this field because no group of patients should be deprived of the chance of breast reconstruction.

Early complications include infection, inflammation, hematoma, seroma, poor wound healing, skin necrosis and implant extrusion. Fibrosis, partial loss of skin and soft tissue elasticity and suppleness have a later onset as do capsular contracture, prosthesis rupture, displacement or loss of shape. Finally, pain may occur at any time after RT. Late complications were found to be more common in patients undergoing PMRT after breast reconstruction, while patients receiving PMRT beforehand tended to have more early complications [73].

Complications are defined as major if patients require an additional operation, premature expander or permanent implant removal or reconstruction with another implant and/or an autologous tissue flap. The incidence of implant/prosthesis removal ranged from 4 to 43 % [4, 37, 38, 41, 46, 74–81]. Presenting the latest Memorial Sloan Kettering Cancer Center (MSKCC) results Ho et al. distinguished between implant removal (explantation) and implant replacement [82] but whatever the final outcome, the original implant was always removed, which indicated treatment failure. One interesting point which emerged from this study was the time link between implant failure and the underlying cause i.e. infection in the first year after PMRT and capsular contracture alone or combined with other factors, such as dissatisfaction or suboptimal cosmesis in the second year or later, with the incidence increasing as follow-up lengthened [79, 83]. Attention has focussed mainly on implant removal and capsular contracture, the most serious side effects which also occur in non-irradiated patients. Like other reports, this chapter will analyze them together.

36.4 Capsular Contracture and Implant Removal

PMRT is the most significant risk factor for capsular contracture (Fig. 36.3) even though its aetiology is also linked to choice of implant filler

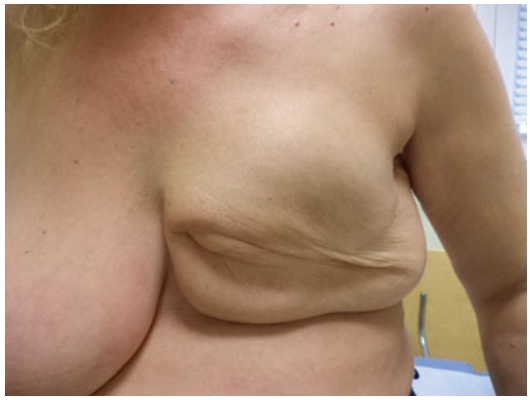

Fig. 36.3 Severe capsular contracture after PMRT in the left breast detected 11 months after PMRT. The prosthesis will be removed

Table 36.2 Spear and Baker [84] classification of capsular contracture after prosthetic breast reconstruction

Class IA	Absolutely natural, cannot tell breast was reconstructed
Class IB	Soft, but the implant is detectable by physical examination or inspection because of mastectomy
Class II	Mildly firm reconstructed breast with an implant that may be visible and detectable by physical examination
Class III	Moderately firm reconstructed breast. The implant is readily detectable, but the result may still be acceptable
Class IV	Severe capsular contracture with an unacceptable aesthetic outcome and/or significant patient symptoms requiring surgical intervention

material, implant position, inflammation, infection and patient age. Classified according to the Spear and Baker system (Table 36.2) [84], the most serious cases (Classes III and IV) of capsular contraction, were reported to range in incidence from 11 to 53 % [4, 38, 39, 41, 43, 46, 76, 77, 79, 80, 85]. Table 36.3 reports Grade III-IV capsular contracture and removal rates in a series of studies. Patients with capsular contracture are referred for surgery to correct it and substantially reduce high-grade fibrosis [43, 85, 86]. Indeed, in the Claßen et al. series, the grade ≥III fibrosis rate declined markedly from the predicted 43 % incidence at 3 years to the real 18 % rate [85].

Several strategies were proposed to reduce the incidence of capsular contracture. The MSKCC designed an algorithm to address PMRT timing [87] because no histological evidence of capsular or dermal alterations was found in an animal model of tissue expansion if irradiation was delivered after expansion was completed [88]. In the clinical setting RT delivery to the permanent prosthesis was expected to minimize unwanted side effects. Briefly, expander was positioned at the time of mastectomy and expanded 1–2 weeks after surgery, with expansion continuing throughout adjuvant chemotherapy. Approximately 4 weeks after systemic adjuvant treatment ended a permanent implant replaced the tissue expander. RT started 1 month later. Under this protocol 11 % of permanent implants were removed from 81 patients. A follow-up of at least 1 year (median 34 months) was available for 68 cases, 68 % of whom developed capsular contracture, (33.8 % grade III; 5.9 % grade IV) [87]. Results were confirmed 2 years later [41]. In a more recent series of 151 patients (median follow-up 86 months; range 11–161), the 7-year rates of implant replacement and removal were 17.1 % and 13.3 % respectively [82].

A low incidence of implant removal was observed with PMRT to expanders. Anderson et al. attributed their 4.8 % rate in 62 patients (median follow-up 48 months) to IMRT in approximately one-third of patients [74]. This retrospective study did, however, contain biases in cohort size and lack of separate analyses for standard RT and IMRT results. After following-up 101 patients (90 of whom were irradiated to the expander) for a median of 50 months, Aristei et al. observed Grades III and IV capsular contracture in 17.4 % and prosthesis removal in 11.9 % [77]. Like Piroth et al. [76] who reported a 22.7 % implant removal rate, the authors were of the view that complete expander filling, which was achieved in all patients before starting RT, might have determined the low removal rate. Results from the Milan Cancer Institute seemed to confirm these findings: 50/159 patients received neo-adjuvant chemotherapy and PMRT during tissue expansion as they could not wait to fill the expander completely without risking the

Table 36.3 Expander/implant breast reconstructions and PMRT. Rates of implant removal and Baker III–IV capsular contracture

Author	Implant removal (%)	Baker III–IV capsular contracture (%)	Follow-up (months)
Jhaveri et al. [4]	43	33.3	Median: 38
Berry et al. [7]	19.6		
Krueger et al. [37]	37		Median: 31
Tallet et al. [38]	26	11	Median: 25
McCarthy et al. [39]		50	Median: 23.5
Cordeiro et al. [41]	4	50.7	Median: 36.7
Benedikkson et al. [43]		20.6	Median: 60
Christante et al. [45]	31		Median: 31
Brooks et al. [46]	20	13.4	Mean: 40.8
Anderson et al. [74]	4.8		Median: 48
Hirsh et al. [75]	22		
Piroth et al. [76]	22.7	24.3	Mean: 24.9
Aristei et al. [77]	11.9	18	Median: 50
Baschnagel et al. [78]	20		Median: 24.1
Cowen et al. [79]	22.7	32.5	Median: 37
Nava et al. [80]	40	53.3	
Peled et al. [81]	15.9		Median: 31
Ho et al. [82]	25		Median: 86
Claßen et al. [85]		43	

oncological outcome. Reconstructions failed in 40 % vs 6.4 % in patients who received PMRT to the permanent implant, suggesting that patients who need neo-adjuvant chemotherapy may not be suitable candidates for immediate breast reconstruction with expander. Interestingly the incidence of Grade III and IV capsular contracture was very similar in the two groups (40 % expander vs 47.7 % permanent; 13.3 % vs 10.1 %) [80]. Further evidence in support of this view comes from Spear et al. who reported severe capsular contracture in 60.7 % of patients who received PMRT during expansion [86].

Besides complete tissue expansion before PMRT, time from the end of RT to expander/implant exchange was another factor in outcomes. Implant failure rate correlated with time to exchange, being highest (28.6 %) when under 3 months elapsed from the end of PMRT to expander/implant exchange. It dropped to 22.4 % in patients with under 6 months' time to exchange and to 7.7 %, in those with over 6 months. Even though the series included only 88 patients who were finely analyzed in several sub-groups, the optimal time for expander exchange appeared to be more than 6 months after the end of PMRT [81].

For patients who demand immediate reconstruction but who might, or probably would, require PMRT, the "delayed/immediate breast reconstruction", was developed at the M.D. Anderson Cancer Center [12, 13, 89, 90] to prevent problems that were reported to be associated with PMRT delivery to an immediately reconstructed breast. In this two-step approach, a filled textured saline tissue expander was inserted under the pectoral muscle immediately after skin-sparing mastectomy so as to prevent skin retraction and loss of breast shape. If histology findings indicated PMRT was not needed, the tissue expander was removed and the breast was reconstructed using autologous tissue or a permanent implant, achieving aesthetic outcomes that were similar to immediate reconstruction. If, on the other hand, PMRT was required, the tissue expander was deflated just before starting it, re-expanded after it ended and finally removed and replaced with autologous tissue or a permanent implant, 6–12 months after the end of RT. Infections in 53 % of patients who had a

medium follow-up of 40 months, were associated with 32 % tissue expander loss which was attributed to a too long stay in situ of the drain. Interestingly, the expander loss rate dropped as the learning curve rose. Finally, no clinical evidence was found of irradiated skin or reconstructed breast contracture [55].

36.5 Risk Factors for Complications

Data on risk factors for complications after breast reconstructions are somewhat discordant. Attempts to identify them were hindered by several biases: risk factors could have been underreported because of unreliable data collection, data were often retrospective, sample sizes and events were small in number, reconstruction techniques were heterogeneous, confounding variables were not always taken into consideration, factors that were significant in univariate analyses became insignificant in the multivariate, different statistical models (or even no model) were used. Some studies focused on one single risk factor, failing to take into account potential combinations; others concentrated on the impact of several factors on one single outcome; diverse risk factors were correlated with overall complications or with only specific complications.

Factors that are related to the patient and her lifestyle may increase the incidence of complications after breast reconstruction. As for any other form of surgery, older age [7, 46, 52, 75, 77, 91], obesity (body mass index –BMI- of 30 or greater) [7, 11, 46, 52, 75, 91], hypertension [52], and the smoking habit [52, 79, 91, 92] were recognized as risk factors. More specifically breast volume also plays a role [91, 93]. In patients receiving PMRT, large breasts were more susceptible to RT-related toxicity due to the difficulty in achieving homogenous dose distribution in the target volume. Tumor size vis-à-vis breast volume is another risk factor. Cowen et al. speculated that large tumors in small breasts involved sacrifice of a large skin area which made expansion more difficult. Indeed, 45.5 % of patients in this series had tumor ≥30 mm in size and, even though information on cup-size was missing in 32/141 patients, reconstruction failure occurred more frequently in patients with A or B cup-sizes (35.9 % vs 16.7 % in the others $p=0.009$) [79].

One treatment-related risk factor for complications was the skill of operating surgeon, suggesting that reconstruction should be performed by, or in collaboration with, a plastic surgeon. A team of expert surgeons would reduce the risk of hemorrhage and underlying aponeurosis injury, which might impact upon vascularization [79]. Hormonal therapy was associated with tamoxifen-related toxicity [37, 79] which current use of aromatase inhibitors should reduce in postmenopausal patients. Chemotherapy [38], and RT [7–9, 34–46, 79, 86] are treatment-related risk factors for toxicity but in the Tallet et al. series their effects could not be distinguished because all but three patients received both [38].

RT-related factors were the irradiated volumes, irradiation techniques and, consequently, dose distribution in target volumes. Outcomes were adversely affected by the dose to the chest wall, a boost dose to the mastectomy scar, and a bolus i.e. tissue-equivalent material placed on the skin to avoid under-dosage [9, 94, 95]. For example, bolus was associated with a 51 % complication rate vs 23 % without it ($p=0.0009$) [94]. Good-to-excellent cosmetic results were observed in 87 % of patients who were irradiated without bolus compared with 37 % with it ($p=0.016$) [95]. A significantly lower rate of complications was reported with the use of a bolus customized to the reconstruction shape compared to the use of a standard bolus, as the 3-year complication rate was 9 % vs 24 % ($p=0.05$). The custom-fashioned bolus eliminated the air gap and appeared to protect skin from overdoses due to contaminant electrons in the gap region [96].

To predict the patient complication rate and identify which patients were best suited for tissue expander/implants Berry et al. [7] created a nomogram with variables including administration or not of RT and chemotherapy, chemotherapy timing (neo-adjuvant or adjuvant), reconstruction type (autologous or expander).

Like all nomograms this one needs validation before it can be applied to clinical practice. Cowen et al. [79] derived a mathematical model to predict the probability of reconstruction failure from the results of a prospective French multicenter study with 141 patients (median follow-up 37 months). Risk factors for the 22.7 % implant removal rate were smoking habit, tumor size and nodal positivity in uni- and multi-variate analyses. The probability of reconstruction failure increased progressively 7–100 % as the number of factors increased. The authors believed the model could be useful in routine clinical practice prior to proposing breast reconstruction but admitted a preoperative assessment of tumor size and lymph node status was problematic. Since no other data have linked tumor size and nodal stage with implant removal, these factors require validation and furthermore, the model itself requires validation.

36.6 Cosmesis and Quality of Life

Cosmetic outcome and patient satisfaction are major endpoints of breast reconstruction after mastectomy because the primary goals are to improve body image and satisfy patient expectations. Despite the complication rate, most patients affirmed cosmetic outcomes were excellent or good with rates rising up to 90 % [4, 38, 74, 77, 78, 95]. Results were not always comparable due to small series, varying lengths of follow-up, lack of control groups (women who underwent the same reconstructive procedure with or without RT), lack of, or different, scales and questionnaires for assessing toxicity, cosmesis and patient satisfaction. Furthermore, patient satisfaction is particularly hard to assess because responses to questionnaires are subjective and refer to the time of administration. They may not reflect the patient's real perception of cosmetic outcome which can fluctuate with mood, time, expectancies, understanding of realistic alternatives and potential consequences, as well as the patient's personal views of the entire reconstructive process. It is worth noting the patient's satisfaction with the reconstruction decision is likely to be highest when she has been adequately informed and her involvement in decision-making was consistent with her own wishes and expectations.

Although aesthetic results and complications clearly impacted upon patient satisfaction, they might not have been the only factor contributing to satisfaction. Cowen et al. [79] reported young pre-menopausal women were more dissatisfied than the post-menopausal, because they attributed more importance to body image while Alderman et al. [97] reported that although age had no significant effect on satisfaction, older women tended to be less satisfied, perhaps because of late asymmetry produced by gradual contralateral breast ptosis. Furthermore, older women are at greater risk of complications which were reported to be a particularly important indicator of dissatisfaction with reconstruction [98].

Overall patient satisfaction was high after tissue expander/implant reconstruction and PMRT, with similar satisfaction rates in patients and controls (63.16 % vs 66.88 %) [44]. The Michigan questionnaire for patients with tissue expander/implant-based reconstruction found no significant differences in general and aesthetic satisfaction whether PMRT was delivered or not, despite a higher rate of expander/implant reconstruction failure and complications in the group receiving RT [37]. Cordeiro et al. [41] observed a 95 % satisfaction rate while 91.4 % of patients stated they would choose the same reconstruction again. In a very small series of 33 patients Piroth et al. [76] found that although 19 % of patients would not undergo breast reconstruction again, refusal did not correlate with outcome dissatisfaction ($p=0.79$) because 5/11 patients (45.5 %) who were only somewhat ($n=4$) or not ($n=1$) satisfied would nonetheless repeat the procedure.

To investigate long-term satisfaction with breast reconstruction BREAST-Q, a new patient-reported outcome measure focusing on breast surgery outcomes, evaluated satisfaction in 110 patients with expander/implants in terms of the reconstructed breast appearance, shape, softness, size and projection [99]. Only 19 % of patients received PMRT. Dissatisfaction grew with the

passage of time. For example at under five years after surgery 18 % were not happy with breast appearance compared with 55 % at 8 years and 16 % were dissatisfied with breast size vs 55 % after 8 years follow-up. In any case, with or without PMRT, results may change over time as implants do not become naturally ptotic with age, do not change in size as a patient gains or loses weight and may become distorted in shape due to capsular contracture (Fig. 36.3).

Conclusions

The benefits of breast reconstruction include improved body image, self-esteem and well-being. To ensure patients have realistic expectations they have to be clearly informed of the risks that can impact upon cosmesis and quality of life, or lead to prosthesis removal. As long as appropriate patients are selected and the oncological and reconstructive surgical teams are well-coordinated in a multidisciplinary approach, PMRT after breast reconstruction with tissue expander/implant is safe and provides excellent/good cosmetic outcomes and a high grade of satisfaction in most patients. It seems to be the preferred option in the USA while Europeans tend to opt more for autologous tissue flaps [100]. More widespread application of advanced RT and surgical techniques [86, 101] are expected to reduce the risk of complications in coming years.

In evaluating the indications for a reconstructive procedure, the risk of complications such as the effects of PMRT and the difficulties in delivering PMRT to reconstructed breasts have to be carefully considered. Expander/implant breast reconstruction has not yet been optimized but strategies include delayed-immediate reconstruction [12, 13, 89, 90], complete expander filling [76, 77] and a minimum delay of 6 months before prosthesis insertion [81] or expander replacement with the prosthesis before starting PMRT [1, 41, 82, 87]. As results do not vary greatly, choice of strategy is linked to institutional preferences. To have a comprehensive evaluation of breast reconstruction surgery specific modules to assess patient reported outcomes will need to be developed and validated [102, 103]. It is to be hoped they will also be forthcoming in the near future.

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