

# Options in Reconstructing the Irradiated Breast

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**Background:** As radiation therapy becomes more prevalent in the treatment of breast cancer, more patients requesting breast reconstruction for mastectomy defects will have a history of radiation therapy.

**Methods:** A retrospective chart review study was performed of a single surgeon's 5-year experience with reconstruction of the irradiated breast.

**Results:** Sixty-six primary patients and 13 secondary patients were treated over a 5-year period (2001–2005). Of the 66 primary patients, 25 (38 percent) presented for reconstruction after recurrence following prior breast conservation therapy: 12 had prosthetic based reconstructions (with or without a latissimus flap) and 13 had autologous reconstructions. Twenty-five patients (38 percent) presented after mastectomy followed by radiation therapy: six had prosthetic-based constructions and 19 had autologous reconstructions. Twelve patients (18 percent) had their reconstructions performed before radiation therapy: nine had implant-based reconstructions and three had autologous reconstructions. Four patients (6 percent) presented for corrections of breast conservation therapy deformities. One hundred seventy-five total operations were performed for the primary patients, with an average of 2.65 operations per patient. Thirteen patients were treated secondarily after previous reconstruction at other institutions with a variety of reconstruction methods used. Twenty-eight total operations were performed for the secondary patients, with an average of 2.2 operations per patient. Capsular contracture rates using the prosthetic score are reported.

**Conclusions:** Because of the variability of presentation of the irradiated breast cancer patient, there is no one method of reconstruction ideally suited for all irradiated patients. In this 5-year review, the authors found that with careful patient evaluation and selection, good results can be attained regardless of reconstructive method. (*Plast. Reconstr. Surg.* 122: 379, 2008.)

As the indications for radiation therapy in the treatment of breast cancer increase,<sup>1–4</sup> surgeons are encountering more patients presenting with a prior (or concurrent) history of radiation to the breast, chest wall, and skin. With these larger numbers of patients heading to plastic surgeons' offices seeking reconstruction after either breast conservation therapy or mastectomy followed by irradiation, it is important to consider a variety of techniques appropriate for the various clinical scenarios with which these patients present.

In previous publications, we described our experience in reconstructing the irradiated breast with several methods, including implants,<sup>5–7</sup> latissimus flaps,<sup>8</sup> and transverse rectus abdominis myocutaneous (TRAM) flaps.<sup>9</sup> When taken individu-

ally, each of these articles describes the benefits and risks of their respective methods. The purpose of this review is to describe the longitudinal experience of a single surgeon (S.L.S.) at a tertiary breast care center in an attempt to define a comprehensive approach to the patient requiring reconstruction of the irradiated breast.

## PATIENTS AND METHODS

A retrospective chart review study was performed of a single surgeon's practice (S.L.S.) between the years 2001 and 2005 to include all patients who had undergone reconstruction in the setting of breast cancer with a history of radiation therapy either before or concurrent with their reconstruction.

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Any patient that had initiated treatment before 2001 was excluded to keep our review up to date with our current practices. Institutional review board approval has been obtained. Patients were divided into two main groups: those who were seen as a primary patient (had not received any reconstruction previously) and those who were seen as a secondary patient (had received some sort of previous reconstruction). The chart review included the patient's anatomical features, the type of radiation received, the timing of irradiation, types of operations performed, timing of operations performed, and complications.

**RESULTS**

During a 5-year period between 2001 and 2005, 66 primary and 13 secondary breast cancer patients with a history of irradiation were treated (Tables 1 and 2). Capsular contracture was measured using the capsular contracture classification after prosthetic breast reconstruction from Spear and Baker<sup>10</sup> (Table 3).

**Primary Patients**

Twenty-five patients presented with a history of breast conservation therapy with subsequent recurrence of cancer treated with mastectomy. Nineteen of these patients underwent immediate reconstruction (76 percent) and six underwent delayed reconstruction (24 percent). Of these 25 patients, 12 (48 percent) underwent implant-based reconstruction, with the majority (eight of 12) undergoing immediate expander placement with a latissimus dorsi flap (Fig. 1); two underwent immediate expander placement with later implant exchange (no latissimus dorsi flap); and two underwent immediate expander with later implant exchange with the addition of a latissimus dorsi flap at the second stage. Four complications (four of 12) were noted in this group: one infection (which was treated with implant exchange), one hematoma, one expander deflation, and one mastectomy flap partial necrosis. All of these patients had capsular contracture ratings of class IA, IB, and II at final reconstruction. Thirteen of the 25

**Table 1. Primary Patients\***

	Implant Based	Autologous
Prior BCT with recurrence and mastectomy (25 patients)	12 implant-based reconstructions (48%) 8 immediate expanders with latissimus dorsi flaps 2 immediate expanders with exchange to implant 2 immediate expanders with exchange to implant and latissimus dorsi flaps	13 autologous only reconstructions (52%) 4 immediate pedicled TRAM flaps 3 immediate free TRAM flaps 4 delayed pedicled TRAM flaps 1 delayed free TRAM flap 1 delayed latissimus dorsi flap
Mastectomy followed by irradiation (25 patients)	6 implant-based reconstructions (24%) 5 delayed expanders with latissimus dorsi flaps 1 delayed expander with exchange to implant	19 autologous only reconstructions (76%) 14 delayed pedicled TRAM flaps 5 delayed free TRAM flaps
Reconstructions that preceded irradiation (12 patients)	9 implant-based reconstructions (75%) 6 expanders that were irradiated, followed by exchange to implant only 3 expanders that were irradiated, followed by exchange to implant with latissimus dorsi flap	3 autologous only reconstructions (25%) 1 immediate pedicle TRAM flap that was irradiated 1 immediate free TRAM flap that was irradiated 1 immediate expander that was removed for a pedicled TRAM flap later
BCT deformities (4 patients)	2 implant reconstructions (50%) 2 delayed implants	2 autologous only reconstructions (50%) 2 delayed latissimus dorsi flaps

BCT, breast conservation therapy.  
\*n = 66 patients.

**Table 2. Secondary Patients\***

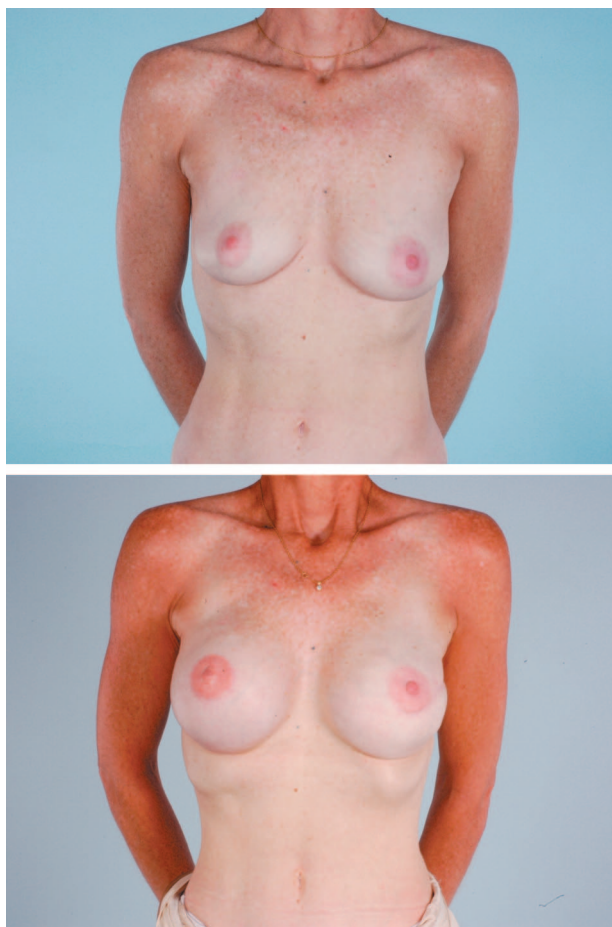
	Implant-Based Reconstruction Revisions	Autologous Reconstruction Revisions
Previous implant reconstruction (11 patients)	8 implant reconstructions (73%) 4 capsulectomies with implant exchange 2 exchanges of expander to implant 1 exchange of implant with latissimus dorsi flap 1 capsulectomy, expander placement and latissimus dorsi flap	3 autologous only reconstructions (27%) 3 implants removed with placement of pedicled TRAM flap
Previous autologous reconstructions (2 patients)	2 implant reconstructions (100%) 2 expanders placed under previous TRAM flaps	None

\*n = 13 patients.

**Table 3. Classification of Capsular Contracture after Prosthetic Breast Reconstruction\***

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

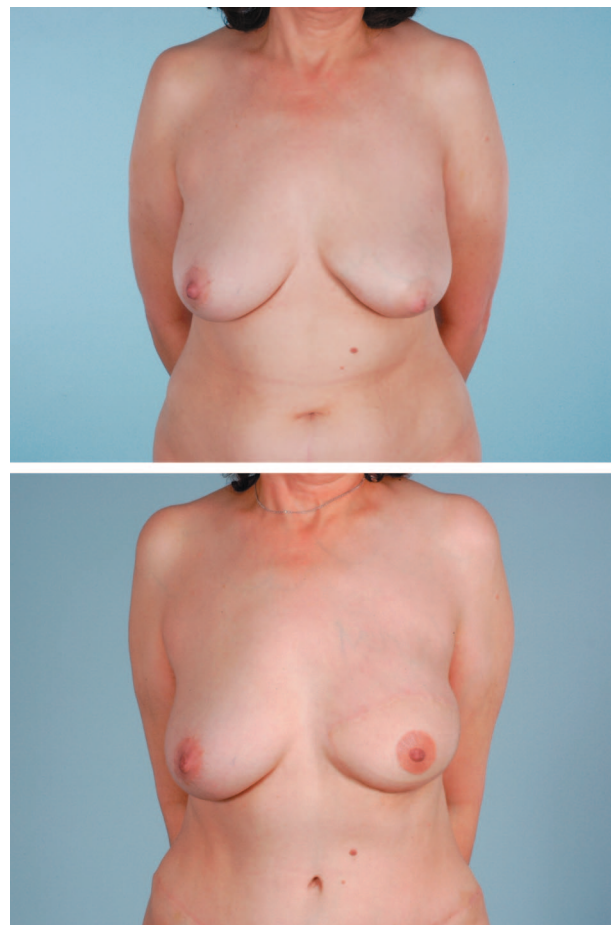
\*From Spear, S., and Baker, J. L. Classification of capsular contracture after prosthetic breast reconstruction. *Plast. Reconstr. Surg.* 96: 1119, 1995.



**Fig. 1.** Photographs of a 49-year-old woman with a history of right breast conservation therapy who developed recurrent breast cancer. She was thin and was not a candidate for TRAM flap reconstruction. She underwent mastectomy with immediate expander and latissimus flap. Prophylactic mastectomy on the left with expander placement was also performed. Four months later, she underwent exchange of expanders to implants with nipple reconstruction. A photograph obtained at 15-month follow-up from initial reconstruction is shown *below*.

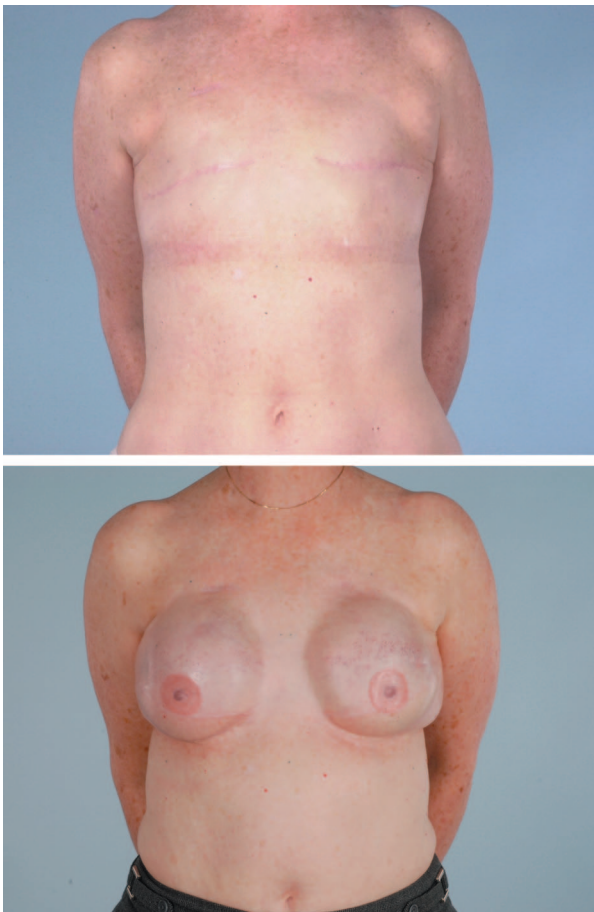
breast conservation therapy patients (52 percent) underwent a purely autologous reconstruction: four underwent immediate pedicled TRAM flap reconstruction (Fig. 2); three underwent immediate free TRAM flap reconstruction; four underwent delayed pedicled TRAM flap reconstruction; one underwent delayed free TRAM reconstruction; and one underwent delayed latissimus dorsi flap reconstruction. Three complications (three of 13) were noted in this group: one partial flap necrosis after a pedicled TRAM, one partial fat necrosis after a pedicled TRAM flap, and one partial fat necrosis after a free TRAM flap.

Twenty-five patients presented with a history of mastectomy followed by radiation therapy. Six of these patients (24 percent) underwent implant-based reconstructions, with all but one (five of six)



**Fig. 2.** Photographs of a 54-year-old woman with a history of left breast conservation therapy who developed recurrent breast cancer. She underwent mastectomy and immediate pedicled TRAM flap reconstruction. One revision operation was performed which included fat grafting along the superior pole as well as nipple reconstruction. A photograph obtained at 16-month follow-up is shown *below*.

receiving an expander with latissimus dorsi flap and later implant exchange (Fig. 3); one underwent expander placement with later implant exchange (no latissimus flap). No complications (zero of six) were noted in this group. Capsular contracture rating was class IB for all implants combined with a latissimus dorsi flap and class II for the implant-only final reconstruction. Nineteen of the 25 postmastectomy irradiated breast patients (76 percent) underwent autologous reconstructions, with the majority (14 of 19) receiving a delayed pedicled TRAM flap (Fig. 4); five underwent delayed free TRAM flap reconstructions. Twelve of the 14 pedicled TRAM flaps underwent a delay procedure 1 to 3 weeks before the TRAM flap by ligating the deep inferior epigastric vessels. Two complications (two of 19) were noted in this group: one partial flap necrosis after a



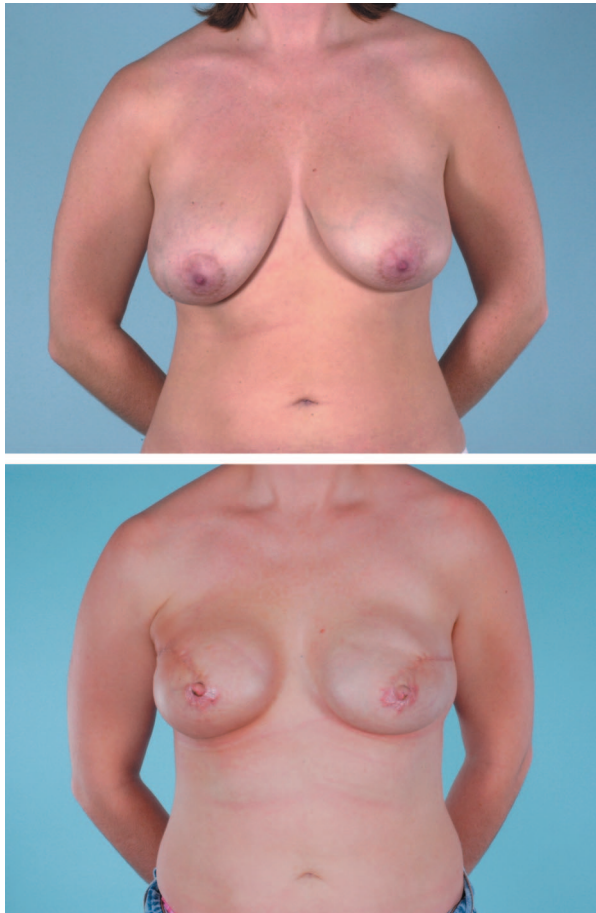
**Fig. 3.** Photographs of a 52-year-old woman with a history of right breast cancer with bilateral mastectomies and right-sided irradiation. She underwent bilateral delayed latissimus flaps with expander placement. Exchange of expanders to implants with nipple reconstruction was performed 6 months later. A photograph obtained at 41-month follow-up is shown *below*.



**Fig. 4.** Photographs of a 43-year-old woman with a history of right breast cancer treated with mastectomy followed by irradiation. She underwent delayed right pedicled TRAM flap surgery. At a second stage, the left breast was augmented and nipple reconstruction was performed on the right. A photograph obtained at 17-month follow-up is shown *below*.

pedicled TRAM flap and one partial flap necrosis after a free TRAM flap.

Twelve patients underwent immediate breast reconstructions that were followed by adjuvant radiation therapy. Ten patients had undergone immediate expander placement that was subsequently irradiated, and the majority (six of 10) underwent an exchange to implant only (Fig. 5); three underwent exchange to implant with the help of a latissimus dorsi flap, and one patient had the implant removed and a TRAM flap performed after radiation therapy was complete. Two patients had autologous flaps that were irradiated [one free TRAM (Fig. 6) and one pedicled TRAM flap]. The one complication in this group receiving adjuvant radiation during reconstruction (one of 12) was a seroma in the back after latissimus dorsi flap harvest. Capsular contracture ratings for the six



**Fig. 5.** Photographs of a 32-year-old woman with right breast cancer. She underwent bilateral mastectomies with immediate expander placement. Right-sided irradiation was performed after expansion. Twelve months after the initial operation, her expanders were exchanged for implants with nipple reconstruction. A photograph obtained at 13-month follow-up is shown below.

patients with implant-only reconstruction were class III in four patients and class IB in two patients for their final reconstructions. The three patients with addition of the latissimus flap all had class III/IV capsular contracture before the flap and class IB capsular contracture after the flap. The one patient with the replacement of the implant with a TRAM flap had a class IV contracture before replacement.

Four patients presented for correction of asymmetries associated with breast conservation therapy. Two patients underwent implant placement in the breast conservation therapy side and two underwent latissimus dorsi flap reconstruction of the breast conservation therapy side. No complications were seen in this group (zero of four). The capsular contracture rating for the two implant were both class II.



**Fig. 6.** Photographs of a 55-year-old woman with left breast cancer. She underwent left mastectomy and immediate free TRAM flap surgery. Left-sided irradiation was performed after TRAM flap surgery. Eleven months after the initial operation, revision of the left side was performed with nipple reconstruction and reduction was performed on the right side. A photograph obtained 18 months after immediate TRAM flap surgery is shown below.

### Secondary Patients

A total of 13 patients with previous breast reconstructions in the setting of radiation were seen for correction. Eleven patients had undergone prior device-based reconstructions (with irradiation having been performed at different times). Eight patients (73 percent) had implant-based correction; four of those eight underwent capsulectomy with implant exchange (class III contracture to class IB for all four); two had exchange of an expander to an implant (class III contracture for both final results); one had exchange of an implant with the assistance of a latissimus dorsi

flap (class III before, class IB after flap surgery); one had a new expander placed with a latissimus flap (class IV before, class II after flap surgery). The remaining three patients underwent autologous reconstruction, with all three receiving a pedicled TRAM flap after expander removal (Fig. 7). Among these 11 patients, there were two complications (18 percent): partial flap necrosis after a pedicled TRAM flap, and one back seroma after latissimus dorsi flap harvest.

Two patients had undergone prior TRAM flap reconstructions that were subsequently irradiated. Both patients underwent expander placement with subsequent implant placement. Neither of these patients suffered a complication.



**Fig. 7.** Photographs of a 49-year-old woman with a history of left-sided breast cancer, mastectomy with expander placement, and right reduction by another physician followed by irradiation therapy. She underwent removal of the expander with a pedicled TRAM flap reconstruction. Five months later, revision surgery was performed to both breasts along with nipple reconstruction. A photograph obtained at 9-month follow-up is shown *below*.

### Number of Operations

Table 4 delineates the average number of operations each group underwent up to the final result. No statistically significant difference in the number of operations was noted.

### DISCUSSION

A great deal has been written recently about radiation therapy and breast reconstruction.<sup>11-32</sup> Most authors discourage the use of prosthetic materials in the irradiated breast because of the high rate of complications, and as such, the common practice for most surgeons is to recommend a totally autologous reconstruction for these patients. However, not every woman is a candidate for total autologous tissue reconstruction because of anatomical and/or personal reasons. In addition, not all radiation is the same in its dose, timing, and patient tolerance. Therefore, we have reviewed our experience with reconstruction of the irradiated breast to try and glean information that may aid others in choosing reconstruction options when confronting this difficult subject.

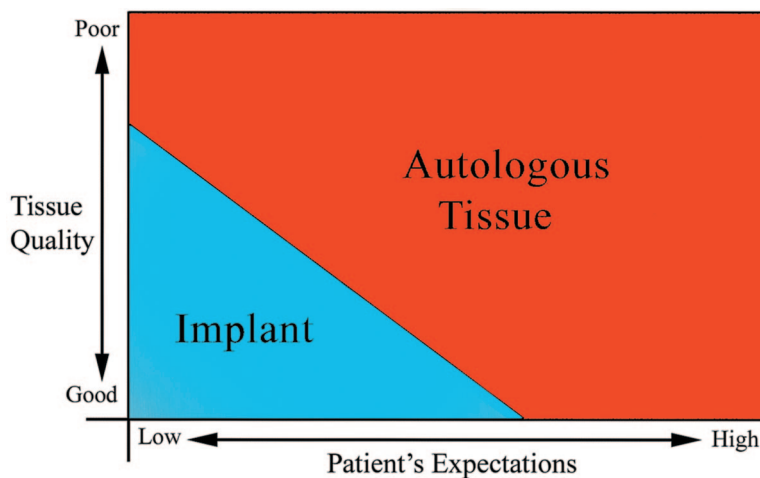
Everything being equal, autologous reconstruction is our preference when faced with a patient who has or will have radiation therapy. Unfortunately, there are patients who cannot or prefer not to undergo this type of reconstruction. These include women who are very thin, morbidly obese, have prior surgical scars, or do not wish to undergo the recovery period necessary for a TRAM or deep inferior epigastric perforator flap. For many of these patients, device reconstruction may remain a viable option, despite its limitations. Device reconstruction is well suited to patients with smaller breasts, minimal radiation injury, or in bilateral reconstructions. It is our practice to carefully screen patients for possible device reconstruction and inform them of the elevated risk and to rely on the latissimus dorsi flap as a possible salvage procedure when necessary.<sup>8</sup>

It is also important to gauge the patient's expectations regarding reconstruction and their willingness to undergo multiple operations for an adequate final result. A graphic interpretation of our philosophy is shown in Figure 8. As a patient's expectations rise or the quality of the tissue worsens, the likelihood of autologous reconstruction increases. The extremes of these situations are evident. For a woman who has low expectation for a "perfect" reconstruction, shows little evidence of radiation injury, and prefers to have the fewest and least invasive operations possible, an implant-based reconstruction may be an acceptable alternative.

**Table 4. Average Number of Operations Performed**

Presentation	Procedure	Average No. of Operations
BCT with recurrence	Implant-based reconstruction with or without latissimus	3.1
BCT with recurrence	Autologous reconstruction	3.0
Mastectomy followed by irradiation	Implant-based reconstruction with or without latissimus	2.5
Mastectomy followed by irradiation	Autologous reconstruction	2.7
Irradiated reconstructions	Implant-based reconstruction with or without latissimus	2.6
Irradiated reconstructions	Autologous reconstruction	2.3

BCT, breast conservation therapy.



**Fig. 8.** Our philosophy on reconstruction with respect to tissue quality and the patient's expectations.

Conversely, a woman with very high expectations, poor local breast tissue quality, and who is willing to undergo more extensive surgery is a better candidate for autologous reconstruction. Patients who are between these extremes (which is more common) illustrate the difficulty in making the best decision in reconstructing the irradiated breast.

Reconstructing the irradiated breast cancer patient is typically a two-stage or more endeavor. The majority of our patients underwent either two or three procedures to achieve their final results. To limit the number of operations and maximize the outcome, it is important to set the stage as well as possible at the first operation. We currently use cadaveric dermis (AlloDerm; LifeCell Corp., Branchburg, N.J.) attached to the pectoralis major muscle<sup>33</sup> inferiorly over the implant to provide a better pocket for the implant and assist in helping define the inframammary fold. When using a latissimus dorsi flap to salvage an unsatisfactory irradiated expander or implant, we prefer to place the cutaneous portion of the flap along the lower border of the breast and inframammary fold to allow for expansion of this added, nonirradiated tissue where expansion should ideally occur. Placing the

latissimus at the site of the previous mastectomy scar can lead to a “bubble” appearance of the breast as the latissimus flap pseudohermiates from the central portion of the breast while the lower pole remains tight and flat. When performing a TRAM flap (either pedicled or free), it is important to correctly calculate how much skin needs to be replaced and plan accordingly. Contralateral reductions, augmentations, or other “symmetry” procedures are usually better performed at the second stage when the reconstructed breast size and shape are more evident. Nipple reconstructions are usually performed during implant exchange or when a contralateral procedure is planned.

When evaluating a patient who has undergone prior breast conservation therapy or mastectomy with radiation therapy, it is important to get an accurate understanding of the patient, taking special care to note how the patient tolerated radiation therapy and how the skin and soft tissue responded to (and recovered from) that insult. Tissue that is firm, atrophic, noncompliant, and still discolored from the radiation is much less likely to be amenable to an implant-based reconstruction. For patients where the breast skin and

soft tissues are supple with little or no evidence of radiation damage, implant-based reconstructions may be a good option, especially if the patient is not, for one reason or another, a good candidate for an abdominal flap.

Radiation therapy and its associated damage presents in a variety of ways. Patients may have no clinical signs of damage or they may present with hyperpigmented, thin, inelastic tissues. In our review, we were able to divide the patients into four main categories: patients with radiation therapy from breast conservation therapy, patients with expected postmastectomy irradiation, patients undergoing irradiation after reconstruction of the breast had begun, and patients with breast conservation therapy deformities requesting revision. In addition, a review of secondary reconstruction correction offers a variety of scenarios with failed primary reconstruction after mastectomy. Looking at each of these groups separately helps to better understand our reconstructive strategies.

The subgroup of patients with a history of breast conservation therapy and need for completion mastectomy represent a difficult group to treat. The degree of damage to the proposed mastectomy flaps from the prior irradiation is often difficult to assess until after the mastectomy is completed. Our preference has been immediate reconstruction in the majority of cases (19 of 25) with autologous tissue (15 of 19). Of the four patients who had immediate device reconstructions, two required a latissimus flap in the second stage because of unsatisfactory results from tissue inelasticity. This represents a common finding after irradiation: successful two-stage device reconstruction after previous breast irradiation is the exception rather than the rule. Thankfully, device reconstruction in combination with a latissimus flap provides soft, pliable lower pole tissue for expansion and often allows for successful breast reconstruction. Attempting a device reconstruction in the presence of prior irradiation is not heresy provided the patient is aware that a salvage of the reconstruction with a flap may be necessary should the outcome prove unsatisfactory.

For patients who have undergone mastectomy and irradiation, we chose either purely autologous or implant reconstruction with a latissimus flap for 24 of the 25 breasts. When faced with mastectomy flaps that have been allowed to heal to the chest wall and are then irradiated, these patients have much less inviting tissue for expansion. As such, device-only reconstructions in this subset are rare. For patients in whom abdominal tissue reconstruction is not an option, our second choice is to use

an expander combined with a latissimus flap to replace the skin of the lower pole. The complication rate with this second option is low and mostly confined to latissimus donor-site seromas.

In any large-volume center, there will be a percentage of patients who need irradiation after an immediate breast reconstruction. Tumor size and proximity to the chest wall, axillary metastases, and questionable margins can all result in unanticipated irradiation. Of all the consecutive patients reviewed over 5 years, 12 of our reconstructions received radiation following initiation of reconstruction. We found in this series that of those patients with expanders, the majority went on to successful two-stage device-only reconstructions (60 percent). For those who did not fair as well, in every case the addition of a latissimus dorsi flap for the lower pole provided adequate release of constricted lower mastectomy flaps. The TRAM flaps that were irradiated required revisions secondary to contraction and fat necrosis. Because of the high incidence of fat necrosis and contraction, we continue to prefer to delay autologous tissue reconstruction in patients who we know or expect will be irradiated. It is ironic that immediate expander placement in a patient at higher risk of needing radiation therapy afterward may burn fewer bridges for future reconstruction than would purely autologous reconstruction.

In patients seeking breast conservation therapy deformity correction, our series had such a limited number of patients that it is difficult to draw conclusions. We do suspect a higher complication rate than would occur with nonirradiated tissues, but our data of only four patients did not bear this out.

Secondary reconstruction patients who are referred for correction of their reconstructions represent a distinct group. The radiation damage is typically more severe, with a poorer overall result. In our series, the number of secondary reconstructions corrected had a variety of radiation histories. For the 11 device reconstructions, only two (18 percent) were simply exchanged for a new implant. Four (36 percent) required extensive capsulectomies and implant exchange, two (18 percent) had a latissimus flap included in the salvage, and three (27 percent) had the implants completely replaced by TRAM flaps. The two patients with TRAM flaps that had been irradiated required insertion of implants to correct volume discrepancies because of the radiation-induced contraction of the TRAM flap. These results are similar to what we found in our own series of primary patients: device reconstructions may be

salvaged by flaps when needed, but flaps should ideally be delayed when radiation therapy is suspected in a patient's future.

## CONCLUSIONS

There is no one-size-fits-all approach to reconstructing the irradiated breast. Although autologous tissues are the preferred method of reconstruction in the majority of patients, they are not always available, either because of anatomy or because of the patient's desire. We believe that expander placement and a trial of expansion in an appropriate patient may accomplish a reasonable reconstruction. For the previously irradiated patient, it is important to discuss the latissimus flap as a salvage should the expansion not proceed well. As for the high-risk patient with a questionable radiation future, we suggest the following: if autologous reconstruction is planned, it should be delayed; and if device reconstruction is planned, it should be performed immediately and the expansion completed before irradiation.

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## Instructions for Authors: *Update*

### Registering Clinical Trials

Beginning in July of 2007, *PRS* has required all articles reporting results of clinical trials to be registered in a public trials registry that is in conformity with the International Committee of Medical Journal Editors (ICMJE). All clinical trials, regardless of when they were completed, and secondary analyses of original clinical trials must be registered before submission of a manuscript based on the trial. Phase I trials designed to study pharmacokinetics or major toxicity are exempt.

Manuscripts reporting on clinical trials (as defined above) should indicate that the trial is registered and include the registry information on a separate page, immediately following the authors' financial disclosure information. Required registry information includes trial registry name, registration identification number, and the URL for the registry.

Trials should be registered in one of the following trial registries:

- <http://www.clinicaltrials.gov/> (Clinical Trials)
- <http://actr.org.au> (Australian Clinical Trials Registry)
- <http://isrctn.org> (ISRCTN Register)
- <http://www.trialregister.nl/trialreg/index.asp> (Netherlands Trial Register)
- <http://www.umin.ac.jp/ctr> (UMIN Clinical Trials Registry)

More information on registering clinical trials can be found in the following article: Rohrich, R. J., and Longaker, M. T. Registering clinical trials in *Plastic and Reconstructive Surgery*. *Plast. Reconstr. Surg.* 119: 1097, 2007.