Revising Prepectoral Breast Reconstruction

Adam M. Goodreau, M.D.
Cassandra R. Driscoll, M.D., M.P.H.
Anthony Nye, M.D.
Lauren C. Nigro, M.D.
Nadia P. Blanchet, M.D.

Richmond, Va.

Summary: Prepectoral prosthetic breast reconstruction continues to gain popularity, largely due to its decreased postoperative pain, animation deformity, and operative time as compared to subpectoral reconstruction. Widespread use has led to opportunities for surgical revisions. While some techniques for submuscular reconstruction revisions, such as implant exchange and fat grafting, also apply to prepectoral revisions, others require modification for the prepectoral space. The prosthesis' unique reliance on the mastectomy flaps and acellular dermal matrix for support leads to a progressive alteration of the breast footprint, conus, envelope, and nipple-areola complex position. To date, revisions of prepectoral reconstructions have not been addressed in the literature. This article presents the senior author's (N.P.B.) techniques for (1) revising prepectoral breast reconstructions, including staged and direct-to-implant reconstructions, with a special focus on nipple-sparing reconstruction, and (2) minimizing undesirable outcomes of prepectoral reconstruction. (*Plast. Reconstr. Surg.* 149: 579, 2022.)

Prepectoral reconstruction with acellular dermal matrix coverage has rapidly gained popularity, likely due to its decreased postoperative pain, shortened length of hospital stay, quicker return to activities, elimination of animation deformity, decreased operative time, and decreased capsular contracture rates.[1–8] Despite these advantages, revisions are inevitable as the breasts "settle," changing appearance over time. In addition, some preexisting asymmetries may need to be addressed. The use of anterior acellular dermal matrix implant coverage results in a pocket that can be a tool for performing revisions. In this article, we identify common indications for breast revision in prepectoral breast reconstructions and present novel solutions involving acellular dermal matrix modifications and nipple-areola complex repositioning. We also present strategies to implement at the initial reconstruction to mitigate untoward outcomes of prepectoral reconstruction.

PATIENTS, METHODS, AND SURGICAL TECHNIQUES

Patients included in this retrospective series underwent both prepectoral breast reconstruction and secondary revision procedures between February of 2017 and March of 2020. Nipple-sparing mastectomies were preceded by a delay procedure 2 weeks earlier.[9,10] Revisions occurred either at a planned exchange of a tissue expander for a permanent implant or as a separate, secondary procedure after direct-to-implant reconstruction. All study procedures conformed with the Declaration of Helsinki. The techniques used to perform all revisions are described below and summarized in Table 1.

Adjusting the Footprint

For inferior and lateral descent due to gravity, readvancement of the acellular dermal matrix is used to move the entire footprint superomedially, with concomitant nipple-areola complex advancement in the same vector. [**See Figure, Supplemental Digital Content 1**, which demonstrates acellular dermal matrix readvancement to correct implant descent. (*Left*) Inferior descent of the left implant on the chest wall, with notable step-off in the upper pole. (*Right*) Eight months after readvancement of the acellular dermal matrix pocket superomedially with an additional inferior acellular dermal matrix sling to support

From the Division of Plastic and Reconstructive Surgery, Virginia Commonwealth School of Medicine.
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Table 1. Summary of Encountered Issues and Techniques to Address

Anatomic Issue	Techniques to Avoid Revisions	Revision Techniques
Inferolateral descent of the implant	Anticipate movement and place implants superomedial	Resuspend pocket with ADM reattachment Onlay ADM sling in the inferior pole to support larger implants
Nipple-areola malposition	NAC barbed suture cable suspension at time of mastectomy*	>1-cm Crescentic excisions with mirror capsulotomy
Rippling	More cohesive implant	Autologous fat grafting
Radiation therapy–induced encapsulation	Irradiated side: lower IMF in anticipation of superior shift after irradiation; select implant with larger base width/footprint, less projection, and possibly higher volume Nonirradiated side: more-projecting implant, placed higher on the chest wall	Inferolateral capsulotomies to expand pocket, with additional ADM to reline the pocket ADM reattachment superiorly, more-projecting implant, ADM sling inferiorly

ADM, acellular dermal matrix; IMF, inframammary fold; NAC, nipple-areola complex.
*Zhang S, Blanchet NP. Reelevating the mastectomy flap: A safe technique for improving nipple-areolar complex malposition after nipple-sparing mastectomy. *Plast Reconstr Surg Glob Open* 2017;5:e1426.

the prosthesis. Note softening of the upper pole step-off after readvancement with no additional fat grafting, ***http://links.lww.com/PRS/E888***.] This is especially useful for patients who do not have enough fat to mask the border of the implant with fat grafting. Similarly, this technique is used to move the footprint medially, softening a sharp implant border and medializing the cleavage (Fig. 1). For asymmetries of the breast footprint, the acellular dermal matrix can be separated and reattached, using additional acellular dermal matrix as needed to line the new pocket. After the pocket is readvanced higher onto the chest wall, an inferior or inferolateral acellular dermal matrix sling can be used for additional support, particularly with larger implants. We have also used this approach when a patient prefers the aesthetic of the radiated side. [**See Figure, Supplemental Digital Content 2**, which shows repositioning of both the inframammary fold and nipple-areola complex to improve symmetry in an irradiated breast. In this case, the patient preferred the irradiated (*left*) side, and so acellular dermal matrix readvancement was performed superolaterally on the right, combined with crescentic excisions above the nipple-areola complex and an inferior supportive acellular dermal matrix sling. The result is shown at 12 months postoperatively, ***http://links.lww.com/PRS/E889***.] An acellular dermal matrix sling is attached to the posterior chest wall, sutured to the anterior acellular dermal matrix, and incorporated into the inframammary fold incision for additional stability. Permanent, braided sutures are used for long-term stability, since incorporation may or may not occur with additional stacked acellular dermal matrix. Finally, in irradiated reconstructions, inferior or inferolateral capsulotomy with the addition of new acellular dermal matrix along the interface of the old pocket and the chest wall can correct superior displacement and excess projection by expanding the breast pocket (Fig. 2). [**See Figure, Supplemental Digital Content 3**,

Fig. 1. Acellular dermal matrix advancement to medialize and soften the edge of the implant. (*Left*) In this thin patient, fat grafting was not an option, so lateral migration of the prosthesis was addressed by medial acellular dermal matrix advancement. Crescentic acellular dermal matrix excisions were also used to medialize the left nipple-areola complex. A larger implant was used to address rippling. (*Right*) The result is shown at 6-month follow-up.

Fig. 2. Acellular dermal matrix adjustments in unilateral, irradiated mastectomy flap. (*Left*) The patient is shown after left nipple-sparing mastectomy with immediate direct-to-implant prepectoral reconstruction and subsequent radiation, complicated by constriction of the breast envelope and ascent of the prosthesis. (*Right*) The patient is shown at 6 months after contralateral mastopexy and inferolateral capsulotomy with acellular dermal matrix insertion.

which shows inferolateral acellular dermal matrix (*ADM*) inset. Additional acellular dermal matrix is secured to both sides of a capsulotomy incision. This maneuver is useful in irradiated breasts to allow expansion of the pocket, ***http://links.lww.com/PRS/E890***.]

Adjusting the Nipple-Areola Complex Position

For nipple-areola malposition, two to three serial, parallel, crescentic acellular dermal matrix excisions are used to move the nipple-areola complex in one vector (Fig. 3). The ideal width for each crescent is just over 1 cm. When the crescent width is less than 1 cm, there is minimal movement. When the crescent width is much more than 1 cm, the overlying mastectomy flaps can bunch. At least 1 cm of intact acellular dermal matrix should be left between crescents to preserve the smooth surface of the implant. These excisions make the skin envelope smaller and flatter, so a balancing "mirror" capsulotomy on the opposite side of the same pocket is often necessary.

These capsulotomies can be with or without the addition of an acellular dermal matrix patch

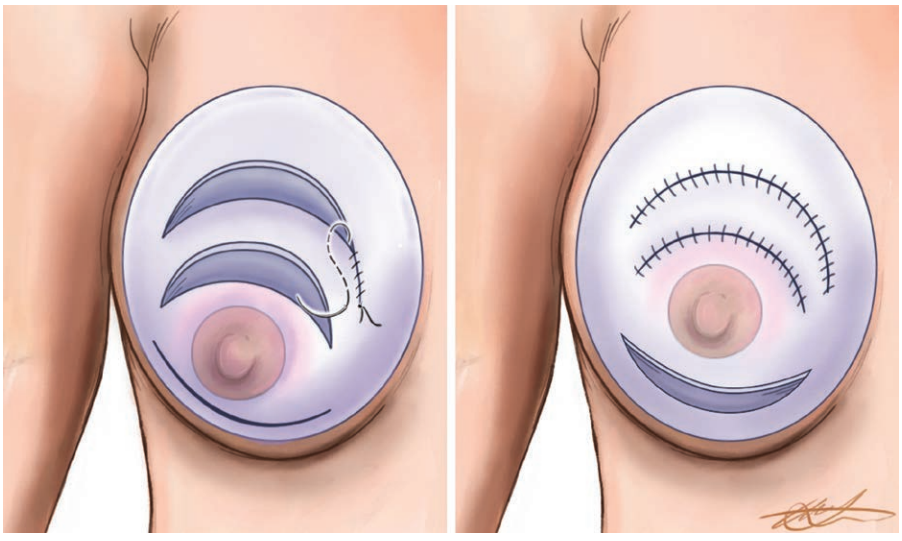

Fig. 3. Crescentic acellular dermal matrix adjustments for nipple-areola complex repositioning. (*Left*) Two parallel crescentic acellular dermal matrix excisions of just over 1 cm width are designed perpendicularly to the desired vector of nipple-areola complex movement. Each crescent will be closed with a nonabsorbable suture, as pictured, repositioning the overlying nipple-areola complex. An inferior balancing capsulotomy is planned to mitigate constriction of the pocket, prevent flattening of the skin envelope, and maintain volume. (*Right*) Closure of concentric crescents with correction of nipple-areola complex position.

to support the skin envelope. If large capsulotomies are made, the implant will herniate into this area, so acellular dermal matrix support is necessary. In general, some degree of overcorrection is necessary. Although these flaps are by definition "delayed," prudence would mandate caution in irradiated or excessively thin flaps.

In addition to crescentic excisions for nipple-areola complex repositioning, we adapted a previously described "thermal capsulorrhaphy" for use in prepectoral reconstruction.[11] This approach uses thermal contraction of the capsule brought about by applying a cautery unit directly to the capsule, creating a contractile, partial-thickness thermal injury to the incorporated acellular dermal matrix. Because of the adherence of the acellular dermal matrix to the overlying mastectomy flap, this technique is able to move a slightly malpositioned nipple and can be combined with crescentic excisions. [**See Figure, Supplemental Digital Content 4**, which shows thermal capsular injury for nipple-areola complex repositioning. (*Left*) A patient with bilateral prepectoral reconstruction and inferior displacement of the left nipple-areola complex. (*Right*) Three months after a thermal capsulorrhaphy was used to reposition the left nipple-areola complex, ***http://links.lww.com/PRS/E891***.] Similar to the above, this technique is not advisable for irradiated or excessively thin flaps.

RESULTS

Seventy patients underwent prepectoral reconstructions between February of 2017 and March of 2020. Of these, 48 (68.6 percent) were direct-to-implant reconstructions and 60 (85.7 percent) were nipple-sparing mastectomies. Of 70 prepectoral reconstructions, 23 patients (32.9 percent) underwent secondary revisions using the above-described procedures. (**See Table, Supplemental Digital Content 5**, which lists descriptive and quantitative statistics for patients undergoing prepectoral breast revisions in this series, ***http://links.lww.com/PRS/E892***.) A total of 45 breasts were included in this study. Mean follow-up was 570 days (range, 187 to 1074 days). The average patient age and body mass index were 49 years (range, 20 to 69 years) and 25.1 kg/m^2 (range, 18.3 to 42.5 kg/m^2), respectively. Five of 45 revised breasts (11.1 percent) were irradiated after their initial reconstruction.

Of the 23 patients who required secondary revisions, nine (39.1 percent) underwent acellular dermal matrix adjustments during a planned exchange of a tissue expander for a permanent implant. Fourteen patients (60.9 percent) had revisions performed after a direct-to-implant reconstruction. Among those who underwent two-stage reconstruction, the mean time between expander placement and exchange for a permanent implant was 93.8 days (range, 29 to 210 days). The mean time between implant placement and subsequent revision in the direct-to-implant cohort was 236 days (range, 57 to 1563 days). All patients required revision to adjust the breast footprint. Fourteen (61 percent) of the patients underwent adjustment of the nipple-areola complex position. Concomitant fat grafting was a commonly used adjunct, occurring in 82.6 percent of revisions. One direct-to-implant patient underwent two revision procedures, with 76 days between them.

Patient data were queried for complications, including hematoma, infection, seroma, unsatisfactory scarring, and partial- or full-thickness mastectomy flap necrosis. None of these events were encountered following a revision procedure during the follow-up period.

DISCUSSION

Prepectoral breast reconstruction with acellular dermal matrix coverage is being increasingly used by plastic surgeons. Though there are many established benefits, over time, progressive settling and asymmetries occur. Furthermore, asymmetries present at the time of the original mastectomy may persist after prepectoral reconstruction. The techniques described here effectively address these changes for even the most challenging reconstructions. [**See Figure, Supplemental Digital Content 6**, which shows combination acellular dermal matrix adjustments to revise a delayed prepectoral reconstruction. (*Above, left*) Reconstruction was delayed for poor perfusion as noted on intraoperative indocyanine green fluoroscopy. (*Above, center*) The patient is shown after hyperbaric oxygen therapy and subsequent expander placement in a prepectoral plane. (*Above, right*) The patient is shown 1 year after exchange of expanders for implants and readvancement of the acellular dermal matrix superiorly and inferior acellular dermal matrix insets bilaterally. Crescentic acellular dermal matrix excisions on the left were used to reposition the nipple-areola complex. (*Below, left*) Preoperative view. (*Below, right*) Improvement of nipple-areola complex position and expansion of lower pole after combination implant exchange and acellular dermal matrix adjustments, ***http://links.lww.com/PRS/E893***.]

When considering the breast footprint, the senior author (N.P.B.) initially placed prepectoral implants where they appeared to be most aesthetic on the chest wall. However, the reconstructions have shown a tendency to drop inferolaterally over time, especially with larger implants. This is true even when the initial pocket is tight.[12,13] We now place the implants higher and more medially to compensate for this. The thickness and elasticity of the original mastectomy flaps as well as the thickness, elasticity, and number and nature of acellular dermal matrix perforations all have an impact on the final outcome. This elasticity is anticipated in our reconstructive plan, and overcorrection is often required. For example, a single crescent may stretch over time, so multiple parallel crescents are usually necessary to illicit meaningful nipple-areola complex movement.

Prepectoral irradiated breast reconstructions have been shown to have less pain and encapsulation than submuscular reconstructions[14,15]; nonetheless, the irradiated side tends to be higher, with a smaller footprint and more projection. These changes can be anticipated by placing a less-projecting implant lower on the chest wall than the contralateral, nonirradiated side. During a second stage, capsulotomy with additional acellular dermal matrix to reline the inferior junction of the chest wall and the breast pocket can expand the envelope to correct these untoward radiation changes. Some techniques, such as fat grafting and implant exchange, are still applicable in prepectoral reconstruction, as seen in our series, in which a majority of patients received fat grafting as part of their revision. Other techniques, however, such as capsulotomy, need to be modified to prevent implant pseudoherniation. Finally, techniques such as re-elevating the entire mastectomy flap to address nipple-areola complex malposition, are not technically feasible.[16]

The senior author (N.P.B.) has previously described using polydioxanone cable sutures to position the nipple-areola complex intraoperatively at the time of the initial mastectomy, affixing the mastectomy flap to the subjacent acellular dermal matrix.[17] She has since discovered that a barbed suture through the mastectomy flap has facilitated this technique. The shortcoming of the initial positioning technique is the same as the acellular dermal matrix revision techniques presented here: both the mastectomy flaps and the acellular dermal matrix are elastic structures subjected to the weight of the implant over time. Therefore, overcorrection is recommended, especially with larger implants. Some authors use acellular dermal matrix with very wide perforations to conserve it, or they use thinner mesh to facilitate incorporation. In these instances, acellular dermal matrix crescents may not be technically feasible due to a thinner capsule. Finally, when acellular dermal matrix sling support is added on top of already-incorporated acellular dermal matrix, it remains to be seen if the additional matrix will incorporate, thus permanent sutures are used to anchor the acellular dermal matrix sling.

CONCLUSIONS

This article describes commonly encountered challenges after prepectoral reconstruction and introduces strategies to both minimize their occurrence and correct them through acellular dermal matrix adjustments. Though a learning curve was encountered, these techniques have proven efficacious over long-term follow-up in this series.

Nadia P. Blanchet, M.D.
9210 Forest Hill Avenue
Richmond, Va. 23235
nadia@nadiablanchet.com

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