Latest Trends in Subpectoral Breast Reconstruction

Christine Oh, MD, MSc[1] Sebastian J. Winocour, MD, MSc, FACS[2] Valerie Lemaine, MD, MPH[3]

[1] Division of Plastic and Reconstructive Surgery, Department of Surgery, Mayo Clinic, Rochester, Minnesota
[2] Division of Plastic Surgery, Michael E. DeBakey Department of Surgery, Baylor College of Medicine, Houston, Texas
[3] Plastic Surgery Consultants, Edina, Minnesota

Address for correspondence Valerie Lemaine, MD, MPH, Plastic Surgery Consultants, 3300 Edinborough Way Suite 410, Edina, MN 55435 (e-mail: lemainev@gmail.com).

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Abstract

There has been a shift in recent years toward a growing popularity of implant-based breast reconstruction, especially in the setting of increased frequency of concurrent contralateral prophylactic mastectomy. Advancements in implant safety and technology have also allowed for an expanding implant reconstruction practice across the country. The traditional approach is immediate two-stage implant reconstruction with placement of a tissue expander within a subpectoral pocket. The introduction of acellular dermal matrix has revolutionized implant-based breast reconstruction, allowing surgeons the opportunity to minimize morbidity while maximizing aesthetic outcomes. There have also been advances in the management of postoperative pain control as well as secondary revision surgery.

Keywords
- breast reconstruction
- subpectoral
- mastectomy
- breast cancer

Implant-based breast reconstruction has continued to grow in popularity as the preferred approach for immediate breast reconstruction in the era of skin-sparing and nipple-sparing mastectomy. In addition, there has also been an increase in the popularity of contralateral prophylactic mastectomy which further expands upon a trend toward prosthetic breast reconstruction.[1] Advances in available techniques and technology, as well as progress in the management of breast cancer, have allowed for the evolution of implant-based breast reconstruction. The traditional approach to creating a prosthesis pocket utilizes the pectoralis major muscle for implant coverage, with early techniques elevating the serratus anterior muscle in its entirety as well.[2] Concern for the viability of the mastectomy skin flap may negatively impact the outcomes of implant-based breast reconstruction given the risk of further compromising the already ischemic skin envelope, yet the submuscular technique tends to be a safe and successful approach as it elevates a well-vascularized muscle against the mastectomy skin flap. In the past two decades, the introduction of acellular dermal matrix (ADM) has revolutionized prosthetic breast reconstruction. The constant evolution in surgical technique, perioperative care, and revision surgeries has subsequently reduced surgical morbidity and greatly improved aesthetic outcomes.

Pocket Creation and the Use of Acellular Dermal Matrix

A subpectoral implant pocket remains the standard in breast reconstruction, with the prime advantage of added soft tissue to conceal implant edges and rippling.[3] The disadvantage of total submuscular implant is limitation in soft-tissue compliance and restriction of breast shape and projection. There is an incongruity between the submuscular pocket and the skin envelope, which is often inherently smaller than the subcutaneous pocket; thus, even with the advent of skin-preserving techniques, the preserved breast skin is not fully utilized within the reconstruction due to limitations in tissue expander fill volume.[4] Disadvantages of total submuscular implant placement including a constricted lower pole, blunted inframammary fold (IMF), as well as superior implant displacement ushered in enthusiasm for the use of ADM and standardization of the dual-plane, partial subpectoral implant pocket with inferior division of the pectoralis muscle off the chest wall and addition of ADM sling for soft-tissue support.[5] ADM is used extensively in primary and secondary breast surgery and has significantly impacted implant-based breast reconstruction. Duncan initially utilized ADM to address rippling after breast augmentation.[6] Breuing and Warren then first described

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creating the classic ADM inferior sling to control the lower pole deficit and "window-shading" effect created by inferior release of the pectoralis major muscle.[7] ADM acts as a scaffold for tissue ingrowth and thus creates a more aesthetically contoured lower pole in the setting of an implant.[8] Current standard technique for partial, dual-plane subpectoral reconstruction utilizes an "inferior sling" in which the ADM is sutured along the inferior aspect of the pectoralis major muscle. In this technique, the muscle/ADM interface and prosthesis pocket are created prior to the insertion of the tissue expander. Tissue expanders with tabs may be used to increase stability of the footprint of the new reconstructed breast.[9,10] The medial aspect of the tissue expander should be positioned as medial as possible with the tab sutured to the chest wall to maintain the position and define the medial breast contour. The primary purpose of the ADM is to provide soft-tissue support inferolaterally to create a well-defined pocket for the permanent implant with less lateral and inferior migration.[8] The physical properties of ADM make it similar to dermis, allowing elasticity and deformation under load while resisting tearing. This allows for compliance during prosthetic breast reconstruction, maintaining lower pole coverage and support and allowing for more aesthetic contour.[8,11]

Sbitany et al published a retrospective review comparing complete submuscular placement and partial subpectoral placement with an ADM inferior sling and reported that the use of ADM allowed for a greater initial fill volume of the tissue expander with 412 mL per expander in the ADM group versus 130 mL per expander in the total submuscular group ($p = 0.0001$) as well as approximately three less fills for the ADM group versus the total submuscular group to complete the reconstruction.[4] The study concluded that using ADM may potentially improve cosmetic outcomes by capitalizing on preserved mastectomy skin as well offering the potential for more predictable revision surgeries.[4] The use of ADM also expedites the time to final tissue expander fill. ADM reconstruction is also believed to offer more aesthetic outcomes as well as act as a protective layer in the setting of an implant exposure.[12,13] Davila et al conducted a study of complication rates of ADM-assisted tissue expander breast reconstruction with traditional submuscular methods using the American College of Surgeon's National Surgical Quality Improvement Program (NSQIP) registry and found no significant difference in total or reconstruction-related complications.[14]

In staged breast reconstruction, the ADM is typically sutured to the inferior edge of the pectoralis major muscle first, pulled inferiorly to determine the optimal position of the muscle with the ADM trimmed to size and then a deflated tissue expander is inserted in the breast pocket.[8] One of the challenges encountered with this traditional technique of suturing the ADM to the IMF without the tissue expander in place is that the surgeon must subjectively anticipate the required projection and suturing tension of the ADM at full device expansion. An ADM suturing tension that is too restrictive may constrict the lower breast pole and elevate the position of the tissue expander and the overall footprint of the newly reconstructed breast mound.[13] This may lead to asymmetry in bilateral cases. In addition, undue restriction of the lower pole projection by ADM sutured with too much tension can result in dehiscence of the ADM from the IMF or pectoralis muscle during the expansion process. Any of these outcomes may negatively affect breast contour and aesthetics and can lead to problems such as breast asymmetry (e.g., if the ADM is not sutured identically on both sides in bilateral cases) and lack of lower pole projection (e.g., if the ADM is sutured with too much tension). These problems can make the implant exchange surgery challenging. Nahabedian described the ideal ADM position as being without folds or ripples to ensure total contact with the mastectomy skin flap for maximal adherence and to minimize the incidence of a seroma.[13] Since the expander is typically filled to 40 to 60% capacity to minimize compression of the subdermal vascular plexus and breast skin ischemia, it may be challenging to anticipate the shape of the ADM at full device expansion using the traditional technique.[13] The appropriate degree of ADM draping comes with surgeon experience.

The senior author (V.L.) utilizes a modified technique to improve symmetry and aesthetic outcomes in which the ADM is sutured to a fully expanded tissue expander ex vivo (►**Fig. 1**).[15] This technique involves suturing the ADM to the tissue expander tabs at full expansion. The ADM covers the inferior pole of a fully inflated device and the surgeon is able to confirm the absence of any rippling prior to insertion into the mastectomy pocket, ensuring maximal contact with the mastectomy skin flap once the device is ultimately filled. In addition to the standard tissue expander breast reconstruction, this technique can also be applied in subpectoral direct-to-implant cases. This is then sutured to the inferior aspect of the pectoralis major muscle in the typical fashion. This prefabricated device draping technique has resulted in improved outcomes by improving breast symmetry in bilateral reconstructions, creating desired lower breast pole projection that is reproducible and easily teachable to residents. Furthermore, the device can be prefabricated while the mastectomy is performed, which can maximize operative efficiency. Finally, the second stage procedure is simplified by nearly eliminating the need for capsulectomy, capsulorrhaphy, and any other breast pocket adjustment and overall minimizing the need for revision surgeries.

As an alternative to the use of ADM and when serratus fascia is unavailable, the use of subpectoral fascia to provide lateral expander coverage is safe and effective.[16] The subpectoral fascia is unlikely to be disrupted by the mastectomy portion of the surgery and can be rotated laterally to provide inferolateral coverage with well-vascularized autologous tissue. Saint-Cyr et al also reported that when used in conjunction with ADM, the subpectoral fascial flap can help limit the size of ADM required, thus helping to reduce overall costs of the reconstruction.[16]

Postoperative Pain Control

A disadvantage of subpectoral implant placement is pain and discomfort in the immediate postoperative period as well as during tissue expansion especially when compared with a prepectoral breast reconstruction. There have been several trends in subpectoral implant reconstruction to address this

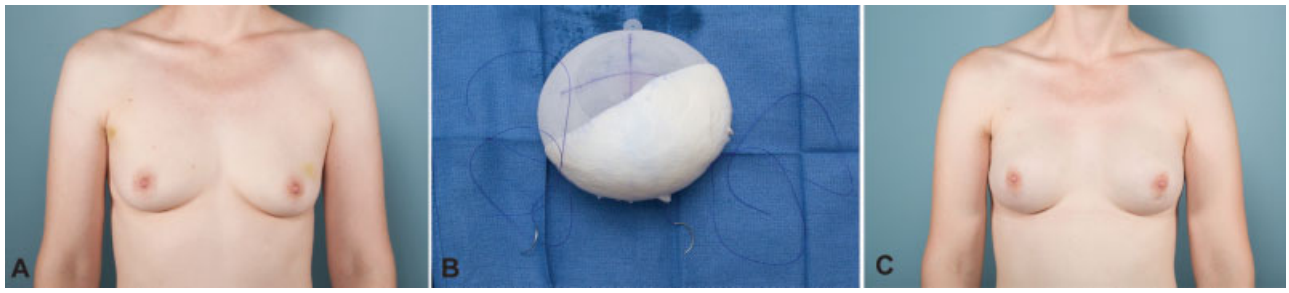

Fig. 1 (**A**) Preoperative photograph. (**B**) Ex vivo ADM wrapped fully expanded inflated tissue expander. (**C**) Postoperative photograph status post bilateral nipple sparing mastectomy (inframammary incision) and subpectoral ADM implant reconstruction. (Reproduced with permission from Oh C, Winocour S, Lemaine V. Acellular dermal matrix in submuscular implant-based breast reconstruction: a novel technique to improve symmetry. Plast Reconstr Surg 2017;140(04):641e–643e.[15])

issue. Intercostal regional nerve block as well as infiltration within the pectoralis muscle itself with local anesthetic is one method in which postoperative pain associated with the muscle dissection can be improved. Nasr et al compared the intercostal block with direct pectoralis infiltration only using bupivacaine with epinephrine and concluded that neither method significantly improved pain score following submuscular breast augmentation.[17] In contrast, a retrospective study by Jabs et al evaluated the efficacy of tumescent infiltration and bupivacaine injection and found patient-reported decreased pain and use of narcotics when compared with a control group that received no intervention.[18] Chaudhry et al used a portable pain pump catheter which was placed within the breast pocket and delivered bupivacaine.[19] The pain pump was removed prior to discharge and results revealed a statistically significant reduction in pain scores in addition to reduced hospital length of stay. Liposomal bupivacaine (Exparel; Pacira Pharmaceuticals, Inc.) has been approved for use in breast reconstruction and has shown positive results in alleviating postoperative pain control. Prior to the use of liposomal bupivacaine, paravertebral blocks were often placed for postoperative pain control and were found to decrease pain as well as hospital length of stay in multiple studies.[20–22] Abdelsattar et al conducted a retrospective study comparing liposomal bupivacaine injection into the pectoralis major, serratus anterior fascia, and along the breast footprint with a paravertebral block in patients undergoing mastectomy with immediate tissue expander reconstruction and concluded a significantly decreased use of opioids postoperatively in the liposomal bupivacaine group.[23] In a retrospective study comparing narcotic pain medication, liposomal bupivacaine infiltration, and a bupivacaine pain pump in immediate implant-based breast reconstruction, the patients who received a field block of the third to fifth lateral and medial intercostal nerves with liposomal bupivacaine had decreased pain scores and an overall reduced inpatient length of stay.[24]

The use of botulinum toxin type A (BTX-A) is not new as an adjunct to subpectoral implant placement. The senior author (V.L.) reported the use of 100 units of botulinum toxin to protect the repair of the pectoralis major sternal head when it caused tethering at the lower border after subpectoral breast augmentation.[25] To address botulinum toxin–resistant postoperative myospasm, Adkinson et al recommend medial and lateral pectoral neurectomy as a potential surgical intervention after implant reconstruction.[26] A more recent trend for botulinum toxin use is for postoperative pain control.[25,27–30] Layeeque et al retrospectively studied 48 patients undergoing immediate subpectoral two-stage breast reconstruction following mastectomy. Twenty-two patients received botulinum toxin infiltration. Patients received 100 units of BTX-A diluted in 40 to 60 mL of normal saline into the pectoralis major, serratus anterior, and rectus abdominis insertion using a 20-gauge spinal needle.[29] The patients who underwent BTX-A infiltration did significantly better with pain postoperatively and required less narcotic pain medications as well as fewer expansions.[29] The mechanism of action of BTX-A includes not only muscle paralysis by inhibition of neurotransmitter release but also inhibition of substance P for a true analgesic effect.[28,31] Lo and Aycock conducted a double-blinded randomized controlled trial comparing use of 100 units of BTX-A throughout the pectoralis major in one breast versus normal saline placebo in the other breast in patients undergoing bilateral mastectomy with immediate tissue expander reconstruction and concluded no significant reduction in pain attributable to the BTX-A injection.[32] This study was limited by a sample size of 23 patients, but overall concludes that given the cost of the intervention with minimal benefit does not justify the use of botulinum toxin in tissue expander placement.[32] Overall, there seems to be a potential for the therapeutic benefit of using of BTX-A in prosthetic breast reconstruction, with no report of increased complications, although efficacy is yet to be determined and requires future randomized studies.

Secondary Fat Grafting

With total submuscular coverage, a common problem was excess upper pole volume and associated superior implant displacement, yet the pendulum has swung with an occasional deficient upper breast pole with the use of ADM and partial subpectoral pocket creation.[5] The ideal upper to lower pole ratio is quoted to be 45:55 and to achieve a pleasing contour, volume augmentation with fat grafting has contributed a significant shift toward secondary procedures to improve aesthetic outcomes, whether implant-based or autologous breast reconstruction.[12]

In the setting of implant-based reconstruction with radiation therapy, secondary fat-grafting procedures play a critical role in helping to create a thicker subcutaneous layer and allow improved breast contour.[33] Fat grafting may be performed multiple times, with each intervention adding more volume, improving tissue quality, and potentially helping to minimize capsular contracture in those patients who received radiation. The preadipocytes within the grafted fat have an angiogenic potential that can improve tissue quality. Komorowska-Timek et al compared aesthetic outcomes of irradiated and nonirradiated patients who underwent tissue expander reconstruction with secondary fat grafting and found no significant difference between the two groups.[34] The authors emphasize fat grafting of the irradiated mastectomy defects to create increased pliability and vitality of the implant envelope, indicating that patients who require postmastectomy radiation can still have aesthetic outcomes with implant reconstruction.[35,36]

Primary fat grafting directly into the pectoralis major muscle in the setting of an irradiated field can also help "marble" the muscle with intramuscular fat to soften the effects of radiation changes. It seems plausible that the angiogenic properties of preadipocytes can be applicable within any plane and thus have an intramuscular effect as well to combat the radiation-associated fibrosis. Niddam et al reported the use of primary intrapectoral fat grafting at the time of a latissimus dorsi muscle flap to increase breast volume.[37] The advantage of intrapectoral fat grafting includes the addition of greater volume within the upper pole of the breast where the edge of the implant may often be visible, especially with any associated muscle atrophy. Fat grafting can be repeated until aesthetic outcomes are considered satisfactory by the patient and the surgeon. To address concerns regarding fat grafting in the setting of invasive breast cancer and possible recurrence with the transfer of stem cells, Petit et al collected data from 322 patients who underwent fat grafting with mean follow-up of 4.6 years and observed no difference in recurrence, axillary or distant metastases, or contralateral breast cancer when compared with matched controls.[38] Additional studies have all concluded no increased risk of recurrent or new cancer with fat grafting.[39–41] Patient-reported outcome studies have shown improved patient satisfaction with secondary fat grafting revision procedures to improve contours.[35,36]

Conclusion

The majority of breast reconstruction in the United States is now implant based and the popularity of mastectomy with immediate reconstruction continues to grow. Subpectoral breast reconstruction has evolved from total submuscular coverage often resulting in a flat, round breast with a poorly defined breast footprint and IMF to a dual-plane, partial subpectoral reconstruction with an ADM sling to create a more natural appearing breast. New pain control modalities have improved the morbidity of submuscular dissection and the addition of fat grafting as a revision surgery only continues to improve aesthetic outcomes, elevating the goals of recreating a natural breast mound after mastectomy.

Disclosures
None of the authors have a financial interest in any of the products, devices, or drugs mentioned in this article.

Conflicts of Interest
None declared.

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