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LOCAL-REGIONAL EVALUATION AND THERAPY (DM EUHUS, SECTION EDITOR)

Prepectoral Breast Reconstruction

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Abstract
Purpose of Review Prepectoral breast reconstruction has recently experienced resurgence and continues to grow in popularity. This review seeks to discuss the history, indications, technical considerations, and outcomes associated with this technique.
Recent Findings Recent literature on prepectoral breast reconstruction has demonstrated that no significant differences in complication rates exist between prepectoral and subpectoral methods. Furthermore, our experience at our institution demonstrated that patients undergoing prepectoral breast reconstruction have consistently high levels of satisfaction with overall outcome, satisfaction with breasts, emotional well-being, and physical functioning.
Summary Prepectoral breast reconstruction is an acceptable and safe alternative to subpectoral approaches and can offer equal if not superior esthetic results. As with any procedure, proper patient selection is critical and should be an important consideration when determining which method of breast reconstruction is likely to yield the most favorable outcomes.

Keywords Prepectoral breast reconstruction · Breast reconstruction · Local-regional evaluation and therapy · Review

Introduction

Although not a new technique, there has been a marked increase in the number of plastic and reconstructive surgeons employing the prepectoral technique for prosthetic breast reconstruction. Previously, a lack of soft-tissue support made this approach nonviable with a high patient morbidity. The prepectoral approach of today offers several advantages over subpectoral techniques and, when performed in the appropriate candidate, can offer equal if not superior esthetic results. We will discuss the history, indications, technical considerations, and outcomes associated with prepectoral breast reconstruction.

History

With the introduction of prosthetic breast reconstruction in the 1960s, the primary method of reconstruction was the subcutaneous, prepectoral placement of the tissue expander. Due to an unacceptably high number of complications, plastic surgeons switched to placing tissue expanders and implants in the subpectoral space. Such complications associated with prepectoral placement included high rates of skin flap necrosis, capsular contracture, and need for explantation of the implant [1]. These complications largely were due to a lack of soft-tissue support for the implanted prosthesis. Due to this need for implant support, surgical technique was switched to subpectoral implant placement with coverage by the pectoralis major and serratus anterior.

Unfortunately, subpectoral implant placement is associated with its own set of complications. High levels of postoperative muscle elevation pain, muscle animation deformity, muscle spasms, and "windowshading," along with a decrease in strength and mobility, resulted in unfavorable views of this reconstructive approach (Fig. 1) [2]. Windowshading is the creasing of overlying skin when the underlying muscle contracts, usually occurring when a scar forms between muscle edge and surrounding soft tissue. Both animation deformity and windowshading are based upon the tissue expander being placed below the pectoralis muscle. The interplay between the static and dynamic states of muscle contraction can create the esthetic and functional deformity secondary to the subpectoral tissue expander and permanent implant placement. Over time, the chest wall can develop a concavity secondary to the constant muscle contraction and placement of the prosthetic device on the chest wall. This high level of morbidity, along with

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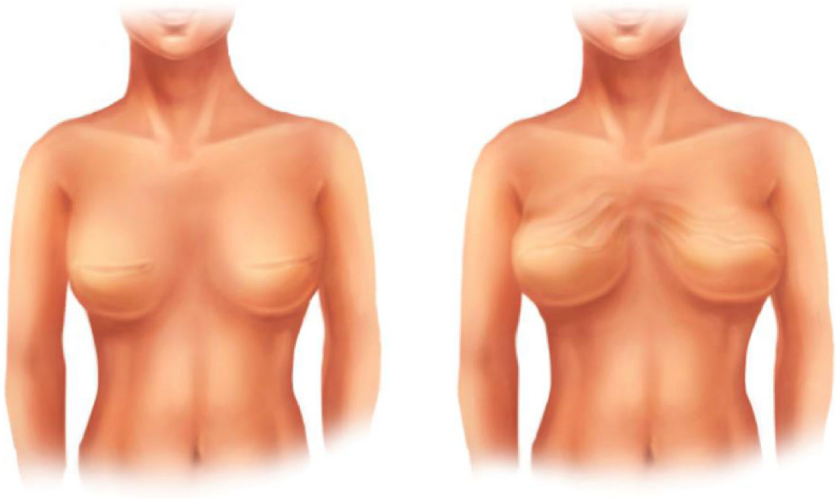

Fig. 1 Animation deformity seen with the submuscular or dual-plane approach for breast reconstruction: occurs with any movement of the pectoralis major muscle and results in a visible contraction and lateral displacement of the breast

the advent of the use of acellular dermal matrix (ADM), led to a partial muscle coverage (PMC) approach, also known as the dual-plane approach (Fig. 2). Now, with the wider adoption of ADM and autologous fat grafting, more and more plastic surgeons are considering the prepectoral approach for breast reconstruction (Fig. 3).

Potential benefits of a prepectoral approach include the elimination of the pain and morbidity from muscle elevation as well as the muscle animation deformity, as the need for muscular manipulation is obviated with a subcutaneous implant insertion. Furthermore, recovery time is shortened and surgeons often have greater control of the shape and form of the breast reconstruction [3]. Since there is no overlying muscle to compress the implant, there is less of a chance for implant malposition. Importantly, patients notice improved mobility and do not have to deal with decreased muscle strength. As such, prepectoral breast reconstruction is a suitable technique for the ideal candidate (Figs. 4, 5, 6, and 7).

Patient Selection

As with any procedure, proper patient selection is imperative for ensuring a successful outcome. Optimal patient selection is one that is non-diabetic and non-smoking with a body mass index (BMI) < 35 and well-perfused mastectomy skin flaps. Well-vascularized flaps are critical to achieve success with this procedure. Prepectoral breast reconstruction may also be a viable option for patients who present with a need for a revision of a dual-plane reconstruction, who experience muscle animation deformity or pain, whose muscle has been aggressively dissected, or who have Poland's syndrome.

Factors and therapies that could contribute to non-incorporation of the implant include history of radiation, smoking, high BMI, large, pendulous breasts, poor tissue quality, and neoadjuvant chemotherapy. These factors serve as relative contraindications when selecting the optimal candidate for prepectoral implants. It may be possible to achieve good results when operating on patients with these comorbidities if the skin flaps are well-perfused, but this is not the optimal choice of patient for a surgeon's first prepectoral procedure. For patients with a high BMI (> 40), it is worthwhile to consider a staged approach, consisting of delaying the reconstruction over several weeks and performing the prepectoral technique with fat grafting as an adjunct. This is done if there is concern for mastectomy flap necrosis. Patients at high risk for mastectomy flap necrosis are those with a high BMI, smokers, or diabetics. If considering a prepectoral placement of tissue expanders or direct to implant, it is recommended to delay prosthetic device placement for 2–3 weeks. This delay must also be considered in the context of the potential adjuvant oncological treatment.

Technical Considerations

It is important to discuss the operative technique with the oncologic breast surgeon to align long-term oncologic implications and incision options. Patients with tumors invading the skin, chest wall, or pectoralis major muscle are contraindications for prepectoral breast reconstruction [4]. Placing an implant on top of the chest wall may place the patient at risk for delayed diagnosis of tumor recurrence in these scenarios. Reconstructive results are optimal when surgical resection borders do not surpass the natural borders of the breast. Furthermore, preserving sufficient skin flaps and maintaining adequate vascularization to the skin flaps is critical to proceeding with the prepectoral approach. Poorly vascularized flaps merit strong consideration for delaying reconstruction for several weeks. Clinical assessment of the mastectomy flaps is the gold standard for evaluating perfusion. One can also utilize a tissue perfusion assessment device such as laser angiography

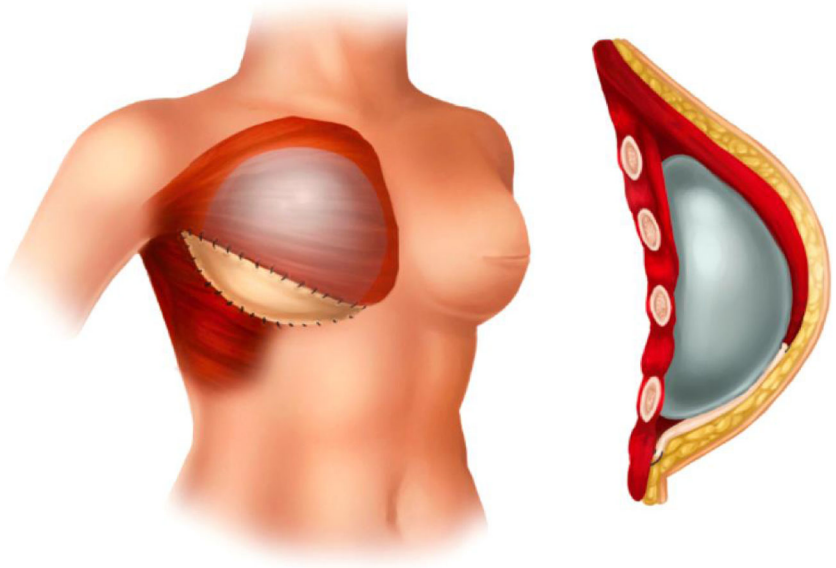

Fig. 2 Partial muscle coverage + ADM approach: the pectoralis muscle reinforces the upper pole and ADM reinforces the lower pole

and/or tissue oximetry to assess the perfusion and viability of the breast flaps prior to performing the prepectoral technique. This may help guide clinical judgment. If committed to a prepectoral breast reconstruction in these situations, one can fill the expander with zero to minimal volume of saline or consider a delayed placement of the prosthetic device. Delaying the placement of a prosthetic device, although relegating the patient to a second operation, will allow the mastectomy flaps to heal and reduce the potential for mastectomy flap necrosis. In our practice, a delay of implant is rare if the volume of the tissue expander is left at minimal to zero volume.

In our favored approach, we use prosthetic tissue expanders in combination with acellular dermal matrix placed anteriorly in a drape-like fashion. Following a skin or nipple-sparing mastectomy, the breast skin envelope and chest wall are assessed for hemostasis. Two closed suction drains are inserted at the interface of the anterior axillary line and the inframammary fold. Using the weight of the mastectomy flap as a guide, we choose a tall or full-height tissue expander with securing tabs. The ADM is then cut to fit over the tissue expander on the back-table. Based on clinical assessment of the mastectomy flaps, either no volume or partial volume is filled into the tissue expander using saline. The ADM is then

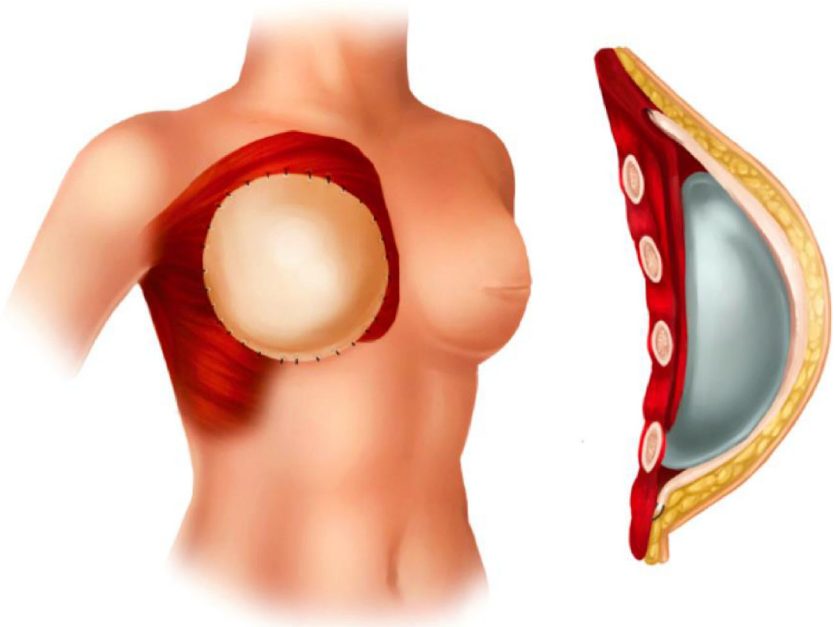

Fig. 3 Prepectoral approach: Implant is placed in the subcutaneous, prepectoral plane. ADM Matrix provides full anterior reinforcement of weak tissue

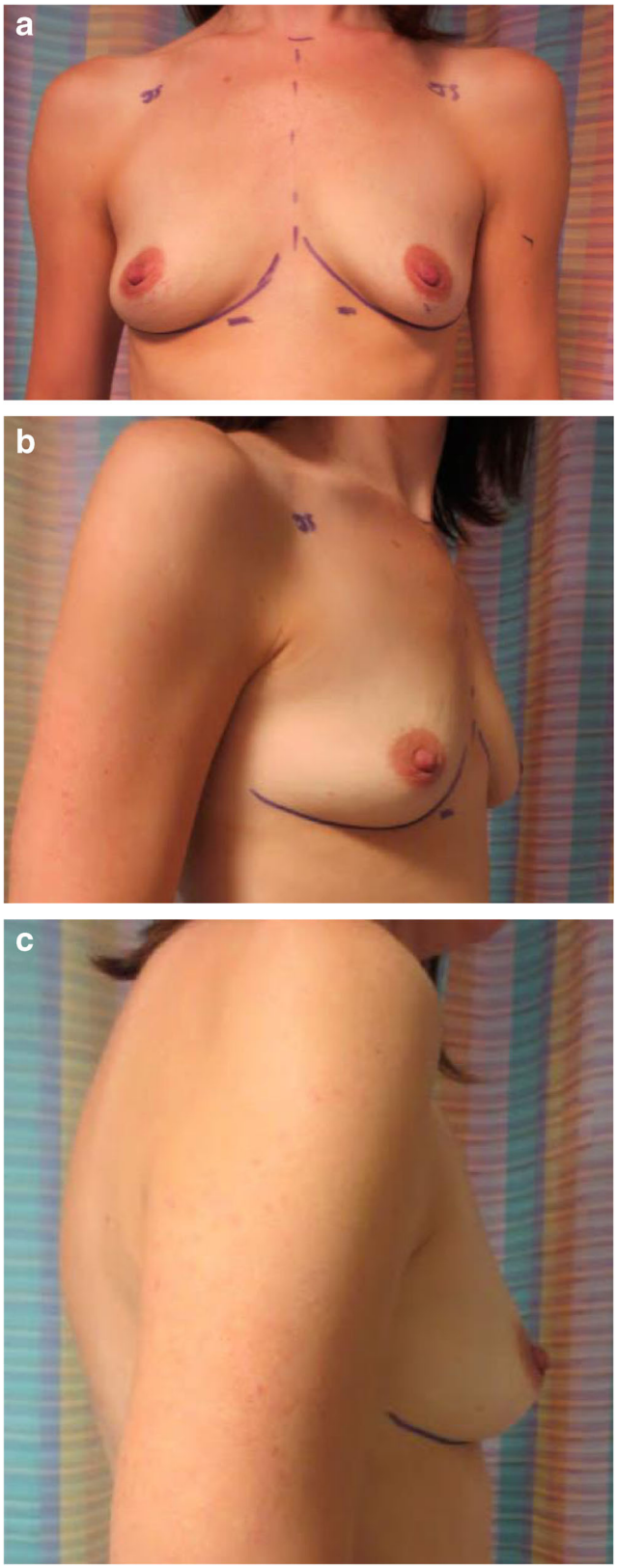

Fig. 4 **a**–**c** Pre-operative images of nipple-sparing mastectomy candidate prior to prepectoral tissue expander placement with acellular dermal matrix

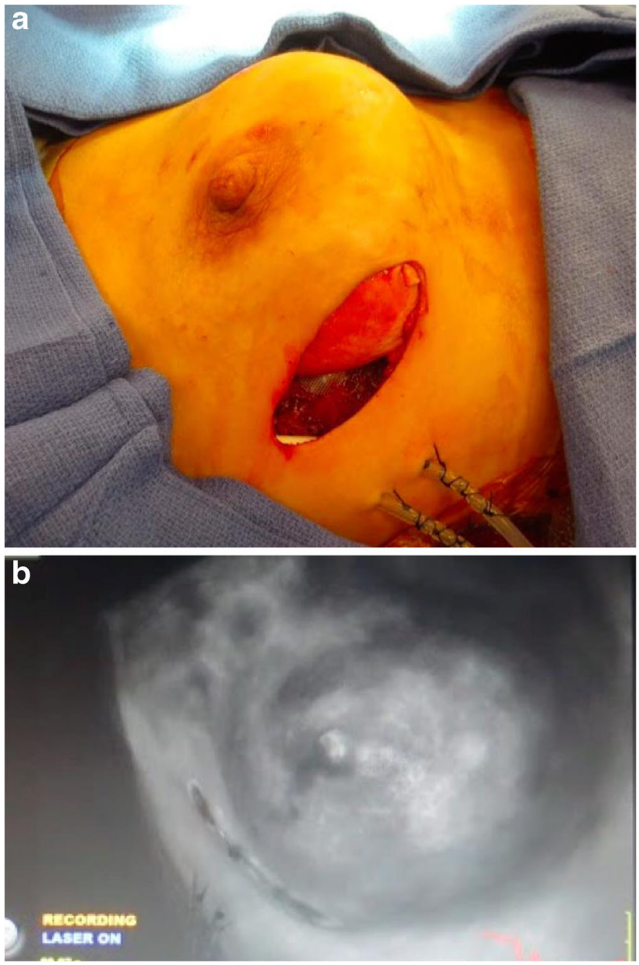

Fig. 5 **a** Prepectoral placement with acellular dermal matrix placement. **b** Intraoperative use of indocyanine green and use of near-infrared laser angiography

placed into a prepectoral fashion onto the chest wall into the mastectomy defect. The ADM is secured with absorbable sutures. After changing gloves, the tissue expander is then placed into the prepectoral plane and suture tabs secured. The ADM is then sutured over the tissue expander and

Fig. 6 Postoperative image of prepectoral tissue expander placement after completion of postoperative filling with normal saline

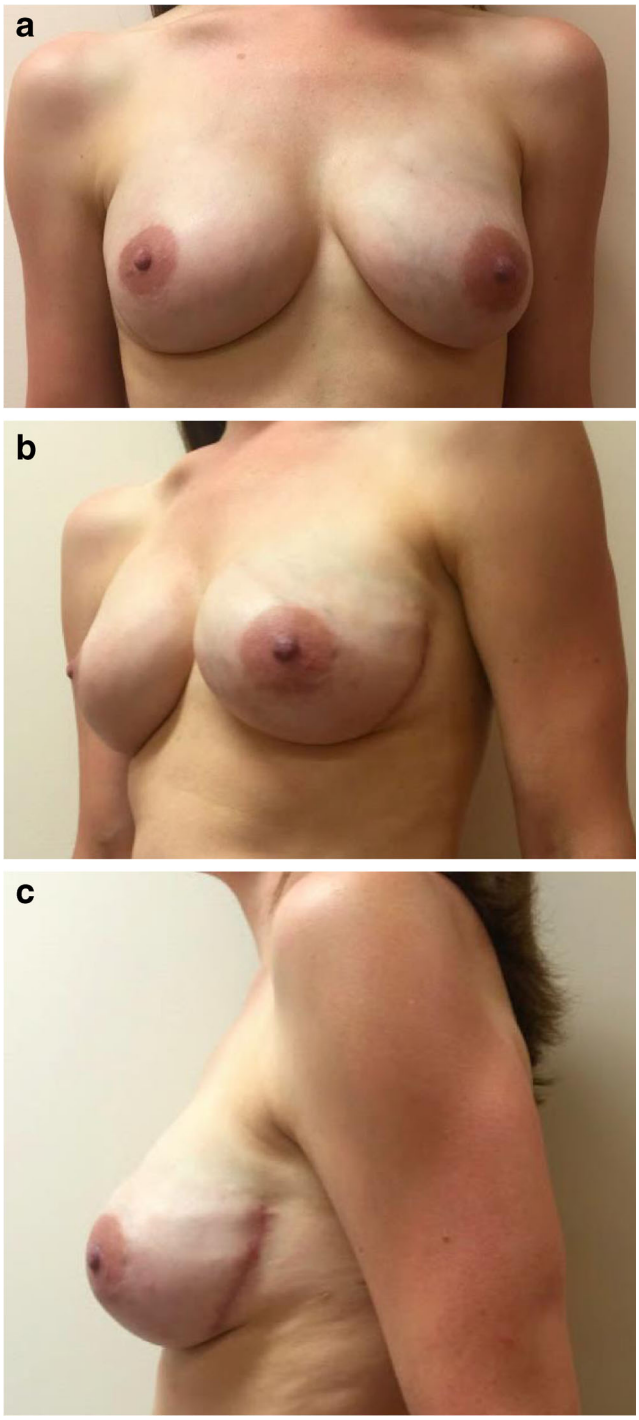

Fig. 7 **a**–**c** Postoperative images of nipple-sparing mastectomy candidate following removal of prepectoral tissue expander and placement of permanent smooth-round cohesive silicone implants and autologous fat grafting

secured superiorly, medially, in the inframammary fold, and then laterally. The pocket is then irrigated and then skin is closed in layers and covered with a sterile dressing.

The use of ADM is helpful in achieving a successful reconstructive result. Serving as a cover and soft-tissue reinforcement for the implant, it has been demonstrated to decrease rates of capsular contracture by reducing inflammation [5]. The entire anterior surface of the prosthesis is covered with ADM, with variable portion of the posterior surface covered as well. Suturing the ADM down at the lower pole of the breast implant allows for the surgeon to determine the location of the inframammary fold (IMF), which allows for long-lasting implant support and a reduction in the risk of implant descent over time [6]. Allowing for a surgically created IMF line with ADM results in better esthetics, as the oncologic dissection during mastectomy may have extended beyond the natural IMF [6]. However, there is data in the literature that supports the idea that ADM may not be necessary for successful reconstructive outcomes and avoiding capsular contracture. Salibian et al. have demonstrated low rates of clinically significant capsular contracture (7.6%) over a 10-year period in a study involving 250 breast reconstructions using a prepectoral technique without ADM [7].

Autologous fat grafting is also a useful adjunct to performing the prepectoral technique. This procedure aids in filling in any volume deficits in the upper pole of the breast that may be present after placement of implant and ADM. Using this technique helps eliminate potential rippling that can occur with prepectoral implant placement. Based on our experience, it may require multiple procedures as fat grafting itself is an imperfect procedure and is associated with high levels of resorption and oil cyst formation. Donor site availability may also be a limiting factor.

Postoperative Course/Complications

Postoperative antibiotics are continued until the drains are removed; however, there is no level one evidence for this. Patients are generally discharged on postoperative day 1 and sent home with oral antibiotics. Drains are removed once less than 20 cm^3 over 24 h. We typically begin all expansions in clinic at 2 weeks from the date of mastectomy and tissue expander insertion. The “expansion” is actually more of a restoration of volume, as the muscle does not need to be stretched out and the mastectomy volume under the skin is restored.

Case Presentation

A thirty-seven-year-old female presented with a left breast neoplasm. She underwent a right prophylactic and left nipple-sparing mastectomy with sentinel lymph node biopsy. Staged reconstruction was performed with insertion of prepectoral tissue expander and acellular dermal matrix for soft-tissue reinforcement. indicated. The patient required tamoxifen only for adjuvant therapy. She ultimately underwent

exchange of prepectoral tissue expanders for cohesive silicone gel implants and autologous fat grafting for superior pole deformities. She has no reported dysfunction in activities of daily living at over 2 years from initial procedures (Figs. 4, 5, 6. and 7).

Outcomes

At our institution, we conducted a retrospective review of quality of life (QoL) and clinical outcomes for patients who underwent prepectoral tissue expander (TE) placement with ADM with at least 30-day follow-up data. Health-related patient QoL using responses to Breast-Q© and RAND-36 questionnaires were assessed, and chart review was performed for demographic and clinical outcomes data. Nineteen patients (33 breasts) were included in this analysis. Unpublished data pertaining to median postoperative Breast-Q© and RAND-36 questionnaire scores demonstrated consistently high levels of satisfaction across the board, especially with overall outcome, satisfaction with breasts, and physical functioning. Patients also scored very high on questions related to emotional well-being. When a comparison of postoperative pain scores between patients undergoing prepectoral breast reconstruction ($n = 26$) and subpectoral reconstruction ($n = 109$) was conducted, the prepectoral cohort demonstrated statistically significant decreased pain as compared to the subpectoral group consistently at postoperative hour 12, postoperative day 1, and postoperative day 7.

There are several publications in the literature that demonstrate the prepectoral breast reconstruction technique with and without the use of ADM for full anterior skin flap reinforcement. Hammond et al. demonstrated complete resolution of animation deformity in all 19 breast revision cases after suturing the pectoralis major muscle to the chest wall and employing a prepectoral reconstruction technique [8]. Zhu et al. studied 88 patients who underwent two-stage breast reconstruction: 50 subcutaneous cases and 108 submuscular. The subcutaneous group was associated with greater intraoperative and first-visit postoperative expansion, shorter expansion duration, fewer expansion visits, and less average pain during admission [9].

A 2017 paper by Nahabedian and Cocilovo examined outcomes in 89 women undergoing mastectomy followed by immediate implant-based breast reconstruction [10]. They received either prepectoral or partial subpectoral breast reconstruction, and ADM was used in all patients. Their results demonstrated that surgical site infections and seromas occurred at a higher frequency in patients undergoing prepectoral breast reconstruction (8.1 versus 4.8% and 4.8 versus 2.4%, respectively). Patients undergoing the dual plan approach of submuscular and acellular dermal matrix sling, however, experienced a greater incidence of hematoma formation (4.8% versus 0). Explantation rates were 6.5% for the prepectoral group and 7.2% for the partial subpectoral group. Clinically significant animation deformity necessitating conversion to a prepectoral method occurred in 7.2% of patients [10].

Another paper by Sbitany et al. compared incidence of postoperative complications in patients undergoing immediate prepectoral or dual-plane reconstruction [11]. Eighty-four breasts were included in the prepectoral group, and 186 breasts were included in the partial submuscular group. Patient comorbidities and postoperative radiation exposure were similar across both populations, and no significant differences existed in overall complication rate between the two groups (17.9 vs 18.8%) [11]. The body of evidence on this technique continues to grow; however, no truly long-term data currently exists on this technique.

Conclusion

Prepectoral breast reconstruction is an alternative to subpectoral approaches. Proper patient selection is critical for successful outcomes and is an important consideration to employing this technique. Patient with poorly vascularized flaps should be delayed or can be considered for submuscular prosthetic reconstruction. Patients have improved postoperative pain scores, are satisfied with esthetic outcomes, and enjoy greater upper extremity mobility with this approach.

Compliance with Ethical Standards

Conflict of Interest Deepa Bhat and Halley Darrach declare that they have no competing interests. Justin M. Sacks is a consultant/speaker of Allergan and a co-founder of LifeSprout.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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