Prepectoral Revision Breast Reconstruction for Treatment of Implant-Associated Animation Deformity: A Review of 102 Reconstructions

Aesthetic Surgery Journal
2018, Vol 38(5) 519–526

DOI: 10.1093/asj/sjx261
www.aestheticsurgeryjournal.com

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Abstract

Background: Animation deformity is a direct consequence of subpectoral implant placement for breast reconstruction following mastectomy. Current treatment options ameliorate but do not address the source of the problem. Moving the implant from subpectoral to prepectoral has the potential to eliminate animation deformity.

Objectives: Describe the technique and outcomes of prepectoral revision reconstruction in over 100 cases and discuss patient selection criteria for a successful outcome.

Methods: Patients who presented with animation deformity following two-stage implant reconstruction were included in this retrospective study. Revision surgery involved removal of the existing implant via the previous incision site along the inframammary fold, suturing of the pectoralis major muscle back to the chest wall, creation of a prepectoral pocket for the new implant, use of acellular dermal matrix to reinforce the prepectoral pocket and completely cover the implant, and fat grafting to enhance soft tissue. Patients were evaluated for resolution of animation deformity and occurrence of complications during follow up.

Results: Fifty-seven patients (102 breasts) underwent prepectoral revision reconstruction with complete resolution of animation deformity. Complications occurred in 4 breasts (3.9%) and included seroma (2 breasts), skin necrosis (3 breasts), and wound dehiscence (1 breast). All 4 breasts with complications had their implants removed and replaced. There were no incidences of infection or clinically significant capsular contracture in this series.

Conclusions: Revision reconstruction with prepectoral implant placement and complete coverage with acellular dermal matrix resolves animation deformity and results in aesthetically pleasing soft breasts. Patient selection is critical for the success of this technique.

Level of Evidence: 4

Editorial Decision date: September 7, 2017; online publish-ahead-of-print January 20, 2018.

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Animation deformity is a recognized complication of subpectoral implant-based breast reconstruction.[1,2] Symptoms arise with contraction of the pectoralis major muscle and include visible lateral, superior, or inferior displacement of the implant; implant distortion; pain; chest tightness/discomfort; and implant wrinkling/rippling. Placement of the implant under the pectoralis major muscle invariably leads to some degree of implant movement with contraction of the overlying muscle, but the extent and severity varies considerably. Animation deformity compromises breast aesthetics and affects patients' quality of life.[1,2]

Treatment of animation deformity in postreconstruction patients often involves a combination of pectoralis muscle release/division, capsulotomy, capsulorrhaphy, implant size change, and fat grafting and/or use of acellular dermal matrix to mask wrinkling/rippling.[3-5] In postaugmentation patients, an additional treatment approach involves moving the implant from the subpectoral to the subglandular or prepectoral plane.[6] The prepectoral approach virtually eliminates animation deformity as the implant lies anterior to the pectoralis muscle and is minimally impacted by muscle flexion. Until recently, there was less enthusiasm for the prepectoral approach in postreconstruction patients because these patients often have thinned skin flaps with lack of subcutaneous soft tissue following mastectomy. This lack of soft tissue increases the risk of implant malposition, loss, visibility, and wrinkling when placed subcutaneously. Moreover, prepectoral implant placement increases the risk of capsular contracture.[2,7]

The advent of skin- and nipple-sparing mastectomy techniques coupled with improvements in fat grafting techniques and the availability of a wide range of acellular dermal matrices have now created an era where inadequate soft tissue coverage can no longer be perceived as a barrier to prepectoral implant placement. In fact, prepectoral implant placement is gaining popularity as a feasible option in select patients undergoing primary breast reconstruction postmastectomy.[8-21] In this study, we present the prepectoral approach as a treatment for animation deformity and report the successful resolution of symptoms in over 100 reconstructions.

METHODS

Patients who underwent prepectoral revision reconstruction for the treatment of animation deformity in the authors' practices between July 2011 and December 2016 were included in this retrospective study. The study was approved by the local Institutional Review Board (PeaceHealth Southwest Medical Center, Vancouver, WA). All included patients developed animation deformity subsequent to two-stage expander/implant breast reconstruction. Patients were excluded if they were current smokers and had poor skin quality/perfusion, uncontrolled diabetes, and previous irradiation (unless they had implant-based latissimus [LAD] flap reconstruction). Skin perfusion was determined intraoperatively using the PDE Fluorescence Imaging System (Hamamatsu Mitaka USA, Denver, CO) when available and when the flap was tenuous.

During the revision procedure, a pocket change from submuscular (dual plane) to prepectoral followed by implant removal and immediate replacement was performed in all patients (Figure 1). The existing implant (4th generation round silicone implants) was accessed and removed via the previous inframammary fold incision or a new inframammary incision was made if the prior scar was central. In general, we do not utilize the central scar unless a latissimus is being performed. Lower-pole capsule and acellular dermis, if present, were removed. Anterior capsule was removed when possible and if the mastectomy flap was too thin then a facelift scissor was utilized instead of an electrocautery to minimize tissue damage. Lower pole acellular dermal matrix (ADM) was removed as much as possible to redrape the pectoralis major back to the chest wall. In patients who had an LAD flap placed at the lower pole during primary reconstruction, the pectoralis muscle was detached from the flap, which was retained at the lower pole. The pectoralis muscle was detached from the overlying subcutaneous tissue and tacked down to the lower pole and chest wall with 0-Vicryl sutures (Ethicon US LLC, Somerville, NJ). A new pocket was created above the pectoralis muscle. Depending on the thickness and tightness of the skin flap, a direct-to-implant or two-stage tissue expander/implant reconstruction was performed. In both cases, the prosthesis was placed in the prepectoral pocket and covered with a 16 cm × 20 cm, thick sheet of perforated or pie-crusted acellular dermal matrix (AlloDerm Tissue Matrix *Ready To Use*; LifeCell Corporation, Branchburg, NJ). If an expander were placed, it was fully inflated at this time. The acellular matrix was tacked to subcutaneous tissue superiorly and to the inframammary fold inferiorly with a 3 cm to 4 cm cuff on the chest wall (anterior to the tacked down pectoralis major) and served to reinforce the anterior skin flap and cushion the implant. One drain was utilized and placed between the acellular matrix and the prosthesis followed by skin closure. The use of perforated acellular matrix eliminated the need for a second drain between the matrix and the newly dissected prepectoral pocket. Postoperatively, the drain was removed when there was less than 30 mL of output over 24 hours. Expanders were exchanged for implants (highly cohesive anatomic implants or higher fill ratio round implants) after an average of 3 months of tissue expansion. Implant sizes varied from 400 to 800 cc (mean, 603 cc). Autologous fat grafting was performed in patients who required additional soft tissue coverage to enhance breast volume and shape at a secondary surgery and not at the same time as the prepectoral conversion. Autologous

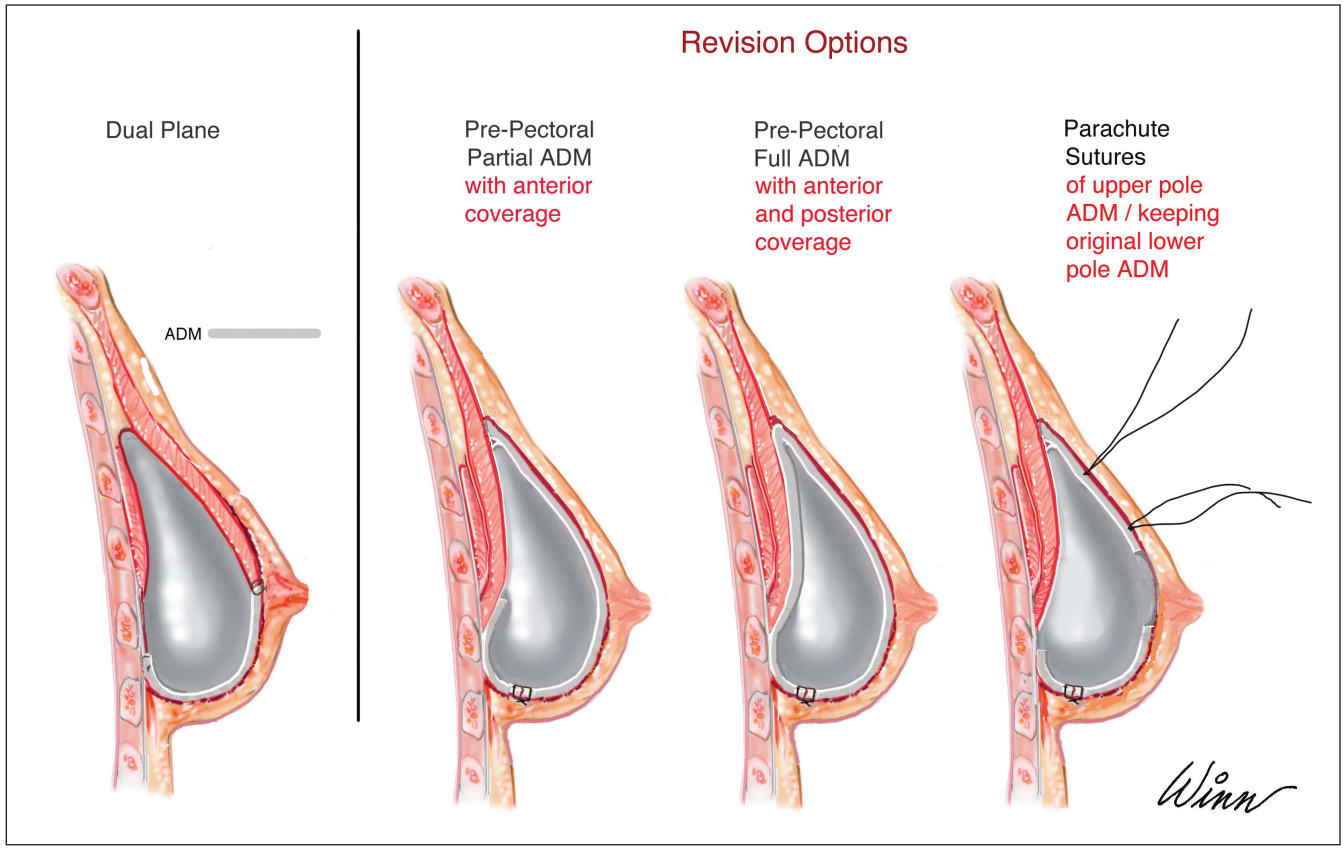

Figure 1. Revision options from dual plane to prepectoral space. The first option includes complete capsulectomy and removal of prior acellular dermal matrix (ADM) and complete anterior ADM coverage with 3 cm posterior gutter coverage. The second option includes complete capsulectomy and removal of prior ADM and complete anterior and posterior ADM coverage. The third option includes complete capsulectomy, and keeping the original lower pole ADM and adding upper pole ADM only.

fat was injected into the subcutaneous space between the skin flap and acellular dermis. In addition, some cases had fat injected prior to the revision to ensure adequate flap thickness and ease the dissection and separation of the pectoralis major from the overlying skin envelope. This is especially important if the mastectomy was done through a central scar and the scar is completely adherent to the pectoralis major. Same holds true if the patient had any wound healing issues following her mastectomy and the central aspect of the skin envelope was completely adhered to the pectoralis major/dermal matrix junction.

All complications that occurred postoperatively were recorded. Patients were evaluated for resolution of animation deformity following revision surgery.

RESULTS

Fifty-seven patients, representing 102 reconstructions, who had undergone two-staged expander/implant breast reconstruction and had clinically confirmed animation deformity were included in this analysis (Table 1). However, not all patients complained of animation deformity; for some patients pain was a greater concern than animation deformity. Forty-one patients (73 breasts) had skin-sparing mastectomy and 16 patients (29 breasts) nipple-sparing mastectomy. Forty-five of the reconstructions were bilateral and 12 unilateral. Patients had a mean age of 53.2 years (range, 34-77 years) and a mean body mass index (BMI) of 27.3 kg/m^2 (range, 19-47 kg/m^2). A quarter of the patients were obese (BMI $\geq$ 30 kg/m^2) and one patient had controlled diabetes mellitus. Nine breasts had been previously irradiated. In addition to animation deformity, 4 patients (8 breasts) presented with implant malposition.

Revision reconstruction with pocket change from submuscular to prepectoral was performed in all 102 breasts. In 9 breasts, the LAD muscle had been recruited to provide additional support at the lower pole during primary reconstruction. After revision surgery, patients were followed for a mean of 16.7 months (range, 4.0-65.8 months). Complications occurred in 4 patients (4 breasts), for an overall complication rate of 3.9% (Table 2). Complications included seroma (2 breasts), skin necrosis (3 breasts), and wound dehiscence (1 breast). All breasts that had complications had their implants removed (4 breasts)

Table 1. Patient Demographics

No. of patients	57
No. of breasts	102
Age, yr	
Mean	53.2 (±11.4)
Range	34-77
Body mass index, kg/m^2	
Mean (±SD)	27.3 (±5.0)
Range	19-47
Comorbidities, no. of patients (%)	
Body mass index ≥30 kg/m^2	14 (24.6)
Diabetes mellitus (controlled)	1 (1.8)
Type of mastectomy, no. of breasts (%)	
Skin sparing	73 (71.6)
Nipple sparing	29 (28.4)
Laterality, no. of patients (%)	
Unilateral	12 (21.1)
Bilateral	45 (78.9)
Irradiation, no. of breasts (%)	9 (8.8)
Presenting complaint, no. of breasts (%)	
Animation deformity	96 (94.1)
Pain	97 (95.1)
Animation deformity and pain	91 (89.2)
Other presenting complaint, no. of breasts (%)	
Implant malposition	8 (7.8)

and replaced with same form and size implants. In one breast, a latissimus flap was utilized. In this breast, the acellular dermal matrix was removed during reoperative surgery. The matrix was retained in the other 3 breasts. One patient (1 breast) who had a skin necrosis had prior irradiation. All other patients with complications had no comorbidities. There were no incidences of infection or clinically significant capsular contracture (Baker Grade III/IV). Breasts were soft and rated as having Grade 1 contracture. Animation deformity was resolved in all breasts. The resolution of pain was not evaluated in this study, although patients did not report pain during the follow-up period. Representative patient cases are presented in Figures 2 and 3.

Table 2. Complications

Type	No. of breasts (%)
Implant removal	4 (3.9)
Seroma	2 (2.0)
Skin necrosis	2 (2.0)
Wound dehiscence	1 (1.0)
Total*	4 (3.9)

*Breasts with ≥1 complication were computed once.

DISCUSSION

Implant-based breast reconstruction is the current standard procedure following mastectomy, with over 86,000 procedures performed in 2015 by American Society of Plastic Surgeons members.[22] Typically, the implant is placed in a subpectoral pocket, utilizing the overlying pectoralis major muscle to cushion the implant. Subpectoral implant placement, thus, minimizes complications such as implant palpability and wrinkling/rippling, skin breakdown, and implant exposure/extrusion.[2,7] Subpectoral implant placement, however, is not without limitations. Animation deformity is a particular concern, although its extent and severity is unknown. However, some degree of animation is to be expected in all patients by virtue of placing the implant subpectorally.[1]

Prior to adopting the prepectoral approach for treating animation deformity, we spent a great deal of time in improving animation deformity with addition of fat between the mastectomy flap and the muscle/acellular dermis layer. In reconstructive patients, the skin flaps are generally thin and devoid of adequate subcutaneous tissue, which can lead to severe adherence and scarring to underlying structures, which in this case is the muscle on the upper pole and acelluar dermal matrix in the lower pole in a dual plane reconstruction. In addition, the fascia of the muscle is removed during an oncologically appropriate mastectomy, which further leads to severe scarring directly to the surface of the muscle. To change the behavior of this layer, fat grafting was attempted to increase the gliding surface between the muscle and the mastectomy flap. This was not as successful given that the fascia was missing from the muscle, which would have served as an anatomical separation between these layers. Fat grafting, however, was not a waste in these cases, as it contributed to upper pole thickness, which can keep the muscle away from the pocket, as well as provided coverage to the underlying implant. Utilizing an acellular dermal matrix at the upper pole further enhanced implant coverage.

Figure 2. (A) Preoperative view of a 55-year-old woman with diagnosis of stage I, multicentric, invasive ductal carcinoma found in the left breast at the upper inner quadrant. (B) Postoperative view at 12 months following 2 stage dual-plane reconstruction with acellular dermal matrix (AlloDerm) and 4th generation higher-fill silicone implants (Natrelle SRF 695 cc and fat grafting). (C) Postoperative view at 12 months with animation deformity of her breasts. (D) Postoperative view at 6 months following bilateral, prepectoral, revision surgery with upper pole acellular dermal matrix (AlloDerm) and 4th generation higher-fill silicone implants (Natrelle SRF 745 cc). (E) Postoperative view at 6 months after prepectoral revision surgery at contraction with resolution of animation deformity. (F) Postoperative view at 6 months following bilateral mastopexy (12 months following her original prepectoral conversion).

Since 2008, we have resorted to moving the implant from the subpectoral to the prepectoral plane in selected patients presenting with animation deformity. The reasoning behind the pocket change was driven by our experience in successfully resolving animation deformity in augmentation patients and our commitment to creating

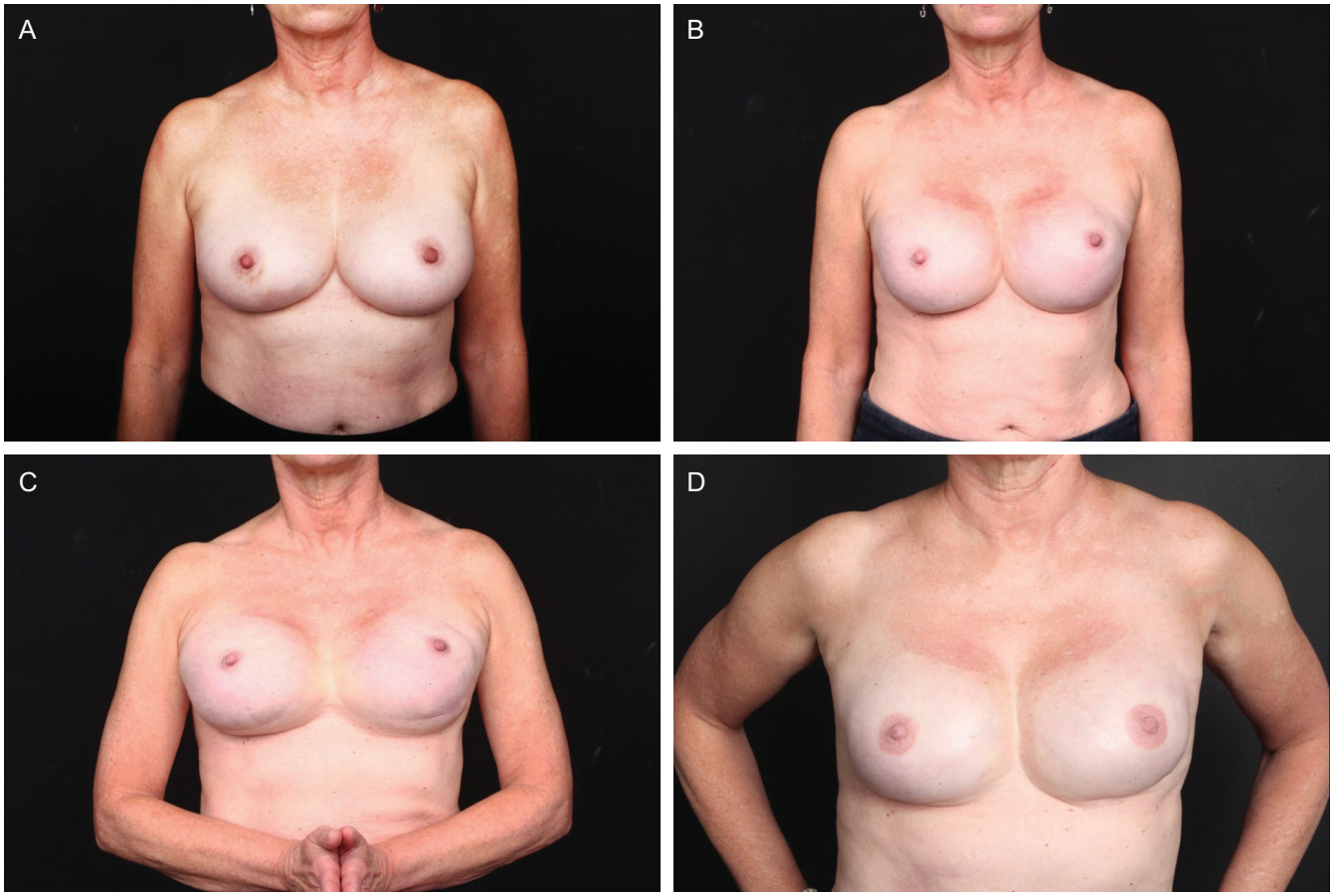

Figure 3. (A) Preoperative view of a 61-year-old woman with a diagnosis of ductal carcinoma in situ, high-grade, estrogen (ER)/progesterone (PR) positive in the right breast lower inner quadrant 4 o'clock position. (B) Postoperative view at 6 months following 2 stage dual-plane reconstruction with acellular dermal matrix (AlloDerm) and 4th generation lower fill silicone implants (Style 45 550 cc and fat grafting). (C) Postoperative view at 6 months with animation deformity of her breasts. (D) Postoperative view at 12 months following bilateral, prepectoral, revision surgery with upper pole acellular dermal matrix (AlloDerm) and 5th generation silicone implants (Natrelle Style 410 MX 410 cc) at contraction with resolution of animation deformity.

a "bioengineered breast."[23] Bioengineered breast is a concept that strives to replace missing tissue after mastectomy by utilizing a combination of autologous fat cells, acellular dermal matrix, and cohesive gel implants to recreate a breast that looks and feels like a natural breast.

In this series of over 100 revision cases, moving the implant from the subpectoral to the prepectoral plane led to the resolution of animation deformity in all cases, demonstrating the efficacy of this treatment modality. There were no particular safety concerns and the risk of postoperative complications was minimal. There was no incidence of capsular contracture in this series. Similarly, we have previously reported the absence of capsular contracture in over 350 primary prepectoral breast reconstructions (follow up, 6-26 months),[8] although both series had a short duration of follow up. A small study by Hammond et al of 10 patients (19 breasts), in contrast, reported a capsular contracture rate of 21.1% following prepectoral revision reconstruction to treat animation deformity (mean follow up, 13.8 months; range, 5-48 months).[24] Hammond et al, however, did report complete resolution of animation deformity with the prepectoral approach. Further evidence that the prepectoral approach is an effective strategy against animation deformity comes from primary reconstruction patients. In these patients, prepectoral implant placement has been reported to prevent the development of animation deformity.[8,11,13]

Careful patient selection is essential for the success of prepectoral revision reconstruction. In a previous publication, we provided guidance on reconstructive and oncologic indications/contraindications for primary prepectoral breast reconstruction (Table 3).[8] These same indications/contraindications can also be applied to prepectoral revision reconstruction. Generally, patients who have thick, adequately vascularized skin flap and have fat donor sites for autologous fat grafting are good candidates. Flap quality is

Table 3. Contraindications to Immediate Prepectoral Reconstruction

Reconstructive contraindications	Oncologic contraindications
Poorly vascularized/ischemic flaps	Large tumors >5 cm
History of prior radiation with lower pole scar/boosted area (unless Latissimus flap is utilized)	Late cancer stage
Body mass index >40 kg/m^2*	Deep tumors
Immunocompromised	Chest wall involvement
HbA1c >7.5%	Grossly positive axillary involvement
Active smokers	High risk of recurrence (based on multi-disciplinary approach)
Lack fat donor sites	—

*With other associated comorbidities (ie, diabetes mellitus, hypertension, etc.); body mass index alone is not a contraindication. Reprinted with permission from Wolters Kluwer Health, Inc.[8]

critical for poorly vascularized flaps increase the risk of skin breakdown and its attendant complications of necrosis and implant exposure/extrusion. Previous radiotherapy, current tobacco use, and uncontrolled diabetes (HbA1c > 7.5%) are contraindications for they can compromise skin perfusion. However, irradiated breasts that were reconstructed with LAD muscle recruitment during primary reconstruction can be considered for prepectoral revision reconstruction, since the pectoralis muscle is eliminated from this pocket without altering the lower pole where the vascularized flap is in place. Nonetheless, the irradiated pectoralis major continues to be a source of pain in our patient population due to its severe fibrosis and cephalad retraction. Of 9 irradiated breasts in this series, there was one incidence of skin necrosis following prepectoral reconstruction. Elevated BMI alone (ie, in the absence of other contraindications) is not a contraindication for prepectoral revision reconstruction. A quarter of the patients in this study had a BMI ≥30 kg/m^2 and all had an uneventful clinical course.

This study is limited by the retrospective study design, the lack of a control group that underwent revision using our previous method, and unblinded patient evaluations. Notwithstanding these limitations, the resolution of animation deformity in all cases, with minimal postoperative complications, attests to the efficacy and safety of the prepectoral approach as a treatment option for animation deformity, at least in the short term. Whether the prepectoral approach would withstand the test of time and provide a long-term solution to animation deformity remains to be seen as we continue to follow these patients.

CONCLUSION

Revision reconstruction with prepectoral implant placement and complete coverage with acellular dermal matrix resolves animation deformity associated with subpectoral implant placement and produces aesthetically pleasing soft breasts. An adequately perfused skin flap is a prerequisite for a successful outcome. The technique can be safely performed in a variety of patient types, including obese patients without other comorbidities, patients with controlled diabetes, and irradiated patients provided they had undergone implant-based reconstruction with LAD flap or are willing to accept a LAD flap during the prepectoral conversion.

Acknowledgement

The authors thank Kalanethee Paul-Pletzer, PhD, for providing medical writing and data analysis support for this manuscript.

Disclosures

Drs Gabriel, S. Sigalove, and Maxwell are consultants for Allergan (Irvine CA). Drs N. Sigalove and Storm-Dickerson are speakers for Allergan. Ms Rice and Ms Pope declared no potential conflicts of interest with respect to the research, authorship, and publication of this article.

Funding

The authors received no financial support for the research, authorship, and publication of this article.

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