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Supplemental Article

Aesthetic Dermal Matrix in Aesthetic Revisionary Breast Surgery

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Abstract
Breast augmentation is one of the most commonly-performed cosmetic procedures worldwide. Unfortunately, many women require revisionary surgery related to unsatisfactory results or complications such as capsular contracture, implant malposition, and ptosis. While, historically, surgeons have relied on often-imperfect native tissue to correct these deformities, acellular dermal matrix (ADM) offers a new option for solving these difficult aesthetic problems. In this article, the authors provide background information about the role of ADM in providing excellent and lasting results to cosmetic breast augmentation patients, and they describe their method of subpectoral revisionary augmentation with ADM.

Keywords
acellular dermal matrix, breast surgery, revisionary surgery

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It is estimated that over 300,000 primary breast augmentations were performed in the United States in 2009; therefore, there are now over 3 million women with augmented breasts in this country.1-3 Based on current data, between 15% and 30% of these women will have a reoperation within five years of their initial procedure.1-3 Unfortunately, this rate climbs to 35% in patients with a prior history of revisionary breast augmentation.4 As procedures become more complex in nature and number, new techniques and solutions are required of surgeons who perform these challenging operations to improve long-term patient outcomes.

Capsular contracture (CC) has historically been the most common complication of aesthetic and reconstructive breast surgery, and it remains the primary reason for most revisionary surgeries.2,3,5,6 While increasing data suggest that CC can be minimized in primary augmentation by technical attention to detail—including precise, atraumatic, bloodless dissection; appropriate antibiotic breast pocket irrigation; and minimizing any points of contamination during the procedure2,6—treatment of an established capsule remains even more challenging than the application of these techniques alone.

US Food and Drug Administration restrictions on silicone gel implants in the early 1990s led American surgeons to begin inserting only saline implants.1 While before the 1992 “moratorium,” the majority of silicone gel implants were placed in the subglandular position, saline implants (due to their palpability) began to be placed under the muscle, in an effort to conceal any untoward contour irregularities.5 However, as many of these implants were of larger volumes, patients often experienced a thinning of the breast parenchyma and overlying soft tissue regardless of whether the implants were in subglandular or subpectoral positions. The thinned tissues in turn led to long-term complications such as palpability, rippling, implant extrusion, “double bubble” deformity, “Snoopy” deformity, symmastia, “bottoming out,” and implant malposition.1,8,9

As a result, implant malposition and concerns with ptosis or skin stretching became the next-most-common causes for aesthetic revisionary surgery (following CC). These issues are more frequently associated with larger-volume saline implants but can be a result of planning decisions, surgical technique, or the effects of time (gravity) with silicone gel implants as well. Historically, our options for revision and improvement have included

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replacing saline implants with gel implants, performing capsulorrhapsy, dissecting capsular flaps, or performing site change operations. The site change principle, first described in the mid-1980s, combined total or partial capsulectomy with conversion to a different pocket (generally, a subglandular-to-subpectoral site change) for the replacement implant. While site change procedures have been successful, none of these procedures alone have resulted in complete resolution of the described complaints. Change was clearly necessary to improve clinical outcomes in this population of breast revision patients, so newer techniques and technologies were pursued.

In our experience, the majority of breast revisions require a new pocket for the new implant. Since many patients have had implants placed in multiple pockets and as the majority of implants in revisionary patients today are already in the subpectoral position, in 1991 we developed the “neopectoral pocket” concept to dissect a new pocket in the subpectoral-precapsular space. Although we initially developed the concept for double-bubble problems (inferior malposition), we also applied it to symmastia (medial malposition), CC, ptosis, and conversion of round to anatomical-shaped implants (which demand a snug, hand-in-glove fit). The detailed operative technique of dissecting the neopectoral pocket was described in a previous publication and is not covered here. For patients presenting with implants in the subglandular position, a subpectoral site change is performed.

Notwithstanding the importance of the site change concept, the chief addition to our clinical approach has been the utilization of acellular dermal matrix (ADM) as a regenerative construct to help address these challenging clinical presentations. The successful use of ADM has been reported in a range of clinical settings, including abdominal wall repair, hernia repair, facial and eyelid surgery, cleft palate repair, soft tissue augmentation, tendon repair, ulcer repair, vaginal sling repair, and breast reconstruction. While its placement in reconstructive expander and implant breast surgery has become a standard of care, its adoption in aesthetic revisionary breast surgery has been slower, and ADM products have only recently gained widespread attention for that purpose.

EVALUATION AND PLANNING

We are all familiar with the sound surgical principles that are essential in diagnosing and treating the underlying causes necessitating revisionary aesthetic breast surgery, and ADM is a useful adjunct during the treatment phase. Clinical data show that the four main indications (drivers) for revisionary surgery are CC, implant malposition, ptosis, and implant visibility or palpability. Each patient must be individually evaluated regarding her concerns, goals, and knowledge of previous surgical and implant specifics. Preoperative evaluation should include careful assessment of her breasts—dimensions, quality/quantity of overlying soft tissue, and scarring (which is critical in planning surgery and maintaining the necessary vascularity to manipulated tissues). As always, appropriate candidate selection is important for achieving successful outcomes, and high-risk patients (eg, smokers and those with a body mass index higher than 35) should be discouraged from undergoing elective surgery.

Despite the apparent complexity of a given clinical presentation, there are five basic underlying etiologies that may be the cause—or contribute to the cause—of the problem: skin, soft tissue, capsule, implant, and chest wall. These underlying components must be carefully and systematically analyzed from the outside in (or inside out) until all layers have been evaluated. The main drivers for revisionary surgery should always be kept in mind as these five components are evaluated. We have learned from our revisionary and reconstructive breast experience that one or more of these components and layers may need to be addressed surgically, aside from the placement of ADM. Such surgical manipulations may include skin envelope reduction, fat injection, lamellar separation, capsulectomy, and/or capsulotomy and site change of the replacement implant.

To effectively plan for the surgery, some general principles can be followed. For patients whose original implants were subglandular, a pocket change to a subpectoral plane and lower pole coverage with ADM is generally performed. For those patients whose original implants were subpectoral, a neopectoral pocket with the addition of ADM is generally preferred. For patients who have adequate breast tissue, a subfascial pocket may be utilized, with ADM coverage or support as indicated.

INDICATIONS AND TECHNIQUE

Based on the underlying clinical presentation, ADM can be placed for one of four distinct indications: for coverage of the lower pole (usually for revision mastopexy), as an implant stabilizer (usually for malposition correction), as a tissue thickener (usually superomedially or inferriorly), or for treatment of CC (which may be technically similar to lower pole coverage or superior-medial thickening) (Figure 1).

Coverage of the Lower Pole

Placement of ADM for lower pole coverage, which is the technique we most frequently perform, is employed with soft tissue and skin envelope alterations in revision mastopexy with augmentation. As many patients with previously-placed implants develop laxity, sag, or tissue thinning over time, it is necessary to perform mastopexy or revision mastopexy over the replacement implant to achieve an aesthetic breast form. If the existing implant is subglandular, a subpectoral (subpectoral-fascial) pocket is dissected after capsule treatment; the new implant is inserted in the new subpectoral pocket; and the lower portion of the implant is covered with ADM. This allows a circumvertical, or “inverted T,” mastopexy to be safely performed without the underlying muscle, as the ADM separates the skin closure from the implant. If the existing
implant is already subpectoral, a neopectoral site change is carried out and the ADM utilized similarly. If there has been a previous implant in both the subglandular and subpectoral pockets, “lamellar” separation may be necessary (i.e., dissecting the pectoralis muscle from its superficial and deep scarred attachments) (Figure 2). ADM is then considered to be the outer layer of the underlying implant (to which it is intimately engaged by proximity of placement) and may require suture stabilization. Thus, the ADM may be tacked to the inferior border of the pectoralis major above and to Scarpa fascia or the deep fascia below (at the level of the inframammary fold).

Parachute pull-out sutures may alternatively be placed to redrape the ADM. When there is lamellar scarring

Figure 1. Placement of ADM at various anatomical locations during revisionary surgery.
requiring separation, the remaining pectoralis muscle may have "window shaded" up in the pocket, requiring lower muscle inferior pull following its release. In this situation, lower pole coverage is best achieved by suturing the ADM along the entire length of the lower pectoral border, draping it over the implant inferiorly and securing it tautly at or near the IMF. This application is similar to the reconstructive model, where the ADM acts as a "pectoral muscle extension" (Figure 3). In all instances, an adequate environment, cover, and stability over the non-muscle-covered portion of the implant (lower pole) by the ADM will allow the skin envelope to be safely lifted and tightened (the mastopexy portion of the operation), assuming adequate respect for the vascularity to the redraped tissue as well as compliance with all sound surgical principles (Figures 4-6).

Biomechanical properties of a desirable ADM require rapid revascularization in order for the ADM to conform and redrape over the surface of the implants leading to the intimate engagement of the surface contours. If the patient had CC, a more compliant material may be desired. If the patient presents with more laxity or a stretch deformity, a more taut material might be preferable.

Figure 2. Intraoperative view of lamellar separation.

Figure 3. Interposition of regenerative matrix between implant and skin closure. This is similar to the “reconstructive model.”
Figure 4. (A-C) Preoperative views of a 37-year-old woman who had undergone breast augmentation. (D-F) Thirty-two months after revision augmentation mastopexy (inverted T), which included the development of neopectoral pocket, lower pole coverage with ADM, and replacement of implants with form-stable, highly-cohesive gel anatomical implants.
Implant Stabilization

ADM allows the surgeon enhanced control in maintaining implant position in a “neo” pocket and/or provides reinforcement after capsulorrhaphy in various forms of implant malposition correction. Inferior malposition (double bubble), medial malposition (symmastia), and lateral malposition are generally treated by capsulorrhaphy or site change (the authors’ preference). In a certain percentage of patients, the tissue is strong enough to support this correction with a new pocket and appropriate suturing alone. A number of these patients, however, will have thin tissue, previous scarring, or problematic bony contour slopes such that reinforcement of the site change (eg, a neopectoral pocket of appropriate dimensions in the correct location, with old pocket obliteration) with ADM is highly advisable to buttress the corrected implant position (Figures 6-8). These materials are sutured in the appropriate position with proper purchase to achieve support. The desired biomechanical properties of the ADM for this indication are strength and tautness to maintain implant stabilization.

Tissue Thickening

The tissue-thickening concept is an extension of second-stage breast reconstruction, where expander-to-implant conversion is facilitated by superomedial placement of an extra-thick ADM to enhance soft tissue coverage of the implant and provide a better visual and palpable confluence of chest to the breast form. In aesthetic revisions, this is also most frequently applied to the upper pole (or superomedial area) to thicken tissue, minimize visibility of traction rippling, camouflage implant edges, and enhance cleavage. An extra-thick allograft material is generally utilized and appropriately trimmed. This material is important in enhancing the upper pole contour, so again, an ADM in the extra-thick category is preferable. It is draped over the implant for intimate engagement on its deep surface and in contact with the existing capsule or new.neo pocket on its superficial surface. Parachute 2-0 Prolene sutures with Keith needles are utilized in the ADM corners and interspersed on the medial side to facilitate placement and redraping. The suture ends are tied to themselves externally, under no tension, and covered with Tegaderm for seven to 10 days. This same application is occasionally used laterally or inferolaterally for implant visibility or palpability and inferiorly to “thicken” a very thin cutaneous cover (Figures 7 and 8). The key to success is proper pocket alteration with incorporation of the extra-thick ADM providing bulk yet revascularization and cellular repopulation.

Treatment of CC

Even though the presenting problem may be CC, additional deformities may be identified following detailed analysis from skin envelope to chest wall as noted above. This can include thinned tissue over an encapsulated implant, malposition of the encapsulated implant, or stretch deformity, Snoopy deformity, or ptosis over an encapsulated implant. If the encapsulation is in the subglandular position, a total capsulectomy with site change to the subpectoral position is usually performed. If the encapsulation is in the subpectoral position, a neopectoral pocket with partial anterior capsule excision and residual capsule obliteration or total (perhaps partial) capsulectomy is performed. In these cases, the ADM is again selected for rapid revascularization, conformability to the implant, and performance. The technique is most frequently similar to the “lower pole cover” concept but may be closer to a “medial thickener” or “malposition reinforcer” depending on the presenting problem (Figures 9 and 10). There is an increasing body of documentation that the coupling of the ADM to the implant will further reduce the incidence of CC. If CC is the only clinical diagnosis, then we recommend the placement of the ADM at the lower or middle poles.

The surgical techniques used are based on the preoperative findings and indications described above. The ADM should be conformed to, and in intimate contact with, the outer surface of the implant (like a hand in a glove). The appropriate pocket is created whether it is neopectoral, subpectoral, or subfascial. Three to five half-mattress stabilizing “parachute” sutures are placed between the skin and ADM to stabilize the tissue and place it in the desired location. Sizes selected are normally in the range of 6 to 8 cm × 10 to 16 cm (depending on the size of the implant), are rectangle or “contour” shapes, and are trimmed as needed. Seroma formation should be prevented in all breast revisions, to further revascularization and cellular repopulation of the ADM, so drains are always recommended.
Figure 6. (A, C, E) Preoperative views of a 49-year-old woman who had undergone augmentation mastopexy. (B, D, F) Thirty months after revision augmentation mastopexy (inverted T), which included the development of neopectoral pocket, lower pole coverage, and reinforcement of inferior and lateral walls with ADM and replacement of implants with form-stable, highly-cohesive gel anatomical implants. Successful correction of inferior and lateral malposition was achieved.
Figure 7. (A, C, E) Preoperative views of a 38-year-old woman who had undergone multiple previous revision augmentations. (B, D, F) Twenty-six months after revision augmentation through the inframammary fold incision, which included the development of a neopectoral pocket, lamellar separation, lower pole coverage with ADM, and replacement of implants with textured gel implants.
DISCUSSION

Breast augmentation is the most common aesthetic procedure performed in the United States and perhaps the world. As plastic surgeons, we strive to achieve perfection and continue to improve our surgical techniques to achieve the aesthetic breast form. Despite advances in implant technology and surgical techniques, undesired outcomes are encountered leading to revisionary surgeries. In preparing for a revisionary breast augmentation, one must understand patients’ goals and expectations and evaluate the probability of their accomplishment, as well as the risk-benefit ratio. When a decision is made to move forward, the goal should be to plan and execute the most precise and efficient surgical correction. To achieve this goal, one must understand the problems and variables involved and then look for new solutions.

In the past, our options were limited to working with only native tissues that were available to us for these procedures. With the advent of ADM, the indications for and the scope of correction of secondary deformities have improved.

Application of acellular dermal products has been popularized in breast and abdominal wall reconstructions.14-24 In reconstruction cases, ADM has been used to replace tissue, extend existing tissue, or act as a supplement. In aesthetic revisions, the ADM essentially becomes an outer-conforming, regenerative layer around the implant. ADM has been used to correct implant rippling and displacement, ptosis, and CC.26,27,29 ADM is used as an alternative to autologous tissue methods of coverage and provides camouflage, thus decreasing rippling and increasing soft tissue padding.30 In addition to all the indications described previously, we have used ADM as a mode of treatment for CC.25 Breast CC is similar to lamellar scarring in the eyelids. At the cellular level, CC is most likely caused by any process that produces increased inflammation, which in turn leads to the formation of deleterious cytokines within the periprosthetic pocket. Consequently, in addition to the many techniques described for treating and preventing CC,4,5,8,31-37 we believe that the addition of ADM is another modality in fighting the evolution of the capsule. ADM can counteract the inflammatory process, adding more tissue in-growth availability and controlling the interface of the pocket by providing a regenerative layer between device and native tissue.

The rising demand for the use of ADM coupled with good outcomes in breast reconstructions has spurred tremendous interest in its use for aesthetic breast surgery patients.

In the past, revisionary surgeries were generally performed with a total capsulectomy, removal of the implant from the subpectoral plane, and placement of a new implant in the subpectoral position.5,8,10 This is a fairly simple procedure, involving a change in implant placement from over the muscle to under the muscle. More recently, it has become necessary to perform revisionary surgery on volume-depleted or severely scarred breasts. In correcting these deformities as described in the indication section, and in addition to the site change operation, ADM can provide additional coverage where the repair is performed.

The recently published series of 78 consecutive patients who underwent revisionary breast augmentation/mastopexies with ADM was one of the largest series to date to address the use of ADM in revisionary aesthetic breast surgery.12 Of the 78 patients, 56 had their original implants in the subpectoral position and 22 in the subglandular position. Complications included two patients (2.5%) requiring reoperation, one for a hematoma and the other for an implant malposition (Table 1).

Presenting clinical signs are listed in Table 2, and the type of operation performed is listed in Table 3. As expected, the majority of complaints were due to “implant hardening.”

Of 78 patients, 77 (99%) were assessed as having soft implants with a Baker I level of CC at final follow-up; one patient (1%) had a Baker II contracture. No patient had a Baker III or Baker IV classification postoperatively (Table 4).

In our series, we have noted one seroma formation due to double-layering of ADM and others (total of < 2%) following early drain removal. Several minor “infections” resolved with appropriate antibiotic treatment. No implant losses were documented in our series. As the results continue to be satisfactory to both surgeon and patient, we continue to exploit new concepts and new techniques to improve outcomes, minimize risks while enhancing patient safety, increase efficiency, and lower costs. We are now seeing product differentiation in outcome assessment; thus, we are carefully documenting these findings to report in peer-reviewed literature.

A challenge that we continue to face in aesthetic revisionary surgery is the cost of these products and their affordability to the patient. Yet, the greatest potential cost of performing a revisionary surgical procedure (to patient and surgeon alike) is the need to perform another surgical revision due to failure of the planned procedure. Therefore,
Figure 9. (A, C, E) Preoperative views of a 45-year-old woman who had undergone multiple previous attempts at correction of capsular contracture. (B, D, F) Twenty-two months after revision augmentation through the inframammary fold incision, which included the development of a neopectoral pocket, lower pole coverage with ADM, and replacement of implants with higher-profile, lower-volume textured gel implants.
as we continue to report our outcome data with ADM in revisionary aesthetic breast surgery and compare them to the outcomes without ADM, a new picture may emerge. No doubt, the coming years will be exciting as we further define the issues and advance the science and our understanding of it via evidence-based medicine for the benefit of our patient population.

Table 1. Complications

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<th>Complication</th>
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<td>Hematoma</td>
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<td>Seroma</td>
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<tr>
<td>Implant malposition</td>
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<tr>
<td>Implant rupture</td>
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<tr>
<td>Infection</td>
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<td>Total</td>
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Table 2. Presenting Clinical Signs

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<td>Capsular contracture</td>
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<tr>
<td>Implant exposure</td>
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<tr>
<td>Rippling</td>
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<td>Implant malposition</td>
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<tr>
<td>Bottoming out</td>
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<tr>
<td>Symmastia</td>
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Table 3. Augmentation Versus Augmentation/Mastopexy

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<tr>
<td>Augmentation/mastopexy</td>
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<td>Total</td>
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Table 4. Preoperative and Postoperative Baker Classification in All Patients (in Percentages)

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<th>Postoperative (%)</th>
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<tr>
<td>Baker II</td>
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<tr>
<td>Baker III</td>
<td>64.1</td>
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</tr>
<tr>
<td>Baker IV</td>
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Disclosures

Dr. Maxwell is a consultant for, stockholder in, and recipient of royalties from Allergan Medical. He has participated in compensated and uncompensated educational programs for LifeCell (manufacturer of the products discussed in this supplement) and MTF/Ethicon. He has consulted for LifeCell. Dr. Gabriel is a paid member of the speaker’s bureau for LifeCell and Allergan.

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REFERENCES