Breast augmentation mammoplasty is the most popular cosmetic surgical procedure in the United States, but it remains plagued with a significant incidence of less-than-optimal clinical outcomes. Data from Food and Drug Administration premarket approval trials, in fact, showed that within four years of the initial operation, over 23% of all primary augmentation patients underwent a reoperation. Approximately 40% of reoperations were to correct capsular contracture (CC), and 35% of revision patients underwent another subsequent operation, with CC being the leading cause.

While various initiatives undertaken in recent years have improved primary augmentation outcomes and reduced reoperation rates, revision augmentation has remained a challenging clinical problem. As an evolution of our revisionary techniques, the site change concept was introduced for revisionary breast surgery, specifically for implants that had been placed in a subglandular pocket. Moving the implant from the subglandular to the subpectoral space (dual plane) proved to be successful, but pocket change is necessary in all revision cases, and implants were being placed with increasing frequency in the subpectoral position, which necessitated dissection of a different pocket in the same space, utilizing the same principles. Consequently, the "neopectoral pocket" concept was introduced in 1991 and has now become one of our most common revisionary techniques in breast surgery, for both reconstructive and aesthetic patients. The operative details of the neopectoral procedure have been described. In recent years, our revisionary technique has evolved to include the placement of acellular dermal matrix (ADM) materials to support the site change principles and minimize reoperation rates, which has improved our patient outcomes. Our initial experience with favorable revisionary aesthetic breast procedures utilizing ADM has been described.

Revisionary breast surgeries are challenging, and advanced techniques must often be utilized in the correction of the underlying anatomical deformities. In this Featured Operative Technique, the authors describe their method, which includes a combination of revisionary surgery techniques with site change and acellular dermal matrices. This use of acellular dermal matrices has four indications based on the underlying clinical presentation: (1) as a lower pole implant interface (usually for revision mastopexy), (2) as a capsular contracture treatment (technically similar to lower pole interface), (3) as a tissue thickener (superomedial or inferolateral implant interface), or (4) as an implant stabilizer (malposition correction).

Keywords: acellular dermal matrix, ADM, revisionary breast surgery, capsular contracture, implant malposition, breast augmentation, augmentation-mastopexy, operative technique

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Acellular dermal materials, biologically derived from allografts or xenografts, are thought to serve as a regenerative scaffold when placed in the human body, promoting the healing process. These materials have become popular in breast reconstruction, where they are used as a tissue extension or tissue replacement (“soft tissue patch”) following extirpation of the breast (the so-called “sling technique”). Our work with ADM began in revisionary aesthetic breast surgery, where ADM was placed in an attempt to prevent CC, unlike in breast reconstruction, where it would have acted as a tissue replacement. Having employed “host-compatible” implant surfaces in breast revision, we have utilized a similar concept in introducing ADM as a dermal regenerative interface, which engages the geometric contour of the breast implant surface (Figure 1). The precise indications for ADM in breast revisionary surgery are, in fact, the four primary reasons (or “drivers”) for aesthetic revision surgery in the above-mentioned premarket approval studies: (1) CC, (2) implant malposition, (3) ptosis, and (4) implant visibility or palpability. These indications are not often singularly distinct; they frequently coexist, with two or more being present in a given patient.

In this article, we describe our experience with ADM in revisionary aesthetic breast surgery over the past six years, including the evolution of our approach, the refinement of the underlying surgical principles, and the technical additions that have continued to improve patient outcomes. A case-based study of a patient with combined CC and ptosis provides the framework for our description of the clinical process that we currently utilize for ADM-incorporated aesthetic breast revisions (Table 1).
A careful history is imperative in understanding the cause of a patient’s presenting complaint. This history should include all previous breast operations, including technique details and information about the type of implants placed. Previous operative notes and detailed documentation regarding the existing implants (type, volume, location, and status) are highly desirable. A careful analysis of the patient’s current “form,” asymmetries, dimensional measurements (Figure 2), and tissue characterization is mandatory. Any previous or current pathological concerns should be discussed, as accompanied by diagnostic imaging of the breasts or implants and information about the patient’s overall health, unrelated surgeries, and medications. Given these details, we can craft a realistic goal with regard to anticipated outcome and the risk-benefit ratio of achieving it.

PREOPERATIVE PLANNING

During preoperative planning, key decisions are made regarding the replacement implant (type, volume, dimensions, filler, shape, and surface) and treatment of the existing capsule, overlying parenchyma, soft tissue, and skin envelope (mastopexy). Four-dimensional imaging systems (Precision Light, Nashville, Tennessee) with automated measurements, implant deflation software, and specific implant outcome simulation are helpful during this planning process (Figure 3). Overall, we prefer to utilize site-change pockets, silicone gel implants (which generally have a “biocell texture”), and ADM (which we select on the basis of its biomechanical properties, design, indications, documented outcomes, and cost considerations). Preoperative deflation of saline implants may be considered.

In our clinic, drains are always placed, and fat grafting is frequently incorporated.

GENERAL SURGICAL CONSIDERATIONS

We almost always perform these revisionary breast procedures under general anesthesia and through an inframammary fold incision. This is true even when a concurrent mastopexy is indicated, in which case the incision is in the area to be excised. Again, ADM has four indications in revisionary aesthetic breast surgery, based on the underlying clinical presentation: (1) as a lower pole implant interface (usually for revision mastopexy), (2) as a CC treatment (technically similar to lower pole interface), (3) as a tissue thickener (superomedial or inferolateral implant interface), or (4) as an implant stabilizer (malposition correction) (Figure 4).

In general, we place porcine ADM contour shapes (Strattice, LifeCell Corp., Branchburg, New Jersey) as lower pole interfaces for CC and ptosis correction and extra-thick cadaveric ADM (LifeCell Corp.) as upper pole interfaces. The thicker, cadaveric ADM materials are hand-shaped intraoperatively to conform to the superomedial implant’s geometric contour, so they may act as a tissue thickener. Proper intraoperative handling of the ADM is essential; it should be handled in the same manner as the silicone implant. First, only the surgeon should touch the implantable materials. Second, both the prosthetic device and the ADM should be bathed in a solution consisting of 50,000 U of bacitracin, 1 g of cephazolin, and 80 mg of gentamicin in 500 mL of normal saline before insertion into the pocket. All ADM pieces undergo an initial soak with normal saline for five minutes, after which the fluid is discarded and the ADM is placed into the triple antibiotic solution and covered until utilized. Third, traffic through the operating room should be minimized, just as with any implant case.

All patients receive perioperative antibiotics, primarily first-generation cephalosporin. Incisions are injected with 1% lidocaine with epinephrine, and all surgical wounds are irrigated with the triple antibiotic solution described above.

SURGICAL TECHNIQUE

Again, we prefer an inframammary approach in most revision cases. Whenever possible, old inframammary incision scars are utilized, as they were in the patient featured throughout the photographs in this article. Before beginning, preoperative markings are confirmed and reinforced (Figure 5). The incision is placed in the area where the planned skin excision will be performed. A surgical headlight is utilized for illumination. Electrocautery is used in coagulation mode for prospective hemostasis. The
Figure 3. (A) Four-dimensional (4-D) preoperative view of the patient shown in Figure 2. (B) Preoperative measurements with 4-D imaging. (C) Preoperative 4-D simulated bilateral deflation of breasts. (D) Simulated 4-D outcome with patient goals and desires. (E) Actual postoperative outcome.
dissection is carried down to the surface of the old capsule (Figure 6A and 6B). Care is taken not to enter the capsule, to avoid silicone escape in instances of rupture. Some calcifications may be encountered during this dissection. Continuing with the electrocautery extender, the dissection is completed around the entire capsule (Figure 6C and 6D). The implant and capsule are expressed together through the inframammary incision.

The width and volume of the removed implant are estimated. In the majority of cases, the contracture of the capsule narrows the width of the previously-placed implant. In the case of the patient shown in the intraoperative figures, the implant width measured 12 cm, which was within the range of the selected replacement implant. Volume displacement can be utilized to assess the volume of the removed implant if the shell remains intact.

A concurrent capsulectomy is then performed, which creates a lax and ptotic soft tissue envelope (Figure 7). If an implant is placed in this large dissected pocket following total capsulectomy without a site change operation, implant malposition, ptosis, and/or recurrent CC becomes likely. Thus, a subglandular-to-subpectoral site change is performed (as in the case of the patient example). If the implant is in the subpectoral space, a neopectoral site change is performed.

In executing the subpectoral site change, we prefer to maintain the lateral serratus fascia element, to limit and control the lateral extent of the pocket dissection at the

Figure 4. ADM placements in revisionary aesthetic breast surgery: (A) lower pole implant interface (usually for revision mastopexy); (B) tissue thickener (superomedial implant interface); (C) tissue thickener (inferolateral implant interface); (D) implant stabilizer (malposition correction).

Figure 5. The patient featured in Figures 2 and 3 is shown preoperatively with revisionary breast augmentation mastopexy markings and measurements.
Figure 6. (A, B) Intraoperative dissection is carried down to the surface of the old capsule. Care is taken not to enter the capsule, to avoid silicone escape if ruptured. (C, D) An electrocautery extender is utilized to complete the dissection around the entire capsule.

Figure 7. Intraoperatively, the patient demonstrates a ptotic, lax soft tissue envelope following complete capsulotomy and implant removal.

anterior axillary line. The procedure is performed similarly to a dual-plane augmentation, by dividing the origin of the pectoralis major muscle just above the inframammary fold across its lateral extent (Figure 8). The lateral border of the pectoralis major muscle is not elevated, and dissection remains superficial to the periosteum and perichondrium, to minimize postoperative pain and discomfort. The dissection extends across the entire inferior portion of the muscle to the lateral edge of the sternum and does not extend superiorly along sternal border. A sizer, which we always utilize in revision cases, is inserted. The implant then will have pectoral coverage above, pectoral fascial coverage laterally, and be exposed inferiorly to the inframammary fold (Figure 9). After sizers are placed, the patient is positioned in a 90° (upright) position, to facilitate further decision-making regarding implant selection.

Once the replacement implants are chosen, they are rinsed with triple antibiotic solution and placed into the dual-plane pocket. We then select a corresponding contour-shape ADM with appropriate dimensions to engage the outer geometric surface of the implant. The ADM is positioned within the pocket with an orientation that allows it to properly conform to the implant, which in turn has a snug fit within the dissected pocket. The ADM is tucked under the medial and lateral extension of the pocket. This allows the shape of the contoured ADM to redrape around the shape or surface of the implant (Figure 10A-10C).

Suture fixation of the ADM to the tissues is performed on an as-needed basis, balancing the desire for operative efficiency with the quality of the tissues. With intimate engagement of the ADM to the implant being the keystone, a snug fit among the implant, the ADM, and the pocket surface may obviate the need for sutures in some cases. In some situations, a few tacking sutures may be needed; in still others, total (or near total) peripheral ADM suturing may be required for fixation and support. For example, in cases of inferior malposition (stretch
deformity cases), the ADM is sutured along the inframammary fold. The ADM is sutured to the released caudal edge of the pectoralis major muscle in revision cases where the muscle has retracted superiorly (or “window-shaded” up). Figure 11 demonstrates the placement of 2-0 PDS sutures (Ethicon, Inc., Somerville, NJ) at the 6 o’clock and 12 o’clock positions to secure the ADM and enhance its adherence to the implant surface. The ADM separates the implant from the overlying tissue, which allows a mastopexy to be safely performed, even with a “T closure” in the lower pole.

The mastopexy portion of the procedure (two operations in one) is commenced by flexing the operating room table such that the patient is in a near-90° position. The “tailor tack” technique is used to further refine the preoperative markings, adjusting the skin envelope around the underlying implant and the ADM (Figure 12). The designated tissue is resected, and complete closure is achieved (Figure 13). Adjunctive procedures such as liposuction of the axillary tail or fat grafting may be performed as needed to complete the case.

The importance of precise surgical dissection, antibiotic irrigation, “no-touch” technique for devices (including the ADM), and drains cannot be overemphasized.

Clinical results from the patient described in the intraoperative figures are shown in Figure 14. A video of this procedure is available at www.aestheticsurgeryjournal.com.

**POSTOPERATIVE MANAGEMENT**

We advocate gentle, “yoga-like” arm stretches immediately postoperatively. As we generally place implants with an aggressive silicone surface texture, implant displacement exercises are not recommended. We do utilize individualized dressings for shaping, such as Topifoam (Mentor LLC, Santa Barbara, California), breast augmentation bands, or inframammary fold taping as indicated. Revascularization, cellular ingrowth, and regenerative repair around the implant are the keys to success with ADM, so fluid formation (hematoma and seroma) must be prevented. Drains are kept in place until output is less than 25 cc in 24 hours for two consecutive days. Antibiotic coverage is maintained during the perioperative period, and the patient is kept in a supportive brassiere for four to six weeks.

**DISCUSSION**

There have been eight other reports,18-22 including our own series published in 2009,23 of ADM-assisted breast revisionary surgery. Collectively, they demonstrate that ADM can be successfully utilized for the correction of a number of implant-related deformities, broadly categorized...
Breast ptosis is a common phenomenon among augmentation patients. The subglandular or subpectoral placement of large implants may, over time, cause thinning of the breast parenchyma and the overlying soft tissues, resulting in ptosis. Treatment options include mastopexy in conjunction with subpectoral or neopectoral implant replacement. However, performance of a circumvertical or “inverted T” mastopexy is precluded because of insufficient lower pole muscle coverage of the implant. In these instances, we place ADM for lower pole coverage. Not only does the ADM provide a protective layer over the exposed implant so
that mastopexy can be safely performed, but it also offers implant support.

Thinned breast tissue may result in implant visibility, manifesting as rippling/wrinkling and visible implant edges, or palpability. As rippling is often observed with saline implants, replacing the implant with a silicone device may help reduce rippling, but it does not address the underlying cause, the lack of tissue. Other techniques to mask implant visibility and palpability include site change and fat injection. The latter could be associated with a risk of calcifications, cyst formation, and indurations. The use of ADM serves to circumvent the risk associated with fat injection while augmenting soft tissue where needed.

Various types of implant malposition (medial, lateral, or inferior) are encountered in augmentation patients as a result of capsular atrophy or attenuation. Our previous corrective measures have included site change with implant replacement in conjunction with capsulorrhaphy, or the use of capsular flaps to reinforce the capsule. However, patients may not have enough native tissue for capsular flaps, because of atrophied scar tissue. ADM is ideal in these situations as capsular support material, stabilizing and maintaining the implant within the newly-created pocket.

CC is the most challenging complication in augmentation patients as well as in reconstruction patients. It is also the most frequent reason for revisionary surgery. The precise cause of CC is not known, but there is strong evidence that subclinical infection is a likely underlying cause. Inflammation associated with subclinical infection is believed to be responsible for pathological CC. The treatment approach for CC should thus entail measures to prevent or diminish the bacterial load as well as the inflammatory response. Traditionally, the correction of CC has involved capsulectomy, pocket change, and implant exchange, and these measures may contribute to decreasing the bacterial load. The placement of an ADM layer between the pectoralis major muscle and the chest wall at the lower or middle pole of the breast may also serve to counteract the inflammatory process and reduce capsule formation. Encouraged by our initial experience in 78 patients, we have now performed revisionary surgery with ADM in more than 150 patients undergoing augmentation.

CONCLUSIONS

In summary, the placement of ADM in revisionary breast surgery is a novel adjunctive procedure. This procedure can also be utilized for revision of implant-based reconstructed breasts. Although other revisionary techniques may be appropriate in some patients, based on our results, the technique that we describe is straightforward, anatomically compatible, precise, and highly successful in correcting iatrogenic breast deformities while avoiding the introduction of other deformities and complications. The success of ADM in revisionary surgery lies in its biomechanical properties of revascularization, recellularization, strength, and tautness.

Disclosures

Dr. Maxwell is a paid consultant for Allergan, Inc. and a paid member of the speakers bureau for LifeCell Corporation. Dr. Gabriel is a paid member of the speakers bureau for Allergan, Inc. and LifeCell Corporation. Drs. Maxwell and Gabriel are stockholders in Precision Light, Inc., manufacturer of the 4D imaging devices described in this paper.

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Figure 14. (A, C, E) This 52-year-old woman (featured in the intraoperative images) had undergone breast augmentation with subglandular silicone gel breast implants in 1987. She presented after having developed painful capsular contracture over time, with associated deformity. (B, D, F) Eight months after revisionary breast augmentation-mastopexy with Style 115 silicone (272 cc) implants (Allergan, Inc., Irvine, California) and ADM.
REFERENCES