# Surgical Treatment of Capsular Contracture with Acellular Dermal Matrix: 100 Consecutive Cases

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**Background:** Capsular contracture is a challenging entity to treat with consistent success. Recently, acellular dermal matrix (ADM) has been shown to be a highly effective therapeutic adjunct, particularly for patients at high risk for recurrence.
**Methods:** A total of 100 consecutive patients with Baker grade III and IV capsular contracture treated with ADM between 2014 and 2024 were included in this retrospective study. ADM was indicated for patients deemed high risk for failure of conventional surgical therapy. Data collected included patient characteristics, primary breast augmentation and revision procedure history, capsular contracture, surgical and nonsurgical treatments, and follow-up findings. Treatment success was defined as Baker grade II or better.
**Results:** The success rate of capsular contracture treated surgically with ADM was 90%. Among the 10 patients with ADM treatment failure, 8 had silicone implants, of whom 2 had new silicone implant ruptures. Four others had a history of silicone implant rupture before treatment with ADM. Some had additional notable characteristics: 2 resumed smoking, 1 had a hematoma, 1 underwent systemic chemotherapy, and another underwent breast radiation therapy. Salvage of ADM treatment failures with ultrasound was successful in 2 of 5 patients; both patients had saline implants. This increased the overall ADM success rate to 92%.
**Conclusions:** Adding ADM to conventional surgical techniques has produced the highest success rates in capsular contracture treatment. Given that ADM treatment failure is associated with silicone implant rupture, saline implants are recommended to maximize result longevity. When early ADM treatment failure occurs, ultrasound therapy may salvage those with saline implants. *(Plast. Reconstr. Surg.* 157: 635, 2026.)

Capsular contracture is the most common complication and reason for reoperation after breast augmentation, one of the most frequently performed aesthetic surgery procedures worldwide.[1,2] Clinically significant capsular contracture (Baker grade III or worse) can cause both distortion and discomfort. Its presentation is variable, occurring unilaterally or bilaterally, on both sides synchronously or asynchronously, soon after surgery, or years later. In one study, 25% of cases presented by 3 months, 50% by 6 months, and 75% by 2 years after primary breast augmentation.[3] Given that silicone implants commonly remain implanted longer than most longitudinal study follow-up periods, the true incidence of capsular contracture is likely higher than the 10% to 15% reported in U.S. Food and Drug Administration premarket approval Core studies.[4–7]

Conventional surgical treatment for capsular contracture that constitutes the standard therapy consists of capsulectomy, implant replacement, plane change to subpectoral when applicable, and using 14-point plan surgical technique principles.[8–10] Despite these techniques and precautions, the current standard continues to be plagued by high failure rates, exceeding 50% in some studies.[3,10–12]

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More recently, lining the breast implant pocket with acellular dermal matrix (ADM) has been demonstrated to be a powerful and safe adjunct capable of achieving treatment success rates over 90%.[3,13–17] This study examines long-term results of 100 consecutive capsular contracture patients treated surgically using ADM. It includes a subgroup analysis of treatment failures.

## PATIENTS AND METHODS

A retrospective cohort study of 100 consecutive patients surgically treated with Strattice ADM (Allergan, Irvine, CA) for capsular contracture from 2014 to 2024 was conducted following Weill-Cornell institutional review board approval. Indications for ADM use followed a previously established algorithm, where patients with either bilateral capsular contracture or recurrent unilateral contracture qualified.[4] Collected data included patient characteristics, surgical history, findings at surgery, surgical and nonsurgical treatment methodologies, and follow-up results.

### Operative Technique

The procedure can be performed through either a periareolar or an inframammary incision, neither of which requires lengthening (Fig. 1). Although total capsulectomy may be marginally superior, anterior capsulectomy has proven highly effective. A subpectoral plane is always used both because of proven benefit in reducing capsular contracture and to limit the amount of ADM material required (no ADM needed deep to the muscle itself). When a subglandular plane is encountered, a plane change to subpectoral is performed.

Next, a sizer is placed inside to serve as a mandrel for shaping the ADM on the breast surface. Two pieces of ADM are typically required because the largest size available is not enough by itself, so a second partial piece is needed with the former positioned adjacent to the inframammary crease, and the latter between the first piece and the inferior margin of the pectoralis major muscle (Fig. 1). Darts are cut out to create a smooth three-dimensional contour.

The fixation points to the pectoralis margin and inframammary crease are marked on the skin. The pieces are pie-crusted and sutured to the muscle edge with absorbable sutures and to the inframammary crease with percutaneous sutures tied over external gauze bolsters (Fig. 1). A single drain is placed within the pocket, deep to the ADM.

Saline implants are preferred because of their reduced propensity for capsular contracture formation and their greater observed longevity in our experience, and also to avoid the

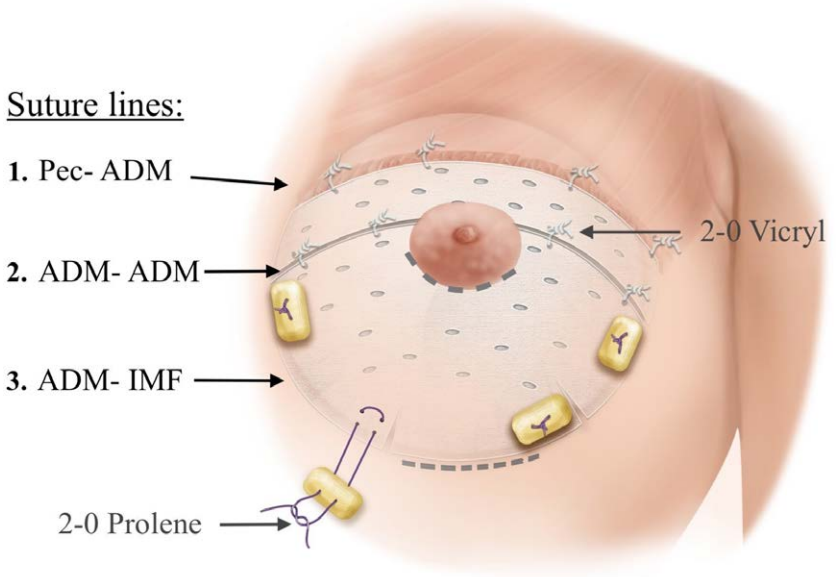



**Fig. 1.** Two pieces of ADM are typically required. They are sutured to the inframammary crease with external bolster sutures and to each other and the pectoralis muscle with absorbable sutures.



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prospect of silicone implant rupture, an event observed to be associated with recurrent capsular contracture despite the presence of ADM. Saline implants were recommended for suitable candidates as a first choice, with increasing conviction as the series progressed and these advantages became clearer. However, more patients chose silicone overall, particularly early in the series.

One side is completed in its entirety before starting the second side, to minimize the length of time wounds are open. A second dose of intravenous antibiotics is given after the first side is complete. The drains and external bolster sutures are removed 1 week later.

### Ultrasound Treatment

Ultrasound therapy using the Aspen system (Aspen Rehab Technologies, Coral Springs, FL) was performed on 5 treatment failures. According to the manufacturer's protocol, 2 paddles are sequentially positioned in several perpendicular orientations on the breast, and ultrasound energy is delivered from 4 to 6 minutes each time. Implant displacement manipulation for several minutes in medial, superior, and lateral directions follows. Ten sessions are scheduled several days apart. An elastic band for downward compression is worn between sessions, with implant manipulation exercises performed at home. Experience with this modality is entirely anecdotal, as there are no published clinical studies to support its efficacy. In essence, it was used as a last resort to attempt nonsurgical salvage.

### Patient Follow-Up Methodology

Treatment success was defined as Baker grade II or better. This was assessed by the patient's most recent in-office examination.

### Statistical Analysis

The data were summarized as counts, percentages, means ± SDs, and medians and interquartile ranges. Continuous variables were compared using 2-sample *t* tests when parametric assumptions were satisfied, and Wilcoxon rank sum tests otherwise. Chi-square and Fisher exact tests were used to compare categorical variables, and for contingency table analysis. The level of statistical significance for hypothesis testing was set at $\alpha = 0.05$. Statistical analyses were performed using SAS version 9.4 (SAS Institute, Inc., Cary, NC).

**Table 1. Preoperative Characteristics before Treatment with ADM[a]**

| Characteristic | Success | Failure | *P* |
|---|---|---|---|
| No. | 90 | 10 | |
| Breast implant | | | |
| Mean volume, cc | 277.9 ± 77.8 | 289.5 ± 54.6 | 0.648 |
| Surface, % | | | |
| Smooth | 89 | 80 | 0.299 |
| Textured | 11 | 20 | |
| Shape, % | | | |
| Round | 97 | 90 | 0.348 |
| Anatomical | 3 | 10 | |
| Filler, % | | | |
| Silicone | 86 | 80 | 0.643 |
| Saline | 14 | 20 | |
| Pocket, % | | | |
| Subpectoral | 87 | 100 | 0.604 |
| Subglandular | 13 | 0 | |
| Incision, % | | | |
| Periareolar | 62 | 70 | 0.999 |
| Inframammary | 32 | 30 | |
| Axillary | 6 | 0 | |
| Complication, % | | | |
| Implant rupture (silicone) | 26 | 50 | 0.137 |
| Capsular contracture | | | |
| Laterality | | | |
| Bilateral | 66 | 80 | 0.490 |
| Unilateral | 34 | 20 | |
| Baker grade | | | |
| III | 66 | 70 | 1.000 |
| IV | 34 | 30 | |
| Previous treatment failures, % | | | |
| 0 | 46 | 20 | 0.070 |
| 1 | 37 | 30 | |
| 2 | 13 | 20 | |
| 3 | 3 | 20 | |
| 4 | 2 | 10 | |

[a]Success and failure ADM groups are compared.

## RESULTS

A total of 100 consecutive patients underwent surgical treatment of capsular contracture with ADM in this study (Table 1). The majority underwent their original surgery elsewhere. Most had subpectoral smooth silicone implants and 67% exhibited bilateral capsular contracture. The median time to capsular contracture onset was 50 months. Thirty-four percent of patients had undergone 3 or more operations previously, with 57% having had at least 1 recurrent contracture.

The procedure was performed through the patient's existing scar except when the original was axillary ($n = 5$). Silicone implant rupture was



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**Table 2. Characteristics of ADM Treatment Failure Patients**

| Case No. | Capsular Contracture | | | Implant Fill | Silicone Rupture | Other Risk Factors |
|---|---|---|---|---|---|---|
| | Occurrence Laterality | Recurrence Laterality | Time to Recurrence (mo) | | | |
| 1 | Bilateral | Bilateral | 84 | Silicone | No | Postoperative hematoma; resumed smoking |
| 2 | Bilateral | Bilateral | 71 | Silicone | Yes | — |
| 3 | Bilateral | Bilateral | 32 | Silicone | [a] | Chemotherapy for lung cancer |
| 4 | Bilateral | Unilateral | 88 | Silicone | No | — |
| 5 | Bilateral | Unilateral | 73 | Silicone | Yes | Radiation therapy for breast cancer |
| 6 | Bilateral | Unilateral | 2 | Silicone | [b] | — |
| 7 | Bilateral | Bilateral | 7 | Silicone | [b] | Resumed smoking |
| 8 | Unilateral | Unilateral | 1 | Silicone | [b] | — |
| 9 | Bilateral | Unilateral | 3 | Saline | N/A | — |
| 10 | Unilateral | Unilateral | 1 | Saline | N/A | — |

N/A, not available.
[a]Unknown; the patient died.
[b]Imaging was not performed.

**Table 3. Ultrasound Therapy for ADM Treatment Failure Patients[a]**

| Case No. | Recurrence Laterality | Implant Fill | Improvement | Durable Success (F/U Months to Date) |
|---|---|---|---|---|
| 6 | Unilateral | Silicone | No | No |
| 7 | Bilateral | Silicone | Yes | No |
| 8 | Unilateral | Silicone | Yes | No |
| 9 | Unilateral | Saline | Yes | Yes (34) |
| 10 | Unilateral | Saline | Yes | Yes (17) |

F/U, follow-up.
[a]Aspen therapy was performed in the latter 5 ADM failures after the device became available to the practice.

found in 32% of patients at the time of their treatment with ADM. The implants were of various generations, and no specific observations could be made regarding the relationship between the degree of cohesiveness and the propensity to rupture. A plane change from prepectoral to subpectoral was performed in 11% of cases, and implants were changed from silicone to saline in 33% of cases. An anterior capsulectomy was performed in 60% of cases, total capsulectomy in 39%, and a neopocket in 1 patient.

Postoperatively, 3 patients developed seromas requiring drain placement and 2 patients developed hematomas requiring operative evacuation. One patient developed cellulitis that resolved with antibiotics. Five patients complained about palpable ADM edges.

The success rate of capsular contracture treated surgically with ADM was 90%. Among the 10 patients with ADM treatment failure, time to contracture recurrence followed a bimodal distribution, with half of cases observed between 1 and 7 months postoperatively and half between 32 and 88 months postoperatively. Eight of these patients had silicone implants, of whom 2 had developed silicone implant ruptures; 4 others had a history of preoperative silicone implant rupture. Two patients in the failure group had resumed smoking, 1 had a postoperative hematoma, 1 underwent chemotherapy for lung cancer, and another had radiation therapy for breast cancer (Table 2).

Five of the treatment failure patients in the early recurrence group underwent attempted salvage with ultrasound therapy (Table 3). This was successful in 2 cases (40%), and the Baker grade II or better result was maintained for an average follow-up of 2.1 years. Ultrasound therapy was successful in both ADM treatment failure patients who had saline implants and in none of those with silicone. Ultrasound-salvaged patients increased the overall success rate to 92%.

The average in-office follow-up time was 2.3 years (61% >1 year). Although limited, it has been reported that over 75% of postoperative capsular contractures occur within this time frame.[4]

## DISCUSSION

Improved surgical practices have helped reduce the incidence of capsular contracture.[18] Nevertheless, recurrence rates after conventional surgical therapy have been reported to exceed 50%, frustrating patients and surgeons alike.[3,10,11]


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Moreover, studies show that failure rates increase with additional surgical treatments performed and may be as high as 67% in high-risk cases.[3] This historical record highlights the need for a dramatically more effective approach.

The protective benefit of ADM against capsular contracture was first demonstrated among breast reconstruction patients when used in a sling-like fashion for subpectoral placement of prosthetic implants.[19] In 2009, Maxwell and Gabri applied such reconstructive techniques to the treatment of capsular contracture in aesthetic breast surgery.[13] Seventy-eight patients with capsular contracture were treated with 1 of 6 different types of ADM, and the authors reported a success rate of 100%, with average follow-up time of 1 year. In 2012, Hester et al. treated 80 capsular contracture patients exclusively with Strattice ADM and reported a success rate of 96%, with average follow-up time of 1.3 years.[14] In 2019, Wagner and Mirhaidari treated 43 capsular contracture patients with Strattice ADM and reported a success rate of 97%, with average follow-up time of 4.7 years.[16]

In 2020, a comparative study of conventional versus ADM treatment of capsular contracture found that although the success rate of conventional treatment was as high as 83% for first-time unilateral cases, it dropped as low as 33% in bilateral cases with a previous surgical treatment failure.[3] In contrast, treatment with ADM was 96% successful among a group wherein one-third had already experienced failure of conventional surgical therapy. The study proposed selective ADM use for first-time bilateral capsular contracture and recurrent unilateral capsular contracture. Defining best indications was intended to mitigate the disadvantages of greater cost and longer operating time associated with ADM use.

Despite these innovative and confirmatory studies, there are relevant issues that have not been investigated. These include whether implant filler type has any impact on either the quality or longevity of results, what impact does silicone implant rupture have on long-term results with ADM, and what modalities exist for ADM treatment failures.

This study (the largest to date) demonstrated a success rate of 90%. Among the 10 failures, 80% involved silicone implants, of which 20% developed silicone ruptures after treatment and another 30% had a history of silicone implant rupture at presentation, before treatment with ADM. The high prevalence of silicone implants in the failure group is not surprising, as silicone gel is known to stimulate capsular contracture formation.[20] Although this phenomenon is typically attributed to frank rupture, "silicone bleed" has also been postulated to be causative.[21]

Given these silicone implant characteristics, saline implants offer an attractive alternative to maximize the longevity of capsular contracture treatment. Our clinical experience has shown that saline implants routinely last 20 years or more (the rare premature deflation aside), and incite minimal tissue reaction over time. Rippling and palpability drawbacks are mitigated when ADM is used, because it thickens the soft-tissue layer. This helps make most patients good candidates for saline implants (Fig. 2).

Risk factors, including smoking, radiation therapy, and chemotherapy, were noted in some of the treatment failures. Two patients who smoked and continued to do so ultimately experienced treatment failure, suggesting that treatment with ADM does not prevent recurrent capsular contracture in this setting. Whether treatment with radiation therapy to the breast or systemic chemotherapy contributes to failure is speculative because of the small sample size.

Recurrent capsular contracture following treatment with ADM poses a treatment enigma. The likelihood of success by an identical second effort using ADM is only possible and without data to support efficacy.

Ultrasound therapy may provide an effective nonsurgical salvage modality for capsular contracture when initiated promptly.[22,23] Five patients who experienced ADM treatment failure in this study and developed Baker grade III capsular contracture were treated with ultrasound therapy (Table 3). In the 2 patients with saline implants, salvage was successful, increasing the overall ADM treatment success rate to 92%. This is contrary to our experience with capsular contracture recurrence after conventional (non-ADM) treatment. In these cases, ultrasound therapy has rarely produced a stable grade II result (unpublished data). Whether the difference in salvage is attributable to the presence of ADM or having saline implants is not clear. However, this demonstrated difference in response is novel, unexplained, and worthy of further study.

Half of the patients with ADM treatment failure developed capsular contracture recurrences at an average of almost 6 years later. Silicone implants were used in all 5 of these patients and found to be ruptured in 2 (40%). Because of its nature, ultrasound therapy should be avoided in the setting of possible silicone implant rupture. Furthermore, none of the 3 silicone implant failures treated with ultrasound were successful in this study.



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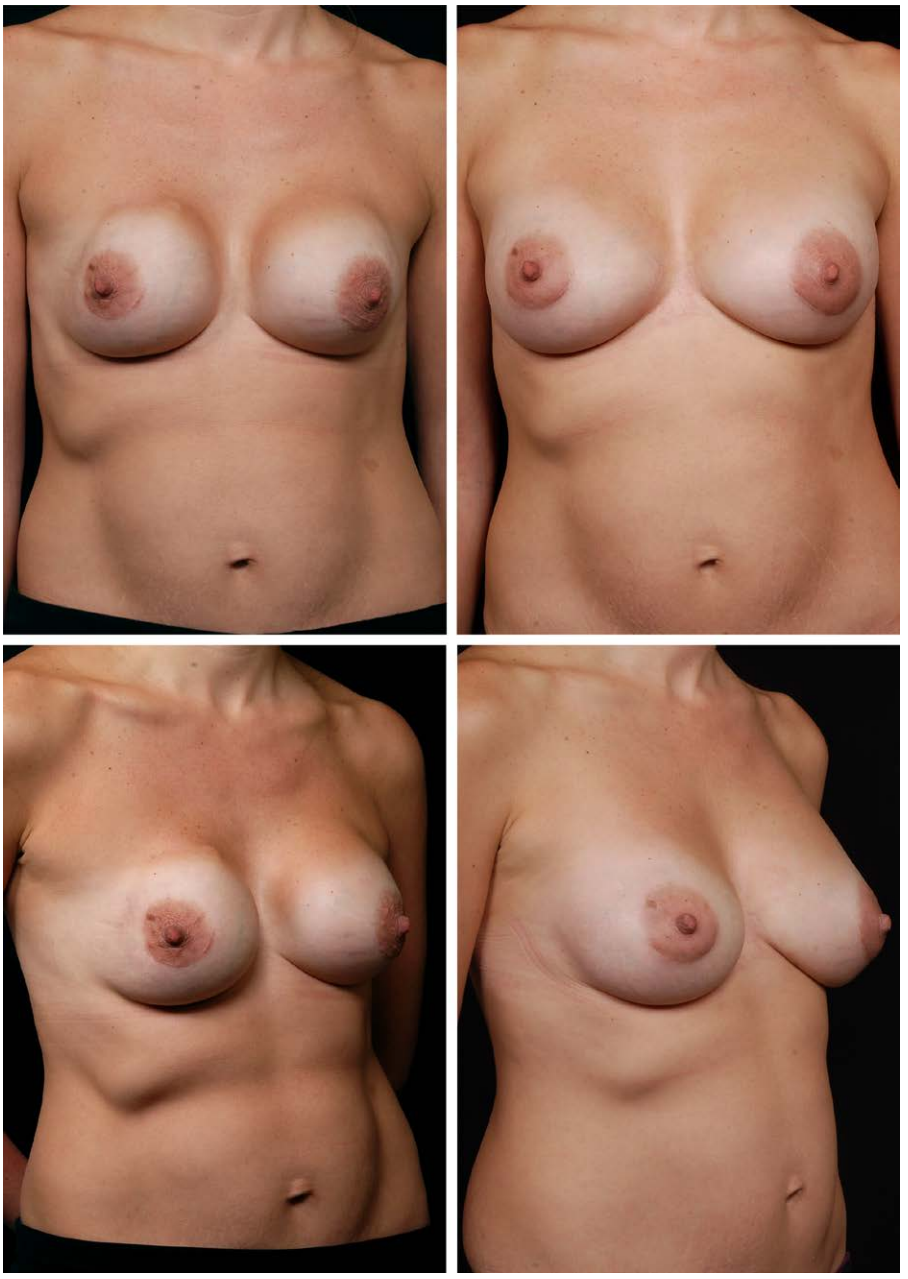


**Fig. 2.** Preoperative views of a patient with early-onset bilateral capsular contracture (*left*). Postoperative views after conventional surgical therapy with ADM and placement of saline implants (*right*).

ADM is thought to prevent capsular contracture formation by means of biological and physical mechanisms. Lacking antigenic epitopes, ADM may be an immunologically inert biomaterial capable of attenuating the encapsulation response of the immune system. Histologic samples from ADM capsules have shown significantly lower levels of inflammatory markers and myofibroblasts compared with those from native breast tissue capsules.[24,25] ADMs also may act as a physical blockade able to resist the contractile forces of capsule myofibroblasts, which may explain why thicker ADM types work better (eg, Strattice versus AlloDerm).[26]

A 2023 meta-analysis of 6 ADM types revealed that Strattice, AlloDerm, FlexHD, and DermaMatrix were all very effective at treating capsular contracture, although only Strattice was statistically more effective than conventional surgical therapy.[17] Another advantage of



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**Fig. 3.** Preoperative views of a patient with a "long soft implant interval" before onset of bilateral capsular contracture (*left*). Postoperative views after conventional surgical therapy without ADM and placement of saline implants (*right*).

Strattice is that it is substantially less expensive for the self-pay aesthetic surgery patient compared with the others. It is also a stiffer, less elastic biomaterial. As such, it may mitigate late lower pole stretch in those predisposed, although this is speculative.[27] Given these advantages, Strattice is arguably the best ADM choice for capsular contracture treatment in the aesthetic surgery patient.

The use of ADM in capsular contracture treatment is associated with complication rates ranging from 0.9% to 6.3%.[17,19] One series reported 2 seromas, 1 hematoma, and 1 implant malposition among 78 cases; another had 2 seromas among 80 cases; a third had hematomas and 2 *Staphylococcus epidermidis* subclinical infections among 43 cases; and 1 other series had 1 seroma among 32 cases.[3,13,14,16] This study also reports a very low



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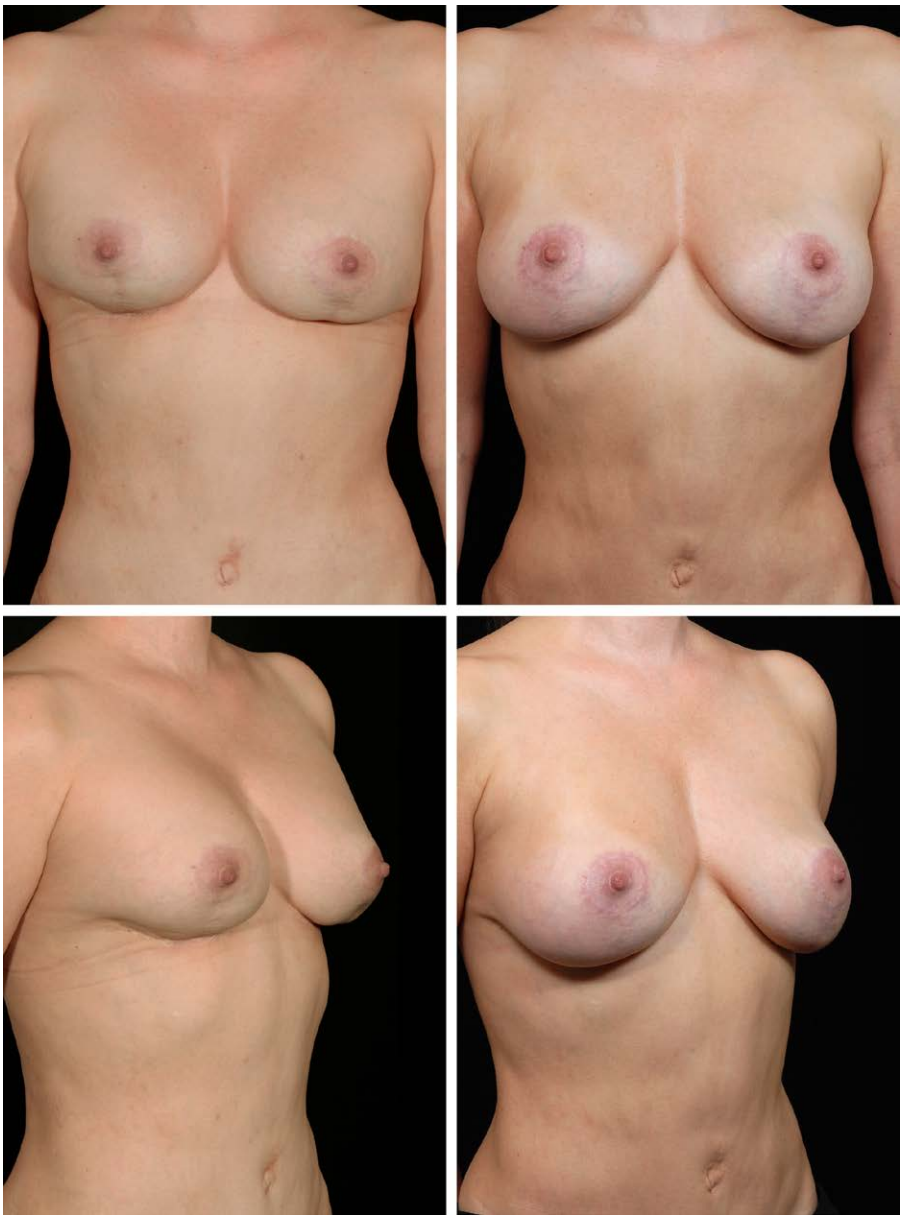


**Fig. 4.** Preoperative views of a patient with early-onset bilateral capsular contracture and a previously performed vertical mastopexy (*left*). Postoperative views after conventional surgical therapy with ADM and placement of saline implants (*right*). No revision of the previous mastopexy was required.

incidence of largely inconsequential complications. Considering the amount of foreign body material involved in these cases (both implant and ADM) and the long surgical times reflecting procedure complexity, it is remarkable that the complication rate is so low.

The decision to use ADM beyond patient candidacy is most influenced by the higher cost and secondarily by the potential increased safety risk associated with longer operating times. Bilateral ADM cases, for example, add up to 2 hours of additional anesthesia and facility fee time plus at least $6000 for ADM material. However, these drawbacks must be weighed against the prospect of failure of conventional surgical therapy without ADM. The latter scenario would then require another procedure, the same as passed over in the first place, and now with a total cost that includes both procedures. Although ADM selection in some cases may appear aggressive to avoid this very prospect, the cost is always cheaper than failure. There was an occasional patient who declined



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treatment because of cost concerns. As an aside, there were no patients who declined treatment because of concerns regarding the source of ADM material.

The ADM versus no-ADM quandary also comes into play in 2 other situations. The previously described algorithm favors conventional treatment without ADM for first-time unilateral capsular contracture, but there is still an approximately 20% failure rate with this choice. Therefore, the benefit of ADM is not quite as compelling as it is in bilateral first-time capsular contracture, where treatment without ADM fails in 50%.[3] Second, opting for ADM in recurrent unilateral capsular contracture raises the question of whether this should also be done on the unaffected side. If the implants are old, this is an easier decision, because both sides will likely be treated anyway. Moreover, treating both sides the same way would ensure similar quality aesthetic results. It would also make saline implants an option (if they were silicone before) which, by itself, provides both additional protection against recurrent capsular contracture and avoids the silent silicone rupture issue later. Given costs and other considerations, this decision is best made together with the fully informed patient.

Another quandary is the case of unilateral recurrent capsular contracture in the patient with silicone implants that are not old. Although treatment with ADM limited to the affected side is logical, the added benefit of using a saline implant is called into question by having a silicone implant on the unaffected side. Therefore, if silicone is again selected for the affected side (together with ADM), the risk of late failure exists if and when silent rupture occurs in the future, an event likely to necessitate capsulectomy and ADM replacement. These gray areas regarding indications will possibly be better clarified with additional experience and reporting.

Although first-time bilateral capsular contracture warrants ADM, the timing of condition onset is important. For example, the algorithm is correct for patients with relatively early-onset bilateral capsular contracture but less reliable in those with late-onset disease. Patient history is therefore key in establishing the indication for ADM in bilateral cases. Our experience has shown that patients who have had a "long soft implant interval" following their original procedure, and present with bilateral capsular contracture many years later, are in a different category. Most will probably do well without ADM use. These patients typically have old, neglected implants that are often proven at surgery to exhibit either frank rupture or significant silicone bleed. In addition, many of these patients are in an older age group and are amenable to replacement with saline implants. This offers the prospect of 20 years or more of runway before needing another implant replacement. Saline implants also mitigate the risk of recurrent capsular contracture because of their less bioreactive nature compared with silicone (Fig. 3).

Another observation revealed in this study is that patients with bilateral capsular contracture who have previously undergone a vertical or inverted-T mastopexy do not necessarily require its revision, despite presenting with extreme breast distortion. Treatment of the capsular contracture with ADM usually restores breast aesthetics without the need for mastopexy revision (Fig. 4). Limitations of this study consist primarily of its retrospective nature and, to a lesser degree, the average length of patient follow-up.

## CONCLUSIONS

The addition of ADM to the treatment of capsular contracture with conventional techniques has produced the highest success rate, particularly in refractory cases. Although adding considerable complexity and operating time, it is associated with surprisingly minimal complications. The use of saline implants contributes to the longest lasting results, as eventual silicone implant degradation and rupture uniformly leads to recurrent failure, even in the presence of ADM. Ultrasound therapy, when initiated early after the onset of recurrent capsular contracture, offers promise as an effective nonsurgical salvage modality in patients with saline implants.

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## DISCLOSURE

*The authors have no financial interest to declare in relation to the content of this article.*

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