Mastopexy: with or without Acellular Dermal Matrix?

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Background: In the years after unilateral breast reconstruction, the reconstructed breast resists ptosis more than natural breast tissue in the native contralateral breast. As acellular dermal matrix (ADM) becomes fully incorporated into the recipient's anatomy, thus reinforcing the inferior pole of the uplifted breast, we combined our mastopexy cases with ADM in an attempt to reduce the rate of recurrent ptosis.
Method: This was a prospective randomized analysis of a cohort of 24 patients, divided into two groups (A and B); all underwent primary unilateral mastopexy to correct grade III breast ptosis. Our patients had previously undergone contralateral skin sparing mastectomy with immediate breast reconstruction, for invasive breast cancer or ductal carcinoma in situ that originally was symmetrical to their native breast. The symmetrization mastopexy in half of our patients was carried out with the addition of an ADM sling to the inferior pole of the breast, to act as an internal, subcutaneous supportive "bra" (A). The other half of patients received a standard symmetrization mastopexy, without the addition of an ADM support (B). Patients were followed up for 36 months.
Results: The difference between control arm and study groups revealed a statistical difference ($P < 0.05$), when comparing the follow-up period. From the sixth postoperative month onward, the measurements for group A revealed a statistically significant difference ($P < 0.05$) when compared with group B.
Conclusion: The additional ADM sling acts as an added layer of support, thus delaying reoccurrence of ptosis following mastopexy. *(Plast Reconstr Surg Glob Open 2022;10:e3952; doi: 10.1097/GOX.0000000000003952; Published online 28 April 2022.)*

INTRODUCTION

Breast ptosis is the most common condition treated by plastic surgeons, with over 100,000 women undergoing mastopexy every year in the United States.[1] Despite being a ubiquitous issue, little evidence exists on definitive causes of ptosis, though many have found positive associations with age, smoking, number of pregnancies, cup size, high body mass index, and significant weight loss.[2] The aforementioned factors are thought to negatively influence the support provided to the breast by its suspensory ligaments of cooper, and lead to a change in shape and nipple projection over time.

To correct ptosis, mastopexy techniques have gone through an iterative process of improvement. The first nipple–areola complex transposition based on a vascular pedicle was attributed to Morestin[3] in 1907.

The first surgeon to stress the importance of preoperative planning and who utilized a geometric system as a guide was Aufricht. It was however Wise, who standardized the preoperative marking system,[4] most commonly relied on today. Regnault[5] categorized ptosis into three degrees and gave surgeons the tool to objectively quantify the different stages of ptosis. This system of classification, published in 1976, remains the most commonly used staging system for ptosis to date.

In 1981 the idea of "internal bra suspension" was first described by Johnson,[6] who used a synthetic Marlex mesh to support the mammary tissue. A key part of his attempt to permanently uplift the breast against the axial forces of gravity was to attach the Marlex mesh to the perichondrium of the second rib. Auclair and Mitz further explored this technique and modified it by utilizing an absorbable mesh, inserted onto the anterior surface of the breast tissue.[7]

We were concerned about rapid recurrent ptosis of the uplifted breast. As acellular dermal matrix (ADM)

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becomes fully incorporated into the recipient's anatomy by a process of repopulation of the dermal matrix with recipient cells, thus reinforcing the inferior pole of the uplifted breast, we combined our mastopexy cases with ADM, in an attempt to reduce the rate of recurrent ptosis.

PATIENTS AND METHODOLOGY

This study was designed to investigate the effect of incorporating an "internal bra" on ptosis following symmetrization mastopexy in postcontralateral mastectomy patients. The control group in this study underwent the symmetrization procedure as outlined below (see surgical technique)—with no added ADM support. The intervention group underwent the same procedure, excepting the addition of an ADM sling, with the aim of supporting the breast over the long term and reducing ptosis.

Ethical Approval

Ethical approval for this study (IRB approval number 315 PS) was sought from the ethics committee of the Cairo University Review Board and was approved on August 1, 2015. All patients were consented for participation in this study and underwent counseling and detailed explanation of all the aspects of the study.

Outcomes of Interest

The primary outcome of interest was the long-term change in the suprasternal notch to nipple (SSNtoN) distance in the breast undergoing mastopexy. Baseline (preoperative) measurements were made by a single clinician on the morning of surgery. The measurements were repeated postoperatively at 1 week and then at 6, 12, 18, 24, and 36 month follow-up appointments. Secondary outcomes of interest included nature and incidence of both intraoperative and postoperative complications and operative time.

Patients

Patients seeking unilateral breast symmetrization mastopexy were prospectively recruited during the study period: September 2015 to February 2016.

Inclusion criteria: previous unilateral skin sparing mastectomy for invasive breast cancer or ductal carcinoma in situ, reconstruction of mastectomized breast, contralateral breast with grade III ptosis, age above 18, body mass index below 35, nonsmokers (not smoked in the 6 months before surgery), ASA score of I or II, and a normal ipsilateral mammogram within 12 months of their expected date of symmetrization surgery.

Exclusion criteria: evidence of hypertrophic scarring or keloid formation, previous radiotherapy treatment.

On a rolling recruitment basis, patients were sequentially randomized to the intervention group (group A) and the control group (group B).

Methodology – Surgical Technique

With the patient in an erect position, a Wise pattern skin marking is drawn on the breast to be uplifted. Under

Takeaways

Question: Following unilateral breast reconstruction, the reconstructed breast resists ptosis more than natural breast tissue. We added acellular dermal matrix in mastopexy cases, in an attempt to reduce the rate of re-ptosis.

Findings: This is a prospective randomized cohort study of 24 patients, divided into two groups (A and B); all underwent primary unilateral mastopexy, to correct grade III breast ptosis. The difference between the control arm and study groups revealed a statistical difference ($P < 0.05$).

Meaning: The additional acellular dermal matrix sling acts as an added layer of support, thus delaying reoccurrence of ptosis following mastopexy.

general anesthetic, the patient is prepared and draped and positioned with the arms at 90 degrees of abduction.

A vertical incision in the midline of the breast (along its meridian) is made from the 6 o'clock point of the areola to the inframammary fold, thus, only incising the lower half of the breast. Next, the potential space between lamina anterior and the superficial fascia in the breast is developed. Dissection is carried both medially and laterally within this plane, reaching the pectoral fascia medially and serratus fascia laterally. Following this, the inferior border of the breast is dissected off the inframammary fold and the breast mound is then freed off the pectoralis fascia from a caudal to a cephalic direction. This upward dissection is carried to the lower level of the areola. This creates a central and superiorly based pedicle for the nipple and areola to be mobilized on, in a cephalic direction. The medial and lateral halves of the breast tissue are then plicated vertically in line of the breast meridian with PDS 2/0 sutures, so as to bring the breast mound to a smooth conical shape.

In group A only: Once conical, the breast mound is then pushed into an uplifted, medialized position and a piece of ADM, measuring 16 cm × 8 cm is secured to the chest wall using PDS 3/0 sutures (Fig. 1). The ADM that now acts as a hammock for the breast is secured medially and caudally to the pectoral fascia and laterally to the serratus fascia, to support the breast (Fig. 2). The ADM we used was Strattice. This step was omitted in group B patients (Fig. 3). Two size 15 Blake silicone suction drains are inserted: one superficial to the ADM sling in the subcutaneous space and one deep to the sling, between the breast tissue and the sheet of ADM. Then, all the excess skin within the Wise pattern markings is excised in both groups, in a similar fashion. The residual medial and lateral skin flaps are brought together and secured with 3/0 Monocryl followed by a subcuticular skin closure with a Stratafix 3/0 suture. Finally, the nipple areolar complex is passed through a circular skin defect, to allow repositioning the nipple areolar complex. The nipple areolar complex is secured in its new position with Monocryl 4/0 and 5/0 sutures.

Statistical Analysis

Data were statistically described in terms of mean ± SD (± SD), or frequencies (number of cases) and percentages when appropriate. Comparison of numerical variables
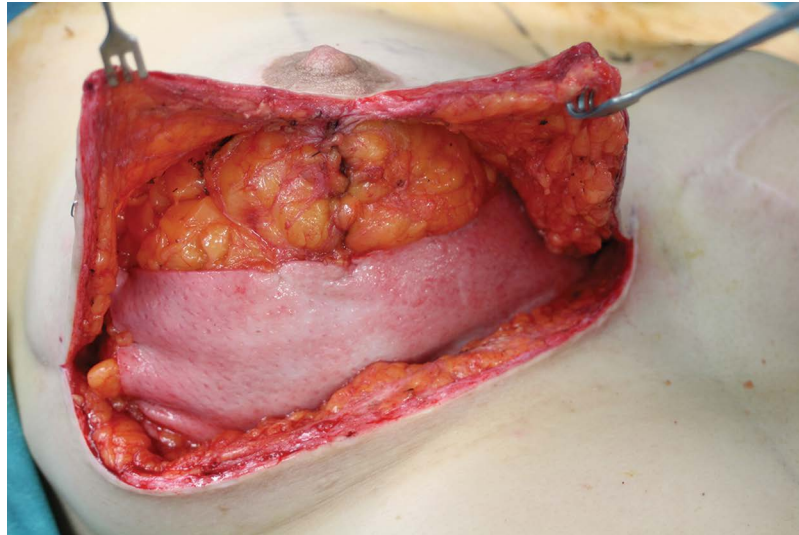
Fig. 1. Intraoperative image with ADM in situ supporting the breast mound (right breast).

between the study groups was done using Student t test for independent samples. Within-group comparison of numerical variables was done using paired t test. The Kolmogorov-Smirnov test was used to test for normality. For comparing categorical data, chi-square (χ^2) test was performed. Exact test was used instead when the expected frequency was less than 5. Two-sided P values less than 0.05 were considered statistically significant. All statistical calculations were done using computer program IBM SPSS (Statistical Package for the Social Science; IBM Corp, Armonk, N.Y.) release 22 for Microsoft Windows (Microsoft Corp, Redmond, Wash.).

The statistical analysis comparing age, body mass index, and smoking history revealed no statistically significant difference between the two groups. The difference between control arm and study groups did, however, reveal a statistical difference ($P < 0.05$) in our project, when comparing the follow-up period. Specifically, from the sixth postoperative month onward, the measurements for group A revealed a statistically significant difference ($P < 0.05$) when compared with group B.

RESULTS

Patient Demographics
Our recruitment yielded a total of 24 patients, with 12 in the intervention group (group A), and the same number in the control group (group B). Their characteristics are summarized in Table 1.

Supra Sternal Notch to Nipple Distances
All patients experienced a sizeable decrease in SSNtoN from their preoperative to 1 week follow-up measure, which corresponds to the extent of lift achieved by the
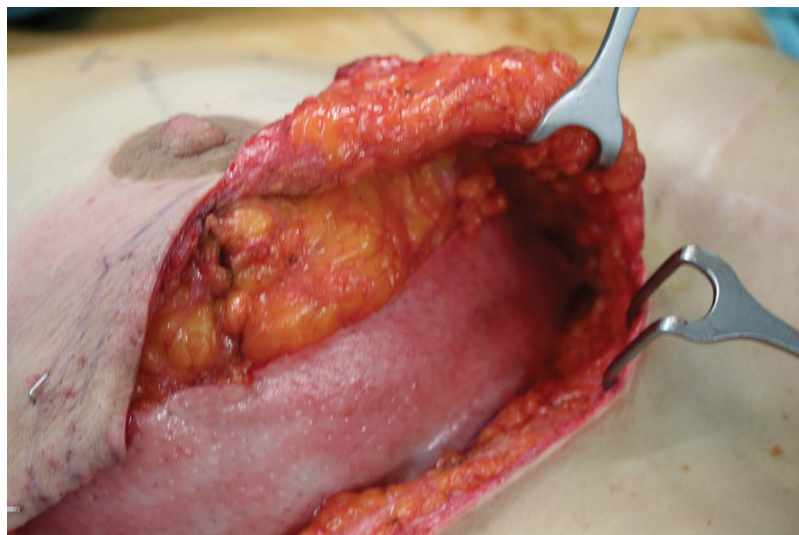

Fig. 2. Intraoperative image showing medial attachment of ADM (right breast).
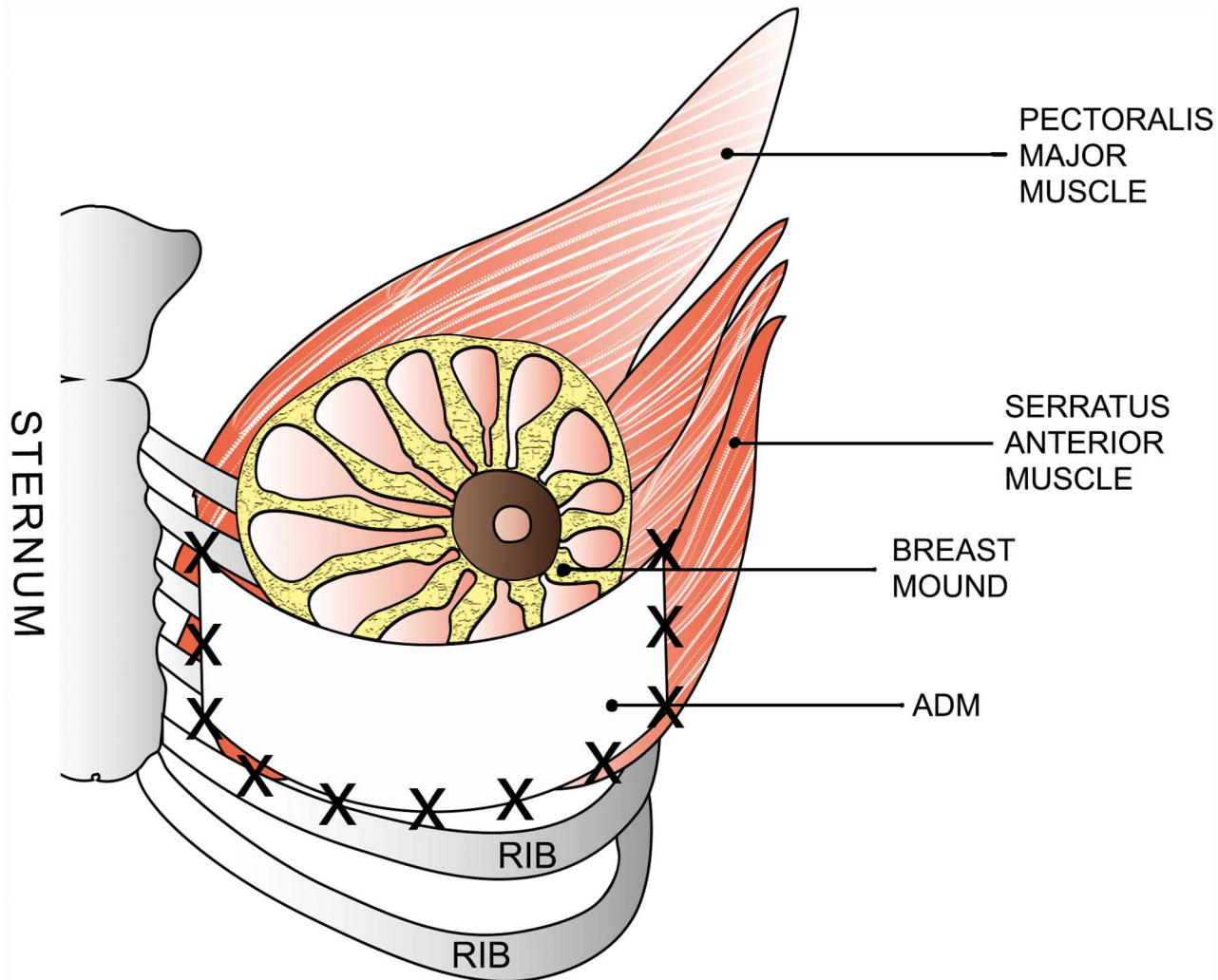
Fig. 3. Diagram showing ADM fixed to pectoralis fascia medially and caudally; lateral fixation to serratus fascia.

operation. In group A, this was a median decrease of 9 cm (IQR = 3), or 30%. In group B, this was a median decrease of 8.5 cm (IQR = 3.25), or 28%. SSNtoN distances are shown in Tables 2 and 3 for groups A and B, respectively.

All patients in both groups showed a minimum increase in SSNtoN distance of 1 cm from 1 week to 3 years postoperatively. This is quite likely due to resolving postoperative

Table 1. Patient Demographics and Surgical Data of Groups A and B

Patient Demographics	Group A	Group B
Variable		
No. of cases	12	12
Patient factors		
Mean age, y (range)	48 (36–60)	52 (41–63)
Mean BMI, kg/m² (range)	32 (29–35)	31 (27–35)
Diabetes	2	3
Ex-smoker	5	2
Surgical factors		
Mean surgical time, min (range)	130 (115–145)	90 (70–110)
Intraoperative complications	0	0
Postoperative complications	2	1

edema that naturally occurs in response to any form of surgical trauma.

To facilitate data analysis, patient results were clustered into three tiers, including 0%–5%, 5%–10% and greater than 10%. Therefore, patients from both groups have been bucketed into their percentage increase in SSNtoN over the 3 year follow-up: 0%–5%, 5%–10% and greater than 10%. Six patients from group A showed an increase of only 4.8%, compared with only four patients in group B. Five patients from group A increased their SSNtoN distance by 9.5%, compared with six from group B. Only one patient in group A showed an increase of their measurement by 14.3%, compared with two cases in group B. Therefore, in each bucket of the larger percentage increases (0%–5% and >10%), there were more patients from group B, which was found to be statistically significant ($P < 0.05$).

In absolute terms, group A patients showed a median increase of 1.5 cm (IQR = 1), or 6.95% over the follow-up period. Patients from group B showed a larger median increase of SSNtoN over the 3 year follow-up—this was a median of 2 cm (IQR = 1), or 9.1% (Tables 2 and 3).

Table 2. Group A Measurements in Centimeters (from Suprasternal Notch to Nipple)

Patient	Preoperative	1* Week	6 Months	12 Months	18 Months	24 Months	36 Months	% Change
1	28	21	22	22	22	22	23	9.5%
2	29	21	22	22	22	22	23	9.5%
3	30	21	21	21	21	21	22	4.8%
4	31	22	22	22	22	23	23	4.8%
5	29	21	22	23	23	23	23	9.5%
6	30	21	23	23	23	24	24	14.3%
7	33	22	23	23	23	24	24	9.5%
8	34	21	22	23	23	23	23	9.5%
9	28	22	23	23	23	23	23	4.8%
10	29	21	22	22	22	22	22	4.8%
11	32	21	22	22	22	22	22	4.8%
12	33	22	23	23	23	23	23	4.8%

Table 3. Group B Measurements in Centimeters (from Suprasternal Notch to Nipple)

Patient	Preoperative	1* Week	6 Months	12 Months	18 Months	24 Months	36 Months	% Change
1	34	23	24	24	24	24	24	4.8%
2	29	22	23	23	23	23	23	4.8%
3	30	21	21	22	23	23	23	9.5%
4	34	22	22	22	22	22	23	4.8%
5	29	22	23	23	23	23	23	4.8%
6	29	21	23	23	24	24	24	14.3%
7	31	22	22	23	23	24	24	9.5%
8	29	21	23	23	24	24	24	14.3%
9	28	21	22	23	23	23	23	9.5%
10	33	22	23	24	24	24	24	9.5%
11	32	23	23	23	23	24	24	9.5%
12	29	21	23	23	23	23	23	9.5%

The difference between control arm and study groups did reveal a statistical difference ($P < 0.05$) in our project, when comparing the follow-up period. Specifically, from the sixth postoperative month onward, the measurements for group A revealed a statistically significant difference ($P < 0.05$) when compared with group B.

Evaluation of Complications

No patient of either subgroup suffered any intraoperative complications. In the postoperative period, a total of three patients (12.5%) of the total patient cohort encountered postoperative problems. There were two cases of wound breakdown at the T junction (one case from each subgroup), which resolved within 6 weeks, with conservative management, necessitating changes of dressings (Aquacel ag with Mepilex) twice weekly. The third patient to encounter postoperative problems was of group A and suffered from a prolonged seroma accumulation.

Ultrasound investigation confirmed this to be in the subcutaneous space between the skin and the ADM; this required four sessions of percutaneous aspiration a week apart in the outpatient department. The total volume of aspirate was 960 ml before the seroma resolved. One case in group A developed postoperative erythema to the lower pole of the breast (red breast syndrome) which was managed expectantly and resolved spontaneously after 9 weeks; as no invasive intervention was required, the patient was not included in the complications. The incidence of complication in the entire patient cohort is low and showed no statistical significance.

Operating Time

Operating time was approximately 30% shorter in group B, lasting a mean of 90 minutes, compared with 130 minutes in group A ($P < 0.05$).

EXAMPLES OF PATIENT PHOTOGRAPHS

A. Example Case 1 – Group A (Figs. 4–7)

B. Example Case 2 – Group A (Figs. 8, 9)

DISCUSSION

Various different tissues have been utilized as biologic scaffolds after being harvested from different species, including cows, pigs, and horses as xenografts, and humans as allografts. The tissues harvested include small intestine,[8] dermis of skin,[9] pericardium of the heart,[10] and among others, the urinary bladder.[11]

The dermis is a commonly used biologic scaffold; ADM allograft was originally developed as an alternative to skin grafting for burn patients. Ever since its introduction in 1994, ADM has been used as a soft tissue replacement[12] in the field of reconstructive surgery. This has provided surgeons with a new source for soft tissue cover when dealing with soft tissue loss.

In the field of breast reconstructive surgery, Breuing and Warren first reported the combined use of implants and human acellular dermis in implant-based breast reconstruction in 2005,[13] followed by Bindingnavele in 2007, who used ADM in combination with tissue expander-based

Fig. 4. Case 1 patient (group A) AP view preoperative.

breast reconstruction.[14] Following growing adoption of their use in breast reconstruction, many have employed a variety of these synthetic and biological meshes in post-mastectomy patients, typically to reconstruct the resected breast. In the mastectomized patient, this enabled the multi-staged reconstruction of expander followed by implant, to be replaced by a single stage "direct to implant" technique of reconstruction. The mesh allowed the creation of pocket to support an implant[15] without relying solely on the skin envelope to prop it up, which had previously fallen out of favor due to the unacceptable scarring, incomplete correction of the upper pole, and high rates of recurrent ptosis. Initial resistance to mesh support was overcome when it became clear that their use does not interfere with breast cancer screening and is safe to use, indeed, this method of reconstruction has now become one of the most commonly used techniques in breast reconstruction[17] and underscores the value of mesh in breast surgery more widely. [16,17]

Despite there being a lack of empirical evidence, it is a widely accepted assertion that ptosis primarily develops due to a laxity of supportive ligaments that surround the breast footprint and provide its structural support and maintain its shape.[18] It is then logical to attempt to correct this laxity by utilizing exogenous support mechanisms. Thus, in a manner similar to breast reconstruction, principles of breast support have also been implemented into various mastopexy techniques, and the use of mesh is now widely accepted.

What remains controversial, however, is the choice of mesh. There are innumerable options available to the reconstructive surgeon: synthetic mesh versus biological mesh, absorbable versus nonabsorbable. There is, however, minimal robust evidence to favor one type over the other.[19] Complication rates have consistently been shown to be relatively similar amongst synthetic versus biological; however, dermal matrices have been associated with higher rates of hematoma formation.[20] We circumvent

Fig. 5. Case 1 patient (group A) oblique view preoperative.

Fig. 6. Case 1 patient (group A) AP view, postoperative at 3 months.

Fig. 7. Case 1 patient (group A) Oblique view, postoperative at 3 months.

this issue by placing drains; indeed, none of the patients in our intervention group developed hematomas. On the other hand, biological matrices have been shown to be associated with lower rates of infection,[20] which would typically mandate explantation, and ultimately failure of the operation.

ADMs are soft tissue matrix grafts that are created by a complex process, which results in decellularization of the dermis, leaving the extracellular matrix of the dermis intact, thus maintaining the structural integrity of the graft. This matrix provides a scaffolding that will eventually be repopulated by the recipient's own cells, which will ultimately lead to the revascularization and incorporation of the transplanted dermis.

Grafts such as Strattice rapidly revascularize, as through the careful processing, the 3D structure of the blood vessels is left intact. As such, when implanted, these blood vessels become rapidly repopulated with the patient's own endothelial cells and blood flow is readily re-established. This in turn is important in infection control; if an infection should occur, it could be more readily treated with intravenous antibiotics, rather than implant removal.

ADM was first described for use in breast surgery in 2001[21] and several ADMs are commercially available on the market, including the freeze-dried allograft,

Alloderm by LifeCell; Neoform, by Mentor; the fully hydrated, allograft FlexHD, by Ethicon; the porcine Permacol by Covidien, and Strattice, by LifeCell.[22] Several other studies exist that have looked at the combination of breast surgery and ADM, with the aim of reinforcing the lower pole of the breast. A series of three cases was presented by Kornstien.[23] All three cases included underwent augmentation and mastopexy, where ADM was utilized to reinforce the inferior pole of the breast, supporting the augmented, uplifted breast in a satisfactory manner. A survey study by Ibrahim et al[24] looks at the uses of dermal matrices across the board of US-based plastic surgeons in breast surgery, including primary and secondary breast augmentations, as well as postmastectomy reconstructions. A further article by Bengston and Baxter[25] looks at the benefits of combining ADM with breast surgery. Lastly, van Deventer et al[26] describe an impressive series using a synthetic mesh to help correct ptosis, and show its efficacy over time—the data presented here corroborate our assertion that mesh-based mastopexy resists ptotic forces more robustly than non-mesh mastopexy techniques. It is likely that our study was underpowered, and therefore was unable to detect a significant difference between the intervention and control

Fig. 8. Case 2 patient (group A) AP view preoperative.

Fig. 9. Case 2 patient (group A) AP view, postoperative at 6 weeks.

groups, a type II error. Despite this, we fill in an important gap in the literature—all of the aforementioned studies in this article focus on either breast reconstruction and aesthetic breast revision surgery. We have failed to identify any other comparative study of similar size that looked at primary symmetrization mastopexy following mastectomy, and that used ADM in an attempt to reduce the rate of unilateral breast ptosis.

CONCLUSIONS

The use of ADM in combination with mastopexy, with the aim to reduce the rate of ptosis, has shown promising results. The measurements obtained revealed that the addition of an ADM layer does seem to reduce ptosis to some degree. The difference between the control arm and study groups did, however, reveal a statistical difference ($P < 0.05$) in our project, when comparing the follow-up period. Specifically, from the sixth postoperative month onward, the measurements for group A revealed a statistically significant difference ($P < 0.05$) when compared with group B. As the cohort of patients studied is relatively small, further studies with lengthier follow-up periods, involving more patients and possibly the use of BREAST-Q may be advisable to ascertain the long-term benefits and cost effectiveness for patients.

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