CME

Getting the Most Out of Augmentation-Mastopexy

Konrad Sarosiek, M.D.
G. Patrick Maxwell, M.D.
Jacob G. Unger, M.D.

Nashville, Tenn.

Learning Objectives: After reviewing the article, the participant should be able to: 1. Understand the tenets of proper patient selection. 2. Be familiar with the assessment of patients for augmentation-mastopexy. 3. Be able to plan an operative approach and execute the critical steps. 4. Be able to recognize common complications and have a basic understanding of their management. 5. Be aware of emerging adjunctive techniques and technologies with respect to augmentation-mastopexy.

Summary: Despite being a multivariable and complex procedure, augmentation-mastopexy remains a central and pivotal component of the treatment algorithm for ptotic and deflated breasts among plastic surgeons. Careful preoperative planning, combined with proper selection of approach and implant, can lead to success. Physicians need to understand that there is a high frequency of reoperation cited in the literature with regard to this procedure, and discussions before the initial operation can help alleviate common misunderstandings and challenges inherent in this operation. (*Plast. Reconstr. Surg.* 142: 742e, 2018.)

Since its first description by Gonzalez-Ulloa in 1960, augmentation-mastopexy has continued to evolve into its many permutations and become a close ally of the plastic surgeon.[1,2] As litigation has become commonplace within the medical community, plastic surgery has also felt its reach, and augmentation-mastopexy remains one of most litigated procedures in the cosmetic population.[3] Perhaps the root of dissatisfaction and pursuit of litigation is the perpetual challenge augmentation-mastopexy poses: the combination of two procedures working against one another.[4,5] By definition, a breast augmentation centers on using volume to expand breast tissue, whereas mastopexy constitutes reducing the soft-tissue envelope by the excision and redraping of skin and parenchyma.[6,7] Thus, we are creating a smaller pocket and subsequently trying to fill it with more volume. Several authors have pointed out that the combination of these two operations does not simply add the individual complications numerically, but rather results in an exponential increase.[5] Therefore, an abundance of articles have since been published portraying modifications of widely accepted techniques to produce better results and improve patient outcomes when combining mastopexy with breast augmentation in an effort to decrease complications.

Although the majority of cosmetic breast surgery has been aimed primarily at combating postpartum deflation and age-related changes, the landscape has begun to shift. In the year 2016, over 216,000 bariatric procedures were performed, and the numbers are expected to continue to rise.[8–10] As massive weight loss patients become a growing portion of the plastic surgery practice, special circumstances need to be considered in working with their specific tissue characteristics and their perioperative care. Although a complete review of augmentation-mastopexy is beyond the scope of this article, we focus on the most common methods of reconstruction and highlight some of the new emerging techniques, surgical and nonsurgical, being discussed today.

From the Department of Plastic Surgery, Vanderbilt University Medical Center; and Maxwell Aesthetics.
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PREOPERATIVE ASSESSMENT

Patient Evaluation

A thorough patient evaluation is clearly paramount, with extensive emphasis placed on the patient's expectations (e.g., breast size, nipple position, scarring) and emotional sense.[11] Being diligent to identify characteristics of psychological disorders such as body dysmorphic disorder before a surgical intervention can help prevent untoward outcomes.[12] A review of a patient's history with a focus on desires for future breastfeeding, weight loss, abnormal bleeding, occupation, history of cancer with or without radiation therapy, and behavioral habits such as smoking or illicit substance use must be performed.[13] A multitude of studies have demonstrated adverse effects associated with smoking, including an increased risk of necessitating revision surgery; thus, current recommendations do not endorse operating on smokers.[14,15] Haeck et al. have created an evidence-based patient safety advisory, which includes a checklist and is available on the American Society of Plastic Surgeons website free of charge[13,16] (https://www.plasticsurgery.org/for-medical-professionals/resources-and-education/patient-safety-resources/patient-selection).

Evaluation of the massive weight loss patient demands a thorough understanding of the weight loss procedure, whether it was a restrictive procedure (i.e., sleeve gastrectomy) or a combined restrictive and malabsorptive (i.e., Roux-en-Y), and its effect on the patient's nutritional status.[17] Patients having undergone combined restrictive and malabsorptive procedures tend to experience higher levels of complications secondary to nutritional deficiencies, especially early in the postoperative state. Deficiencies of various micronutrients can affect wound healing and need to be tested preoperatively. Understanding the roles of protein; vitamins A, B, and C; arginine; glutamine; iron; zinc; and selenium and their optimization before surgical intervention will lead to a greater chance for success and reduced complications.[18,19] One of the more dire examples, an elevation of homocysteine levels in bariatric patients, can result in a hypercoagulable state with a predisposition for recurrent venous thrombosis.[20,21]

Knowledge of previous breast surgery, elective or reconstructive, will inevitably affect surgical planning regarding approach, incision, implant pocket, and closure. Obtaining prior operative reports can help avoid common pitfalls, such as injury to a previous pedicle, with potentially devastating outcomes.

Physical Examination

A comprehensive, detailed physical examination is required. Specifically, assessments of skin quality, tone, and elasticity are used in combination with metric measurements for operative planning. With the patient standing, the surgeon must first appreciate any discrepancies between both breasts; not only are these discrepancies those that are perceived by the surgeon's eye, but inquiry into the patient's concerns are warranted as well, ensuring adequate communication between the surgeon and patient. The degree of ptosis is assessed by examination of the nipple position with regard to the inframammary fold in accordance with the Regnault classification system[22] (Table 1). Bilateral measurements include but are not limited to the following: base diameter; sternal notch–to-nipple, nipple-to–inframammary fold, nipple-to-nipple, and nipple-to-midline distances; nipple diameter; and upper pole soft-tissue pinch test.[11,23] Obtaining these measurements has been described elsewhere and is beyond the scope of this article; however, in Figure 1, we include a few basic parameters in a typical patient (Fig. 1). (**See Video, Supplemental Digital Content 1**, which displays preoperative markings. This video is available in the "Related Section" of the full-text article on PRSJournal.com or at **http://links.lww.com/PRS/D72**.) Despite being able to record these measurements

Table 1. Ptosis Classification*†

Type	Degree	Nipple Location Relative to IMF	Description
Pseudoptosis		Above	Breast tissue below IMF, whereas nipple is above
Grade 1	Mild	0–1 cm below	Nipple position at the IMF
Grade 2	Moderate	1–3 cm below	Nipple position below the IMF but above the majority of the breast
Grade 3	Severe	>3 cm below	Nipple position below the IMF and at the lower pole of the breast

IMF, inframammary fold.
*From Regnault P. Breast ptosis: Definition and treatment. *Clin Plast Surg.* 1976;3:193–203.
†Classification of ptosis based on nipple position relative to an axis extending from the IMF.

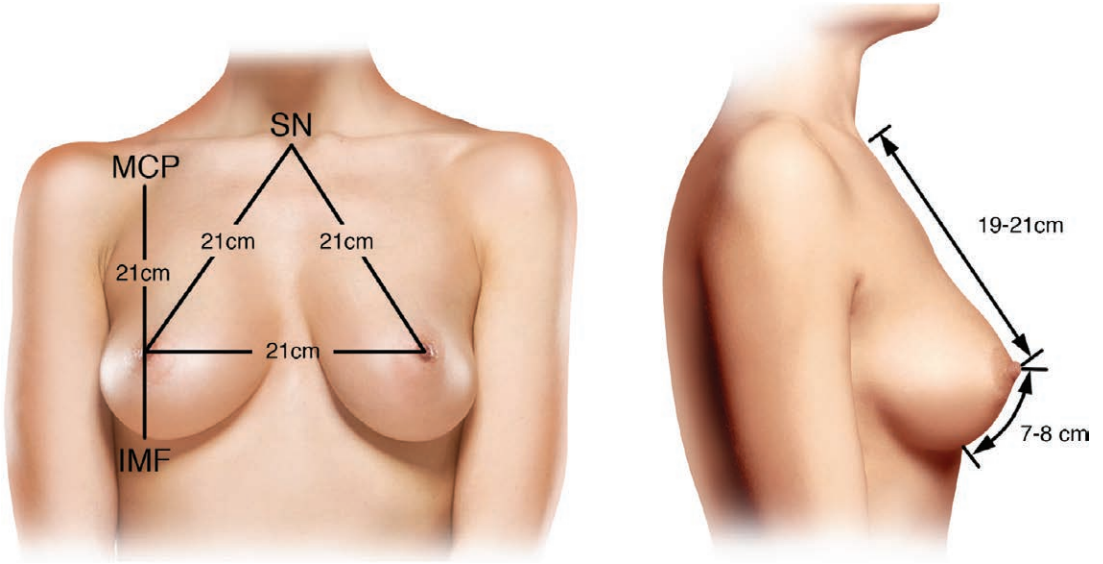

Fig. 1. Standard breast measurements. *SN*, sternal notch; *MCP*, midclavicular plane; *IMF*, inframammary fold.

Video 1. Supplemental Digital Content 1 displays preoperative markings. This video is available in the "Related Section" of the full-text article on PRSJournal.com or at **http://links.lww.com/PRS/D72**.

for preoperative planning, it is imperative to understand that the addition of volume through the use of an implant in augmentation-mastopexy will act to distort these numbers and thus the surgeon would do well to also use intraoperative tacking for the final result.[24]

The ideal breast includes a full upper pole and a descending slope toward a lower pole where, at its maximal projecting point, rests the areola, which then terminates in a soft curve toward the torso.[25] Applying a more quantitative approach, the ideal breast has a 45:55 ratio of above-to-below the nipple volume.[26] The nipple sits at the upper and lower pole boundary and points at a 20-degree angle from the cross-section drawn at that point, and the upper pole should be straight or slightly concave and the entire lower pole convex.[26]

Decision-Making

The effect of the implant on the soft-tissue envelope is difficult to predict and can result in increased complications.[5] To help with this lack of foresight, several algorithmic systems have emerged to assist the surgeon in the decision-making process.[7,24,27–30] A major focus of these articles is the dilemma of whether to stage the operation as two separate individual operations or to perform them together as a single procedure. Performing the operation as a single procedure has the benefit of lower costs and only one episode of anesthesia, but there is frequent debate in the literature about whether this is a good option for everyone.[29] For instance, one article describes how the decision between staged versus single-procedure augmentation-mastopexy is decided using the breasts' vertical excess[7] (Fig. 2). When vertical excess is greater than 6 cm, the algorithm indicates the need for a double-stage procedure to lower the risk for major complications and reoperation. Another group found a direct trend in the number of revisions and the degree of ptosis. They concluded that patients with advanced or grade 3 ptosis need to have their augmentation-mastopexy performed as a two-stage procedure to avoid revision procedures.[31] A third study

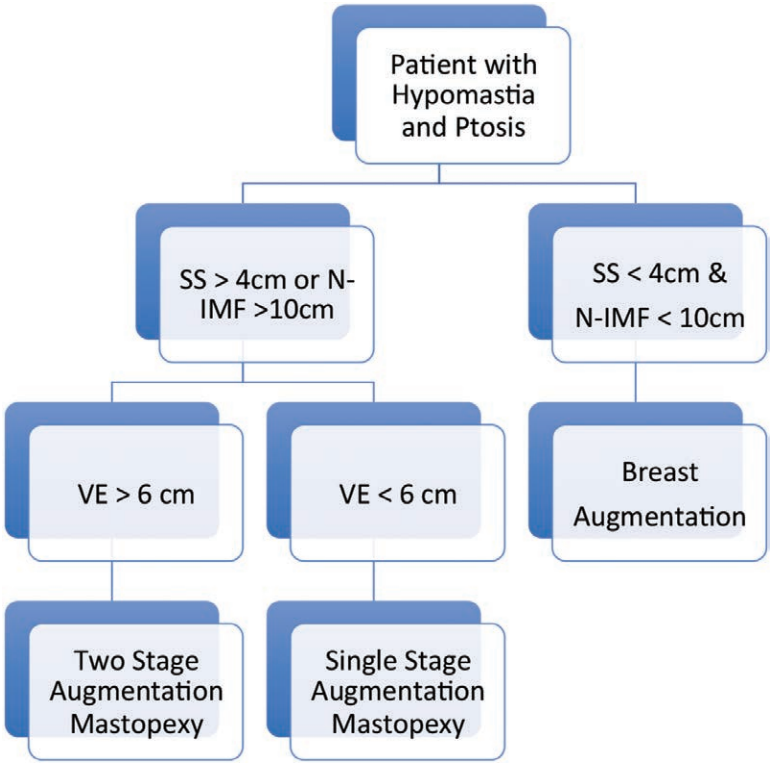

Fig. 2. Tissue-based decision-making for surgical planning in augmentation-mastopexy. (From Lee MR, Unger JG, Adams WP. The tissue-based triad: A process approach to augmentation mastopexy. *Plast Reconstr Surg*. 2014;134:215–225.) *SS*, skin stretch; *N-IMF*, nipple-to–inframammary fold distance; *VE*, vertical excess.

analyzed single-stage augmentation-mastopexy versus augmentation alone and compared complications. They deduced that the single-stage augmentation-mastopexy risk of reoperation is, in fact, lower than the individual mastopexy and augmentation risks when combined.[14,32] Others advocate the use of "one procedure fits all" in the use of a vertical augmentation-mastopexy to simplify the decision-making process and attempt to standardize the procedure.[24] In short, the literature contains a plethora of options and opinions about the best way to go about augmentation-mastopexy with regard to staging, but the ultimate decision belongs to the surgeon.

When performing a staged augmentation-mastopexy, the mastopexy component is frequently performed first followed by the augmentation at a later time point, which can be 6 to 12 months or longer.[33] The breast envelope is first shaped and the nipple-areola complex reset to a new position producing the most aesthetically pleasing result. Once the tissues have healed and the breast parenchyma settled into its new position, the patient is then reassessed for the augmentation component. At this time, implant selection can be more precise and accurate, producing a reliable result. In contrast, in patients who require minimal elevation of the nipple-areola complex but have a deficiency of breast tissue requiring augmentation, implant insertion should be performed at the initial operation. Performance of the augmentation component will elevate the nipple-areola complex and potentially avoid the necessity of performing the mastopexy component.[34] However, in this situation, patients will need extensive preoperative discussions regarding the possibility of requiring an additional episode of anesthesia, and the additional costs that accompany the second operation.[33]

Special Considerations

Tuberous breast deformity is a complex and infrequent condition, with limited published studies confined to few subjects. What is clear is that these patients require special considerations to redistribute the parenchyma with scoring, expansion, or autologous flaps; volume augmentation with implants and/or fat; and recreation of an aesthetic nipple-areola complex.[35–37]

SELECTION OF IMPLANT AND POCKET

Silicone versus Saline

With the moratorium on silicone implants in the United States in 1992, plastic surgeons focused on the use of saline implants for breast augmentation and reconstruction for 14 years. In 2006, the U.S. Food and Drug Administration found no increased risk of rare adverse events and gave their stamp of approval for use in plastic surgery. By 2010, half of all breast implants used for augmentation or reconstruction in the United States were silicone devices.[38] At that time, to help provide concise talking points between doctors and cosmetic patients when discussing saline versus silicone implants, an article was published with a set of "salient points," which are listed in Table 2.[39] Since that publication, additional research comparing the newer generation of implants (currently, we are on the fifth generation[25]) and complication rates has been performed. Codner and colleagues found that the most common overall complication was capsular contracture with a rate of 8.2 percent at 6 years followed by rippling at 7.1 percent.[40] They found no significant difference when comparing rates of capsular contracture between saline and silicone implants over 6 years, and this was unaffected by pocket location. Rippling and size change were found to be the second and third most common complications in their study. Rippling was found more frequently when patients had saline implants placed in the subglandular position accompanied by a low body mass index of less than 18.5 kg/m^2.[40] Considering revision surgery, Stevens et al. found that changing implant size was the most common reason for reoperation when considering implant-related revisions after augmentation-mastopexy.[14] In their study, saline implants were used in 21 percent of the operations, and they concluded that 30 percent of all revision procedures were performed on those implants.

Additional advantages of saline implants include the use of a smaller incision for implant insertion, lower cost, and the ease of intraoperative volume adjustment. In addition, they are filled with sterile saline which, should it leak, poses no threat to the patient. Silicone, in contrast, better resembles a natural breast when compared to saline, has less rippling, and with the advent of the new form-stable or shaped implants, is argued by some to be more aesthetically pleasing.

Shaped versus Round

Limited literature has been published specifically looking at shaped versus round implants in augmentation-mastopexy patients, as the majority of the literature focuses on the primary augmentation cohort. Bengtson et al. described in their article looking at over 940 subjects with the Style 410 (Allergan, Inc., Dublin, Ireland) highly cohesive breast implant and showed the most common complication in primary augmentation was implant malposition (2.6 percent), with the remainder of all complications occurring in less than 2 percent of subjects.[41]

Another group used the same implant in reconstructive patients and found a similar rate of malposition (1.4 percent) but had a higher overall complication rate of 19.8 percent, with the majority being rippling and asymmetry.[42] This dramatic increase in complications can potentially be attributed to the reconstructive nature of the operation stemming from the disease process, thin flaps, and radiation exposure.

Nevertheless, Hedén et al. presented the six misconceptions regarding anatomical devices (Table 3) and argue that the following three key factors should be used to determine anatomical versus round implant: the patient's desires, the patient's anatomy, and the patient's surgical history.[43] They provide an algorithm to guide selection of shaped versus round implants, which they describe as being based on the authors' experience of performing over 20,000 such procedures.

Breast Implant Surface

Use of either a textured or smooth implant in augmentation-mastopexy is a hotly debated topic

Table 2. Salient Points to Convey to Patients Regarding Saline versus Silicone Implants*

1. Saline implants have an overall decreased capsular contracture and rupture rates compared with silicone breast implants.
2. Saline implants require a smaller incision for placement.
3. Rupture detection for silicone implants depends on magnetic resonance imaging, which the U.S. Food and Drug Administration recommends be performed periodically and which is likely not reimbursed by insurance. Saline implant rupture can be detected by physician and patient.
4. Primary breast augmentation surgery is not an isolated operation and implants will need to be replaced. Revision surgery is easier with saline than with silicone gel implants.
5. Patient satisfaction is high with both types of implant.
6. The cost of saline implants is roughly half that of silicone gel implants.
7. Both implant types require additional views to adequately image the breast.

*From Rohrich RJ, Reece EM. Breast augmentation today: Saline versus silicone. What are the facts? *Plast Reconstr Surg.* 2008;121:669–672.

Table 3. The Six Misconceptions Regarding Anatomical Devices*

Misconception	Explanation
1. There is little to no difference between anatomical and round implants.	In a patient with poor tissue coverage but desiring great projection, shaped implants have a distinct advantage in creating a more natural appearing breast.
2. Anatomical devices create an empty upper pole.	Anatomical implants have a more linear upper pole slope which is aesthetically desired; placing the implant too low can produce an empty upper pole and must be avoided.
3. Anatomical implants have a high risk of rotation.	Two prospective studies at 6 yr showed a rotation rate of 2.5%; use of the inframammary incision, precise pocket size, atraumatic technique, and prospective hemostasis act to reduce incidence of rotation.
4. Anatomical implants are overly complex for the surgeon to use.	There is a definite learning curve and process to using shaped implants, although this process should be applied to all augmentations and, once incorporated, shall become routine.
5. Anatomical implants are too firm.	Yes, these are a bit more firm; however, grade 2 capsular contracture produces a more "firm" implant than an anatomical implant.
6. Round implants are always suitable alternatives to shaped implants.	Round implants have a fixed width and height. In patients with a well-defined inframammary fold and short nipple-to-fold distance, round implants may produce contour irregularities such as the "double-bubble" phenomenon.

*From Hedén P, Montemurro P, Adams WP Jr, Germann G, Scheflan M, Maxwell GP. Anatomical and round breast implants: How to select and indications for use. *Plast Reconstr Surg.* 2015;136:263–272.

both because of strong opinions on both sides, and the current climate regarding breast implant–associated anaplastic large cell lymphoma (BIA-ALCL) risk with a possible link to textured devices. Textured implants are associated with lower rates of capsular contracture when placed in the subglandular plane, an advantage that appears to disappear when the implant is placed subpectorally.[44] Others argue in support of texturing, stating that it allows for better tissue incorporation into the implant shell, increasing its adherence to the chest wall.[25] However, recently, the identification of a rare cancer termed breast implant–associated ALCL has gained momentum. BIA-ALCL was first diagnosed in 1994 and, by 2006, the number of patients diagnosed was 11. Currently, the U.S. Food and Drug Administration has reported 359 adverse reports associated with BIA-ALCL, which is an exponential increase, likely partially because of increased levels of awareness and reporting, but concerning all the same. The current hypothesis suggests that chronic inflammation, which accompanies biofilms and bacterial burden, leads to stimulation of T cells, which have been linked as a potential inciting factor in BIA-ALCL.[45] Textured implants result in an increased surface area compared with smooth implants and thus the possibility of supporting a greater bacterial load. There are some early indications that the more severe the texturing (nano versus micro versus macro), the larger the overall surface area, and thus the larger the possibility of supporting additional bacterial contamination.[46] The incidence of the disease has been closely associated with these textured devices and their ability to support biofilm formation from such bacteria as *Ralstonia* species.[45,47] For patients, these data suggest a lifetime risk of developing this disease ranging from one in 1000 to one in 30,000 with textured implants.[48] Not all textured devices are made equally, and three texturing processes are widely used today. Mentor (Irvine, Calif.) uses negative imprinting or stamping of their implants to produce the textured surface, whereas Sientra (Santa Barbara, Calif.) uses ammonium carbonate and heat.[49] Allergan, which possesses the most aggressive macrotextured surface that results in an increased surface area, uses sodium chloride crystals to create their textured surface.[50,51] Despite the previously mentioned hypothesis, as of March of 2018, the American Society of Plastic Surgeons has stated that there is no definitive evidence that increasing the surface area of the implant is directly associated with the development of BIA-ALCL.[52] At this time, there are no reported cases of ALCL in patients exposed to only smooth breast implants.[53]

Implant Location

Pocket creation for implant placement relies largely on the upper pole pinch test to determine adequate upper pole fullness in combination with an assessment of the skin envelope and glandular tissue that will drape over the implant.[23] Patients without adequate volume and less than 2 cm on the upper pole pinch test will likely require subpectoral implant placement to attain sufficient soft-tissue coverage. Subpectoral placement predisposes patients to implant malposition with lateralization and animation deformity but carries a lower risk of capsular contracture and revision procedures when compared with placement in a subglandular pocket.[54] Castello and colleagues went as far as

creating an algorithm for step-by-step pocket selection that uses upper pole pinch, grade of ptosis, and breast volume in the decision-making tree.[29]

The "dual-plane" technique is a common variation of the subpectoral implant pocket in that the implant rests under the muscle superiorly; however, to help create a more aesthetic contour of the breast, the muscle is released from the anterior glandular tissue, allowing the implant to interface with the glandular tissue inferiorly to varying degrees.[11] Benefits of the dual-plane technique include reduced edge visibility, reduced risk of lateral implant displacement with maintenance of the upper pole fullness, minimal stretch on the pectoralis muscle thus decreasing pain, and increased control of the inframammary fold.[55]

Placing the implant pocket entirely above the pectoralis muscle has some advantages. Sbitany looked at patients undergoing breast reconstruction and noted that subglandular implant placement leads not only to elimination of the animation deformity with less implant-deforming forces but also to less pain.[56] They propose that the reduction is secondary to elimination of muscle stretch and spasm, which is avoided by not having to elevate the muscle. In contrast, Brown compared 200 subfascial breast augmentations with 83 submuscular augmentations and showed no statistically significant variation in complications or patient satisfaction when comparing the two pocket locations.[57]

OPERATIVE COURSE

Approach to the Patient

After careful assessment of the patient, operative planning centers on understanding of the various methods used for augmentation-mastopexy and their advantages and common pitfalls, to plan the best individualized procedure. Despite a multitude of approaches, specific consideration must be made in considering scar formation and pattern, given that this will be central to the patient's daily visual experience[58] (Fig. 3). Each approach portends a different scar layout, some of which can be difficult to conceal. Here, the most common methods of performing augmentation-mastopexy are reviewed, and some of the new and emerging adjunctive techniques that surgeons can use to enhance or complement the procedure are discussed.

Augmentation

Patients presenting with the nipple at the inframammary fold or above it with the gland predominantly located at the fold (pseudoptosis) or slightly below can frequently be managed with augmentation alone.[59] One advantage to performing a combined procedure is having the ability to abort the mastopexy after the augmentation should the on-table result be aesthetically pleasing. If the surgeon finds that the nipple is below the maximal projecting point on the breast, two options are available to correct this: using a shaped implant or performing a mastopexy. Shaped implants can offer a very slight degree of nipple elevation because of the nature of the upper pole slope and inferior pole projection.[43,60] The degree of elevation is slight, usually less than 1 cm, but it can prevent an additional procedure (which carries the burden of additional scarring) and still produce an aesthetically pleasing result. Others have found that after initial implant placement through a periareolar incision into the subpectoral pocket, the natural settling of the implant, which occurs over the next 6 to 8 months, will result in elevation of the nipple-areola complex to the desired location without the need for a mastopexy.[61] They argue that by staging the operation in this type of patient, one can potentially avoid unnecessary scarring and trauma to the breast. Should the surgeon require a mastopexy, crescent and circumareolar techniques are reasonable options for minimal distance nipple elevation, especially if the periareolar approach is used for the augmentation.[58]

Crescent

Crescent mastopexy, as described by Puckett et al., is directed at patients requiring a minimal lift of 1.5 to 2 cm[62] (Fig. 4). Their experience showed adequate results in 26 patients, although they found that 46 percent of cases resulted in a widened scar, which is a drawback to performing any incisions around the nipple-areola complex. Gruber and colleagues made additional modifications to the crescent mastopexy by excising two triangles of only parenchyma at the 3- and 9-o'clock positions, which act to reduce the tension on the crescent incision closure and decrease the widening of the nipple-areola complex[63] (Fig. 5).

Periareolar/Circumareolar

Should the breast require a lift greater than 1 to 2 cm, the circumareolar mastopexy not only can provide a higher lift but allows for parenchymal redistribution (Fig. 6). A superiorly oriented vertical component can be added to permit even greater nipple elevation (Fig. 7). Although it is

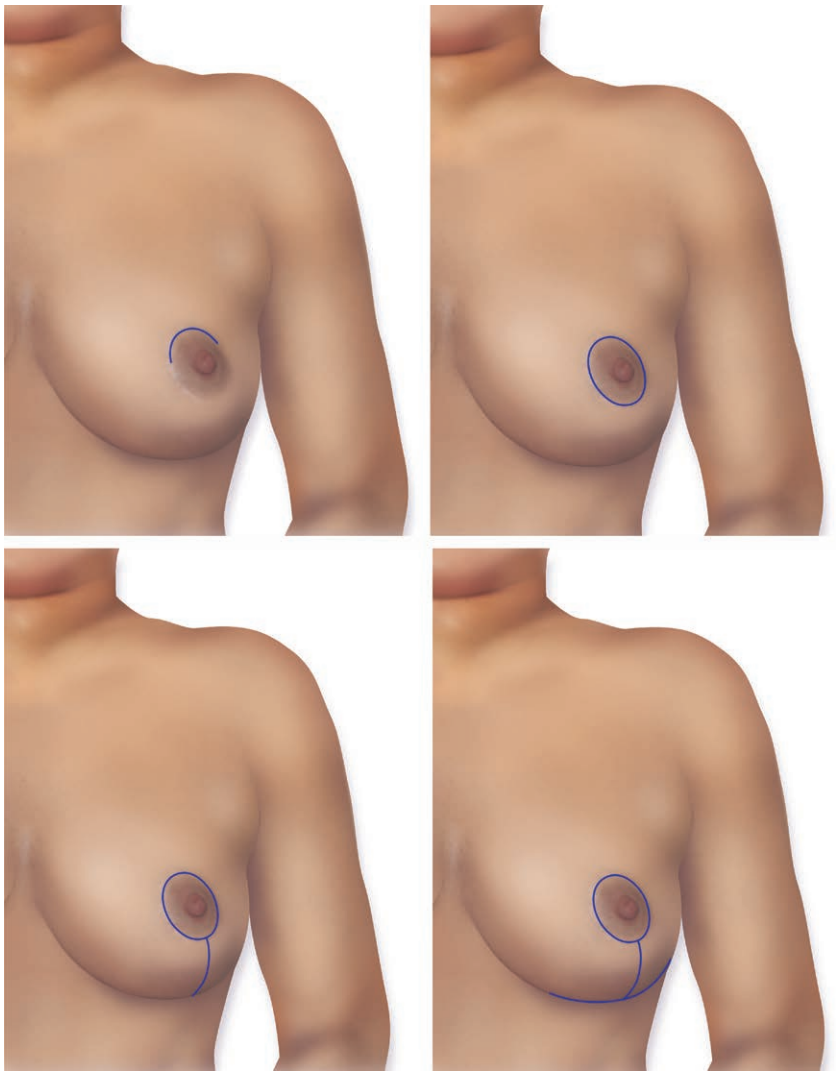

Fig. 3. Scar formation on the breast after various skin excision patterns. (*Above*, *left*) Crescent mastopexy scar. (*Above*, *right*) Circumareolar mastopexy scar. (*Below*, *left*) Circumvertical mastopexy scar. (*Below*, *right*) Wise-pattern mastopexy scar.

able to lift the nipple-areola complex a greater distance, one must account for some of the consequences, including additional scarring, loss of sensation, a larger areola with a flat nipple, and the potential for a flattened breast.[64] Spear and colleagues describe three rules to prevent widening of the areolar scar with this technique (Table 4).[64] Their rules focus predominantly on the forces exerted onto the new nipple-areola complex from the native breast skin pulling outward and the new nipple-areola complex pulling centrally. Essentially, the balance of those two forces will determine the position of the suture line and, should the forces be greater in either direction, can lead to widening of the scar.

Widening of the nipple-areola complex is one of the greatest drawbacks to the circumareolar mastopexy,[65–67] and various closure techniques have been described in an attempt to prevent this phenomenon.[67,68] Hammond et al. wrote one of the cornerstone articles detailing the "wagon wheel" method using Gore-Tex (W. L. Gore & Associates, Flagstaff, Ariz.) suture.[69] They describe the creation of a 5-mm dermal flap on the outer periareolar incision with undermining of 1 to 2 cm circumferentially.[69] Whereas the wagon wheel technique with Gore-Tex offers promise, others have abandoned circumareolar skin incisions altogether. Doshier and colleagues, in their series of 297 augmentation-mastopexy patients, found an increased incidence of areola widening in the circumareolar group, despite using the permanent suture, and ceased performing the technique.[32] They cite that despite using a permanent

Fig. 4. Crescent mastopexy is denoted by the crescent-shaped area above the nipple-areola complex, which is deepithelialized, and the nipple is secured at the new 12-o'clock position.

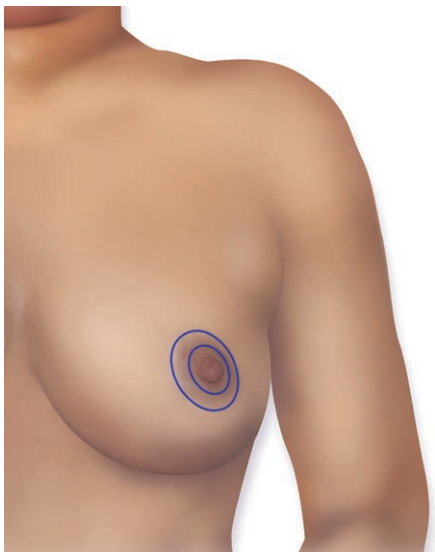

Fig. 6. Periareolar mastopexy with inner and outer incision as above; the area between the lines is deepithelialized and subsequently closed.

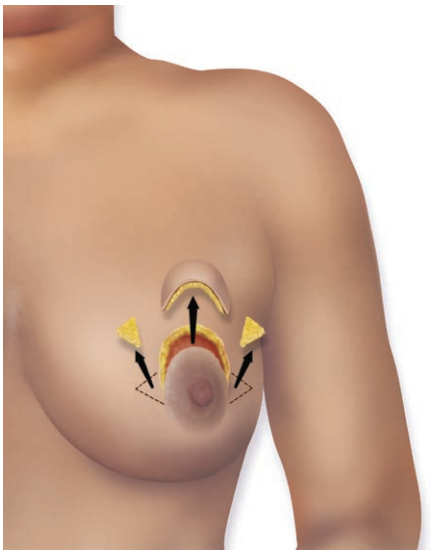

Fig. 5. Crescent augmentation-mastopexy with the Gruber modification. This is reserved for larger crescents to avoid bunching at the 3- and 9-o'clock positions. The upper crescent is excised as a full-thickness specimen, and two triangles of subcutaneous tissue at the 3- and 9-o'clock positions are excised to allow the nipple-areola complex to travel a farther distance and to reduce the tension on the closure of the nipple-areola complex to avoid widening of the scar.

Fig. 7. Circumareolar mastopexy with a superior vertical extension. Circumareolar mastopexy marking with superior extension allows for greater distance of nipple elevation than standard circumareolar mastopexy.

suture, extrusion and suture visibility continued to adversely affect their results.

Circumvertical

To decrease the tension on the areola and help address the excess skin envelope frequently found to accompany ptotic breasts, an inferiorly oriented vertical component can be added to the circumareolar mastopexy (Fig. 8). A true workhorse technique, the circumvertical mastopexy is an ideal choice for patients with ptosis grade 2 or 3, significant breast overhang (>3 cm), nipple location at 2 cm or more below the fold, or nipple-to-fold distance greater than 9 cm.[29] (**See Video, Supplemental Digital Content 2**, which displays the intraoperative markings. This video is

Table 4. Three Rules for Circumareolar Mastopexy*

1.	Diameter of the outside circle must not exceed the original areola by more than the difference between the diameter of the new areola and original areola.
2.	The diameter of the outside circle is not larger than two times the diameter of the inner circle.
3.	Final diameter of the final areola will be half of the sum of the diameter of the outside plus the inside.

*Spear SL, Kassan M, Little JW. Guidelines in concentric mastopexy. *Plast Reconstr Surg.* 1990;85:961–966.

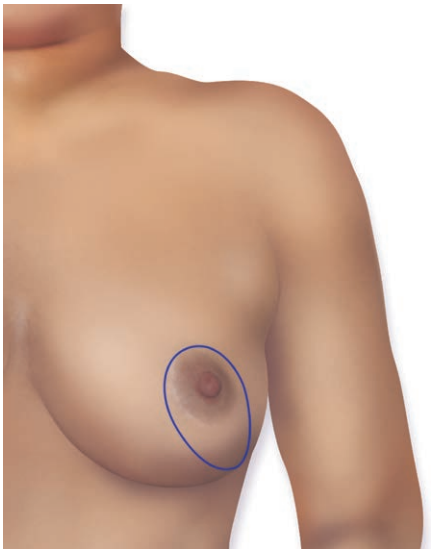

Fig. 8. Circumvertical mastopexy with inferiorly oriented vertical component.

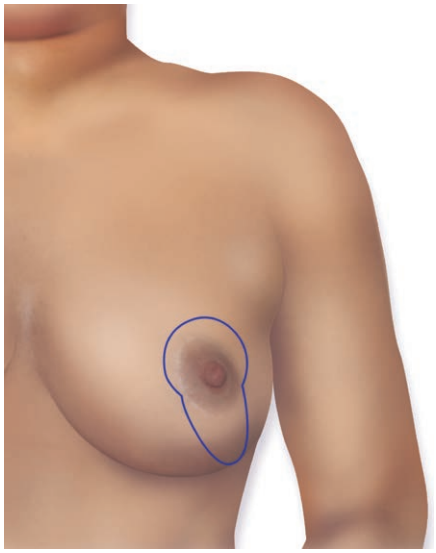

Fig. 9. Vertical mastopexy with circumareolar extension to allow repositioning of the nipple-areola complex with the vertical mastopexy.

available in the "Related Section" of the full-text article on PRSJournal.com or at **http://links.lww.com/PRS/D73**.) The circumvertical augmentation-mastopexy allows for implant insertion and the removal of additional skin and soft tissue from

Video 2. Supplemental Digital Content 2 displays the intraoperative markings. This video is available in the "Related Section" of the full-text article on PRSJournal.com or at **http://links.lww.com/PRS/D73**.

the inferior pole combined with a reduction of the areola.[70] Implant insertion is easily performed through the vertical component and provides access to the subglandular or submuscular plane.[24] After implant insertion, tailor-tacking is again performed to determine the exact horizontal tissue excess, with care taken to avoid descending below the inframammary fold and onto the abdomen. (**See Video, Supplemental Digital Content 3**, which displays the pedicle and vertical incisions. This video is available in the "Related Section" of the full-text article on PRSJournal.com or at **http://links.lww.com/PRS/D74**.) Once the correct tissue envelope has been determined, the nipple and its surrounding parenchyma are released to provide enough superior mobility to permit inset with minimal tension or risk of vascular compromise.

The pattern of skin excision and the type of pedicle used to recreate an ideal nipple-areola complex and breast shape are two distinct entities. Various techniques using a number of different pedicles have been described in the literature.[7,71,72] Most frequently, a superior or superomedial pedicle is the ideal choice to allow transposition of the

Video 3. Supplemental Digital Content 3 displays the pedicle and vertical incisions. This video is available in the "Related Section" of the full-text article on PRSJournal.com or at **http://links.lww.com/PRS/D74**.

Video 4. Supplemental Digital Content 4 displays pocket adjustment technique. This video is available in the "Related Section" of the full-text article on PRSJournal.com or at **http://links.lww.com/PRS/D75**.

nipple to the new location while preserving the blood supply and innervation.[24,72]

A permutation of the circumvertical technique is the vertical mastopexy, which can be used for patients with similar criteria as for the circumvertical technique. In the vertical mastopexy, an ellipse of tissue is removed from just below the areola to just above the inframammary fold. Through principles of geometry, once the two vertical pillars are brought together, they result in an elongation of the vertical vector, thereby raising the nipple.[70] Should nipple repositioning be required, the superior portion of the ellipse can include the areola as well (Fig. 9). This technique also allows for the removal of excess skin, reduction of areola, and elevation of the nipple. However, in patients with a smaller breast and wide areola, who have a short distance from the nipple to inframammary fold, this technique can be quite challenging.[70] (**See Video, Supplemental Digital Content 4**, which displays pocket adjustment technique. This video is available in the "Related Section" of the full-text article on PRSJournal.com or at **http://links.lww.com/PRS/D75**. **See Video, Supplemental Digital Content 5**, which displays tailor tacking and inferior pole excision. This video is available in the "Related Section" of the full-text article on PRSJournal.com or at **http://links.lww.com/PRS/D76**.)

Patients with an ideal nipple position and minimal ptosis but excess skin over the lower pole have another option for augmentation-mastopexy with a smaller scar burden, known as the Y-scar technique.[73] This modification preserves the interface of the native nipple-areola complex with the upper breast skin, thus limiting the scar to the inferior aspect of the areola. The vertical component, when added to this pattern, produces a Y-scar vertical mastopexy, creating tightening of the lower pole with minimal nipple adjustment.[73,74]

Occasionally, an excess amount of tissue can result on the inferiormost aspect of the vertical limb and can be managed with several techniques. Lista et al. describe a box stitch that pulls the excess tissue centrally, permitting skin closure.[75]

Video 5. Supplemental Digital Content 5 displays tailor tacking and inferior pole excision. This video is available in the "Related Section" of the full-text article on PRSJournal.com or at **http://links.lww.com/PRS/D76**.

Fig. 10. Before-and-after photographs of augmentation-mastopexy. (*Above*, *left*) Preoperative anterior view. (*Above*, *center*) Preoperative oblique view. (*Above*, *right*) Preoperative lateral view. (*Below*, *left*) Postoperative anterior view after the patient underwent augmentation-mastopexy with a vertical mastopexy with circumareolar extension and direct excision of full-thickness excess tissue along the inframammary fold. (*Below*, *center*) Postoperative oblique view and (*below*, *right*) postoperative lateral view.

Other techniques describe subcutaneous excision of the excess tissue with triangular parenchymal excisions, leaving the skin intact.[24] Yet another technique involves the excision of small triangular skin and subcutaneous tissue specimens, creating a short horizontal component at the inferiormost aspect of the vertical component.[29] This excision and creation of two small horizontal incisions along the inframammary fold are a segue into the inverted-T technique below. Other creative ways of dealing with the excess skin and soft tissue in the inferior pole have also been published[76–78] (Fig. 10). (**See Video, Supplemental Digital Content 6**, which displays pedicle elevation and final closure. This video is available in the "Related Section" of the full-text article on PRSJournal.com or at **http://links.lww.com/PRS/D77**.)

Inverted-T

The inverted-T technique is largely reserved for grade 3 ptosis in that it removes the largest amount of skin and soft tissue but leaves the most scar burden on the breast[58] (Fig. 11). The scar shape is frequently described as an anchor pattern and has both a horizontal and vertical component combined with periareolar. Avoiding hypertrophic scar formation hinges on a tension-free closure, and placement of the incision just above the inframammary fold acts to prevent the scar's visibility.[58] Beale et al. described their approach to the inverted-T using the transposition of the inframammary fold onto the breast meridian with the standardization of 8-cm vertical limbs in combination with a small implant placed in the subpectoral pocket to produce reliable results with minimal skin flap necrosis.[31] The inverted-T augmentation-mastopexy allows for the greatest excision of skin and redistribution of breast parenchyma, which is especially important in massive weight loss patients.[70]

Video 6. Supplemental Digital Content 6 displays pedicle elevation and final closure. This video is available in the "Related Section" of the full-text article on PRSJournal.com or at **http://links.lww.com/PRS/D77**.

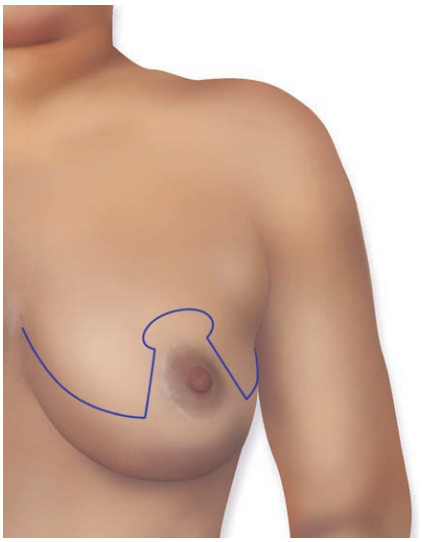

Fig. 11. Inverted-T mastopexy removes the largest amount of tissue and skin for patients with grade 3 ptosis but also produces the largest scar burden.

With weight loss surgery becoming the most common general surgery procedure in recent years, being able to manage the challenges these patients present is imperative. Typical characteristics of the breast in a massive weight loss patient include loss of skin elasticity, grade 3 ptosis with medialization of the nipple-areola complex, a lateral chest roll, asymmetry, and a loss of overall volume not confined to the upper pole.[79–81] A large component of breast surgery when working with the massive weight loss patient is the approach to parenchymal redistribution, various dermal suspension techniques, and the principle of autoaugmentation. Rubin et al. described their technique of dermal suspension reshaping where they used a Wise pattern and created and secured a central dermoglandular flap to the second rib periosteum, with the medial and lateral flaps sutured around the central pedicle to produce an autoaugmented, rounded breast.[79] They found seroma formation and wound healing to be the most frequent complications in their series of breast patients. Coombs et al. presented one of the first series looking at augmentation-mastopexy in massive weight loss patients using a single stage; a submuscular pocket; and either a periareolar, inframammary, or transaxillary approach. In their series of 30 patients, they found that postoperative ptosis was present in 17 percent of their patients at 3 months, and they had an overall implant malposition rate of 62 percent. They postulate that using textured implants might help prevent these potential complications in this subset of patients.[80]

ADJUNCTIVE THERAPY

The past 10 years have seen a dramatic increase in the number of adjunctive therapies that have become available to surgeons promising better results. Some of these therapies rely on existing technology (e.g., liposuction), whereas others use new devices (e.g., energy-based nipple elevation). Most devices promise results with minimal downtime and scarring, and frequently come with a large price tag. We perform a review of this emerging technology and its potential use in breast augmentation and mastopexy but stress caution to the operating surgeon. Randomized controlled trials are the definitive processes that assign credibility to claims and provide objective evidence when comparing one result to a control or measuring the results' reproducibility. Please review all available data on these new technologies before investing in an unknown procedure or technology. Below is a focused and brief review.

Liposuction

Liposuction has been used for breast reduction with great success. Studies cite the high complication rates seen with standard breast reductions and offer liposuction as a means of minimizing complications. Specifically, they state that lipoplasty-only breast reduction can reduce breast size by up to two cup sizes, minimize scars, and retain nipple sensation and the ability to breast feed.[82] In a study of 475 lipoplasty-only breast reductions, Gray cites that, on average, 800 ml of volume is removed, which results in skin contraction, producing an average elevation of the nipple by 6 cm.[82] Another study went on to show the safety and reliability of the liposuction-augmentation mammaplasty by comparing it to mastopexy-augmentation mammaplasty. The study examined 359 patients and found that, by combining augmentation through an inframammary fold incision and liposuction focused on the lower pole of the breast (where the predominant concentration of fat is located), they were able to achieve a 6 percent change in the sternal notch–to-nipple distance.[83] The revision rate was only 2.5 percent in the liposuction group, and the mean operative time for bilateral procedures was 46 minutes compared with 90 minutes for standard augmentation-mastopexy. Although liposuction is certainly not indicated in all cases, its role as an adjunct in breast surgery is increasing and, given its accessibility to the plastic surgeon, likely will continue to grow.

Fat Grafting

The past decade has seen a shift in the management of revision breast surgery. Patients with minor volume deficiencies and asymmetries can be safely managed with autologous fat transfer, which can often be performed in an office-based setting under local anesthesia.[84] The effectiveness of fat grafting to the breast has previously been validated, including a study by Spear and Pittman, where they showed breast lipoaugmentation to produce modest increases in size with high subjective patient satisfaction.[85] Bresnick describes his experience using fat grafting to manage patients presenting with the double-bubble deformity after breast augmentation.[86] In particular, he found that the majority of patients needed two procedures where, on average, 27 cm^3 of volume was injected to correct the defect. In his patient cohort, he found no oil cysts, infections, or donor-site problems. Injection of autologous fat does carry with it an inherent reabsorption rate, which has been shown to be approximately 25 to 29 percent at 1 year, and must be considered during the procedure.[87] In light of the increasing trends in the use of fat grafting, the American Society of Plastic Surgeons has issued guiding principles regarding fat transfer and postoperative cancer surveillance, variability in results related to surgeon experience, and its safety and efficacy.[88]

Mesh

Use of adjunctive materials in revision breast surgery has been at the forefront for almost two decades.[89] Since its introduction in 2001, acellular dermal matrix has played a role in correction of primarily four areas of revision breast surgery: implant malposition, capsular contracture, ptosis, and rippling.[90] The efficacy of acellular dermal matrix use is related to its ability to help create a well-balanced and symmetric pocket that will hold the implant securely and provide a rigid attachment to the chest to help avoid malposition.[91,92] Spear et al. showed that Strattice (LifeCell Corp., Branchburg, N.J.), an acellular dermal matrix, can be used not only in revision breast surgery but also in primary cosmetic breast surgery (i.e., augmentation-mastopexy) to provide inferior pocket support.[91] Hester et al. used acellular dermal matrix in 45 revision operations and in 49 primary augmentation or mastopexy patients in an effort to combat capsular contracture at the onset. In the primary augmentation or mastopexy group, they had no significant capsule formation identified, with 41.3 percent of the patients having at least 1 year of follow-up.[92] Adams and Moses changed gears and took a widely used resorbable monofilament mesh, poly-4-hydroxybutyrate, and used it to reconstruct the lower pole in 11 difficult mastopexy patients and found that at 1-year follow-up, patients experienced a minimal (5 percent) stretch in the lower pole.[93] Thus, the use of mesh continues to broaden, a trend likely to continue to primary breast surgery with an aim of minimizing complications, most notably capsular contracture, and securing the implant and preventing migration, thus decreasing reoperation rates.

Energy-Based Nipple Elevation

Energy-based devices were introduced in 1983 [e.g., BodyTite (Invasix, Yokneam, Israel); ThermaCool TC System (Thermage, Hayward, Calif.); and Miratone Fractional Radiofrequency System (Primaeva Medical, Inc., Pleasanton, Calif.)] and have increased in number over the past decade.[94] Radiofrequency has been used by dermatologists and aestheticians for the treatment of minor rhytides and nonablative skin tightening, especially on the lower face and neck. The technology generates a fractional thermal injury to collagen, which induces an inflammatory reaction.[95,96] Through this reaction, new collagen, elastin, and hyaluronic acid are generated, which leads to tissue remodeling and, in effect, a tightening of the dermis.[96] A recent blinded, randomized study published in *JAMA Dermatology* compared a standard face lift to a minimally invasive fractional radiofrequency system. The study showed a 0.44-laxity grade improvement, which was 37 percent of the improvement seen after a standard face lift, using this noninvasive system without adverse events.[97] Another study took 14 patients who underwent a series of four to six weekly treatments and found that 10 of 14 (71 percent) had moderate to significant clinical improvement in their face and neck.[98] Other recent studies show improvement in the tightening of skin of the arms and abdomen with the addition of radiofrequency, compared with standard liposuction, indicating a possible novel method of achieving skin tightening and elevation.[99,100] Although the technology was applied to the face, arms, and abdomen, devices are now emerging on the market aimed at multiple body regions, including the breast.

COMPLICATIONS

Multiple studies have shown that, for the appropriate patient, a single-stage augmentation-mastopexy can be a safe and effective procedure

to reconstruct the ptotic breast. The Mentor Core Study revealed a 15.4 to 28 percent reoperation rate[101,102] in primary augmentation patients, and recent studies show an implant-associated revision rate of approximately 10 percent in augmentation-mastopexy patients.[103] Spear and colleagues showed an overall 17 percent complication rate in primary augmentation-mastopexy and a 23 percent rate in revision augmentation-mastopexy in their study examining data over a 3-year period.[104] Khavanin et al. performed a metareview of 23 studies looking at single-stage augmentation-mastopexy and found an overall complication rate of 13.1 percent, with a revision rate of 10.7 percent.[6]

When looking at the specific complications, Stevens et al. showed that the most common complication in 615 patients was poor scarring at 5.7 percent, followed by wound healing issues at 2.9 percent, and areola asymmetry at 1.9 percent.[14] Doshier and colleagues showed similar trends in poor scarring and areola asymmetry groups but also found a high rate (10.3 percent) of loss of nipple sensation.[32] Complication rates are shown in Table 5 comparing the patient cohorts reported by Stevens et al., Doshier et al., and Calobrace et al. An encompassing systematic review published by Khavanin et al. revealed that the most common individual complication was recurrent ptosis at 5.2 percent, followed by poor scarring, capsular contracture, and tissue-related asymmetry, which accounts for some technique variation and variability between the studies.[6]

Revision rates can be difficult to isolate because, frequently, patient expectations can be a large factor leading to revision surgery, thus obfuscating the data.[105] Nevertheless, the review by Khavanin et al. stated that in 13 studies, average reoperation rates of 10.65 percent were identified; however, when extended out for at least a 1-year follow-up, those numbers increased to 16.13 percent.[6] Most common indications for revision among augmentation-mastopexy patients include the desire to change implant size and poor scarring (Table 6).

CONCLUSIONS

Interest continues to grow in single-stage augmentation-mastopexy, as it can avoid a second anesthetic event and avoids the additional costs associated with additional procedures, and recent evidence has shown that patient satisfaction can be met. The postulated exponential risk in complications from the combination of these two procedures has been shown to be additive and consistent with the risk of the individual procedures alone. Certain patients, especially the growing number of massive weight loss patients,

Table 5. Complications in Augmentation-Mastopexy

	Stevens et al.[14] (%)	Doshier et al.[32] (%)	Calobrace et al.[103] (%)
Total no. of patients	615	106	235
Complication			
Poor scarring	35 (5.7)	10 (9.7)	5 (2.1)
Wound healing	18 (2.9)	5 (4.7)	
Areola asymmetry	12 (1.9)	25 (12.4)	7 (3.0)
Recurrent ptosis	8 (1.3)	5 (4.7)	7 (3.0)
Loss of nipple sensation	8 (1.3)	11 (10.3)	
Infection	7 (1.1)		1 (0.4)
Breast asymmetry	7 (1.1)	2 (1.9)	5 (2.1)
Pseudoptosis	5 (0.8)		
Hematoma	4 (0.6)	7 (6.6)	2 (0.9)

Table 6. Indications for Revision in Augmentation-Mastopexy

	Stevens et al.[14] (%)	Doshier et al.[32] (%)	Calobrace et al.[103] (%)
Total no. of patients	615	106	235
Indications for revision			
Change implant size	31 (5.0)	2 (1.9)	6 (2.6)
Poor scarring	29 (4.7)	0 (0)	5 (2.1)
Implant deflation	15 (2.4)	0 (0)	1 (0.4)
Recurrent or persistent ptosis	7 (1.1)	2 (1.9)	7 (3.0)
Capsular contracture	7 (1.1)	0 (0)	7 (3.0)
Breast asymmetry	6 (1.0)	2 (1.9)	5 (2.1)
Implant infection	3 (0.5)		1 (0.4)
Implant malposition	3 (0.5)	1 (0.95)	3 (1.3)
Areola asymmetry	1 (0.1)	6 (5.7)	6 (2.6)

need individualized attention to address some of the tissue changes that occur, which might not be readily apparent. Thus, in capable hands, augmentation-mastopexy can be a safe and effective procedure for restoring aesthetic principles to the aging breast.

Jacob G. Unger, M.D.
Vanderbilt University Medical Center
Maxwell Aesthetics
2020 21st Avenue South
Nashville, Tenn. 37212
drunger@maxwellaesthetics.com

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