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Review

Systematic review of outcomes and complications in nonimplant-based mastopexy surgery

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Summary *Background:* Mastopexy is one of the most performed cosmetic surgery procedures in the U.S. Numerous studies on mastopexy techniques have been published in the past decades, including case reports, retrospective reviews, and prospective studies. However, to date, no study has investigated the overall complications or satisfaction rates associated with the wide spectrum of techniques.
Objectives: This review aims to assess the outcomes of the various mastopexy techniques, without the use of implants, thus focusing on associated complications, and to provide a simplified classification system.
Methods: This systematic review was performed in accordance with the PRISMA guidelines. PubMed database was queried in search of clinical studies describing nonprosthetic mastopexy techniques, which reported the technique, indication, and outcomes.
Results: Thirty-four studies, published from 1980 through 2016, were included and represented 1888 treated patients. Four main surgical technique categories were identified: dermal reshape, glandular reshape, glandular reshape associated with perforator flaps, and glandular

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reshape with mesh support. Despite varying techniques, mastopexy was generally found to be a reliable esthetic procedure with unsatisfactory breast shape, thus accounting for only 1.3% of the patients. The overall complication rate was 10.4%. The most represented complications were scar-related (3%, including hypertrophic or unesthetic appearance) and nipple–areola-related problems (2.9%; including distortion, asymmetry, and reduction in sensation).
Conclusions: Mastopexy techniques achieve high patient satisfaction and can be tailored according to patient needs and clinical presentation. Complication rates and morbidity are relatively low. However, a significant number of issues related to scars, asymmetry, and potential ptosis recurrence should be highlighted in the information provided to patients.

Contents

Introduction

Mastopexy is the seventh most performed cosmetic surgery procedure in the U.S. according to the latest American Society for Aesthetic Plastic Surgery (ASAPS) statistics.[1]

Extensive data in the literature show numerous studies in which a wide array of operative techniques is described. These techniques range from a simple dermal manipulation, with or without glandular reshaping, through the use of dermal flaps fixed to the pectoral fascia, to the use of synthetic mesh or sheets.

The esthetically ideal youthful breast should have minimal ptosis, without any part of its lower pole lying on the chest wall. In addition, the nipple should be located 5–7 cm from the inframammary crease along the breast meridian.[2] Apart from the role of the dermis in breast suspension, breast ptosis is partly due to the lower pole breast bulk weighing on Cooper's ligaments that will eventually weaken and provide little breast support.[3] In an attempt to regain this youthful esthetic ideal of minimal breast ptosis, many authors have proposed a support or "hammock" for the lower pole. The literature reveals many descriptions ranging from autologous dermal support[4,5] to the use of synthetic matrices to support the lower pole.[6–8] Some authors have even proposed the use of a pectoral muscle component to increase result durability.[9–11]

Many of the described surgical procedures aim to improve breast projection and upper pole fullness by remodeling some of the breast gland in addition to skin resection. Recently introduced by Kirwan et al., the concept of "autoaugmentation" refers to the use of an autologous, usually glandular, flap to increase upper pole fullness, thus avoiding the use of an implant.[2] The most common autoaugmentation performed among surgeons remains the use of a secondary inferior flap that is advanced upward into a space created under the superiorly based primary NAC pedicle.[3,12–24] Others have described alternative ap-

proaches that use a superiorly or superomedially based glandular advancement flap.[3,25-29]

Thus far, all techniques described to lift and reshape the breast include either one or a combination of the following components: dermal, glandular, and glandular associated with a flap or synthetic mesh. However, to date, no study has investigated the overall complications or satisfaction rates associated with the wide spectrum of techniques.

This comprehensive review aims to assess the outcomes of published mastopexy techniques (excluding prosthetic mastopexy-augmentation procedures) and to provide a clearer and workable classification system. From an educational point of view, the reader should be able to differentiate between the main mastopexy techniques. A clear understanding of the reported outcomes and complications for each of the techniques will allow the reader to determine a safe and effective surgical plan.

Material and methods

Search strategy

This review was conducted according to guidelines set forth in the Preferred Reporting Items for Systematic reviews and Meta-Analysis (PRISMA).[30]

A systematic literature search was conducted using PubMed to identify all articles involving surgical treatment of the breast ptosis. The following search terms were used: ("OR" functions of the following) mastopexy, breast lifting, breast lift), "AND" ("OR" functions of the following) etiology, epidemiology, classification, indications, treatment.

Publications were restricted to include English language studies only. No publication date restrictions were applied. The review was performed between January and March 2017.

Selection criteria

Inclusion and exclusion criteria were established before the search. Eligible levels of evidence included randomized controlled trials (RCTs), prospective studies, retrospective observational studies, case–control studies, case series, and case reports. Review articles and conference abstracts were excluded.

Only articles written in English were selected, thus describing female patients undergoing mastopexy for breast ptosis. Mastopexy surgery type included simple dermal tightening, glandular remodeling, local autologous flap augmentation mastopexies and mastopexies associated with the use of matrices. Exclusion criteria included articles in which mastopexy was combined with prosthesis and breast lift associated with parenchymal reduction and also studies on secondary mastopexy. Studies that did not adequately define the subjects with unclear description of the mastopexy technique, outcomes, or complications were excluded. To avoid quantitative bias, studies including less than 10 patients were also excluded from our quantitative analysis. They were, however, kept in the descriptive table (Table 1) for qualitative description.

Four reviewers (C.M.O., G.S., W.W., and P.D.S.) independently screened the search results for inclusion, through the assessment of titles and abstracts. The references of included studies were reviewed for other suitable studies, and this showed that 12 additional important papers that had been missed.

Data extraction

Four reviewers (C.M.O., G.S., W.W., and P.D.S) independently extracted data from the full texts of all included studies and populated a predesigned standardized table developed for this purpose.

The following data (where available) were extracted from full texts: first author, year of publication, study design; inclusion and exclusion criteria; number of patients; number of procedures; age; sex; indication for surgery; body site; type of surgery; surgical technique; and primary and secondary outcomes.

Because of the heterogeneity of the studies, statistical meta-analysis of the data was impossible. Instead, we performed qualitative and descriptive analyses of the outcomes.

Results

A total of 814 full-text articles were initially identified. After application of exclusion criteria, 41 articles were retained, published from 1980 through 2016 (Figure 1). Characteristics in all included articles are summarized in Table 1.

Six of them were prospective studies, while 35 were retrospective studies. None of the studies were randomized or controlled. After excluding 7 articles that included less than 10 patients, an overall of 1888 treated patients were represented (age range, 17–72 years). Four main technical approaches and their subcategories were identified (Figures 2–8): dermal reshape mastopexy (Type 1, $n = 82$), mastopexy with glandular reshape (Type 2, $n = 1489$), mastopexy with glandular reshape associated with perforator flap (Type 3, $n = 35$), and mastopexy with associated supportive mesh (Type 4, $n = 282$). Considering the variety of differences in glandular reshaping techniques, subcategories were identified according to the examined literature. Particularly, among glandular reshape (Type 2) techniques, we could recognize superiorly based (Type 2a), inferiorly/posteriorly based (Type 2b), and superomedially based (Type 2c) glandular remodeling techniques; all of these techniques directed to breast autoaugmentation. Similarly, among perforator flap reshape (Type 3) techniques, we could recognize flaps depending on thoracic/anterior intercostal artery perforator [ICAP] (Type 3a) and lateral ICAP (Type 3b) vessels.

All mastopexy procedures were bilateral. Many studies investigated outcomes using satisfaction questionnaires. Despite the lack of uniformity among studies, high satisfaction rates were generally reported. Complications occurred in 197 (10.4%) of the 1888 patients.

The overall incidence of scar-related complications (including hypertrophic or unesthetic appearance) that potentially required revision surgery was 3%.[29] Wound-related

Table 1 Characteristics of all 41 included studies.

Author (first listed), Year	Study design	No. of patients	Geographic location	Age of patients (y)	Mastopexy technique	Group	Indications proposed by the authors	General outcome including satisfaction	Complications
Gruber et al., 1980	Retrospective review	13	USA	Not reported	Scar: Circumareolar NAC: circumareolar de-epithelialization "Donut" mastopexy	**1**	Prominent NAC ("Snoopy deformity"), small ptotic breasts, moderate-sized ptotic breast, gynecomastia.	All patients satisfied, ptosis improved, sensation retained, at 9–42 months of follow up.	Globular-shaped breast, nipple discomfort, areola speeding ($n=13$), hypertrophic scar ($n=7$), recurrence of ptosis ($n=2$)
Elsahy, 1982	Retrospective review	12	USA	Range, 29–50	Scar: *T* NAC: Superior pedicle Parenchymal Redistribution/ Autoaugmentation "Hexagonal Technique"	**2a**	Mild degree of macromastia	Successfully applied in all patients (all patients satisfied with the results); follow-up: 6 months-2 years.	Scar revision ($n=2$); insufficient reduction of the breast ($n=1$); breast very small after mastopexy ($n=1$)
Svedman, 1991	Prospective study	10	Sweden	Range, 20–42; mean, 30	Scar: *T* NAC: Superior pedicle "Fold Over" De-epithelialized Lower Thoracic Fasciocutaneous Flap	**3a**	Moderate or severe breast ptosis	Pleasing shape and projection. Follow-up: 3–6 months.	None reported
Fayman et al., 1998	Retrospective review	22	South Africa	Range, 19–57; mean, 34	Scar: *T* NAC: Superior or Inferior according to SN-N or IMF-N distance Autoaugmentation by inferior or superior dermoglandular flap (opposite to NAC)	**2a/b**	Not specified	Pleasing and stable results up to 3.5 months of follow-up.	Delayed wound healing, $n=4$; minimal nipple retraction, $n=4$; hypertrophic scar $n=1$; reversible decrease in nipple sensation (third month), $n=3$
Flowers et al., 1998	Retrospective review	124	USA	Not reported	Scar: *T* NAC: Bipedicled Autoaugmentation flap deep to the bipedicled flap is anchored cranially to the fascia ("Flip/flap")	**2a**	Medium- to large-sized ptotic breast with lower pole excess	Long-term outcome without recurrence of ptosis (duration is not mentioned). Effective in medium-sized ptotic breast.	Skin flap necrosis, $n=2$

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Table 1 (*continued*)

Author (first listed), Year	Study design	No. of patients	Geographic location	Age of patients (y)	Mastopexy technique	Group	Indications proposed by the authors	General outcome including satisfaction	Complications
Botti, 1999	Retrospective review	24	Italy	Not reported	Scar: Vertical NAC: Superior pedicle Autoaugmentation by posterior dermoglandular flap	**2b**	Upper pole emptiness	The technique increases upper pole fullness and turgid appearance for at least 2 years postoperation and solves the upper pole fullness deficiency	Skin necrosis, $n=1$ Hypertrophic scar, $n=1$
Graf et al., 2002	Retrospective review	390	Brazil and USA	Not reported	Scar: *J* NAC: Superior pedicle Autoaugmentation by inferior glandular flap under pectoralis loop/sling	**2bm**		Maintenance of upper pole fullness, prevention of bottoming out.	Fat necrosis, $n=7$, unesthetic scars, $n=19$
Borovikov, 2004	Retrospective review	3	Russia	Not reported	Scar: *T* NAC: Superior pedicle Autoaugmentation by a myofascial flap inferiorly based as a lower pole support	**2am**	Recurrent bottoming out in secondary mastopexy, pseudoptosis, stabilization of lower pole, and IMF	Prevention of bottoming out, anchoring of the breast to the chest wall and avoidance of attraction toward the meridian line. Recommended for mastopexy together with implant.	Prolonged hypercorrection, $n=1$
De la Plaza et al., 2005	Perspective review	28	Spain	Range, 19–58, mean, 35	Scar: *T, J* NAC: Superior pedicle Autoaugmentation by superiorly based dermoglandular "Hammock" flap attached to pectoralis fascia	**2a**	Moderate ptosis and sufficient mammary volume	Appropriate in cases of moderate ptosis. Results maintained in long term with regard to breast shape and position. Early satisfactory result at patient and surgeon evaluation.	Partial dehiscence, $n=1$; hypertrophic scar, $n=2$

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Table 1 (*continued*)

Author (first listed), Year	Study design	No. of patients	Geographic location	Age of patients (y)	Mastopexy technique	Group	Indications proposed by the authors	General outcome including satisfaction	Complications
Kwei et al., 2006	Prospective review	5	USA	Range, 31-62; mean, 46	Scar: Extended *T* NAC: Inferior pedicle Autoaugmentation using an ICAP flap rotated around the inferior pedicle and anchored to the chest wall	**3b**	Massive weight loss, Upper body lift	The lateral and posterior excessive skin and subcutaneous tissue are eliminated by rotation into the breast. Breast ptosis is corrected with standard mastopexy.	None reported
Ritz et al., 2006	Retrospective review	52	Australia	Not reported	Scar: Vertical, *T* NAC: Superior, Superomedial, Superolateral Autoaugmentation by inferiorly based dermoglandular flap suspended behind pectoralis fascial strip	**2bm**	All grades of ptosis	Avoids cancer screening problem and contraction of PEC with less pain and bleeding and less OR time. Disadvantage: no anatomical plane to dissect the fascia from the muscle. Satisfaction of ptosis correction, 8.8/10; satisfaction of symmetry, 8.4/10; satisfaction of upper pole fullness, 9.1/10; postoperative medial breast fullness, 7.8/10; satisfaction breast contour, 8.4/10.	Hematoma, $n=1$; need for conversion to horizontal scar, $n=2$; hypertrophic scar, $n=1$

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Author (first listed), Year	Study design	No. of patients	Geographic location	Age of patients (y)	Mastopexy technique	Group	Indications proposed by the authors	General outcome including satisfaction	Complications
Foustanos et al., 2007	Retrospective review	110	Greece	Range, 18-70	Scar: *T* NAC: Superior pedicle Autoaugmentation using an inferior dermoglandular flap "Double-Flap technique"	**2b**		Pleasing result at surgeon's evaluation in all cases; the majority of patients were pleased with the result. Natural shape of the breast with a true permanent result at 10 years of follow-up.	Hypertrophic scar (treated using cortisone), $n=3$; reversible decrease in nipple sensation (third month), $n=2$
Kirwan et al., 2007	Retrospective review	24	Canada	Not reported	Scar: Vertical, *J*, *T* NAC: Superior pedicle Autoaugmentation using a posterior dermoglandular flap	**2b**	Empty upper pole with excess skin around the areola	Autoaugmentation of empty upper pole; the addition of a large periareolar mastopexy decreases the need for a vertical scar and less areolar distension.	Inadequate NAC elevation, $n=2$; inadequate lift, $n=1$
Graf et al., 2008[50]	Retrospective review	10	Brazil	Not reported	Scar: Extended *T* NAC: Superior pedicle Autoaugmentation using a thoracic Inferolateral glandular flap under pectoralis loop/sling	**3am**	Massive weight loss	Lateral chest wall used for autologous breast augmentation, ensures better upper pole fullness without lateral roll and minimal bottoming out.	None reported

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Table 1 (*continued*)

Author (first listed), Year	Study design	No. of patients	Geographic location	Age of patients (y)	Mastopexy technique	Group	Indications proposed by the authors	General outcome including satisfaction	Complications
de Bruijn et al., 2008	Retrospective review	170	The Nether-lands	Range, 17-65; mean, 41.7	Scar: *T*, Vertical NAC: Central pedicle Central mound Mastopexy with mesh reinforcement	**4**	Can be used to prevent the recurrent ptosis of contralateral correction after a rather rigid breast reconstruction with prosthesis.	Mesh implantation, acting as an internal bra. In no case, recurrent ptosis was observed.	Infection, $n=3$; skin necrosis, $n=3$; hematoma, $n=2$; mesh extrusion, $n=2$; nipple asymmetry, $n=3$; loss of nipple sensation, $n=8$; bottoming out, $n=3$, pathologic scars, $n=5$
Hamdi et al., 2009	Retrospective review	6	Belgium	Range, 40-54; mean, 48.5	Scar: Extended *J* NAC: Superior pedicle Autoaugmentation by lateral intercostal artery perforator flap (LICAP flap)	**3b**	Redundant skin and subcutaneous tissue in the lateral thoracic region.	Perforator dissection allows adequate rotation of the flap into the superomedial portions of the breast.	Seroma, $n=1$; wound dehiscence, $n=2$
Rubin et al., 2009	Retrospective review	91	USA	Range 18-60, mean $43.7+\backslash-9$	Scar: *T* NAC: Inferior pedicle Central dermoglandular pedicle is secured to the second rib periosteum with permanent braided suture. The lateral and medial flaps are raised and secured to the rib periosteum at lower levels.	**2b**	Massive weight loss in patients resulting from gastric bypass, laparoscopic banding, or exercise-induced weight loss.	Maintenance of upper pole fullness and a youthful appearing breast with adequate projection with low ptosis during the time. Suturing to rib periosteum negates the ability to augment the breast at the same time.	Seroma, $n=3$; wound dehiscence, $n=3$; skin flap necrosis, $n=2$

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Author (first listed), Year	Study design	No. of patients	Geographic location	Age of patients (y)	Mastopexy technique	Group	Indications proposed by the authors	General outcome including satisfaction	Complications
Honig et al., 2009	Retrospective review	27	Germany	Mean age, 48	Scar: *T* NAC: Superomedial pedicle De-epithelialized inferiorly based dermoglandular flap for autoprosthesis fixed to the thoracic wall behind the NAC	**2b**	Suitable for patients with small ptotic breasts who desire repositioning of their breasts with autogenous tissue.	Correction ptosis while increasing the projection and apparent volume of the breast. Optimization of the shape and volume of the breast without the use of an implant. The surgical outcome was evaluated according to analyses performed before and after surgery based on pre- and postoperative measurements. Esthetic results considered good to excellent in all cases; contour results stable in the long-term follow-up evaluation.	None reported

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Author (first listed), Year	Study design	No. of patients	Geographic location	Age of patients (y)	Mastopexy technique	Group	Indications proposed by the authors	General outcome including satisfaction	Complications
Panettiere et al., 2009	Retrospective review	54	Italy	Range, 22–69; Mean, 47.7	Scar: *T* NAC: N/A Mastopexy without dermal interruption and with sulcus blockage	**1**	The technique overcomes the choice of a pedicle because it implies no dermal interruption so that neurovascular section and lymphatic alterations are negligible.	Patients reported minimal (16 breasts, 19%) or null (69 breasts, 81%) changes in sensitivity 3 months after surgery, with no repercussions on social life. The overall satisfaction degree was high (5% high and 95% very high). Results: average score at 3 months: 9.62; at 2 years 9.84	Persistent sharp fovea, $n = 2$
Corduff et al., 2009	Retrospective review	25	Australia	Not reported	Scar: Vertical NAC: Superomedial pedicle Extended superomedial glandular rotational mastopexy	**2c**	The technique was successful in breast implant explantation, allowing a one-stage explantation and correction of associated ptosis.	Esthetic assessment of the results was done by showing the photographic series of the 25 patients to two beauty therapists and two receptionists, who were asked to score the photographic results after 1 year or longer as poor (1), average (2), good (3), or excellent (4): average 3.55, range 2.5–4.0	Seroma, $n = 1$, hypertrophic scar, $n = 2$, hematoma, $n = 1$, nipple asymmetry, $n = 3$

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Author (first listed), Year	Study design	No. of patients	Geographic location	Age of patients (y)	Mastopexy technique	Group	Indications proposed by the authors	General outcome including satisfaction	Complications
Thornton et al., 2010	Perspective review	6	United Kingdom	Not reported	Scar: Extended *T* NAC: Large inferior pedicle Lateral thoracic perforator flap to fill upper pole	**3b**	Transposition of this flap reduces lateral chest wall excess, and extension of the vertical donor site scar across the axilla can easily incorporate the brachioplasty excision.	The vascularity of the flap is particularly robust in MLW patients, as vessel hypertrophy achieved with weight gain is preserved following weight loss. Extension of the vertical donor site scar across the axilla can easily incorporate the brachioplasty excision. Robust augmentation with more natural-looking ptotic breasts while avoiding the cost and potential complications of implant augmentation.	Seroma, $n=1$; pathologic scar, $n=1$
Katsaros et al., 2010	Retrospective review	50	Australia	Not reported	Scar: T NAC: Inferior pedicle Triplicated inferior pedicle mastopexy: The medial and lateral parenchymal columns are then sutured together superiorly to create a cone of tissue around the middle pedicle.	**2b**	The technique that overcomes the shortfalls of the inferior pedicle technique and its tendency to inferior descent (pseudoptosis or bottoming out) has been developed.	Combating the complication of "bottoming out" commonly associated with an inferior pedicle breast reduction. Achievement of fullness of the upper pole, which appears to persist with time.	Delayed healing, $n=2$; fat necrosis, $n=4$; re-operation, $n=1$

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Table 1 (*continued*)

Author (first listed), Year	Study design	No. of patients	Geographic location	Age of patients (y)	Mastopexy technique	Group	Indications proposed by the authors	General outcome including satisfaction	Complications
Goes et al., 2010	Perspective study	5	Brazil	Range, 17-41	Scar: Vertical NAC: Posterior pedicle Use of FortaPerm tissue matrix wrapped around as an adjunct to the periareolar double-skin technique	**4**	The addition of a mesh between the skin layers provides even more support, thereby resulting in a more satisfactory, long-lasting outcome.	This material eventually incorporates into the host tissue, thus eliminating the risk of future infection posed by nonabsorbable synthetic meshes while providing the necessary biomechanical strength and persistence to support the breast tissue not offered by absorbable synthetic meshes. All outcomes were rated as average to excellent. Four patients were judged to have no ptosis and one to have mild ptosis. None were judged to have asymmetry of the breasts, and no adverse events were reported. Patient satisfaction was rated average to excellent.	Seroma, $n = 2$; extrusion of the material, $n = 1$

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Table 1 (*continued*)

Author (first listed), Year	Study design	No. of patients	Geographic location	Age of patients (y)	Mastopexy technique	Group	Indications proposed by the authors	General outcome including satisfaction	Complications
Kim et al., 2010	Retrospective review	34	USA	Range, 22–47	Scar: Circumvertical NAC: Superior pedicle Transposition of the glandular tissue to restore central mound projection + narrowing the lower breast base and raising the inframammary crease.	**2a**	Patients were selected preoperatively on the basis of the presence of wide, low-lying breasts lacking central projection. Patients expressed a desire to have a more youthful breast without the addition of an implant.	Restoration of central mound projection, narrowing the lower breast base, raising the inframammary crease, achievement of a more youthful breast shape.	Seroma, $n = 2$; fat necrosis, $n = 1$
Honig et al., 2010	Retrospective review	27	Germany	Mean age, 54	Scar: Vertical NAC: Superior pedicle Inferior pedicle autoaugmentation after breast implant removal	**2b**	In patients who would like a reposition augmentation mammaplasty after breast implant removal but would reject the use of a new implant after implant removal because of capsular contracture.	Minimization of skin scar in cases using vertical mammaplasty techniques and optimization of the breast shape after breast implant removal in patients who do not want a new implant.	None reported
van Deventer et al., 2010	Retrospective review	106	South Africa	Range, 16–68; mean 40	Scar: Periareolar, vertical, or inverted-T NAC: Posteroinferomedial pedicle Retaining the medial vertical ligament of Wuringer	**2b**	The safety of the nipple–areola complex is greatly enhanced by adding the blood supply of the perforating branches of the internal thoracic artery to the inferior pedicle.	Satisfactory breast shape, nipple projection, and upper breast fullness can be obtained (Figures 8 and 9). All of the patients were satisfied with the postoperative results.	Loss of nipple sensation, $n = 6$; infection, $n = 2$; hematoma, $n = 1$

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Table 1 (*continued*)

Author (first listed), Year	Study design	No. of patients	Geographic location	Age of patients (y)	Mastopexy technique	Group	Indications proposed by the authors	General outcome including satisfaction	Complications
Gheita et al., 2011	Retrospective review	48	Egypt	Not reported	Scar: *T* NAC: Superior pedicle Mastopexy using a triple-flap method (superior flap + medial and lateral flap resulting from dog ears)	**2a**	Not reported	Satisfactory esthetic result with an attractive full breast, a pleasant conical shape, and long-term stability. It frequently has replaced the need for an implant. All available breast tissues are used to fill the breast cone, especially the misshapen or empty upper breast segment. Only excessive skin is discarded.	Delayed healing, $n = 3$
Akyurek et al., 2011	Retrospective review	8	USA	Range, 29–57; mean, 39.3	Scar: T NAC: Superior pedicle Mastopexy + LICAP flap	**3b**	Indicated in patients with massive weight loss along with lateral skin excess	LICAP flap can be inset to the retroglandular region under a pectoralis muscle sling. Esthetic outcome was ranked good to excellent by 6 of the 8 patients (75%), with a mean ranking of 4.2 (range: 3–5; from 0 to 5).	Seroma, $n = 1$

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Author (first listed), Year	Study design	No. of patients	Geographic location	Age of patients (y)	Mastopexy technique	Group	Indications proposed by the authors	General outcome including satisfaction	Complications
van Deventer et al., 2012	Retrospective review	112	South Africa	Range, 20-69; mean, 42.6	Scar: T NAC: Postero-inferior pedicle Internal Breast Support System with a Biocompatible Mesh	**4**	It is particularly indicated in the ptotic breast patient with thin skin of poor quality or in patients with high expectations.	Recurrent breast ptosis can be avoided and satisfactory long-term results can be obtained in mastopexy and breast reduction procedures by reconstructing an internal breast-supporting system with nonabsorbable biocompatible mesh to replace the supportive function of the ligamentous suspension.	Infection, $n = 2$; loss of nipple sensation, $n = 8$; hypertrophic scars, $n = 2$
Persichetti et al., 2012	Perspective review	15	Italy	Range, 28-55; Mean, 40.3	Scar: T NAC: Superior pedicle Mastopexy + anterior intercostal artery perforator flap for autoaugmentation	**3a**	Used in patients with massive weight loss, allowing at the same time abdominal tissue lift, solving superior abdominal ptosis.	At 12-month postoperative follow-up, a stable result with desirable nipple position, breast shape, and projection was registered.	Hypertrophic scars, $n = 1$

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Table 1 (*continued*)

Author (first listed), Year	Study design	No. of patients	Geographic location	Age of patients (y)	Mastopexy technique	Group	Indications proposed by the authors	General outcome including satisfaction	Complications
Doft et al., 2012	Letter to the Editor	15	USA	Range, 34–71	Scar: Y NAC: No NAC mobilization or glandular reshaping Dermic reshape with "Fish" mastopexy technique (Y-mastopexy technique).	**1**	For women desiring skin envelope tightening without nipple elevation, in which a significant amount of skin horizontally is removed through a short vertical incision while nipple position is maintained. Fish mastopexy should be considered when operating on a nipple–areola complex at or above the inframammary fold with ptosis of the glandular breast below the inframammary fold.	The technique reliably led to symmetrical breasts, with an unchanged nipple–areola complex location and minimal scar burden.	None reported
Gumus et al., 2013	Retrospective review	17	Turkey	Range 28–43, mean, 31	Scar: Circumvertical NAC: Superior pedicle Extended dermoglandular hammock flap fixed to the prepectoral pocket	**2a**	Effective and suitable for all types of ptosis, except for cases of insufficient mammary volume.	Suspending breast tissue over the pectoralis muscle with strong dermal support, leading to long-term maintenance of the breast shape.	Delayed healing, $n = 1$

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Author (first listed), Year	Study design	No. of patients	Geographic location	Age of patients (y)	Mastopexy technique	Group	Indications proposed by the authors	General outcome including satisfaction	Complications
Kelemen et al., 2013	Retrospective review	20	United Kingdom	Mean age, 35	Scar: T NAC: Superomedial pedicle Postero-inferiorly based dermoglandular flap for autoprosthesis	**2b**	This technique is suitable for severe grade 2 and 3 ptosis, especially for patients who have had excessive weight loss including bariatric surgery.	Volume redistribution resulted in successful and natural-appearing breast shape.	Fat necrosis, $n=1$; nipple sensibility reduction, $n=13$
Gurunlouglu et al., 2013	Retrospective review	26	USA	Range, 38–57, mean 48	Scar: T NAC: Superomedial pedicle Inferiorly based dermoglandular flap for autoprosthesis	**2b**	The described technique may be considered in patients after breast implant removal. Reliable way of reorienting breast volume and configuring breast shape following removal of breast implants without replacement.	Improvement of breast tender-ness/discomfort by making comparative analysis between preoperative and postoperative pain assessment.	Hematoma, $n=2$; delayed healing, $n=1$; hypertrophic scar, $n=1$
Hammond et al., 2014	Retrospective review	10	USA	Not reported	Scar: Circumvertical NAC: Superior pedicle Circumvertical scar Mastopexy using Lower Island Flap Transposition (LIFT) (Posteriorly based dermoglandular tissue)	**2b**	It is offered as an effective option for patients presenting for mastopexy with severe soft-tissue deflation (when SPAIR is not indicated).	Esthetically pleasing breast shape with long-term correction of the upper pole.	None reported

(*continued on next page*)

Table 1 (*continued*)

Author (first listed), Year	Study design	No. of patients	Geographic location	Age of patients (y)	Mastopexy technique	Group	Indications proposed by the authors	General outcome including satisfaction	Complications
Patel et al., 2015	Retrospective review	7	USA	Range, 29-64; mean, 54.9	Scar: Extended T NAC: Large inferior pedicle Extended lateral chest wall fasciocutaneous flap for upper pole	**3b**	Mastopexy augmentation, coupled with simultaneous upper body lift, can be safely and reliably performed by using extended fascio-cutaneous flaps to autologously augment the breast while improving circumferential upper body contour in patients with massive weight loss.	The Upper Body Lift corrects epigastric laxity, repositions the IMF more superiorly, excises lateral chest, and mid-back skin rolls, and, combined with mastopexy, reshapes the breast.	Distal flap necrosis, $n=1$, wound dehiscence, $n=n=1$; hematoma, $n=1$
Miotto et al., 2015	Retrospective review	40	USA	Range, 22–72	Scar: T NAC: Extended full-thickness superomedial. Circumrotational technique + Refixation of IMF	**2c**	The best candidates are patients with massive weight loss who present grade 2 or 3 breast ptosis. The circumrotational technique is also applicable to mastopexy in patients with no massive weight loss but with the same degree of ptosis. Do not perform this procedure in active smokers or in patients who require mastopexy after subglandular implant removal because of the disruption of the vascular supply.	Prospective outcome studies utilizing validated instruments are needed to ascertain the long-term success or failure of the circumrotational technique compared to other mastopexy techniques.	Hematoma, $n=1$, seroma, $n=2$, bottoming out, $n=1$

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Table 1 (*continued*)

Author (first listed), Year	Study design	No. of patients	Geographic location	Age of patients (y)	Mastopexy technique	Group	Indications proposed by the authors	General outcome including satisfaction	Complications
Kirwan et al., 2015	Retrospective review	107	United Kingdom	Range, 19–66; mean, 41	Scar: Vertical / T NAC: Inferior pedicle Breast autoaugmentation (BAA) using an inferior pedicle dermoglandular flap	**2b**	BAA corrects the empty upper pole, as well as the sagging of the primary ptotic, postpartum, and postlactation breast, resulting in the appearance of an augmented breast and a scar in the configuration of a "lollipop." BAA is also a versatile method of salvaging the explanted patient. BAA is not indicated in cases in which there is inadequate breast tissue in the inferior pole.	Versatile technique for women with small breasts associated with primary or secondary ptosis. It is also an effective technique for the salvage of breasts after capsulectomy and explantation.	Hematoma, $n = 2$; NAC necrosis, $n = 1$; secondary mastopexy, $n = 3$;

(*continued on next page*)

Table 1 (*continued*)

Author (first listed), Year	Study design	No. of patients	Geographic location	Age of patients (y)	Mastopexy technique	Group	Indications proposed by the authors	General outcome including satisfaction	Complications
D'Aniello et al., 2016	Retrospective review	45	Italy	Range, 34–63; mean, 47.2	Scar: T NAC: Superior pedicle Lower pole of the breast parenchyma is rolled back and suspended to the pectoralis fascia	**2b**	If the patient has sufficient breast volume, glandular flap can be raised to create support for the ptotic breast. The reshaping of the breast after massive weight loss does not necessarily require the use of breast implants.	95.6% of the patients were satisfied at Likert analysis (0-not satisfied to 5-very satisfied). Highest scores in postoperative breast shape (86% > 4 points) and for asymmetry correction (81% > 4 points). Negative evaluation of the scar only in 5.7% of the patients. At 1-year follow-up, good to excellent results of physicians' clinical evaluation of the photographs compared with the preoperative deformity	Hypertrophic scar, $n = 2$

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Table 1 (*continued*)

Author (first listed), Year	Study design	No. of patients	Geographic location	Age of patients (y)	Mastopexy technique	Group	Indications proposed by the authors	General outcome including satisfaction	Complications
Ors et al., 2016	Retrospective review	63	Turkey	Range, 26–47; mean, 35	Scar: Vertical NAC: Superior pedicle Lower pole of the breast parenchyma is rolled back and suspended to the pectoralis fascia (hammock flap)	**2a**	Innovative and simple technique that can be used in the lifting of small-, medium-, and large-sized breasts.	Satisfactory results for all types of breasts in terms of good breast shape, natural image at the upper pole of the breast, good projection, and reduced bottoming-out deformity.	Patients achieving neither good projection nor natural image at the upper pole of the breasts, $n=4$; bottoming-out, $n=4$; seroma, $n=1$
Ikander et al., 2017	Retrospective review	15	Denmark	Range, 24–63;	Scar: T NAC: Superior pedicle Upper pole autoaugmented with lower pole subglandular advancement mastoplasty (LOPOSAM)	**2b**	The LOPOSAM technique can be used to correct the breast shape in most patients with massive weight loss The presented method is a fast and simple approach for reshaping of the breast, which also addresses the lack of upper pole fullness in patients with massive weight loss.	The majority of patients were very satisfied. However, the patients rated their satisfaction with the result after only 3 months of follow-up.	Hematoma, $n=1$; wound dehiscence, $n=3$

1. Dermal reshape.
2. Glandular reshape.
  a. Superiorly based glandular remodeling for autoaugmentation.
  b. Inferiorly/posteriorly based glandular remodeling for autoaugmentation.
  c. Extended superomedial-based glandular remodeling for autoaugmentation.
  **"m" if muscular slings/myofascial components.*
3. Glandular reshape + flap.
  a. Thoracic/anterior ICAP.
  b. Lateral ICAP.
4. Glandular reshape + matrix.

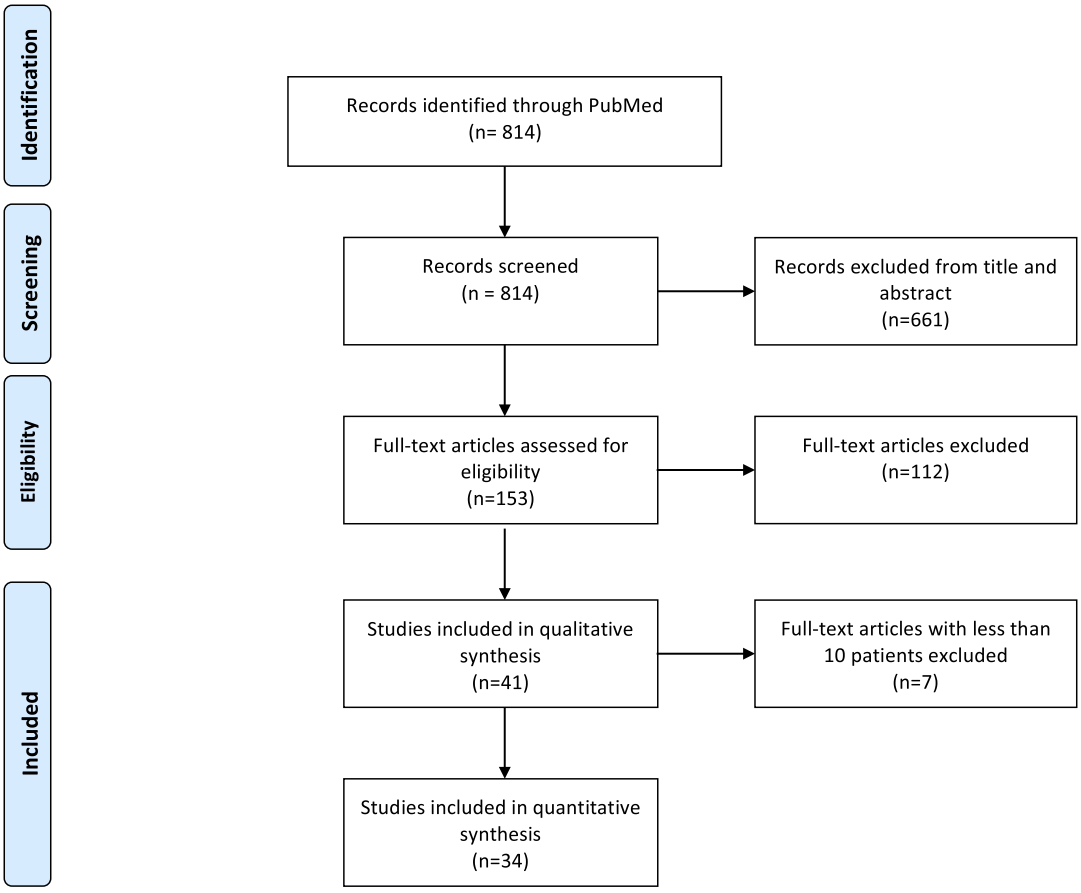

Figure 1 PRISMA flowchart.

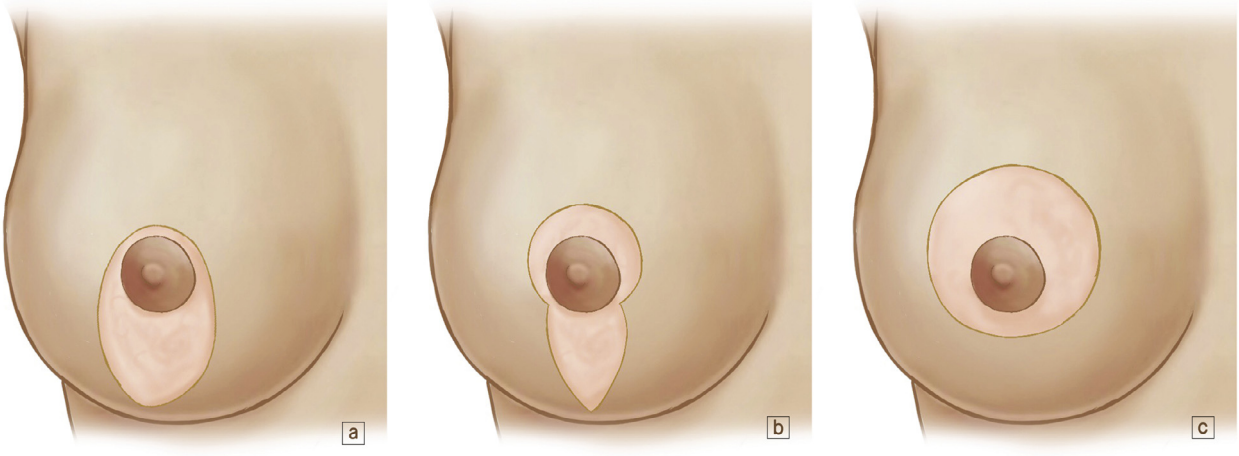

Figure 2 Illustration explaining the dermal reshape technique (Type 1). Preoperative drawings include breast midline, IMF, and breast meridian. After de-epithelialization of the drawing, a significant amount of skin is removed through a circumareolar (A),[34] short circumvertical (B),[36] or inverted "*T*" incision (C).[35] The skin envelope is reduced, and the NAC is lifted to the desired position. Incisions are closed with subcutaneous and dermal sutures.

complications (dehiscence or generally delayed healing) occurred overall in 0.6%. This was particularly observed in dermal reshape (Type 1) mastopexy, with a subgroup incidence of 8.5%. Other notable complications had low overall incidence and included hematoma (0.6%), seroma (0.5%), and infections (0.4%). Not unexpectedly, the subgroup incidence of infection was the highest where mesh was used (Type 4; infection 1.8%). In mastopexy with associated supportive mesh, Van Deventer et al., reported a *Streptococcus milleri* infection resulting in surgical exploration and partial excision of the mesh.[9] Other authors presented infections that were treated empirically with antibiotic

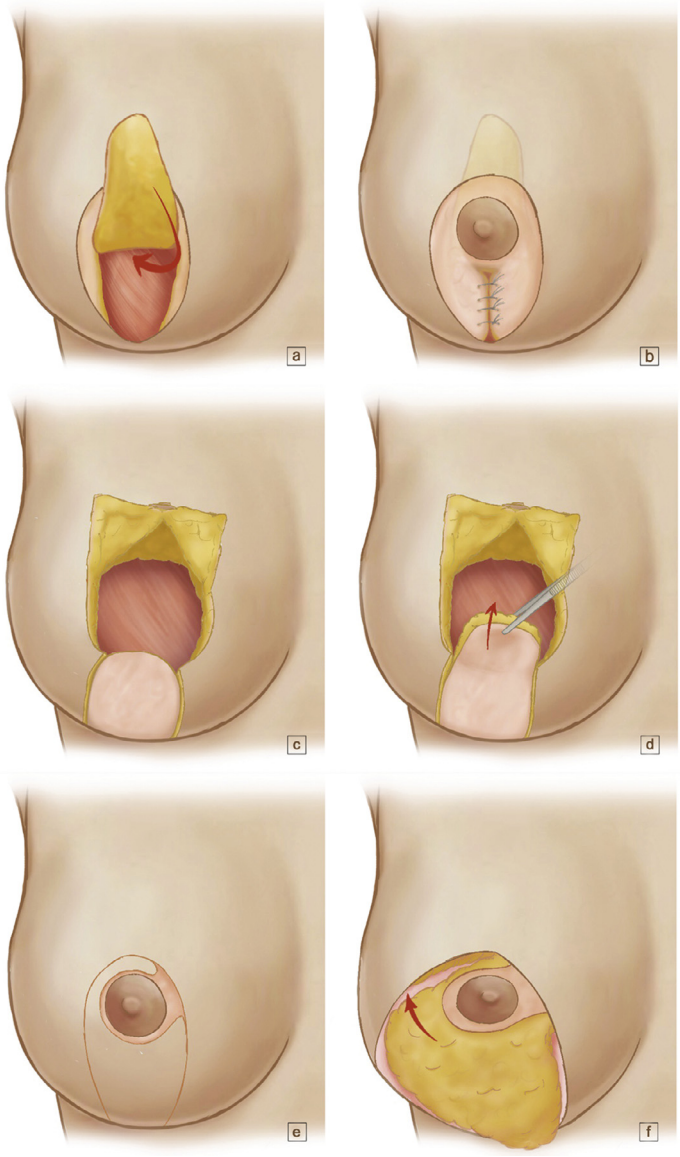

Figure 3 Superiorly based glandular remodeling for autoaugmentation (Type 2a). Preoperative drawings are based on Wise pattern, with preservation of a superiorly based parenchymal flap. After skin incision, the superior flap is raised over the pectoralis fascia (A). The flap is rotated cranially underneath and sutured high on the fascia to increase upper pole volume (B).[3,29] The medial and lateral pillars below are sutured together to narrow the breast base and add support.[4,27,28,39,40] The skin flaps are then redraped and closed in the standard fashion. Inferiorly/posteriorly based glandular remodeling for autoaugmentation (Type 2b). Preoperative drawings are based on Wise pattern. After skin excision, the NAC is isolated on a superiorly based pedicle, which is undermined over the fascia up to the level of the clavicle. The inferior flap is advanced upward into the space created and is sutured high on the pectoralis fascia to increase upper pole fullness (C, D).[2,12-24] Sometimes the flap advanced under a sling of the pectoralis major muscle to guarantee durability in its new position.[8,10,11] Closure of the medial and lateral pillars over the flap optimizes projection.[31] The skin envelope is then redraped and closed in the standard fashion with the NAC in the desired position.
Extended superomedial pedicle remodeling for autoaugmentation (Type 2c). Preoperative drawings are based on standard Wise pattern inverted-T mastopexy, and the desired NAC position is marked (E). Creation of a wide pedicle of approximately 4 cm is marked extending to encompass the superomedial intercostal vascular axis. The subglandular dissection is continued in a cranial direction, thereby creating a subglandular pocket behind the upper pole in the direction of the clavicle. The lower gland is then rotated through 90° into the upper pocket (F).[25,26] The lateral gland comes to lie beneath the upper pole. The skin envelope is then re-draped and closed in the standard fashion with the NAC in the desired position.

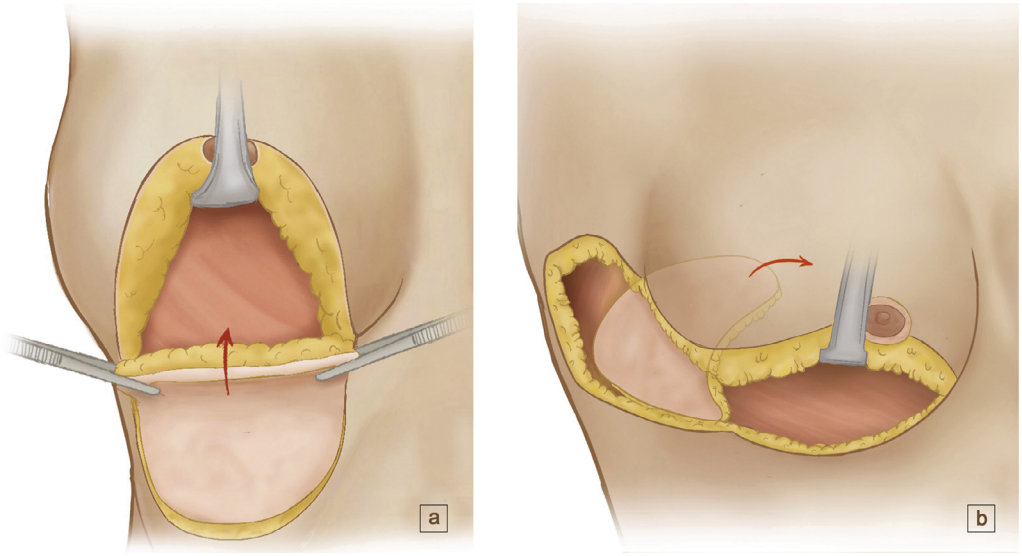

Figure 4 Glandular reshape was associated with an anterior ICAP flap (Type 3a) (A). Preoperative drawings are based on standard Wise pattern inverted-T mastopexy and the desired NAC position is marked. The superior flap containing the NAC is undermined over the fascia to dissect and prepare a retroglandular pocket for the flap. The larger the available flap for auto-augmentation, the narrower the keyhole angle will be to allow tension-free closure. The incision extends toward the LD anterior border. Then the thoracic flap with its lateral portion is de-epithelialized and fixed on the anterior chest wall.[41,44] The upper portion of the gland is sutured to the muscle plane at the second intercostal space, with medial and lateral pillars sutured together to improve the breast shape. The lateral gland comes to lie beneath the upper pole. The skin envelope is then re-draped and closed in the standard fashion with the NAC in the desired position.
Illustration explaining the glandular reshape associated with a lateral ICAP flap (Type 3b) (B). Standard Wise pattern inverted-T mastopexy with parenchymal flaps is performed with the superior flap being undermined over the fascia to prepare a retroglandular pocket for the flap. The incision extends toward the LD anterior border. The dissection plane is above the muscle fascia. Once the posterior branch of the LICAP is visualized, the largest perforator is preserved, and the surrounding tissue is freed. A pedicle of length 3–5 cm is prepared until its origin at the level of the rib. Sufficient length of the pedicle will allow folding of the flap on itself to fill the central part of the breast.[46] Plication of the gland will increase projection.[43,45,46–48] The skin envelope is then re-draped and closed in the standard fashion, with the NAC in the desired position.

therapy with no specific laboratory investigations of bacterial or mesh contamination.[7,18]

Unsatisfactory shape was present overall in 1.2% when combining suboptimal outcomes for both upper and lower poles. However, the need for reoperation in such cases was extremely rare.[31]

Nipple–areola complex (NAC) complications such as asymmetry, distortion, and necrosis were particularly represented in the dermal reshape (Type 1) group, exceeding 15%. In other subgroups, the incidence did not exceed 1%. Concerning NAC sensation, the worse performing subgroup was matrix-associated reshape (Type 4), with 5.7% reporting a decrease/loss of sensation. Fat necrosis (0.9%) was mainly linked to glandular remodeling mastopexies (Type 2) and was generally managed conservatively. There were no serious or life-threatening complications. All complications and subgroup complications are reported in Table 2.

Discussion

Mastopexy is the seventh most common cosmetic surgery procedure in the U.S.[1] During the recent decades, many mastopexy techniques have been described, all having common goals of improving breast projection and increasing the upper pole fullness, facilitated by glandular reshaping and reinforcement of the lower pole with the ultimate aim of a long-lasting result WITH time. With regard to breast projection improvement, the term “auto-augmentation” was first applied to procedures using an autologous (typically glandular) flap to increase upper pole fullness in contrast to the use of an implant.

While other reviews have been published recently[32,33], no comprehensive literature review describing and classifying all mastopexy techniques according to surgical and anatomical concepts has been undertaken. Moreover, a combined publication of overall and technique-related outcomes and complications after mastopexy is lacking. We included 41 articles on 1928 patients treated by mastopexy without prosthesis, of which only the 34 articles including more than 10 patients were considered for quantitative outcome ($n = 1888$). Reported mastopexy procedures since the 1980 s were analyzed, which ranged from simple NAC elevation to autologous augmentation using perforator flaps and the application of a supportive mesh. Techniques have been clearly classified below, with a standardized summary table. In addition to its role in reporting the outcome and complications of different techniques, this review could serve as an educational guide to orientate the reader in the multitude of described mastopexy techniques. The proposed

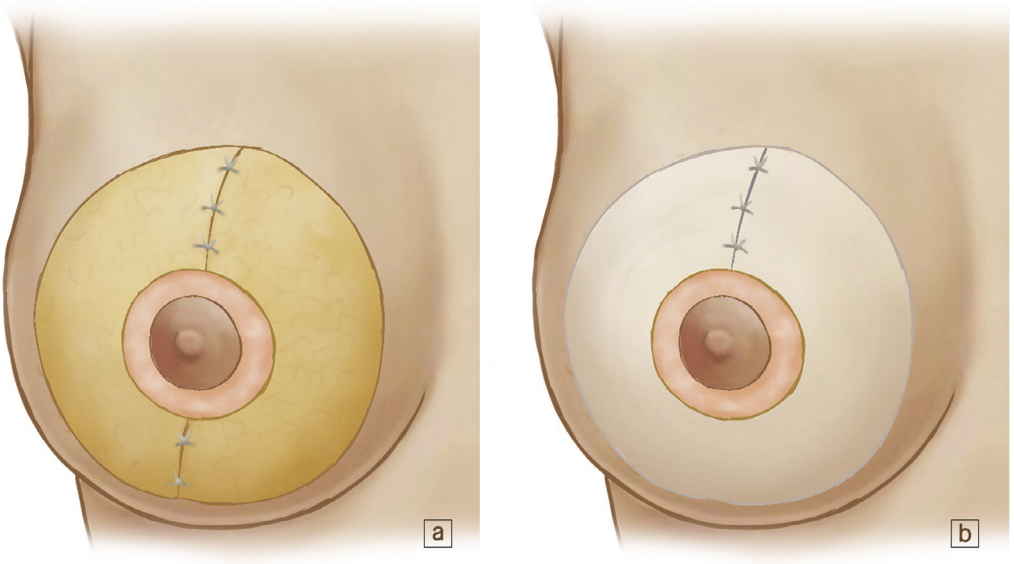

Figure 5 Glandular reshape associated with mesh support (Type 4). The NAC pedicle is de-epithelialized. The breast gland is remodeled to obtain the desired conical shape with the appropriate upper pole lift. This new gland configuration should be fixed to the pectoral fascia by placing sutures before applying the synthetic mesh (A). The gland is then wrapped (usually at its lower pole as a brassiere) with the synthetic mesh to reinforce the shape and add support (B).[7,9] The mesh borders are sutured to the anterior chest wall over the pectoral fascia or over the rib periosteum with long-lasting resorbable sutures. Suturing of the mesh over the chest wall should ideally start at the meridian of the lower pole and ascend along the medial and lateral IMF, with an aim to create a conical shape.[6] The skin flaps are then redraped and closed in the standard fashion.

Table 2 Complications observed after mastopexy with all techniques ($N = 1888$).

Complications	Type 1 ($N = 82$)		Type 2 ($N = 1489$)		Type 3 ($N = 35$)		Type 4 ($N = 282$)		All Types ($N = 1888$)	
	No.	%	No.	%	No.	%	No.	%	No.	%
Scar-related complications (hypertrophic/unesthetic/scar revisions)	7	8.5	41	2.8	1	2.9	7	2.5	56	3
Hematoma	-	-	9	0.6	-	-	2	0.7	11	0.6
Seroma	-	-	9	0.6	-	-	-	-	9	0.5
Unsatisfactory breast volume (Inadequate volume (very big/very small))	-	-	1	0.1	-	-	-	-	1	0.1
Unsatisfactory breast shape (insufficient breast lift/insufficient upper pole fullness/recurrence case)	2	2.4	11	0.7	-	-	-	-	13	0.7
Wound healing-related complication (delayed wound healing/wound dehiscence)	-	-	11	0.7	-	-	-	-	11	0.6
Lower pole unsatisfactory shape (bottoming out/conversion to T scar)	-	-	7	0.5	-	-	3	1	10	0.5
NAC-related complication (nipple retraction/nipple asymmetry/necrosis)	13	15.9	8	0.5	-	-	3	1	24	1.3
NAC sensation (decrease/loss/reversible)	-	-	14	0.9	-	-	16	5.7	30	1.6
Fat necrosis	-	-	13	0.9	-	-	-	-	13	0.7
Skin flap necrosis	-	-	5	0.3	-	-	3	1	8	0.4
Infection	-	-	2	0.1	-	-	5	1.8	7	0.4
Edema	2	2.4	-	-	-	-	-	-	2	0.1
Mesh extrusion	N/A	N/A	N/A	N/A	N/A	N/A	2	0.7	2	0.1
Total number of complications	**24**	**29.3**	**131**	**8.8**	**1**	**2.9**	**41**	**14.5**	**197**	**10.4**

classification is intended to simplify and regroup a variety of techniques found in the literature.

Overall satisfaction and complication rates across the spectrum of mastopexy techniques were determined. The great heterogeneity of the study populations is acknowledged, while potential selection bias and lack of uniformity in measured outcomes prevented a proper meta-analysis and statistical comparisons among groups. Moreover, the largely favorable reported outcome despite many different techniques suggests that author-related biases cannot be excluded. These biases were critically analyzed, high-quality studies selected, and a systematic analysis in terms of surgical anatomy was performed to provide the reader with a clear classification of different techniques and their potential complications.

Dermal reshape (Type 1)

A direct de-epithelialization with reduction in the skin envelope can result in breast tightening and uplift.

Outcome

Among the three articles published between 1980 and 2016, generally favorable outcomes in terms of patient satisfaction and low morbidity were noted.

Complications

Gruber et al., reported esthetically unsatisfactory areola spreading and hypertrophic scars in more than half of treated patients.[34] Ptosis recurred in almost 15% of the patients. Direct tension on the dermis and skin may have been the cause of NAC distortion and scarring. For these reasons, circumareolar and circumvertical dermal reshape mastopexies have historically been one of the most litigious procedures performed. However, more recent reports showed a very high overall satisfaction (95%) [35] and lower scar morbidity [36] using purse string periareolar closure.[37]

Technical Box:

- √ Applied to small to moderate volume breasts.
- √ Applied in excessive skin envelope without a great need for NAC lift.
- √ Different patterns of incision (circular[34], circumvertical[36], and inverted-T[35]).
- √ Advantages: The technique is simple, reproducible, and fast and requires no NAC pedicle because there is no dermal interruption.
- √ Drawbacks: Less long-lasting result because of skin quality dependence and lack of glandular reshape/support.

Glandular reshape (Type 2)

Glandular reshape mastopexy is the most used technique, with 1492 cases described in this literature review (77% of all cases). This technique provides for increased upper pole fullness, with stable results at over 2 years being reported.[3,13] Many procedural variations have been described with regard to gland dissection and pedicle isolation.

Superior pedicle techniques (Type 2a) (used in 340 patients out of 1492, approximately 23% of glandular reshape mastopexy) are generally characterized by a dermoglandular superior pedicle, which is de-epithelialized and raised on a prepectoral plane to reposition the NAC while also filling the upper pole. Further variations to the superiorly based flap, which is anchored as a "hammock" to the pectoralis fascia, are the de-epithelialized lateral and medial flaps to further increase medial and superior projection.[27] Muscular components of the pectoralis major can be integrated with this technique, using the superior pedicled dermoglandular flap to improve upper pole fullness and a myofascial supportive flap to redefine the IMF and protect from bottoming out.[10]

The most used glandular reshape technique to improve breast contour and lift is the inferior pedicle-based mastopexy (Type 2b), popularized by Botti et al., in 1999.[13] This technique recalls the publication of Ribeiro et al., on glandular remodeling in breast reductions.[38] According to the authors' statements, this technique assures upper pole fullness while preventing or limiting bottoming out with time.[13,15] The concept of "autoaugmentation" without the use of an implant is related to the role of the inferior gland, which is used as an autologous prosthesis.[2,14] The inferior gland that is mobilized and responsible for breast projection does not interfere with NAC vascularization, which is still maintained on a superior pedicle of at least 2 cm thickness.[2] While choosing between 2a and 2b techniques is largely author dependent and shares the same indications (moderate to severe ptosis, weight loss, and need for upper pole fullness), the gland reshaping technique is often dictated by the technique that best maintains soft tissue vascularity. When the patient requires a minimal to moderate NAC elevation (up to 6 cm) and has a small breast, a superior pedicle may be more suitable. For ptosis with particularly lax lower pole, glandular reshape (Type 2b) techniques are particularly suitable. Moreover, when patients have previously undergone breast augmentation through infra-areolar incision and desire implant removal with autologous mastopexy, an extended superiorly based glandular flap may be compromised. In such cases, inferiorly based autoaugmentation techniques are most certainly indicated.[22]

Finally, the literature review showed 65 cases of extended superolateral or rotational glandular techniques (Type 3c) and represented the minority of glandular reshaping mastopexies (4%).[25,26] In this technique, upper pole fullness is created by the recruitment of glandular volume designed on a superomedial pedicle, similar to a breast reduction technique but without parenchyma resection. The authors suggest avoidance of this technique in smokers, as the glandular edges may be poorly perfused and induce liponecrosis and further complications.[26]

Outcome

All authors agree that in the former group, results may be better maintained than those in the latter group across the years with regard to breast shape and position.[14,16] Esthetic results were considered good to excellent in almost all cases, thus maintaining projection without the need for implants, narrowing the lower breast base, raising the inframammary crease, and achieving a more youthful breast shape.

Complications

Glandular reshape techniques have been associated with a relatively low complication rate (8.8%). Among these techniques, seroma and hematoma were minimal (less than 1%). Although fat necrosis could be potentially underestimated because of not being always clinically evident, symptomatic fat necrosis after gland mobilization was 0.9%. No clear association of fat necrosis with smoking patients was described in the literature analyzed.

Despite the common T-shape scar closure, scar-related complications occurred in 2.8%, which was significantly lower than that in the dermal reshape group. This goes in line with the concept of improving the breast contour by acting on the glandular structure rather than relying on the skin envelope only. This explains the limited number of cases where the breast shape was unsatisfactory, with ptosis recurrence or need for reoperation (1.2%). In these cases, bottoming out was evident in less than 1% of cases.

Technical Box:

- √ Most common technique.
- √ Remodeling can be achieved using superior (2a), inferior (2b), and superomedial (2c) pedicles.
- √ Applied in moderate to severe breast ptosis with empty upper pole.[15,24]
- √ In type 2a: pedicle is limited to the central part of the gland[39] or can encompass the entire inferior pole of the breast ("extended"), with the length of the lateral wings of the flap not exceeding three times their base width.[4,28,40]
- √ The gland can sutured to the deep fascia[13,14] or to the rib periosteum[15] in the medial superior portion of the breast at about the level of the third intercostal space.
- √ Myofascial flap may be added for support and protection from bottoming out.
- √ Advantage: It produces a long-lasting result because the breast does not rely only on the skin envelope.
- √ Drawback: Gland remodeling needs to be performed to maintain an effective vascularization to the glandular flaps, and an excessive remodeling should be avoided in smokers considering the risk of liponecrosis.

Glandular reshape associated with perforator flaps (Type 3)

Sixty-seven patients out of 1928 cases included in this review (3.5%) underwent autoaugmentation mastopexy using local flaps based on different perforasomes to assure vascularization. The anatomy of perforators and perforasomes originating from the intercostal arteries has been largely studied.[41,42] The main indication for this technique is the patient with massive weight loss (MWL), where perforators have particularly reliable caliber and flap perfusion is assured.[43] Perforator flaps for mastopexy were divided into two categories: Type 3a (thoracic/anterior ICAP flaps) and 3b (lateral ICAP flaps). The flap can be extended laterally and associated with myofascial components.

Outcome

In the authors' statement, patients were satisfied by the pleasant shape[48], with better projection, appropriate nipple position, and shape at 12 months postoperatively.[41] Others have stated that a more natural looking breast, even if moderately ptotic, should be preferred in patients with MWL, thereby avoiding the cost and complication of implant surgery.[43] Satisfaction was generally favorable, with Akyurek et al reporting good to excellent outcomes in 75% of the operated cases.[49]

Complications

The patient should be advised of higher complication rates due to extensive undermining, possibly jeopardizing lymphatic drainage. Wound healing and scar-related complications (globally accounting for 2.9%) are similarly attributed to longer incisions, poorer skin quality, and suboptimal patient nutritional state.

Technical Box:

- √ Indication for this technique is the patient with massive weight loss (MWL).
- √ Perforator flaps are divided into two categories: type 3a (thoracic/anterior ICAP flaps) and 3b (lateral ICAP flaps).
- √ Practically, the lower pole of a Wise pattern can be advanced cranially without the need of perforator skeletonization.[41]
- √ LICAP flaps can be also inset in the retroglandular region under a pectoralis major sling.[49]
- √ In patients with MWL, the axillary "back roll" excess can be isolated on the lateral intercostal artery perforators (LICAP) and transferred cranially to provide upper pole fullness and superomedial projection.[51]
- √ Advantage: Can be combined with other upper body dermolipectomy.[43,47]
- √ Drawback: Requires more technical skills and operative time.

Glandular reshape associated with synthetic mesh (Type 4)

Glandular reshape associated with synthetic mesh was the last group revealed by this comprehensive review. The mesh acts as an internal breast support to replace the function of the weakened suspension of Cooper's ligaments. With 287 described cases (14.9% of patients analyzed in this review), this technique reduces recurrent breast ptosis with stable long-term results.[7,9] Indications for this technique include patients with high expectations, large ptotic breasts with thin skin of poor quality,[9] or contralateral symmetrizing mastopexy following a relatively rigid breast reconstruction with a prosthesis.[7]

The type of mesh used was either polyester/polyglactin or Vicryl/Prolene. In most cases, the mesh was placed over the gland and sutured to the chest wall.[32] Meshes were well tolerated and easy to remove if necessary.[7]

Outcome

Patient satisfaction with this technique was rated from average to excellent.[6]

Complications

The fourfold increased rate of infection (1.8%) compared to the overall infection rate of mastopexy (0.4%) could be expected in this group because of the addition of a foreign body. Another significant increase was noticed in the rate of complications related to NAC sensation (5.7 vs. 1.6% overall). This may be accounted for by the necessary degloving of the breast skin in preparing the mesh recipient site. However, other nipple-related complications such as nipple retraction, asymmetry, and necrosis remained low (1%). This observation potentially indicates that the breast parenchyma is effectively supported with consequent reduction in traction applied to the NAC.

Technical Box:

- √ Indication is patients with poor skin quality[9] or recurrent cases.[7]
- √ No interference with monitoring for breast cancer was reported, and the mesh was not radiologically evident during follow-up.[6]
- √ Advantage: Reduces recurrent breast ptosis with stable long-term results.
- √ Drawback: Higher infection rate.

We have to acknowledge that this review has some limitations. First, there is a need to standardize outcomes (e.g., breast Q, measurements of key breast parameters, complication profile, and breast cancer assessment follow-up). Prospective databases should be developed with these principles to reduce bias error and offer a more objective assessment for this broad spectrum of techniques.

Conclusion

After comprehensively analyzing the literature published since 1980 to present, we could identify four main technical approaches to mastopexy without the use of implants; all correlated to high satisfaction rates for patients and surgeons. Indeed, the largely favorable reported outcomes despite many different techniques indicate that author-related and publication biases cannot be excluded.

This review showed a low rate of infective complications (0.4%), with a satisfactory breast shape and less than 1.5% incidence of insufficient upper pole fullness, insufficient breast lift, or bottoming out. This was particularly evident when a glandular reshape was performed.

Supplementary autoaugmentation procedures using local flaps based on intercostal perforators are particularly indicated in cases of MWL, thereby resulting in desirable patient satisfaction despite the price of increased scarring and wound-related complications. Circumvertical or inverted-T scars were the most used patterns, and patients should be advised of likely cosmetic outcomes according to the pre-existing skin excess, breast ptosis, and residual volume. They should be fully counseled of the potential complications, which include scar (3%)- and NAC (2.9%)-related problems.

Given the variety of indications and surgical techniques, it should be performed by highly qualified board-certified plastic surgeons to ensure efficacy and safety.

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Supplementary material

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.bjps.2018.10.018.

Appendix

Illustration summarizing the 41 retained articles divided into the four main technique approaches with subcategories.

**use of a pectoral muscular component; ICAP: Intercostal Artery Perforator*

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