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Review Article

Longevity of ptosis correction in mastopexy and reduction mammoplasty: A systematic review of techniques

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ABSTRACT

Background: Mastopexy and reduction mammoplasty are commonly performed procedures in plastic surgery with many variations in incision pattern, pedicle design, and additional support maneuvers. Aesthetically pleasing on table results are widely accomplished; however, the longevity of the outcome and sustained correction of ptosis or pseudoptosis is not universal. A systematic review of mastopexy and reduction mammoplasty procedures was performed to investigate which techniques provided the greatest long-term correction of ptosis.

Methods: A broad search of the literature was performed using the PubMed database from inception to December of 2021. Study characteristics, number of patients, number of breasts, technique, outcome, and average follow-up time were extracted for analysis. Study quality was assessed using the Newcastle–Ottawa Scale when applicable.

Results: The primary search yielded 1123 articles. After two levels of screening, 24 articles were identified for analysis. This included 16 case series, seven cohort studies, and one randomized controlled study. From these studies, 1235 patients and 2235 breasts were analyzed. The majority of articles reported on a change in the nipple to inframammary fold and sternal notch to nipple distances.

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Conclusions: In the analytical studies, superior and superomedial pedicles tended to provide greater long-term stability than inferior pedicles. Mesh, dermal suspension flaps, and muscular slings showed promise in providing additional support over standard techniques. No single procedure is ideal for all patients; however, this systematic review provides a valuable description of techniques and long-term outcomes to guide surgical planning.

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Introduction

Mastopexy was the 11th most common cosmetic procedure, and reduction mammoplasty was the 8th most common reconstructive procedure in 2020 according to the ASPS Plastic Surgery Statistics Report.¹ The goals of mastopexy are to reshape the breast, redistribute volume, and reposition the nipple-areola complex. Breast reduction operations strive for these same aesthetic goals while also reducing the size and weight of the breasts for functional purposes. Both operations attempt to produce a long-lasting aesthetically pleasing breast appearance while minimizing scars, recovery, and complications.^{2,3} In the ideal breast aesthetic, the nipple is positioned at the most projecting portion of the breast just above the inframammary fold (IMF). The breast mound is positioned above the IMF on the chest wall, and there is adequate upper pole fullness.^{4,5}

Ptois and pseudoptosis of the breast can develop with normal ageing, pregnancy, significant weight loss, and macromastia.^{6,7} Countless techniques with differing incision patterns, glandular pedicles, suturing techniques, support materials, and autologous flaps have been utilized to correct this ptosis. Aesthetically pleasing results can be accomplished with all of these techniques if tailored to the appropriate patient; however, the longevity of the outcome and sustained correction of ptosis or pseudoptosis is not universal. Breast tissue quality is not altered by these operations and with the ongoing effects of gravity, breasts can lose projection and sag once again with time.^{8,9} This problem of recurrent ptosis has led to many technical innovations, novel uses of surgical implants, and new techniques. With the wide variability in the literature, it is difficult to decipher which methods can provide stable results in mastopexy and breast reduction over time. A systematic review of mastopexy and reduction mammoplasty procedures was performed to investigate which techniques provided the greatest long-term stability of ptosis correction.

Materials and methods

Search strategy

A broad search of the literature was performed using the PubMed database from inception to December of 2021. The database was queried using the following search terms: mammoplasty or breast reduction or mastopexy AND pseudoptosis or ptosis or bottom* out or sagging. In addition, the references of relevant studies were reviewed for potential inclusion. This systematic review was conducted in accordance with the PRISMA guidelines (Figure 1).¹⁰

Selection criteria

Studies were considered eligible for inclusion if they reported on long-term outcomes of breast reduction or mastopexy with quantifiable results describing ptosis, pseudoptosis, or bottoming out and documented mean follow-up of at least one year. Simply stating if ptosis was present or not

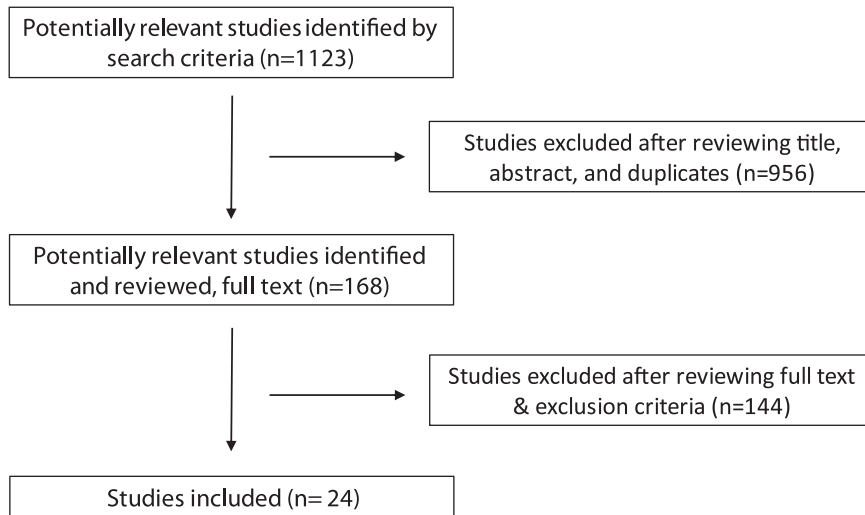


Figure 1. Schematic for the literature search strategy.

post-operatively was not sufficient for inclusion in the analysis. For purposes of this review, ptosis was defined as a nipple position at or below the IMF, pseudoptosis as a normal nipple position with excess breast parenchyma below the IMF, and bottoming out as the redistribution of breast volume from the upper pole to the lower pole of the breast.

The authors independently evaluated each eligible study, and the selection was determined based on two levels of screening. Titles and abstracts were first reviewed for the following exclusion criteria: Meta-analyzes, systematic reviews, case reports, reviews, letters/editorials, and languages other than English. The studies were then read in full and further selected using predetermined exclusion criteria. Studies on breast reconstruction, augmentation mastopexy, liposuction only breast reduction, secondary mastopexy, and massive weight loss patients were also excluded.

Data extraction

Information from the studies that passed both levels of screening was extracted from the full texts for analysis using a standardized data collection sheet (Table 1). The following article information was examined: Author, year, study design, number of patients, number of breasts, technique, outcome, and average follow-up time. Study quality and risk of bias were assessed using the Newcastle–Ottawa Scale for applicable studies. Because study design, surgical technique, and outcome reporting were heterogeneous between studies, a meta-analysis could not be conducted. A narrative systematic review was performed.

Results

Study characteristics

A total of 1123 articles were identified using our search terms and inclusion criteria. After two levels of screening, 24 articles were identified for analysis in our systematic review (see Figure 1). The 24 studies included a total of 1235 patients and 2235 breasts. Mastopexy and breast reduction cases were assumed to be bilateral except when stated as in contralateral symmetry procedures for breast reconstruction.

Table 1
Study characteristics, surgical techniques, and outcomes.

Author, year	# of Patients	# of Breasts	Follow-up (mo.)	Technique			Outcome	
				Incision pattern	Pedicle	Additional support	Change in SN-N, cm (%)	Change in N-IMF, cm (%)
Hamdi, 2021	50	85	36	Wise or vertical	Superior or SM	Mesh	NR	0.5 (7.7%)
József, 2021	117	117	17.5	Wise	Inferior or central	Mesh No mesh	Mesh 1.0 (4.8%) No mesh 3.5 (17.5%)	Mesh 0.5 (7.1%) No mesh 0.75 (13.5%)
Mangialardi, 2021	21	42	13.8	Wise	Superior	Lipofilling	1.5 (7.9%)	0.2 (2.9%)
Sapino, 2021	58	116	24	Wise	Inferior SM	None	Inferior 1.8 (8.6%) SM 1.3 (6.2%)	Inferior 2.7 (38.6%) SM 2.0 (29.4%)
Aquinati, 2019	10	13	15.6	Wise	SM	Dermal flap	0	0
Watfa, 2019	18	29	12	Wise	Superior	Dermal flap No flap	Dermal flap 1.0 (5.7%) No flap 1.7 (8.6%)	Dermal flap 1.1 (21.4%) No flap 1.3 (25.3%)
Adams, 2018	46	92	12	Variable	Variable	Mesh	0.6 (3%)	0.5 (6.6%)
Kemaloğlu, 2018	50	100	12	Wise	Inferior SM	None	NR	Inferior 2.1 SM 2.2
Ors, 2018	20	40	12	Wise	Superior SM	Autoaugmentation	1.0 (5.4%)	0.4 (6.2%)
Hudson, 2017	25	50	12	Wise	SM	Pillar sutures	0	0.68 (6.8%)
Bitik, 2016	38	75	24	Wise	Superior	Pillar sutures	0.2	0.3 (4.5%)
Graf, 2016	21	41	120	Vertical	Central	Muscular sling	NR	NR
Ors, 2016	63	126	24	Vertical	Superior	Autoaugmentation	1.3 (6.7%)	1.6 (29.1%)
Temel, 2015	80	160	12	Wise	Inferior	Dermal flap	0 (0%)	0.5 (4.8%)
Karaci, 2013	10	20	12	Vertical	Medial	Pillar sutures	0.5	0
Persichetti, 2012	28	28	60	Wise	Superior	Dermal flap	2.2 (9%)	1.7 (26%)
Zehm, 2012	34	68	42.4	Wise	Superior Inferior	None	NR	Superior 3.3 (80.5%) Inferior 3.9 (92.9%)
Quan, 2011	10	20	36	Vertical	Medial	Pillar sutures	NR	NR
Honig, 2009	27	54	12	Wise	Superior	Autoaugmentation	1.1 (5.4%)	0.2 (2.8%)
Ahmad, 2008	46	46	48	Vertical	Superior or medial	Pillar sutures	0.3 (1.5%)	−0.4 (3.9%)
Bruijn, 2008	170	327	16.8	Wise or vertical	Central	Mesh	0.7 (3.4%)	0.5 (4.9%)
Cruz-Korchin, 2006	160	320	24	Vertical	Medial	None	Control* 0.2 Study 0.3, 0.3	Control* 1.2 (12%) Study 3.5 (25%), 4.1 (40%)
Abramson, 2005	88	176	12	Wise	Medial	None	NR	0.75, 2.4 (11%, 34%)**
Pallua, 2003	45	90	13	L-Pattern	Superior	Pillar sutures	0	1.4 (20%)

Note: SN-N – sternal notch to nipple distance; N-IMF – nipple to inframammary fold distance; NR – not reported; SM – superomedial.

* Patients undergoing pregnancy after mastopexy with and without breastfeeding compared to a no pregnancy control.

** Values for reductions <500–1200 g and >1200 g, respectively.

Study type was also identified. There were 16 case series, seven cohort studies, and one randomized controlled study. The Newcastle–Ottawa Scale was used to assess the risk of bias in the seven cohort studies. Studies on average scored 6.4 out of nine stars.

Table 2

Proposed techniques to improve longevity in mastopexy over one year.

Autologous
Lipofilling
Dermal flap
Muscular sling
Autoaugmentation flap
Synthetic
Pillar sutures
Absorbable mesh
Permanent mesh

Outcomes

Surgical techniques were classified according to three variables: incision pattern, glandular pedicle, and additional support techniques. A total of 614 patients underwent wise pattern skin incisions, 364 vertical, 45 vertical with lateral extension, and 266 could not be differentiated. There were 424 patients with superior or superomedial pedicles, 268 medial, 191 central, 143 inferior, and 209 patients from studies with variable reporting. Additional support techniques included 383 patients with mesh, 174 with pillar sutures, 136 with a dermal or dermoglandular sling, 110 with flap autoaugmentation, 21 with a muscular sling, 21 with lipofilling, and 390 with standard techniques or unspecified (Table 2).

The most common supportive technique was pillar sutures used in 6 studies with mean nipple to inframammary fold (N-IMF) elongation over the course of follow-up ranging from -0.4 cm (3.9%) to 1.4 cm (20%). Results with meshes had overall promising results with mean N-IMF elongation ranging from 0.5 cm (4.9%) to 0.54 cm (7.7%) across four studies. Four studies included in this review reported on dermal slings with the N-IMF elongation ranging from 0 cm (0%) to 1.7 cm (26%). Autoaugmentation results were also inconsistent ranging from 0.2 cm (2.8%) to 1.6 cm (29.1%) across three studies. Lipofilling and muscular slings were only described in one study each.

The majority of cases reported on a change in the N-IMF distance from intra-op or at first follow-up visit to final follow-up. Eighteen studies reported on both N-IMF and sternal notch to nipple (SN-N) distances. Percentage change in length was calculated when possible. Other methods of quantifying ptosis or pseudoptosis included measurements of lower pole convexity, lower pole distance ratio, angle of breast projection, IMF angle, volume distribution, and surgical clip migration. All studies included in this review had mean follow-up times greater than one year. There were only two studies reporting follow-up times of five years or more.^{2,11}

Discussion

A successful long-term result in mastopexy and reduction mammoplasty is determined by a variety of factors, including surgical technique, extent of breast reduction, tissue quality, weight loss or gain, pregnancy, breastfeeding, and age. Although most of these factors cannot be controlled, the surgeon can control the surgical technique and tailor this to each individual patient.

Incision pattern

The skin incision patterns commonly used in mastopexy include periareolar, vertical, vertical with IMF extension, and wise pattern. The decision on the type of incision used is determined by the degree of pre-operative ptosis, the extent of reduction if required, and surgeon preference and comfort. Here, the goal to optimize breast shape needs to be balanced with an effort to minimize scarring. It is difficult to draw conclusions on the long-term stability of these operations based on incision pattern because vertical reductions are more frequently performed on breasts with a lower degree of ptosis and smaller weight reductions.^{12–14} Further confounding the data, any glandular pedicle and any added support technique can be performed with either incision pattern.

Interestingly, the one study that reported a decrease in N-IMF length over time utilized a vertical reduction pattern with either a medial or superior pedicle and pillar sutures for support.¹⁵ Karacı et al. also published impressive results utilizing a chain purse strain suture technique with vertical breast reduction documenting no elongation of the N-IMF distance over a 12-month follow-up period.¹⁶ All other studies incorporating the vertical reduction pattern reported the elongation of the lower inframammary pole length, bottoming out, or increase in pseudoptosis over the study period.^{2,6,9,17–20}

Pedicle design

The glandular pedicle that supports the NAC is generally selected independent of the skin incision pattern. Superior or superomedial, medial, central, and inferior pedicles were reviewed in this study. Although nationally inferior pedicle breast reduction is the most commonly performed technique, in this review, the most commonly performed pedicle was superior or superomedial.^{21–24} Kemaloglu and Özocak conducted a prospective study in 100 patients comparing superomedial and inferior pedicle designs in large volume reductions and found no significant difference between SN-N distance or N-IMF elongation. However, Zehm et al. reviewed 34 patients who underwent either wise pattern superior or inferior pedicled breast reductions over a 42-month period and reported a trend toward an increased inferior mammary pole length with an inferior pedicle. Furthermore, Sapino et al. also conducted a retrospective study comparing superomedial and inferior pedicle breast reduction techniques in 58 patients, and the superomedial pedicle group was found to have a statistically significant shorter SN-N distance, a lesser N-IMF elongation, and a lower level of pseudoptosis.

Additional support techniques

Because of the mixed long-term results with standard mastopexy and reduction techniques, many additional steps have been described to increase stability. These include pillar sutures, permanent and absorbable meshes, lipofilling, dermal or dermoglandular slings, autoaugmentation flaps, and muscular slings.^{2–4,6,9,11,15–18,20,25–32} The meshes used were variable and permanent or partially absorbable meshes generally had better outcomes compared to fully absorbable meshes. Hamdi et al. compared results in patients who underwent superior or superomedial pedicle mastopexy with a septum-based parenchymal flap supported by Vicryl or mixed polyester/Vicryl mesh and found a significantly greater lower pole elongation with Vicryl mesh.¹⁷ József et al. compared results of contralateral mastopexy symmetry procedures after breast reconstruction using no mesh or ULTRAPRO® partially absorbable mesh, and the no mesh group was found to have a significantly increased SN-N and N-IMF elongation.³²

The autologous counterpart to mesh reinforcement is the dermal or dermoglandular flap referred to as a hammock flap or internal brassiere flap. These flaps are inferiorly based and secured to the pectoralis muscle or chest wall to provide added support to the breast parenchyma.^{4,26,29} Watfa et al. compared six patients undergoing standard wise pattern superior pedicle mastopexy to 12 patients undergoing the same procedure with the addition of a dermal suspensory hammock flap and found a significant increase in lower pole arc length in the standard mastopexy group but no change in SN-N distance.⁴ Another autologous option requiring more extensive dissection is the pectoralis major muscle sling or the pectoralis fascia suspension.^{2,33–35} In the only randomized controlled study included in this review, Graf et al. demonstrated a significant reduction in bottoming out over a ten-year period when a muscular sling was used compared to a control group.²

Patient factors

In addition to surgical technique, many patient factors also play a large role in long-term outcomes of aesthetic breast surgery. Changes in weight, and specifically weight loss, can contribute to secondary ptosis. With weight loss, there is a decrease in volume and deflation of the breasts. Some studies comment on this phenomenon; however, no studies stratified outcomes based on post-operative weight loss or gain.^{4,7,31,36} Mastopexy and breast reduction procedures should be performed when patients reach a stable weight, and patients should be counseled pre-operatively that

significant changes in weight can affect the longevity of results. If additional weight loss is planned, then the procedure should be delayed when possible.

Tissue quality will also affect the stability of results after any breast surgery. Poor skin quality or parenchymal attenuation will accelerate the effects of gravity and contribute to recurrent ptosis.^{4,9,28} Studies reporting on mastopexy and breast reduction in massive weight loss patients were excluded from review for this reason. Tissue quality is also influenced by age. There is thinning of the dermis, loss of elasticity, and deflation of the breasts.^{37,38} Although no studies stratified outcomes by age, some comparative studies did match groups based on age.

Pregnancy and breastfeeding also influence breast tissue quality and appearance. Cruz-Korchin and Korchin retrospectively reviewed 57 patients who had pregnancies after vertical medial pedicle breast reduction matched with 103 controls over a 24-month period and found a statistically significant difference in N-IMF elongation after pregnancy. Notably, the mean N-IMF elongation was greater in pregnant women who breastfed compared to those who did not.¹⁹

Pre-operative breast size and the extent of reduction also influence the long-term stability of results. Abramson et al. reviewed 88 patients who underwent wise pattern medial pedicle breast reduction and reported an 11% N-IMF increase in patients with 500–1200 g reductions compared to a 34% increase in patients with greater than 1200 g reductions.²⁴ In general, patients with larger breasts and longer SN-N distances tend to be more difficult to achieve long-term stability.

The longevity of mastopexy and reduction mammoplasty can be assessed in a variety of ways as seen in the variable data collection and outcome reporting in these studies. Although reporting N-IMF distances or lower pole elongation gives information on bottoming out or pseudoptosis of the breast, it does not give a comprehensive picture of the change in breast shape over time. By also describing SN-N distances, the vertical change in nipple position can be appreciated which is critical to understanding the change in breast appearance. To further categorize changes in breast shape, some studies attempted to quantify breast projection. Aquinati et al. measured lower pole convexity, and Ors measures nipple projection with the patients in the sitting position.^{20,26} With three-dimensional imaging, Adams et al. measured projection as a distance from the chest wall, whereas Quan et al. calculated the angle of breast projection between the superior pole of the breast and the chest wall.^{6,18} It is difficult to state which method of data collection and which metrics for outcome reporting are ideal, but studies reporting information on SN-N length, N-IMF elongation, and projection provided the most comprehensive picture of breast appearance.

Limitations

This systematic review was limited by the heterogeneity in study design, operative technique, and outcome reporting between studies. Follow-up time was variable, and although we excluded studies with follow-up of less than 1 year, this may be insufficient to truly understand long-term change. There is a need for more data tracking changes in breast shape and nipple position over multiple time points in a 5 or 10-year period. The majority of studies reported an N-IMF distance; however, this measurement alone does not fully describe breast shape and appearance. Six comparative studies were included in this review that provided valuable results; however, more controlled studies are needed to better understand the relationship between surgical technique and the longevity of breast shape and appearance.

Conclusion

Mastopexy and breast reduction are commonly performed procedures in plastic surgery with many variations in incision design and technique. Superior and superomedial pedicles tended to provide greater long-term stability than inferior pedicles. Mesh, dermal suspension flaps, and muscular slings showed promise in providing additional support over standard techniques. No single procedure is ideal for all patients; however, this systematic review provides a valuable description of techniques and long-term outcomes to guide surgical planning.

Declaration of Competing Interest

Dr. Rohrich receives instrument royalties from Eriem Surgical, Inc. and book royalties from Thieme Medical Publishing. He is a clinical and research study expert for Allergan, Inc., Galderma, and MTF Biologics. He is a medical monitor for Merz North America and the owner of Medical Seminars of Texas, LLC.

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Statement of ethical approval

Ethical approval: Not required.

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