A Systematic Review of Single-Stage Augmentation-Mastopexy

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Background: The safety of single-stage augmentation-mastopexy remains controversial given the dual purpose of increasing breast volume and decreasing the skin envelope. Currently, the literature is relatively sparse and heterogeneous. This systematic review considered complication profiles and pooled summary estimates in an attempt to guide surgical decision-making.
Methods: Multiple databases were queried for combined augmentation-mastopexy outcomes. Whenever possible, meta-analysis of complication rates was performed.
Results: Twenty-three studies met inclusion criteria. Average follow-up varied from 16 to 173 weeks, with a majority under 1 year. The pooled total complication rate was 13.1 percent (95 percent CI, 6.7 to 21.3 percent). The most common individual complication was recurrent ptosis, with an incidence of 5.2 percent (95 percent CI, 3.1 to 7.8 percent), followed by poor scarring (3.7 percent; 95 percent CI, 1.9 to 6.1 percent). The pooled incidences of capsular contracture and tissue-related asymmetry were 3.0 percent (95 percent CI, 1.4 to 5.0 percent) and 2.9 percent (95 percent CI, 1.2 to 5.4 percent), respectively. Infection, hematoma, and seroma were rare, with pooled incidences of less than 2 percent each. Three published studies reported data on patient satisfaction. The reoperation rate obtained from 13 studies was 10.7 percent (95 percent CI, 6.7 to 15.4 percent).
Conclusions: This meta-analysis encompassed 4856 cases of simultaneous augmentation-mastopexy. Study heterogeneity was high because of differences in surgical techniques, outcome definitions, and follow-up durations. This review suggests that with careful patient selection, pooled complication and reoperation rates for single-stage augmentation-mastopexy are acceptably low. (*Plast. Reconstr. Surg.* 134: 922, 2014.)

Since the seminal work by Dr. Spear in 2003 entitled "Augmentation/Mastopexy: 'Surgeon, Beware'," [1] the safety of single-stage augmentation-mastopexy has remained controversial. There are concerns about the technically challenging nature of the procedure and the fact that it encompasses two objectives that may ostensibly be at odds with each other—expansion of breast volume and reduction of the skin envelope. Heightened risk of nipple loss, devascularization of the central breast parenchyma, nipple malposition, and implant extrusion have been cited as specific caveats.[2,3] In contrast, several recent studies have demonstrated acceptable complication and reoperation rates with the concomitant advantages of avoiding a second operation, lower costs, and potentially greater patient satisfaction.[4–6]

However polarized, the literature on this subject is relatively sparse and varied with respect to surgical technique and outcomes of interest. Furthermore, with the need for careful patient selection and the relative technical difficulty of the procedure, many reports are limited by small patient cohorts. Given these limitations within the literature, it has been difficult to make evidence-based decisions weighing the potential

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added risks of complications and poor aesthetic outcomes against the benefits of a single-stage procedure.

In this study, we aim to undertake a systematic review of the literature to more effectively synthesize the outcomes data available on single-stage augmentation-mastopexy. Whenever possible, we use meta-analysis to assess the safety of a combined augmentation-mastopexy through pooled complication rate estimates. To our knowledge, this is the first systematic review and meta-analysis of simultaneous augmentation-mastopexy.

PATIENTS AND METHODS

Search Methods

A literature search was performed of the Cochrane Library, Web of Science, Embase databases, and by using PubMed to query the MEDLINE database through May 1, 2013. Search terms included "augmentation mastopexy," "simultaneous augmentation mastopexy," and "one-stage augmentation mastopexy." An abstract was obtained for each of the 259 unique articles identified.

Selection Criteria

Selection criteria were defined a priori. Studies underwent two levels of review by two independent researchers. For the first level, titles and abstracts of the 259 articles were screened for the following exclusion criteria: publications of brief communications, discussions, letters, case reports, and reviews; publications about a topic other than one-stage augmentation-mastopexy; and publications without outcomes related to postoperative complications, reoperations, or satisfaction. Each study was also required to clearly indicate the number of one-stage augmentation-mastopexies performed; studies reporting fewer than 25 cases of augmentation-mastopexy were excluded.

Full articles were retrieved for each of the 33 studies that met the first level of selection criteria. Studies needed to report or provide data necessary to calculate a reoperation rate, patient satisfaction, or a complication rate for at least one of the following postoperative complications: seroma; hematoma; infection; nipple-areola, skin, or fat necrosis; partial necrosis; capsular contracture; poor/hypertrophic scarring; implant displacement, malposition, or failure; breast, nipple, or areola asymmetry; or recurrent ptosis. Each study's definition of a total complication was reviewed for heterogeneity. Studies published before 2000 and those in a foreign language were also excluded. When multiple studies reported on overlapping cohorts, the publication with the greatest number of augmentation-mastopexies was included. All studies included in this work have been published in a peer-reviewed journal with approval of their respective institutional review board. No institutional review board approval was required for the current study. A complete overview of the selection process is outlined in Figure 1.

Data Collection

Data were collected and analyzed with respect to the guidelines set forth by the *Cochrane Handbook for Systematic Reviews of Interventions* and the "Meta-Analysis of Observational Studies in Epidemiology."[7,8] A standardized, electronic data abstraction form was created, and two independent reviewers extracted data from all selected studies. The electronic data form included the following variables: lead author, publication year, surgical technique, implant type, number of patients, average patient age and body mass index, percentage of smokers and diabetics, and mean follow-up. Complication data included seromas; hematomas; infection; capsular contracture; poor/hypertrophic scarring; breast, nipple, or areola asymmetry; implant malposition or failure; partial necrosis; and recurrent ptosis. Data on reoperations and patient satisfaction were collected when available.

Statistical Analysis

Cumulative pooled estimates were calculated from each study's complication rate and its standard errors based on the binomial distribution.[9] If a study did not explicitly report an outcome, it was not included in the respective analysis. The DerSimonian-Laird random-effect method was used based on interstudy heterogeneity.[10] Heterogeneity was assessed using the Q statistic and the I^2 statistic.[11] A small p value for the Q statistic indicates statistically significant heterogeneity. The I^2 statistic indicates the percentage of variability across all studies that is attributable to heterogeneity rather than chance, with larger values indicating greater heterogeneity. Statistical analysis was performed using the metafor package for the R statistical computing environment and MedCalc version 12.7.1.0 (MedCalc Software, Ostend, Belgium).

RESULTS

Study Characteristics

A search of the Cochrane Library, Web of Science, and MEDLINE databases identified 259

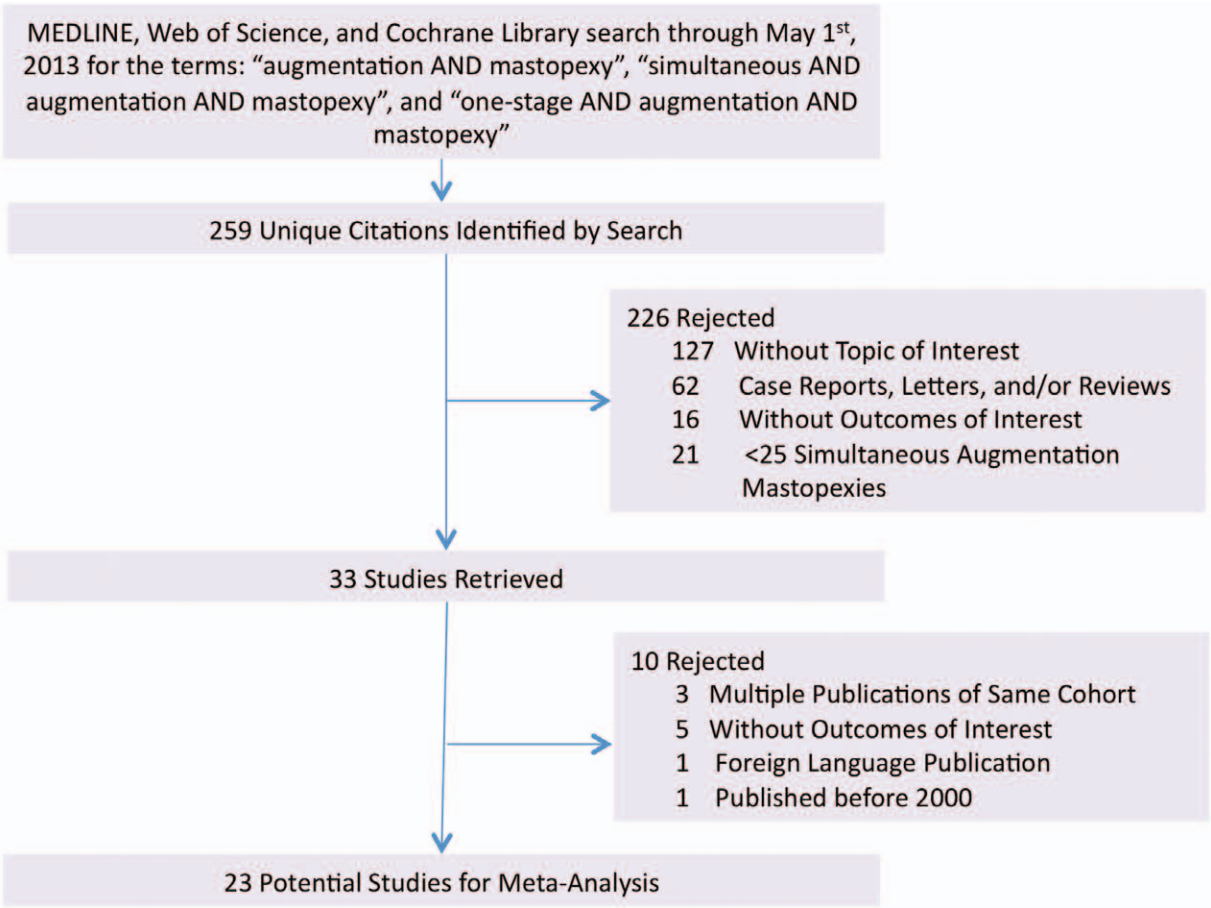

Fig. 1. Study attrition diagram. Four major databases were queried to identify a total of 259 unique citations regarding combined augmentation-mastopexy. After two rounds of attrition by two independent reviewers, 23 publications were identified for inclusion within the study.

articles that were eligible for screening. Of these, 226 were rejected after their titles and abstracts were reviewed. After the full text of the remaining 33 articles was reviewed, an additional 10 were rejected. All 23 articles that were included were retrospective cohort studies (Fig. 1). In total, 4856 primary one-stage augmentation-mastopexies were included in the meta-analysis (Table 1). Whenever data were available, study populations had similar demographics. On average, patients were between 32 and 44 years old, had a low body mass index, and included between 8 and 21 percent smokers. All 23 studies reported data on reoperation rates or postoperative complications,[3–5,12–31] and three articles reported data on patient satisfaction (Table 2).[16,18,28]

Pooled Complication Rates

Among the 15 studies reporting total complications, there was a pooled complication rate of 13.12 percent (95 percent CI, 6.7 to 21.3 percent) (Fig. 2). The most common individual complication was recurrent ptosis, with a pooled incidence of 5.2 percent (95 percent CI, 3.1 to 7.8 percent). Other common tissue-related complications included poor or hypertrophic scarring (3.74 percent; 95 percent CI, 1.9 to 6.1 percent) and postoperative asymmetry of the breast, areola, or nipple (2.7 percent; 95 percent CI, 1.0 to 4.4 percent). Overall, implant-related complications were less common than tissue-related complications. Capsular contracture was the most common implant-related complication, with a pooled incidence of 3.0 percent (95 percent CI, 1.4 to 5.0 percent). Hematoma and seroma were both rare, with pooled incidences of nearly 1.4 percent each. In a combined 3865 patients, the pooled infection rate was 0.93 percent (95 percent CI, 0.5 to 1.4 percent). Within the 13 studies reporting reoperations following a simultaneous augmentation-mastopexy, the pooled reoperation rate was 10.65 percent (95 percent CI, 6.7 to 15.4 percent) (Fig. 3). Table 3 includes a summary of all pooled complication rates.

Table 1. Study and Patient Characteristics

Reference	Mastopexy Technique	Implant Type	Patient Characteristics				
			No. of Patients	Age (yr)	BMI	Smokers (%)	Mean Follow-Up (wk)
Araco et al., 2006[12]	—		36	—	—	—	52
Calobrace et al., 2013[4]	Periareolar, 20%; vertical, 40%; inverted-T, 40%	Silicone,73%; saline, 27%	332	37	24.1	18.10	78
Cannon and Lindsey, 2010[17]	Periareolar	Textured, saline	100	—	—	—	36
Cárdenas-Camarena et al., 2006[18]	Periareolar, 51%; inverted-T, 41%; other, 8%	Textured, silicone	384	37	—	—	—
Ceydeli and Freund, 2004[19]	"Tear-drop," modified periareolar	Round implant, unspecified	35	17–48	—	—	104
Chen et al., 2011[20]	—	—	108	—	—	—	—
Codner et al., 2011[23]	—	Silicone, 70%; saline, 30%	178	—	—	—	114
Colque and Eisemann, 2012[13]	—	—	39	34.5	22.8	—	—
Eisenberg, 2012[21]	Inverted-T	Saline	55	—	—	—	39
Gallent et al., 2003[25]	Vertical	Smooth, saline	50	28–60	—	—	—
Gonzalez, 2012[14]	Periareolar	Round, textured, unspecified	28	34	23.7	14.29	—
Hall-Findlay, 2011[26]	Vertical	Smooth saline, 20%; textured silicone, 63% smooth silicone, 17%	89	—	—	—	—
Hanemann and Grotting, 2010[27]	—	—	2392	—	—	7.90	—
Hickman, 2011[15]	Periareolar mastopexy	Saline	174	24–58	—	—	48
Khan, 2010[24]	Periareolar, 70%; vertical, 30%	Round, cohesive gel, textured silicone	44	32.4	—	—	—
Kropf et al., 2011[22]	Periareolar	Round, saline implants	26	43.9	—	—	—
Migliori, 2011[28]	"Upside down," modified periareolar	Dual-cohesiveness, anatomical silicone	231	38	—	—	69
Persoff, 2003[29]	Vertical	Saline	40	—	—	—	≥43
Spear et al., 2004[16]	Periareolar, 74%; vertical, 26%	Silicone, 75%; saline, 23%; combination silicone/saline, 2%	34	39	—	—	104
Spear et al., 2006[3]	—	Silicone, 77%; saline, 23%	53	—	—	13.21	42
Stevens et al., 2007[31]	Inverted-T, 60%; periareolar, 21%; vertical, 15%; other, 4%	—	321	39	22.7	8.70	173
Swanson, 2013[5]	Vertical	Saline	47	42.5	—	21.30	16
Tessone et al., 2011[30]	Vertical	Textured silicone; 29%; smooth silicone, 23%	60	38	—	20	≥52

Study Heterogeneity

Pooled complication analyses showed a wide range of heterogeneity within outcomes. The heterogeneity values for total complication and reoperation were fairly high (Q statistic: $p < 0.001$, $I^2 = 96.5$ percent; and $p < 0.001$, $I^2 = 83.6$ percent, respectively). The pooled complication analyses for capsular contracture, asymmetry, and recurrent ptosis, however, demonstrated less yet still significant amounts of heterogeneity ($p < 0.001$, Q statistic). Heterogeneity was not statistically significant in pooled analyses for infection, seroma, hematoma, and poor/hypertrophic scarring (Table 3).

DISCUSSION

Single-stage augmentation and mastopexy is a technically challenging procedure with two objectives seemingly at odds with one another—expansion of breast volume and reduction of the skin envelope. Inclusion of augmentation in the combined procedure introduces implant-related concerns such as infection and seroma, whereas mastopexy increases the risk of tissue-related

Table 2. Study Outcomes

Reference	Total No. of Patients	No. of Complications												
		Overall Complication	Seromas	Hematoma	Infection	Capsular Contracture	Poor or Hypertrophic Scarring	Reoperations	Dehiscence	Tissue-Related Asymmetry	Recurrent Ptosis	Satisfied Patients	Implant Malposition	Partial Necrosis
Araco et al., 2006[12]	36	3	0	1	0	1	0	1	—	—	—	—	—	—
Calobrace et al., 2013[4]	332	76	2	5	2	13	11	77	—	16	11	—	6	9
Cannon and Lindsey, 2010[17]	100	11	0	0	1	1	3	—	—	2	—	—	1	1
Cárdenas-Camarena et al., 2006[18]	384	69	—	—	—	—	42	—	6	—	34	333 of 384	10	—
Ceydeli and Freund, 2004[19]	35	2	1	1	0	—	—	—	—	—	—	—	—	0
Chen et al., 2011[20]	108	18	—	—	—	—	—	—	—	—	—	—	—	—
Codner et al., 2011[23]	178	—	—	—	—	—	—	46	—	—	—	—	—	—
Colque and Eisemann, 2012[13]	39	0	—	0	—	—	—	0	—	—	—	—	—	—
Eisenberg, 2012[21]	55	3	—	0	0	0	1	—	—	0	2	—	0	—
Gallent et al., 2003[25]	50	—	—	2	0	0	—	2	0	0	—	—	2	0
Gonzalez, 2012[14]	28	5	—	—	1	—	0	2	—	4	0	—	—	1
Hall-Findlay, 2011[26]	89	—	—	—	0	11	—	—	—	—	—	—	—	—
Hanemann and Grotting, 2010[27]	2392	49	—	—	14	—	—	—	—	—	—	—	—	—
Hickman, 2011[15]	174	60	2	0	0	—	4	14	0	0	8	—	—	2
Khan, 2010[24]	44	—	—	0	1	—	—	2	—	—	—	—	—	—
Kropf et al., 2011[22]	26	5	—	—	1	1	—	—	—	—	3	—	—	0
Migliori, 2011[28]	231	—	—	—	—	0	—	—	—	—	21	231 of 231	—	0
Persoff, 2003[29]	40	—	—	0	0	0	0	3	—	—	—	—	—	—
Spear et al., 2004[16]	34	3	—	—	—	2	—	5	—	—	1	On average satisfied; 7 of 13 would revise	—	—
Spear et al., 2006[3]	53	11	1	1	—	2	—	7	—	—	—	—	—	—
Stevens et al., 2007[31]	321	—	—	2	4	6	8	47	—	12	7	—	1	—
Swanson, 2013[5]	47	8	0	0	0	—	3	—	—	3	—	—	—	—
Tessone et al., 2011[22]	60	—	1	2	1	2	5	6	16	2	—	—	—	—

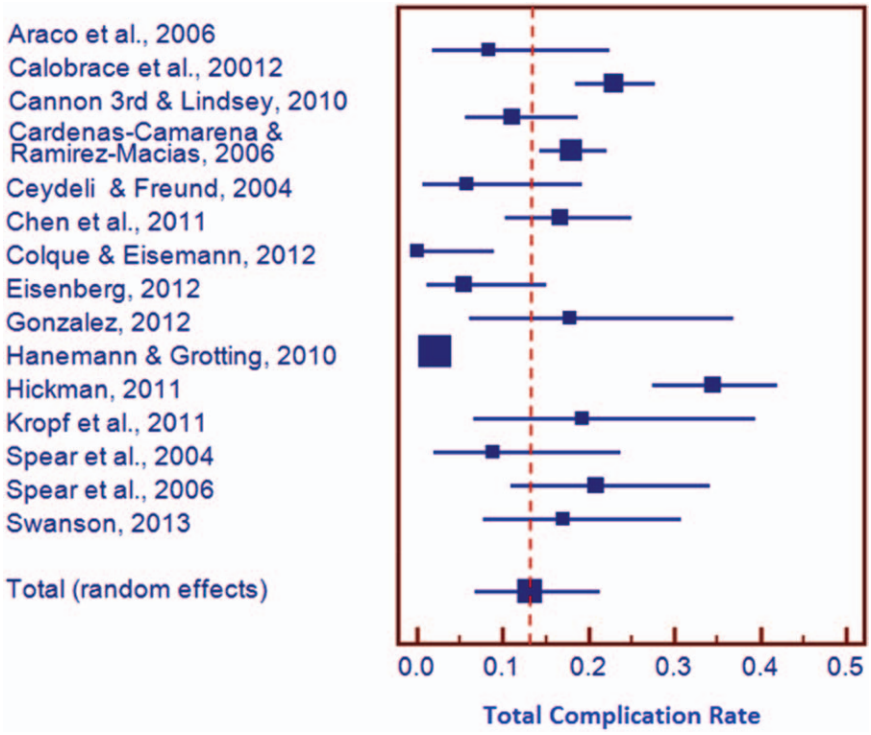

Fig. 2. Pooled total complication rate. A meta-analysis of 15 studies reporting total complication rates, including 3843 patients, found a pooled complication rate of 13.12 percent. The *squares* and *lines* represent the individual study or pooled incidences and 95 percent confidence intervals, respectively. The size of each *square* represents its relative weight within the final pooled estimate.

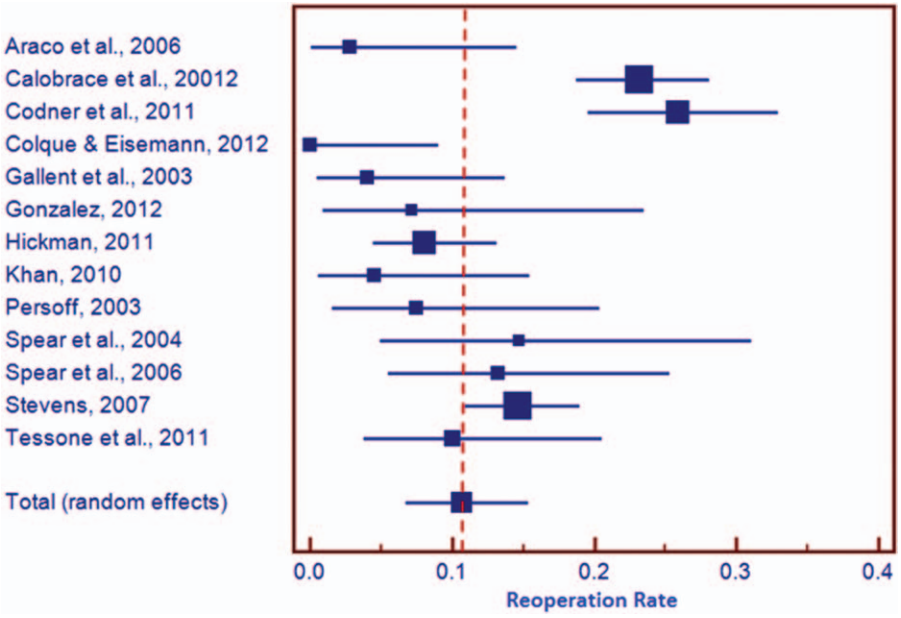

Fig. 3. Pooled reoperation rate. A meta-analysis of 13 studies reporting the incidence of reoperation, including 1389 patients, found a pooled incidence of 10.65 percent. The *squares* and *lines* represent the individual study or pooled incidences and 95 percent confidence intervals, respectively. The size of each *square* represents its relative weight within the final pooled estimate.

Table 3. Pooled Complication Rates for Augmentation-Mastopexies

Complications	No. of Studies	No. of Augmentation-Mastopexies	Pooled Complication Rate (%)	95% CI (%)	Q Statistic, p	I^2 (%)
Total	15	3843	13.12	6.72–21.25	<0.001	96.45
Recurrent ptosis	9	1585	5.20	3.12–7.78	<0.001	72.14
Poor/hypertrophic scarring	11	1577	3.74	1.91–6.14	<0.001	75.6
Capsular contracture	14	1463	2.97	1.44–5.02	<0.001	71.35
Tissue related asymmetry	9	1167	2.94	1.22–5.38	<0.001	73.54
Seroma	9	873	1.42	0.59–2.60	0.198	27.71
Hematoma	15	1422	1.37	0.67–2.30	0.096	34.03
Infection	17	3865	0.93	0.52–1.44	0.237	18.52
Reoperation	13	1389	10.65	6.70–15.39	<0.001	83.55

complications such as nipple/flap necrosis and poor scarring. Although some authors have argued that the combined procedure actually improves exposure, offers technical advantages, avoids a 100 percent reoperation rate compared with two-stage procedures, and improves patient satisfaction,[4–6] other surgeons have advocated caution, suggested strict patient selection criteria, or even discouraged single-stage augmentation-mastopexy altogether.[1,32] Despite controversy over the safety of single-stage augmentation-mastopexy, relatively few statistically rigorous outcomes studies exist.[27] Most reports currently in the literature are single-surgeon experiences or presentations of a particular technique. This diversity and relative paucity of outcomes data suggest the need for a systematic review and meta-analysis of single-stage augmentation-mastopexy to assess safety through pooled complication profiles and summary estimates.

The pooled total complication rate was 13.12 percent, with relatively high study heterogeneity. Definitions of total complications were broad and varied, encompassing both Clavien[33] surgical complications requiring additional medical intervention and undesirable outcomes such as poor scarring and asymmetry. Reporting outcomes in cosmetic surgery is complex by nature because aesthetic results and patient satisfaction are often as important as more tangible measures such as hematoma, infection, or wound breakdown.[34,35] Thus, wide heterogeneity in total complication rate was not unexpected.

The most common individual complications were tissue-related, specifically, recurrent ptosis and breast or nipple asymmetry, with rates of 5.20 percent and 2.94 percent, respectively. Poor/hypertrophic scarring occurred at a pooled rate of 3.74 percent. Predominance of tissue-related complications over implant-related complications was consistent through most studies included in the meta-analysis. It has been postulated that the weight of the implant contributes to the risk of recurrent ptosis; however, there are currently no data to confirm or refute this hypothesis.[36] It is also likely that rates of recurrent ptosis were related to the choice of incision, implant placement, and implant size, variables that were widely represented across the included studies.[5,14,18] The pooled incidence of recurrent ptosis varied between mastopexy approaches, at 3.21 percent (95 percent CI, 1.28 to 5.97 percent) with the inverted-T technique[18,21] and 7.04 percent (95 percent CI, 2.45 to 13.76 percent) with a periareolar procedure.[15,18,22,26] Tissue-related asymmetry rates, however, were fairly constant at 3.22 percent (95 percent CI, 0.01 to 11.77 percent) with the periareolar technique[14,15,17] and 3.26 percent (95 percent CI, 0.47 to 8.44 percent) with the vertical technique.[5,25,30] Although these subgroup analyses provide more nuanced risk estimates, they are limited by possible selection bias, as well as variations in implant selection, implant size, duration of follow-up, and other inherent variations among studies, in addition to the relative dearth of data available for each subgroup.

The pooled rate of capsular contracture for primary augmentation-mastopexy in this meta-analysis was low at 2.97 percent and comparable to published rates for primary augmentation alone of 1.8 to 9.8 percent.[37–40] However, the pooled estimate of capsular contracture may have been underestimated because of limited follow-up periods in some studies. In a cohort of 20 patients undergoing revision, Spear and colleagues found capsular contracture to be the most common indication, with an average interval from original surgery to presentation for revision in this cohort of 7 years.[2] In those studies with a mean follow-up of at least 2 years, the pooled capsular contracture rate increases to 3.23 percent (95 percent CI, 0.44 to 8.45 percent; data not shown). Despite this increasing trend, these values are still consistent with the range reported

for primary augmentations alone.[37,40] Of note, a study by Migliori[28] including 231 post–bariatric surgery patients with an average follow-up of 16 months reports no incidence of capsular contracture. The authors attribute this finding to the use of a modified periareolar, "upside-down" mastopexy technique, and style 510 implants. Given the significant interstudy and intrastudy heterogeneity of implant type and mastopexy technique, we were unable to further stratify our analysis with regard to these variables. Additional high-quality, long-term studies of capsular contracture rates are necessary to better appreciate its incidence following combined augmentation-mastopexy. Other complications, including infection, hematoma, and seroma, were rare. Furthermore, major skin flap or nipple necrosis and implant malposition were rarely reported and thus not included in the meta-analysis.

Reoperation rates for any reason were pooled from 13 studies to yield a pooled reoperation rate of 10.65 percent, which increased to 16.13 percent (95 percent CI, 10.65 to 22.51 percent) in only those studies with an average follow-up of at least 1 year. This is considerably less than the obligate 100 percent reoperation rate for two-stage procedures. Again, the definitions of reoperation among the studies were broad, ranging from minor scar revisions performed under local anesthesia, to reoperations for more severe complications, to implant size exchange for patient preference. In the largest included series by Calobrace et al.,[4] the most common indications for reoperation were capsular contracture, poor scarring, and recurrent ptosis. Tissue-related reoperations were more prevalent than implant-related reoperations and, notably, the tissue-related reoperation rate after single-stage augmentation-mastopexy was comparable to the mastopexy-alone reoperation rate (13.6 versus 10.2 percent, respectively). In contrast, Stevens et al.[6] noted a higher rate of implant-related reoperations, with the most common indications for revision being implant deflation and desire to change implant size. However, like Calobrace et al., Stevens et al. noted a similar tissue-related revision rate of 5.4 percent for combined augmentation-mastopexy versus 8.6 percent for mastopexy alone.[41] Comparing primary augmentation-mastopexy to primary augmentation mammaplasty alone, Codner et al.[23] noted significantly higher overall reoperation rates in the combined procedure, although implant-related reoperation rates were not statistically different. These findings imply that increased overall reoperation rates for the combined procedure were simply additive rather than synergistic. Finally, Spear et al. noted that patients often have complex expectations and that patient satisfaction was a major factor leading to revision augmentation-mastopexy.[16] Only three of the included studies surveyed patients for satisfaction with variable results.[16,18,28] Future studies using validated questionnaires are indicated to shed more light on this important patient-centered outcome.

To our knowledge, this is the first meta-analysis of single-stage augmentation-mastopexy. However, it is not without its limitations. As with any systematic review, the quality of the results depends on the available primary sources. As a relatively infrequently performed procedure, many of the included studies are of a low level of evidence ranging from case series to lesser quality prospective cohort studies. Study design ranged from single-surgeon, single-technique to single-center, multiple technique series. The meta-analysis was inclusive of multiple techniques (e.g., incisions, implant placement) and varying indications (e.g., aesthetic, symmetry procedures following reconstruction,[22] massive weight loss).[28] Furthermore, as discussed above, definitions of total complications and reoperations were broad. As such, we found relatively high study heterogeneity, which we attempt to mitigate by using a random-effects model. Furthermore, although we compare our pooled complication rates to those reported in the literature for augmentations or mastopexy alone, we are unable to more rigorously compare the incidence of complications between these groups. As Spear et al. note, the combination of these two procedures carries risk for certain outcomes that are not necessarily relevant to either procedure alone, and therefore heightened levels of caution are indicated to achieve an acceptable outcome.[3]

The importance of patient selection cannot be overemphasized. A two-stage approach should always remain a viable, alternative option.[32] Calobrace et al.[4] suggested relative contraindications of smoking, obesity, and severe nipple ptosis of greater than 6 cm, and recommended two-stage procedures in these cases. Cannon and Lindsey[17] noted that favorable patient characteristics for a single-stage augmentation with periareolar mastopexy included a flaccid or empty breast, lighter skin tones, lack of deep striae, implant size smaller than 360 cc, and nipple elevation of less than 4 cm. Such selection criteria and preoperative risk stratification were prudent and likely present in the majority of included studies. Subsequently, an inherent bias may have been present in the meta-analysis that must be considered.

Table 4. Favorable and Unfavorable Variables for Single-Stage Augmentation Mastopexy

Variables	References
Favorable	
Grades I or II ptosis	Gonzalez et al., 2012[14]; Hickman, 2011[15]; Kropf et al., 2011[22]
Small to moderate implant (<360 cc)	Cannon and Lindsey, 2010[17]; Beale et al., 2014[43]
Nipple elevation <4 cm	Cannon and Lindsey, 2010[17]; Kropf et al., 2011[22]; Beale et al., 2014[43]
Light toned skin with good elasticity	Hickman, 2011[15]; Cannon and Lindsey, 2010[17]
Nonsmoker	Calobrace et al., 2013[4]
Tuberous breast deformity	Hickman, 2011[15]; Ceydeli and Freund, 2003[19]
Unfavorable	
Grade III ptosis	Gonzalez et al., 2012[14]
Large implant (>400 cc)	Nahai et al., 2007[44]
Nipple elevation >6 cm	Calobrace et al., 2013[4]
Poor skin quality or deep striae	Gonzalez et al., 2012[14]; Cannon and Lindsey, 2010[17]; Kropf et al., 2011[22]
Active smoker	Calobrace et al., 2013[4]; Beale et al., 2014[43]
Obese	Calobrace et al., 2013[4]; Hickman, 2011[15]
Massive weight loss	Hickman, 2011[15]; Tessone et al., 2011[30]
Extreme asymmetry	Nahai et al., 2007[44]
Nipple off midline	Nahai et al., 2007[44]

Although the decision to stage or not to stage must ultimately be based on an individualized, aesthetic evaluation and surgeon experience, based on a survey of the literature,[4,15,17,22,42,43] the ideal candidate for a single-stage augmentation-mastopexy generally has a soft, flaccid breast, requires correction of Regnault grade I or II ptosis without the need for extreme skin or parenchyma resection, desires moderate augmentation (<360 cc), has good skin elasticity, and has low perioperative risk factors (e.g., smoking history, obesity). In contrast, patients with extreme ptosis or those presenting with additional complexities such as extreme asymmetry or a medially displaced nipple may benefit from staged procedures (Table 4).[17,44]

Furthermore, Friedman[42] offered several measures to improve the safety of simultaneous augmentation and mastopexy, including submuscular implant placement, augmentation before mastopexy, avoidance of Wise pattern incisions, and resection of parenchyma as needed to achieve tension-free closure. Beale et al.[43] recommended a conservative approach, which emphasized precise and conservative preoperative markings with 8-cm vertical limbs and a broad pedicle base, limited undermining of thick skin flaps, small implants (<200 cc) placed in the subpectoral space, and nipple elevation less than 4 cm

CONCLUSIONS

Single-stage augmentation-mastopexy remains a technically challenging and controversial procedure. The current state of the literature is relatively sparse and heterogeneous; however, this meta-analysis encompassed 4856 cases of simultaneous augmentation-mastopexy and is the first study to synthesize complication profiles and reoperation rates in a statistically robust manner. Pooled complication and reoperation rates for single-stage augmentation-mastopexy were acceptably low and comparable to published rates for primary augmentation or mastopexy alone. It must be noted that all studies included in this systematic review emphasized the importance of careful patient selection. In a carefully selected patient under the care of a skilled surgeon, combined augmentation-mastopexy can be safe and effective.

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