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Inferior pedicle breast reduction and long nipple-to-inframammary fold distance: How long is safe?

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Abstract *Background:* Free nipple grafting indications in breast reduction surgery are outdated. Safety of inferior pedicle technique for large resections and long pedicles has not been clearly defined. We evaluated patients who underwent inferior pedicle reduction mammoplasty to define the safety constraints of the inferior pedicle.
Methods: A retrospective review of patients who underwent inferior pedicle reduction mammoplasty due to symptomatic macromastia at Mayo Clinic over a six-year period was conducted. Patients with prior breast surgeries were excluded. Demographics, breast measurements, and surgical outcomes were collected. Univariate and multivariate analyses were performed to assess for predictors of necrosis.
Results: Overall, 288 patients (576 breasts) underwent inferior pedicle breast reduction from 2014 to 2019. The mean sternal notch-to-nipple (SN-N) distance was 31.5 cm (standard deviation[SD]:4.2; range[*r*]:16–48), and the mean nipple-to-inframammary fold (N-IMF) distance was 14.8 cm (SD:4.0; r:7.5–27). The mean resection weight was 699.6 g (SD:310.4; r:125–2,385). The median follow-up was 3.9 months (interquartile range[IQR]:2.8–9.0). The overall skin or nipple areolar complex necrosis rate was 2.1%; the overall complication rate was 14.8%. On multivari-

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ate analysis, overall necrosis was not found to be associated with the N-IMF distance (adjusted odds ratio[aOR]:1.05, 95%-CI 0.88–1.16). Resection weight was statistically associated with an increased risk of overall necrosis (aOR:1.003, 95%-CI 1.001–1.005), adjusting for N-IMF and SN-N distances.

Conclusion: Inferior pedicle breast reduction offers low risk of necrosis and can be safely performed in patients regardless of the N-IMF distance. No association was found between N-IMF distance and overall necrosis in our cohort, including lengths >15 cm. However, large resections could increase the risk of necrosis.

Introduction

Patients with high-grade breast ptosis and hypertrophy have been classically approached with free nipple grafting.[1-6] Textbook indications have been vague and outdated in their indications for free nipple grafting in patients with a long sternal notch-to-nipple (SN-N) distance, a nipple-to-inframammary fold (N-IMF) distance and large resections. Specifically, Grabb and Smith[1] recommend free nipple grafting in patients with a nipple-to-IMF distance of 15 cm or greater, resection of 2000 g or greater per side, increased age, or systemic disease where a reduction in operative time is desired. The author does not clarify if these indications are based on prior studies or personal experience. Another popular textbook, Essentials in Plastic Surgery, also recommends free nipple grafting in patients with N-IMF distances greater than 8 cm.[2] Similarly, authors in another well-regarded textbook recommend free nipple grafting in resection volumes greater than 2000 g per breast, without mention of their recommendations on the N-IMF distance cutoff.[3]

In some papers, immediate free nipple grafting is planned in cases of severe hypertrophy due to the concern for inadequate perfusion of nipple areolar complex (NAC). For example, a previous publication describes their indications for immediate free nipple grafting in 11 patients, including extreme macromastia, vascular disorders, or disorders that can impair wound healing (diabetes, collagen vascular disease), previous surgical procedures in the breast, and older patients.[4] The authors describe their technique starting with a planned free nipple graft and do not mention attempting a pedicle breast reduction. Other authors also describe a high incidence of nipple necrosis in patients with resection weights greater than 1000 g per breast, severe ptosis, and excessively long pedicles, recommending immediate free nipple grafting for these patients.[5-7] Recent studies have demonstrated the safety of the superior and central pedicle technique, demonstrating their utility in SN-N distance >40 cm and even 38–52 cm respectively.[8,9]

The inferior pedicle reduction mammoplasty is a straight-forward and reliable technique used by many plastic surgeons. One study that examined the complication rate in patients with large (1500 g) inferior pedicle reductions demonstrated higher complication rates in comparison to smaller reductions; however, they did not report N-IMF distance (inferior pedicle length) and pedicle widths in their findings.[10] These factors can contribute to the adequate perfusion of the NAC. Lacerna et al.[11] also demonstrated success in the inferior pedicle reduction with resection weights >2000 g, however, also did not report any objective measurements in their results. Our study is the largest retrospective cohort in the literature to date describing the safety and utility of the inferior pedicle technique in severe breast ptosis and hypertrophy, assessing resection weight, N-IMF, and pedicle width. We aim to show the safety and success of the inferior pedicle breast reduction and, ultimately, revisiting indications for free nipple grafting, which have been published in several textbooks.

Methods

An Institutional Review Board-approved retrospective study was conducted to identify all patients who underwent inferior pedicle breast reduction mammoplasty at the Mayo Clinic, Rochester, Minnesota, from 2014 to 2019. Only patients who underwent inferior pedicle breast reduction mammoplasty due to symptomatic macromastia were included. Patients who underwent breast oncoplastic surgery or had history of breast cancer or other breast pathology, such as fibroadenoma or pseudoangiomatous stromal hyperplasia, history of prior mastopexy, or breast augmentation, were excluded.

Data on patient demographics, comorbidities, surgical characteristics and technique, skin resection pattern, reduction weight parameters, and breast measurements, as well as complications and surgical outcomes were collected from the electronic medical records. Follow-up time and length of hospital stay were also recorded.

Complications were assessed in the first month and comprised the following: seroma identified by ultrasound and requiring drainage, hematoma requiring surgical evacuation, surgical site infection as defined by the Centers for Disease Control and Prevention (CDC), partial and full-thickness necrosis of skin flap and NAC, partial and full-thickness wound dehiscence (defined as full-thickness wound breakdown more than 1 cm in length), unplanned reoperation, and unplanned readmission. Complication rates were defined as the number of breasts that had acquired any surgical-site complication rather than obtaining the total complication count per cohort to prevent double-counting of event occurrences.

Data analysis was performed using univariate and multivariate logistic regression for predictors of specific complications using SAS JMP® version 14 (SAS Institute Inc., Cary, NC, 1989–2019). For the univariate analyses, Pearson's

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Table 1 Patient demographics.

	Patients$N = 288$		
	Mean or Counts	SD or Percentage	Range
Age, years	43.7	15.5	15–78
Body mass index, kg/m^2	31.5	5.1	21.6–54.4
Smoking history			
Nonsmoker	194	67.4%	
Former	88	30.5%	
Active	6	2.1%	
Hypertension	75	26.1%	
Diabetes	75	26.1%	
Hyperlipidemia	19	6.6%	
Coronary artery disease	6	2.1%	
Hypothyroidism	48	16.7%	
Thrombophilia	9	3.1%	
History of DVT or PE	11	3.8%	
History of stroke	5	1.7%	

DVT, deep venous thrombosis; SD, standard deviation; PE, pulmonary embolism.

chi-square or Fisher's exact test was used to determine statistical significance as was appropriate. The *t*-test was used as our test statistic for continuous variables. An alpha error of 0.05 was used and values of $p < 0.05$ were considered statistically significant.

Surgical technique

Patients were marked in the preoperative holding area in the standing position utilizing the standard Wise-pattern or Drape/Passot pattern. The new SN-N distance was marked at approximately 21–23 cm, the mid-point of the humerus, or by the transposition method. All patients were given preoperative antibiotics. The base of the pedicle was marked at a minimum of 8 cm width. The NAC was marked to have a diameter between 42 and 60 mm. The pedicle was de-epithelialized, and skin flaps were elevated in a standard fashion.

Results

Two hundred eighty-eight patients (576 breasts) underwent inferior pedicle breast reduction mammoplasty due to symptomatic macromastia. The mean age was 43.7 years (standard deviation [SD]: 15.5). The median follow-up was 3.9 months (interquartile range [IQR]: 2.8–9.0) with a mean length of hospital stay of 0.5 days (SD: 0.6). The demographics of our patient cohort are presented in Table 1.

Breast measurements and resection weight parameters are shown in Table 2. Out of the 576 breasts, 48.1% had grade 2 ptosis, 43.4% had grade 3 ptosis and 97.6% underwent Wise skin pattern inferior pedicle reduction mammoplasty. The mean SN-N distance was 31.5 cm (standard deviation [SD]: 4.2; range [*r*]: 16–48) and the mean N-IMF distance was 14.8 cm (SD: 4.0; *r*: 7.5–27). The mean resection weight was 699.6 g (SD: 310.4; *r*: 125–2385). The distribution and relationship between resection weight and N-IMF distance are illustrated in Figure 1. Statistical output of this model showed a moderately strong positive linear correlation (correlation coefficient: 0.56, $p<0.0001$) and a weak adjusted R squared value of 0.31, which means that only 31% of the variability of breast resection weight is explained by the N-IMF distance.

Early complications, defined as within 30 days postoperatively, demonstrated 20 breasts (3.5%) presented with seroma, 9 breasts (1.6%) with hematoma, and 12 breasts (2.1%) with surgical site infection. A total of 32 breasts (5.6%) presented with wound dehiscence; the majority (3.6%) was located at the T junction. Only two breasts (0.4%) showed partial NAC necrosis, and nine breasts (1.6%) presented with skin necrosis (seven partial and two full). None presented with full NAC necrosis. Complications are detailed in Table 3.

When comparing breasts that underwent resection of 1000 g or more to breasts with resection weight less than 1000 g (Table 4), we found that surgical site infection, skin necrosis, and unplanned readmission were significantly higher for breasts with resection weight equal to or more than 1000 g. Similarly, the overall complication rate was statistically higher among this group. However, when comparing breasts with an N-IMF distance of 15 cm or more to breasts with an N-IMF distance of less than 15 cm (Table 5), we found that the group with a longer distance showed a significantly higher rate of surgical site infection. However, no difference was found for either NAC or skin necrosis.

Univariate and multivariate analyses identifying all assessed factors that predict a significant rate of any skin or NAC necrosis (Table 6) or overall complications (Table 7) are also presented. These represent the entire patient cohort (576 breasts). For multivariate models, multiple logistic regressions using backward elimination method were done. Variables included in the initial model were based on clinical significance. Interaction term between the N-IMF distance and the resection weight was also assessed and included if statistically significant. Both, the resection weight and the N-IMF distance were included in the final model to control for potential confounding. For overall necrosis rate, resection weight was found to be associated with an

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Table 2 Resection weight parameters and breast measurements.

Characteristic	Breasts*N* = 576		
	Mean or Counts	SD or Percentage	Range
Ptosis			
1	28 (4.9%)	4.9%	
2	277 (48.1%)	48.1%	
3	250 (43.4%)	43.4%	
Pseudoptosis	21 (3.7%)	3.7%	
Skin resection pattern			
Wise	562	97.6%	
Drape/Passot	14	2.4%	
N- IMF distance, cm	14.8	4.0	7.5-27.0
SN-N distance, cm	31.5	4.2	16.0-48.0
Breast width, cm	17.3	5.0	10.0-27.0
Inferior pedicle width, cm	9.8	1.9	7.0-15.0
Resection weight, g	699.6	310.4	125.0-2385

N-IMF, nipple-to-inframammary fold; SN-N, sternal notch-to-nipple.

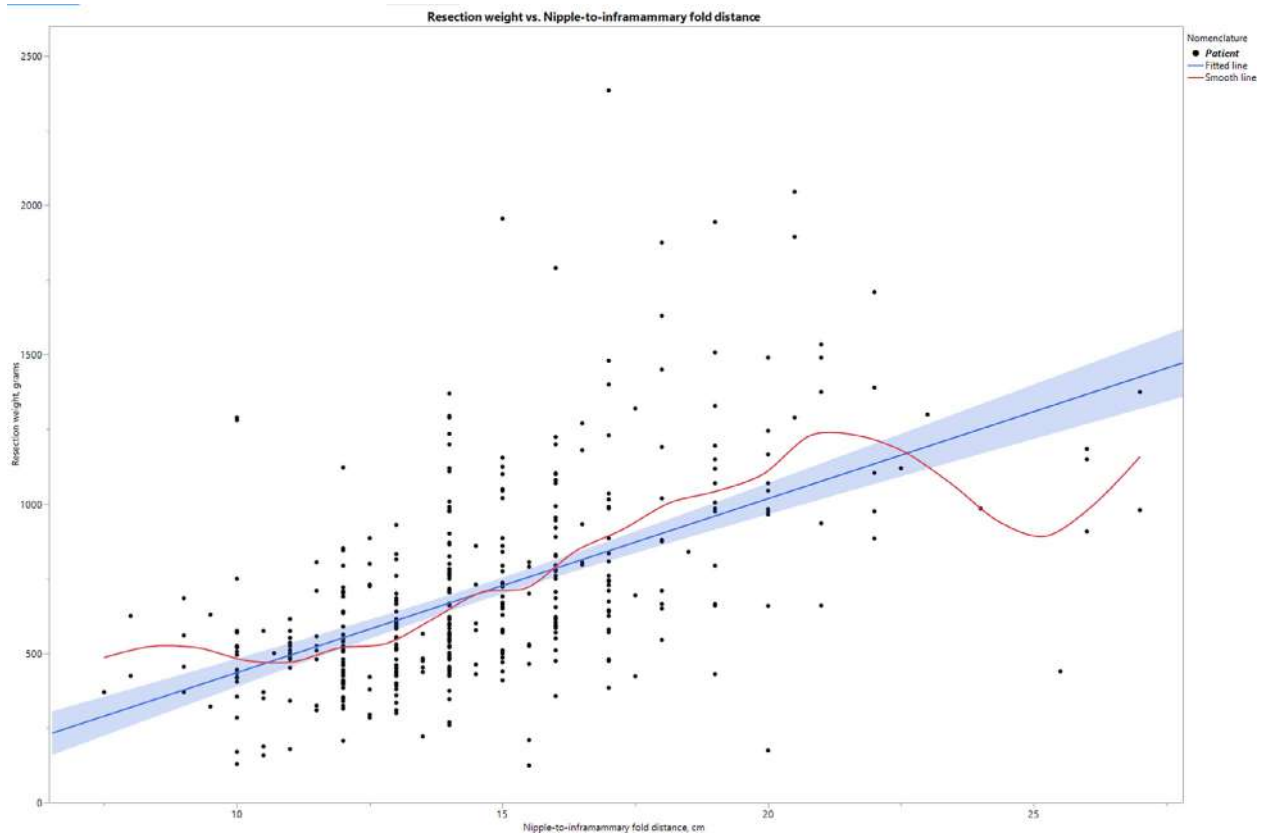

Figure 1 Relationship between resection weight and nipple-to-inframammary fold distance.

increased risk (unadjusted odds ratio [uOR]: 1.003, 95% CI 1.001–1.004; adjusted odds ratio [aOR]: 1.003, 95% CI 1.001–1.005). The N-IMF distance was not found to be statistically correlated with the occurrence of overall necrosis (aOR: 1.05, 95% CI 0.88–1.16).

With regard to overall complications, body mass index and resection weight were found to be statistically correlated with higher overall complication rate on univariate analysis. In order to control for multiple variables, particularly BMI, a multivariate analysis adjusting for age, BMI, SN-N distance and inferior pedicle showed that the N-IMF distance and resection weight failed to reach statistical significance for overall complication. An illustrative clinical case of a patient with long N-IMF is shown in Figure 2.

Discussion

Free nipple grafting indications are defined in the literature, but are made on expert opinion not necessarily in an evidence-based manner.[1-4] These can vary based on patient history, co-morbidities, surgeon experience, and intra-

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Table 3 Complications.

Characteristic	Breasts*N* = *576*	
	Counts	Percentage
Seroma[α]	20 (3.5%)	3.5%
Hematoma[β]	9 (1.6%)	1.6%
Surgical site infection	12 (2.1%)	2.1%
Wound dehiscence	32 (5.6%)	5.6%
T junction	21 (3.6%)	3.6%
Vertical incision	6 (1.0%)	1.0%
Horizontal incision	3 (0.5%)	0.5%
NAC	2 (0.3%)	0.3%
DVT or PE	0	
Nipple necrosis		
Partial thickness	2 (0.4%)	0.4%
Full thickness	0	
Skin necrosis		
Partial thickness	7 (1.2%)	1.2%
Full thickness	2 (0.4%)	0.4%
Unplanned reoperation	14 (2.4%)	2.4%
Unplanned readmission	22 (3.8%)	3.8%
Overall complication	85 (14.8%)	14.8%
Death	0	

NAC, nipple areola complex; DVT, deep venous thrombosis; PE, pulmonary embolism.
[α] Requiring drainage.
[β] Requiring surgical evacuation.

operative perfusion. As previously discussed, classic textbooks and literature used to guide most trainees and young surgeons cite the following as indications for free nipple grafting: patients with nipple-to-IMF distances 15–20 cm or greater, resection of 2000 g or greater per side, increased age, or systemic disease where a reduction in operative time is desired.[1-3] In the most recent edition of the Plastic Surgery series of textbooks[2], the authors even recommend free nipple grafting for pedicle lengths greater than 8 cm.

In 1955, Wise[12] recommended nipple grafting for breast reductions that would reduce bra size by 3 cups, without any evidence supporting the recommendation. In 1995, Nakajima et al.[13] completed an arterial anatomic study of the NAC and concluded that despite the presence of the subdermal plexus vessels, these were insufficient to perfuse the nipple without a feeding perforator and a stalk of tissue protecting it. From this publication, arbitrary measurements with regard to weight or length were recommended as "red flags" for attempting a pedicled breast reduction. In 1977, Courtiss and Goldwyn did not comment specifically on cutoff for a pedicled breast reduction and, however, described successful breast reductions with a resection weight average 1050 g and an average pedicle length of 16 cm in 14 patients.[10]

However, most recent literature including Gradinger[14] recommended free nipple grafting for resections greater than 1500 g, and Lacerna et al[11] for resections greater than 2500 g. Recently, Gerzenshtein et al.[10] have compared outcomes between breast reduction resection <1500 g and >1500 g per side, without nipple loss in either group. For patients who were predicted to have *a* >1500 g resection, the authors recommended a pedicled breast reduction, instead of a planned free nipple graft. However, they did not report their largest resection weight or longest pedicle length in either of the patient groups. These publications, therefore, do suggest that large volume resections of 1500–2000 g are safe, with no nipple necrosis, however did have 3.2% develop NAC epidermolysis in groups with <1000 g and >1000 g resection weights.

We believe that the pedicle length is also an important factor when evaluating patients for reduction mammoplasty, in addition to resection weight. Unfortunately, data to support the safety of inferior pedicle reduction mam-

Table 4 Complications in patients with large resection weight.

Variable	Resection weight		*P* value
	> 1000 g	< 1000 g	
Characteristic			
Age, years	41.8 ± 14.6	43.7 ± 15.7	0.31
Body mass index, kg/m2	36.7 ± 5.4	30.7 ± 4.4	**<0.001***
Complication			
Seroma[α]	6.2	3.0	0.18
Hematoma[β]	2.5	1.5	0.63
Surgical site infection	6.2	1.5	**0.02***
Wound dehiscence	11.1	4.6	**0.02***
Nipple necrosis[μ]	1.2	0.2	0.27
Skin necrosis[μ]	6.2	0.6	**0.002***
Unplanned reoperation	4.9	2.1	0.13
Unplanned readmission	8.6	2.7	**0.02***
Overall complication	27.2	12.4	**0.0005***

Data are expressed as means and standard deviation or percentages. Statistical significance between groups was tested using Student's *t*-test and either Fisher's exact test or Pearson's chi square test.
* Statistically significant.
[α] Requiring drainage.
[β] Requiring surgical evacuation.
[μ] Partial or full necrosis.

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Table 5 Complications in patients with long nipple-to-inframammary fold distance.

Variable	N-IMF distance		*P* value
	> 15 cm	< 15 cm	
Characteristic			
Age, years	43.8 ± 14.9	43.9 ± 16.2	0.95
Body mass index, kg/m^2	33.0 ± 5.1	30.2 ± 4.6	**<0.001***
Complications			
Seroma[α]	4.9	3.8	0.60
Hematoma[β]	1.6	2.1	1.0
Surgical site infection	6.2	1.5	**0.02***
Wound dehiscence	8.1	4.7	0.15
Nipple necrosis[μ]	1.1	0	0.19
Skin necrosis[μ]	2.7	0.9	0.29
Unplanned reoperation	2.7	3.8	0.52
Unplanned readmission	4.9	3.4	0.46
Overall complication	18.9	15.3	0.33

N-IMF, nipple-to-inframammary fold.
Data are expressed as means and standard deviation or percentages. Statistical significance between groups was tested using Student's *t*-test and either Fisher's exact Test or Pearson's chi square test.
* Statistically significant.
[α] Requiring drainage.
[β] Requiring surgical evacuation.
[μ] Partial or full necrosis.

Table 6 Risk factors for overall necrosis.

Risk factor	Unadjusted Odds Ratio (95% CI)	Adjusted Odds Ratio (95% CI)*
Age [λ]	1.04 (1.00, 1.09)	
Body mass index [λ]	1.09 (0.98, 1.19)	
Smoking history [α]	2.5 (0.75, 8.86)	
Hypertension	**3.50 (1.04, 12.28)**	
Diabetes	3.25 (0.48, 13.22)	
Hyperlipidemia	1.64 (0.42, 5.50)	
Coronary artery disease	5.04 (0.26, 30.00)	
Hypothyroidism	0.50 (0.03, 2.63)	
Thrombophilia	3.22 (0.17, 18.34)	
History of stroke	0 (0, 11.60)	
History of DVT or PE	0 (0, 4.91)	
Ptosis [β]	1.41 (0.37, 5.76)	
SN-N distance[λ]	**1.19 (1.05, 1.35)**	0.96 (0.78, 1.19)
N-IMF distance[λ]	1.08 (0.97, 1.17)	1.05 (0.88, 1.16)
Inferior pedicle width[λ]	1.08 (0.76, 1.48)	
Resection weight[λ]	**1.003 (1.001, 1.004)**	**1.003 (1.001, 1.005)**

CI, confidence interval; DVT, deep venous thrombosis; PE, pulmonary embolism; SN-N, sternal notch-to-nipple; N-IMF, nipple-to-inframammary fold.
* Adjusted for sternal notch-to-nipple distance, nipple-to-IMF distance, and resection weight. A multiple logistic regression was performed (AICc 82.26 and AUC 0.78).
[α] History of smoking vs. nonsmoker.
[β] Ptosis grade 3 or pseudoptosis vs. 1 or 2.
[λ] The odds ratio was calculated per one unit increase of the variable.

moplasty in patients with long pedicle length is limited; however, resection weight has largely been investigated and proven to be associated with higher complication rates the more volume is resected. The pedicle length is an important clinical examination finding, as some surgeons may be concerned for perfusion given the long distance from the arterial supply to the nipple-areola complex. Additionally, for patients who suffer from upper pole deflation with severe ptosis, even a small resection weight could limit the amount of peripheral perfusion maintaining the NAC. Arbitrary transposition lengths such as >15-23 cm have been cited in the literature as a consideration for free nipple grafting, without any evidence to support these recommendations.[1,2,15,16] In addition, other relative indications for free nipple grafting have included obesity, hypertension, coronary artery disease, immunosuppression, and throm-

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Table 7 Risk factors for overall complication.

Risk factor	Unadjusted Odds Ratio (95% CI)	Adjusted Odds Ratio (95% CI)*
Age [λ]	1.01 (1.00, 1.03)	1.02 (0.99, 1.04)
Body mass index [λ]	**1.06 (1.02, 1.11)**	1.06 (0.99, 1.14)
Smoking history [α]	1.55 (0.96, 2.47)	
Hypertension	0.73 (0.41, 1.24)	
Diabetes	1.94 (0.84, 4.11)	
Hyperlipidemia	1.58 (0.96, 2.57)	
Coronary artery disease	1.96 (0.43, 6.73)	
Hypothyroidism	1.19 (0.64, 2.11)	
Thrombophilia	0.71 (0.11, 2.58)	
History of stroke	3.99 (1.00, 14.28)	
History of DVT or PE	1.74 (0.56, 4.55)	
Ptosis [β]	0.70 (0.43, 1.14)	
SN-N distance [λ]	1.05 (0.99, 1.11)	0.92 (0.83, 1.03)
N-IMF distance [λ]	1.06 (1.00, 1.13)	1.06 (0.99, 1.14)
Inferior pedicle width [λ]	0.88 (0.76, 1.00)	0.81 (0.60, 1.05)
Resection weight [λ]	**1.001 (1.001, 1.002)**	1.00 (0.99, 1.00)

CI, confidence interval; DVT, deep venous thrombosis; PE, pulmonary embolism; SN-N, sternal notch-to-nipple; N-IMF, nipple-to-inframammary fold.

* Adjusted for age, body mass index, sternal notch-to-nipple distance, nipple-to-IMF distance, inferior pedicle width, and resection weight. A multiple logistic regression was performed (AICc 305.3 and AUC 0.66).

[α] History of smoking vs. nonsmoker.

[β] Ptosis grade 3 or pseudoptosis vs. 1 or 2.

[λ] The odds ratio was calculated per one unit increase of the variable.

bophilias, unfortunately, without any specific evidence to support these recommendations.[1,3,15,16]

Wettstein et al.[8] reported one free nipple graft in ten patients with sternal notch-to-nipple distances greater than 40 cm in the superior pedicle reductions in 10 patients. Karacor-Altuntas et al.[9] reported three cases of partial nipple necrosis and no cases of complete nipple necrosis in 58 patients with pedicle lengths greater than 38 cm in the central pedicle reduction technique. For the superior pedicle technique, these authors have demonstrated that breast reductions with pedicle lengths >20 cm are safe with low incidences of nipple necrosis. There is no data in the literature addressing pedicle length and nipple viability in the inferior pedicle technique.

Our study specifically aims to address anecdotal recommendations regarding indications for free nipple grafting in inferior pedicle breast reduction surgeries and determine the safety of this procedure even in breasts with long pedicles. We intended to add evidence to better guide trainees and update textbook recommendations.

Our study does not demonstrate statistical difference for NAC or skin flap necrosis in patients with long pedicle lengths (N-IMF distance greater or equal to 15 cm) compared to those with short pedicle lengths (N-IMF distance less than 15 cm). In patients with resection weight > 1000 g, the complication rate was higher overall than that in those with resection weights less than 1000 g. This was statistically significant for metrics such as surgical site infection, wound dehiscence, skin necrosis, and unplanned readmission. The incidence of NAC necrosis was 1.2% and 0.2% for the two groups, respectively, but this did not reach statistical significance. When the entire cohort was analyzed, we found that potential risk factors for skin or NAC necrosis included hypertension, SN-N distance, and reduction weight, on univariate analysis (Table 6). On multivariate analysis, only resection weight was found to be statistically correlated with the increased risk of skin or NAC necrosis, which is comparable to previous reports and publications. The N-IMF distance was not found to statistically correlate with the occurrence of overall necrosis (aOR: 1.05, 95% CI 0.88 – 1.16) adjusting for potential cofounders like resection weight. Regarding risk factors of overall complication, univariate analyses showed that body mass index and reduction weight were statistically correlated with a higher overall complication rate. However, on multivariate analysis, BMI, resection weight and N-IMF distance failed to reach statistical significance (Table 7).

Of the 576 breasts in our study, two had partial NAC necrosis managed with local wound care, indicating the low rate of perfusion-related complications. Both of these patients had pedicle lengths of 18 cm and 15 cm, and the etiology could not be related to issues intraoperatively. There were no cases of full NAC necrosis in either group, and thus, from these data, it can be extrapolated that the decision to preemptively complete a free nipple graft is not necessary, contrary to previous publications. We believe that our success is secondary to technical factors that include preservation of the base to the chest wall in the vertical dimension and avoiding resection of breast tissue posterior to the NAC. The pedicle is designed in a manner to capture as many perforators from the intercostal arteries or internal mammary artery as possible. In addition, pedicle width is also designed to be 9–10 cm in order to maintain perfusion through the subdermal plexus and intercostal arteries.

Free nipple grafting is time efficient and technically less demanding than any pedicled breast reduction tech-

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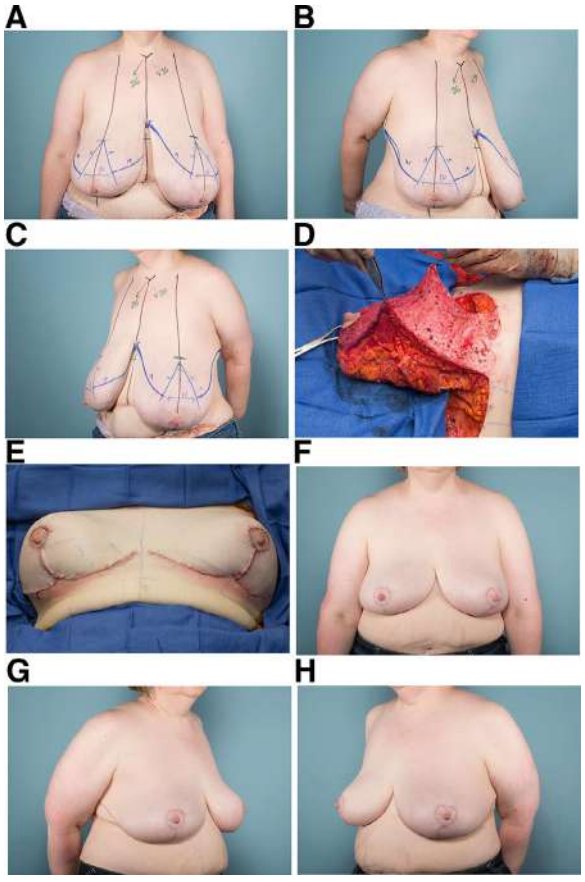

Figure 2 (A), (B), and (C) Clinical pictures of a 42-year-old female patient with a BMI of 36.5 kg/m^2 and a diagnosis of macromastia. The right N-IMF distance was 24 cm and the right SN-N distance was 41 cm; the left N-IMF was 27 cm and the left SN-N distance was 44 cm. The patient underwent an inferior pedicle breast reduction mammoplasty, as shown in pictures (D) and (E). Inferior pedicle width was 10 cm in both breasts. Resection weight was 985 g and 1375 g for the right and left breasts, respectively. The patient had an uneventful postoperative course. Postoperative images at 6 months follow-up are shown in (F), (G), and (H).

nique. Oneal et al.[4] recommended this technique for high-risk patients with insensate or decreased nipple sensation. Based on our data, we agree that older patients with comorbidities should be warned that they are at a higher risk of nipple compromise and may need a free nipple graft. However, in this series, we demonstrate the safety of the inferior pedicle technique in patients with resection weights (> 1000 g per breast) or long pedicle lengths (>15 cm). We strongly recommend against *prophylactic* free nipple grafting in these patients. Free nipple grafting *should not be planned* based on breast measurements or resection weight alone. Free nipple grafts should be considered a salvage procedure after clinical evaluation and possibly the addition of intraoperative angiography for additional assessment.

There are several limitations to our study including a relatively small sample size in the >15 cm pedicle length cohort ($n = 135$) and >1000 g resection weight ($n = 81$), short follow-up duration, and lack of objective measurements for nipple-areola complex sensitivity changes. Our mean follow-up was 3.9 months, but for the purposes of this study, this is a sufficient follow-up period as the complication of interest, nipple-areola ischemia, will be detected within the first day after surgery.

Based on our current study and recently published literature[8-11], we believe that published textbook recommendations for free nipple grafting should be updated. This would include avoiding pre-emptive grafting in breast reductions >2000 g or pedicle lengths >15-20 cm. The decision to complete a free nipple graft should be made as a last resort, intraoperatively, after all attempts to maintain perfusion to the native NAC have been made. We do not specifically have "red flags" or "cut off" points for committing to free nipple grafting, but instead, offer updated evidence on what can safely and successfully be completed in breast reduction surgery, pushing the envelope in an otherwise routine surgical procedure.

Conclusions

In our experience, inferior pedicle breast reduction offers a low risk of skin flap or NAC necrosis and can be safely performed in patients, regardless of breast pedicle lengths (N-IMF distance). However, large volume resections can have increased risks of complications and should be discussed with patients preoperatively. NACs serve an important esthetic and functional role in various aspects of patients' lives, and thus, should carefully be preserved in all cases if possible. We strongly recommend against preemptively completing a free nipple graft as recommended in multiple textbooks in patients with long pedicle lengths and large volume resections.

Declaration of Competing Interest

All authors declare that they have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

Financial disclosure

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ORIGINAL ARTICLE BREAST SURGERY

Combined Breast Reduction Augmentation

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Abstract
Background Numerous methods have been designed to reduce breasts size and weight. The goal today is to not only to reduce size but also to create a pleasing shape. Breast reduction techniques do not obtain the desired upper pole fullness, and commonly recurrent ptosis develops. To improve and maintain breast shape in the late postoperative period, we combine breast reduction with implants.
Methods Three hundred and sixty-six patients who underwent combined breast reduction or mastopexy with implants from January 2014 to November 2017 at IM Clinic were retrospectively reviewed. We present the indications, surgical technique, and outcomes of these patients to determine the safety and efficacy of our technique.
Results No major complications were noted in an average of 2 years of follow-up (range 2 months to 4 years). Minor complications occurred in 61 patients, of whom 46 required revision surgery (12.6%). The most common tissue-related complications were dog ears (7.6%) and poor scarring (4.9%). The most common implant-related complication was capsular contracture (0.8%).
Conclusions Breast reduction with implants is a reliable option to provide additional volume to the upper pole of the breast to improve long-term breast shape and avoid ptosis recurrence. Our study indicates that the procedure is safe and has complication and revision rates comparable to traditional breast reduction or augmentation mastopexy techniques.
Level of Evidence IV This journal requires that authors assign a level of evidence to each article. For a full description of these Evidence-Based Medicine ratings, please refer to the Table of Contents or the online Instructions to Authors www.springer.com/00266.

Keywords Breast reduction · Breast augmentation · Augmentation mastopexy

Introduction

Breast reduction is one of the most common breast procedures performed by plastic surgeons. Although many reduction techniques have been described [1–22], they all have limitations. The two most common problems, shared by all techniques, are a consistent lack of upper pole fullness and bottoming out, which refers to the caudal migration of lower pole parenchymal tissue resulting in a flat, non-projecting breast with pseudoptosis [23–28]. Patient satisfaction is generally high in breast reduction surgery, but the desire for increased excellence in the esthetic appearance of the breast prompted us to seek a better way to provide long-term upper pole fullness.

Considering the limitations of traditional breast reduction, we hypothesized that a combination of complete submuscular breast augmentation with round silicone-filled implants and breast reduction would prevent ptosis recurrence and bottoming out and provide natural, lasting upper pole fullness.

The senior author who introduced the procedure in 2000 called the technique combined breast reduction augmentation (CBRA). In our experience, CBRA has proven to be

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a versatile, effective technique that can also be used to correct ptosis.

The aim of this article is to outline the technical aspects of CBRA and discuss potential complications based on data from patients who have undergone this procedure at our clinic over a period of 4 years.

Patients and Methods

We reviewed the medical records of all patients who underwent either breast reduction (removal of > 200 g of breast parenchyma) or mastopexy (removal of ≤ 200 g of breast parenchyma) with implants between January 2014 and November 2017 at IM Clinic in Barcelona, Spain.

Information recorded included patient age, smoking history, amount of tissue removed, size of implant, follow-up time, and postoperative surgical and esthetic outcomes. All patients had preoperative and postoperative photographs taken and received general anesthetic and antimicrobial prophylaxis and postoperative oral antibiotics for 5–7 days.

A detailed medical history is obtained during the first visit. Thorough preoperative assessment is essential. This includes physical examination of breast size, shape, elasticity, looseness, striae, rashes, bra strap grooving, asymmetry, masses, and consistency. The position of the nipple–areola complex (NAC) relative to the inframammary fold is also assessed. Degree of vertical correction is assessed by measuring the distance from the sternal notch to the nipple and from the nipple to the inframammary fold.

Preoperative Markings

All patients are marked preoperatively in the standing position. Skin incision design begins by marking the inframammary crease and the vertical breast meridian (Fig. 1a). The superior border of the areola is then marked at the level of the medial end of the inframammary crease at the cleavage (Fig. 1b). The vertical incisions are drawn next. A 60° angle is used to determine the location of the two vertical limbs, whose length varies between 10 and 11 cm (Fig. 1c). The design is more conservative in cases of ptosis without breast hypertrophy. In these cases, the angle is reduced to avoid excessive skin removal. The horizontal limbs are then continued down to the inframammary crease boundaries (Fig. 1d).

Surgical Technique

The areola is marked with a 42-mm-diameter nipple marker, and skin incisions are made following the preoperative marks. We use a superomedial pedicle in most patients. A free nipple graft is only used when the NAC transposition distance exceeds 8–10 cm. We also consider comorbidities and other factors, especially smoking status.

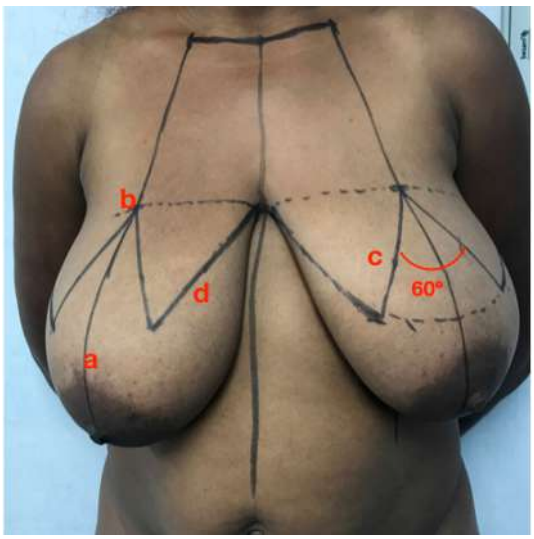

Fig. 1 Preoperative markings. **a** Breast meridian, **b** new nipple position; note that the superior border of the areola is positioned at the level of the medial end of the inframammary crease at the cleavage, **c** location of the two vertical limbs determined using a 60° angle, **d** horizontal limbs

After de-epithelialization of the pedicle or elevation of the NAC as a graft, the intervening superior and lateral periareolar tissue is excised down to the pectoralis major muscle fascia along with the inferior pole breast tissue (Fig. 2a and c).

A medial and lateral wedge is resected to reduce the width of the breast, thereby improving breast contour and preventing a boxy shape (Fig. 2d).

The remaining superior, lateral, and medial flaps are then elevated off the muscular fascia. It is important to undermine the flaps extensively to prevent flattening of the inferior pole of the breast. Further resection is performed to leave 2-cm-thick flaps. This additional tissue removal provides thin, pliable flaps that adapt better to the implant; it also prevents parenchymal ptosis and a snoopy breast. A crease is created in the subcutaneous tissue of the upper pole to achieve better redraping of the breast and an attractive conical shape that does not give the appearance of unnatural upper pole fullness.

Submuscular pocket dissection is made through the pectoralis major muscle (with separation of the fibers) and extended to the posterior fascia. The pocket extends under the serratus fascia and the rectus fascia as needed (Fig. 3). In all cases of previous breast augmentation or augmentation mastopexy with a subglandular implant, the implant site is changed to a submuscular position.

The implants and pockets are rinsed in povidone iodine solution. We use round, microtextured, moderate-profile

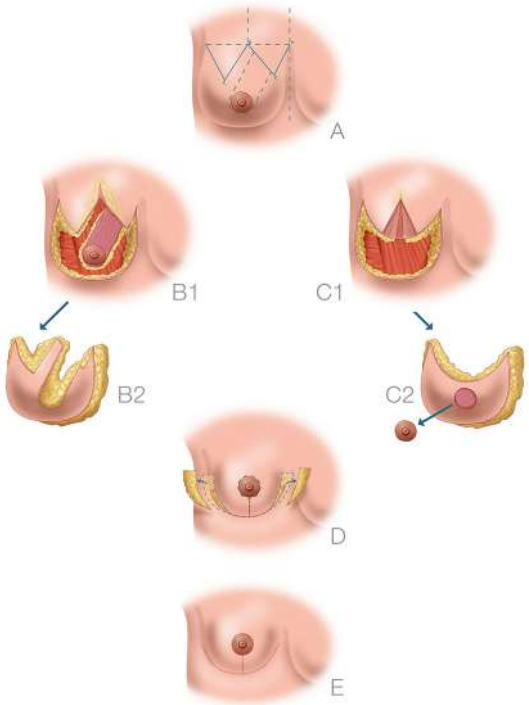

Fig. 2 **a** Preoperative markings, **b1** appearance of breast after parenchymal resection using a superomedial pedicle; note the crease on the subcutaneous plane of the upper pole designed to achieve better redraping of the breast and a conical shape, **b2** excised tissue, **c1** appearance of other breast with nipple–areola complex graft transposition, **c2** tissue resection specimen in the case of the nipple–areola complex graft, **d** removal of a medial and lateral wedge reduces the width of the breast and achieves a better contour, **e** result

implants as their larger diameter helps achieve better padding of the cleavage. Suction drains are routinely left in the implant pocket.

The pillars of breast tissue from the remaining medial and lateral flaps are closed with interrupted 2-0 Vicryl sutures to reduce tension on the vertical closure.

A 38-mm-diameter nipple marker is used to mark the final placement of the areola, and the periareolar tissue is de-epithelialized. Finally, the areola is inset with interrupted 4-0 Monocryl sutures.

All skin defects are closed in two layers. A deep plane is closed with interrupted 2-0 Vicryl sutures, while the skin is closed with subcuticular interrupted 4-0 Monocryl sutures.

Liposuction may be necessary, particularly in the axillary tail of Spence, to help shape the peripheral fatty tissue.

Postoperative Care

As part of the postoperative care program, patients are given guidelines for appropriate activity limitations. They are instructed to wear a postoperative bra without underwire and an adjustable stretch chest band with Velcro to

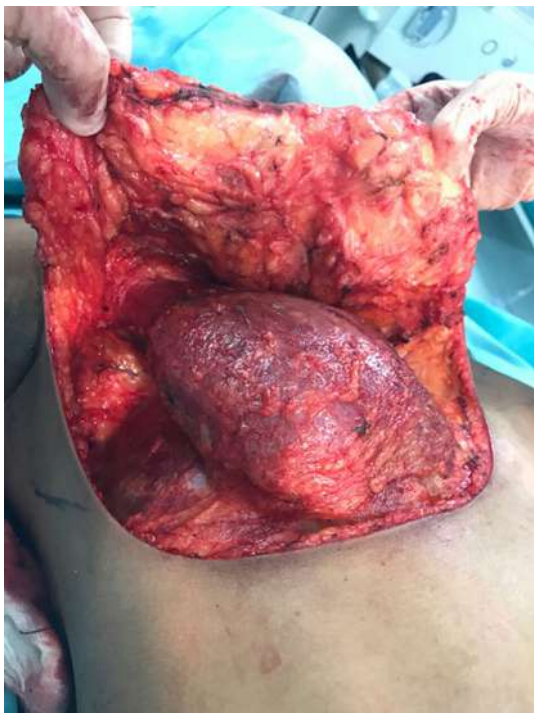

Fig. 3 Complete submuscular pocket

stabilize and position the implants for 4 weeks. Patients can usually resume intense physical activity 6 weeks after the operation. Oral prophylactic antibiotics may be continued for 5 days. Drains are removed on postoperative day 2–4, when the drain output is less than 30 cc per day. All patients are seen 2–3 days after the operation and again at 1 week, 1 month, 3 months, 6 months, and then annually or as needed.

Results

Between January 2014 and November 2017, 366 patients underwent CBRA at IM Clinic: 182 underwent breast reduction with implants, while 184 underwent mastopexy with implants.

The average age of the patients was 39 years (range 17–78 years). Just under a third of patients (n = 121, 33.06%) had a history of smoking, which was defined as smoking up to 2 weeks before surgery.

The average weight of resected breast tissue was 520.1 g/breast (range 202–2308 g) in the reduction mammoplasty group and 140.67 g/breast (range 22–198 g) in the mastopexy group. The average implant volume in the two groups was 321.39 cc and 367.09 cc, respectively. Implant volumes were comparable in both groups. A majority of implants (53.52%) were in the range of 301–400 cc. The volume was less than 200 cc in 4.59% of

cases, 201–300 cc in 31.19%, and greater than 400 cc in 10.7% (Table 1).

The superomedial pedicle technique was used in 340 patients (92.9%) and a free nipple graft in 26 (7.1%).

Complications were divided into tissue- and implant-related categories (Table 2). The most common tissue-related complications were dog ears (n = 28, 7.6%) and poor scarring (n = 18, 4.9%). The most common implant-related complication was capsular contracture (n = 3, 0.8%); two patients had capsular contracture Grade III on Baker scale and one patient had a Grade IV cc. Fifty-three patients (14.4%) required revision surgery: 46 had a complication that needed correction and seven wanted a change in implant size, all changes were made for larger implants (Tables 2, 3). The most common type of revision surgery was minor scar revision performed under local anesthesia for dog ears or poor scarring (n = 28, 7.6%), followed by correction of breast, areola, or nipple asymmetry (n = 10, 2.7%). There were no cases of recurrent ptosis or of implant exposure or infection (Table 3).

Table 1 Types of implants placed in CBRA

Type of implant	Percent of patients (%)
Sebbin microtextured gel	
< 200	4.59
201–300	31.19
301–400	53.52
401–500	9.48
> 500	1.22

Table 2 Complication rates in CBRA

Percent of patients (number of patients)	
Tissue-related complications	
Hematoma	0.5% (2)
Nipple necrosis	1.9 (7)
Skin necrosis	0.3% (1)[a]
Wound dehiscence	1.4% (5)
Implant exposure	0% (0)
Recurrent ptosis	0% (0)
Dog ear	7.6% (28)[a]
Poor scarring	4.9% (18)[a]
Asymmetry	3.5% (13)
Implant-related complications	
Infection	0% (0)
Capsular contracture	0.8% (3)

[a]Eighteen patients experienced more than one complication

Discussion

Breast tissue stretches and descends following weight fluctuations, aging, and pregnancy. Despite the great symptomatic relief that breast reduction provides, prior to the introduction of the CBRA technique at our clinic, we saw many cases of loss of upper pole fullness after just a few years.

Bottoming out can be caused by recurrent glandular ptosis if the surgeon attempts to push tissue higher up into the upper pole, regardless of the reduction technique used. This tissue will inevitably drop back down, particularly in the case of insufficient inferior glandular resection [23–28].

The literature contains many descriptions of procedures aimed at improving upper pole fullness in breast reduction surgery [29–37]. The most popular technique is the use of an inferiorly based parenchymal flap [29, 30]. This method offers great flexibility in terms of resection volume and breast shaping and ensures a reliable blood supply to the NAC complex. However, as time after the operation increases, the breast can become less plump in upper part of the breast and breast ptosis occurs [31]. Another approach designed to create a more lasting breast shape is dermal suspension [32–34]. The dermal suspension sling technique was first reported by Lalardrie in 1982 [32] and involved combining an inferior pedicle with a dermal suspension sling in women undergoing reduction mammaplasty. This technology used a vascularized autogenous dermis package and fix mammary glands to replace the ligament of Cooper function to overcome sagging breasts and loss of upper breast fullness. Suspension meshes are also intended to provide a stronger, more durable support system for the breast parenchyma [35, 36]. Meshes, however, are not suitable for all patients, and tissue quality is fundamental, as potential scarring caused by both the mesh and skin retraction will determine the cosmetic outcome. In addition, suspension meshes are not advisable in breasts with a high proportion of adipose tissue as the greater amount of subcutaneous fat favors tissue detachment from the thoracic wall, resulting in a loss of anterior projection. Chest wall-based flaps are also used to achieve better upper pole fullness [37–39]. This approach involves using a pectoral loop to support the breast in its new position. Passing a permanently fixed flap into the upper pole and closing the breast tissue behind it achieves a desirable breast shape. Although the above techniques all have advantages, in our experience, none of them offer lasting results.

With the CBRA technique, while it may seem unreasonable to use implants in a procedure whose goal is to reduce breast volume, we find that they allow us to remove as much tissue as needed while preventing bottoming out

Table 3 Revision rates in CBRA

Indications for revision	Percent of patients (number of patients)
Tissue related	
Hematoma	0.5% (2)
Nipple necrosis	0.5% (2)
Dog ear	5.7% (21)
Poor scarring	4.9% (18)
Asymmetry	2.7% (10)
Implant related	
Capsular contracture	0.8% (3)
Desire to change implant size	1.9% (7)

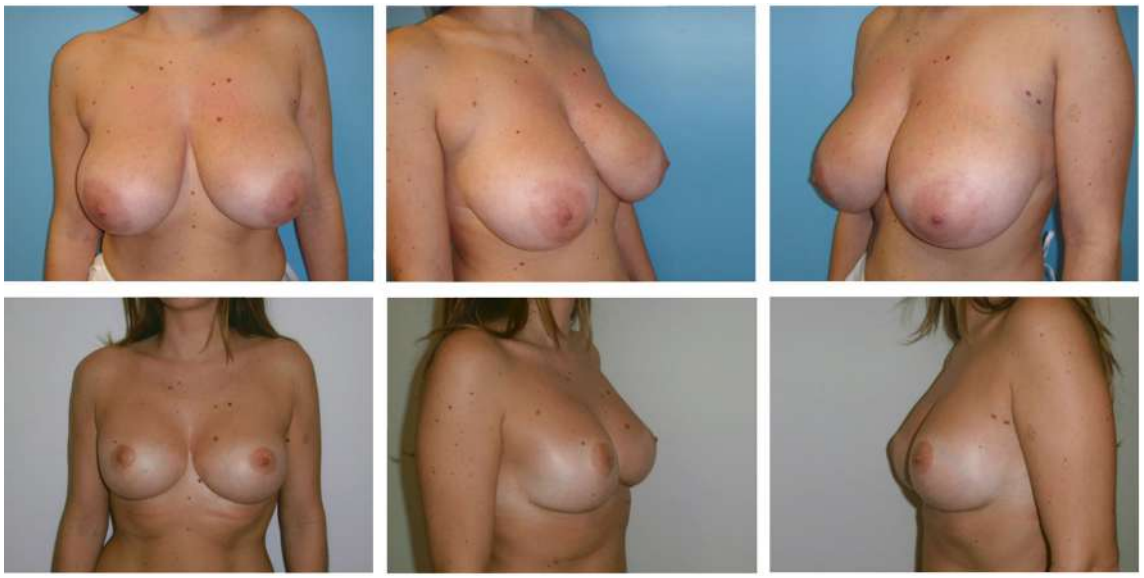

Fig. 4 Preoperative and 2-year postoperative result. Placement of 300-cc Sebbin LS70 implant with excision of 630 g from the right breast and 605 g from the left breast

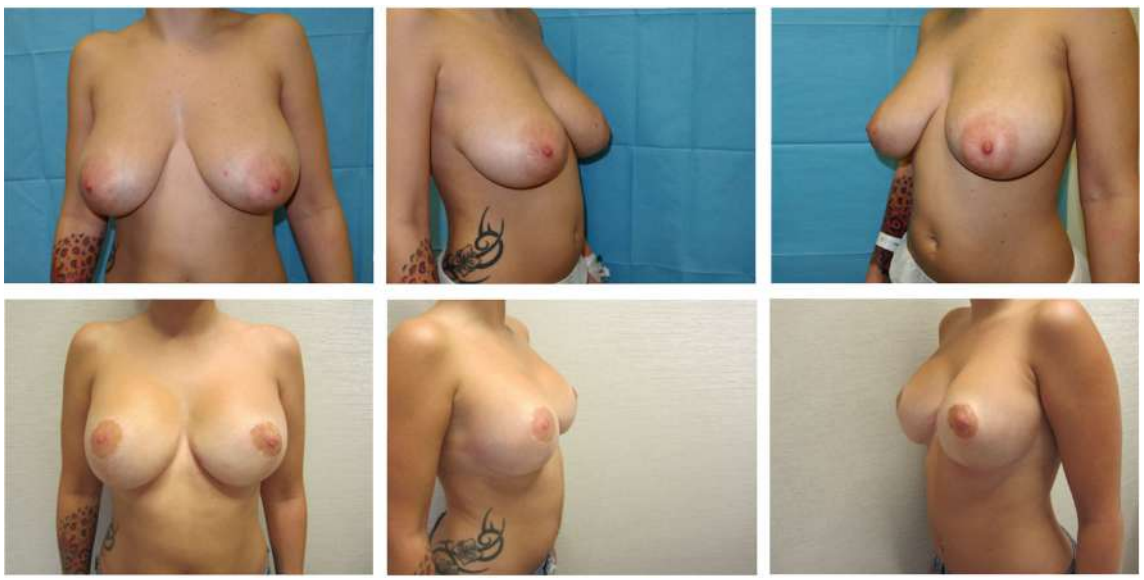

Fig. 5 Preoperative and 2-year postoperative result. Placement of 390-cc Sebbin LS70 implant with excision of 380 g from the right breast and 402 g from the left breast

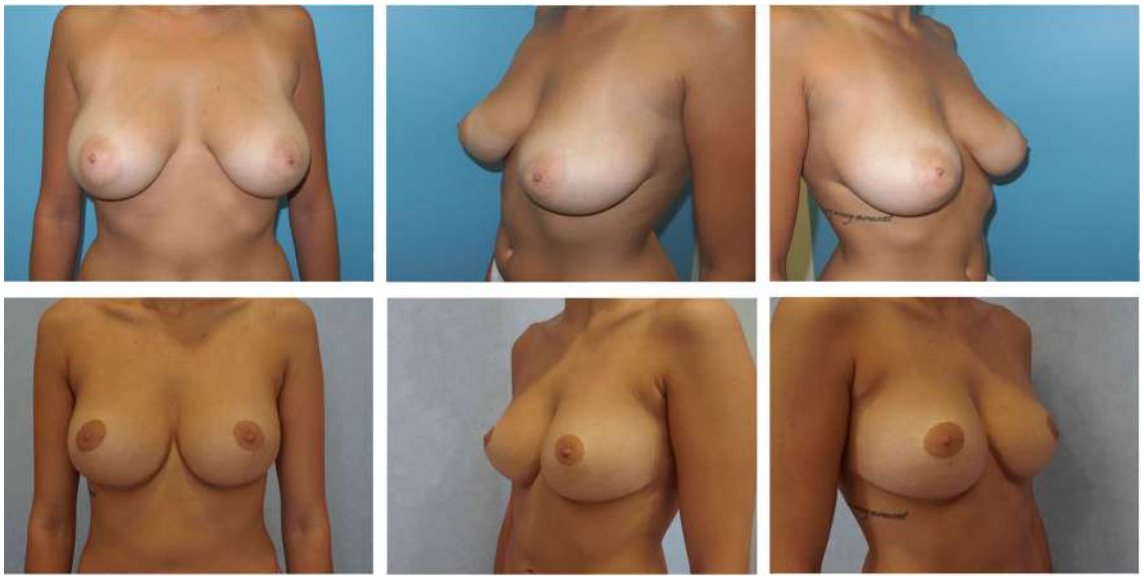

Fig. 6 Preoperative and 4-year postoperative result. Placement of 360-cc Sebbin LS70 implant with excision of 256 g from the right breast and 225 g from the left breast

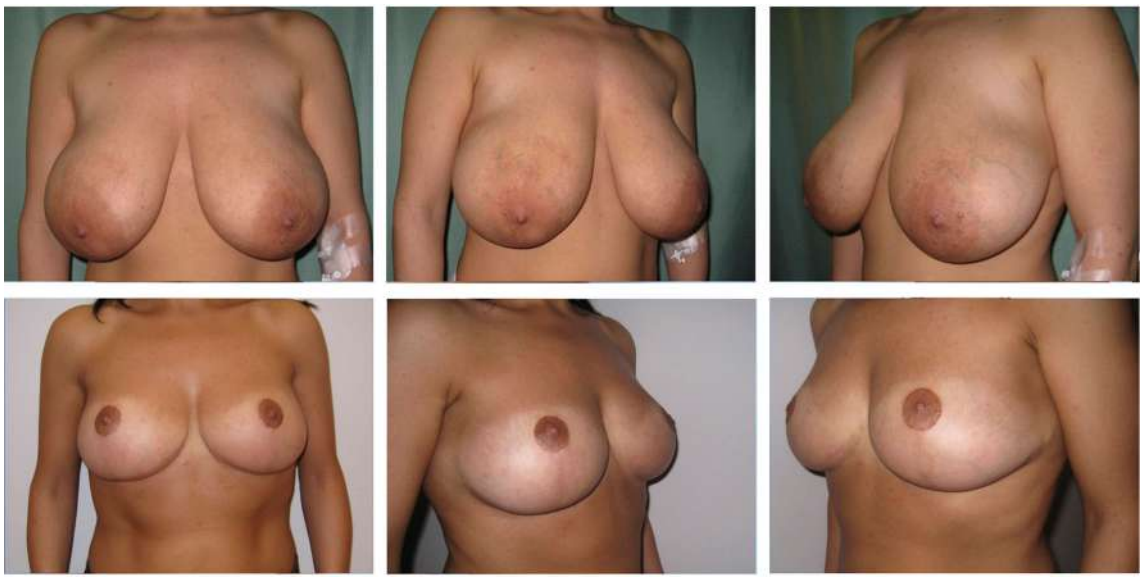

Fig. 7 Preoperative and 3-year postoperative result. Placement of 390-cc Sebbin LS70 implant with excision of 657 g from the right breast and 582 g from the left breast using the superomedial pedicle technique

and creating a round shape and full upper pole that many patients desire (Figs. 4, 5, 6).

It should also be recalled that breast size has been postulated as a risk factor for breast cancer [40–42] and that reduction mammoplasty may reduce this risk [43–49]. Breast cancer accounts for over 10% of all cancers among women worldwide, making it the most common non-skin cancer in this population [50]. If there is, in fact, a direct relationship between excision size and degree of cancer protection, apart from improving esthetic results, our technique might offer a reduction in breast cancer risk, although long-term studies are needed to validate this hypothesis.

Plastic surgeons have been performing simultaneous breast augmentation and mastopexy for decades, and several recent studies have demonstrated acceptable complication and reoperation rates, with the concomitant advantages of a single-stage procedure, lower costs, and potentially greater patient satisfaction [51–67]. The relatively low complication and revision rates observed in

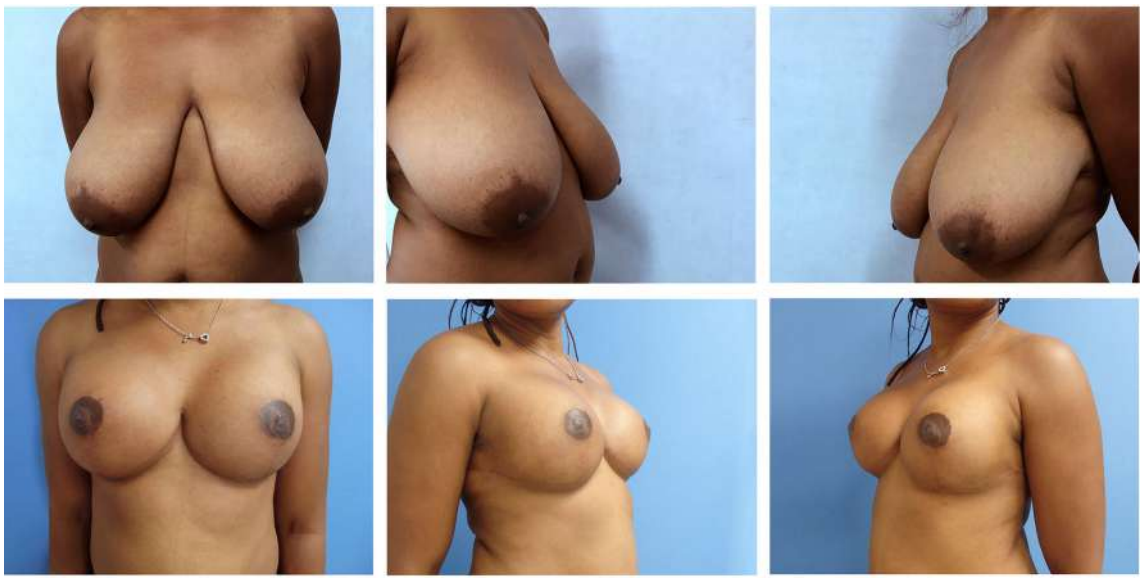

Fig. 8 Preoperative and 6-month postoperative result. Placement of 430-cc Sebbin LS70 implant with excision of 968 g from the right breast and 895 g from the left breast. In this case, a graft was used for the nipple–areola complex transposition

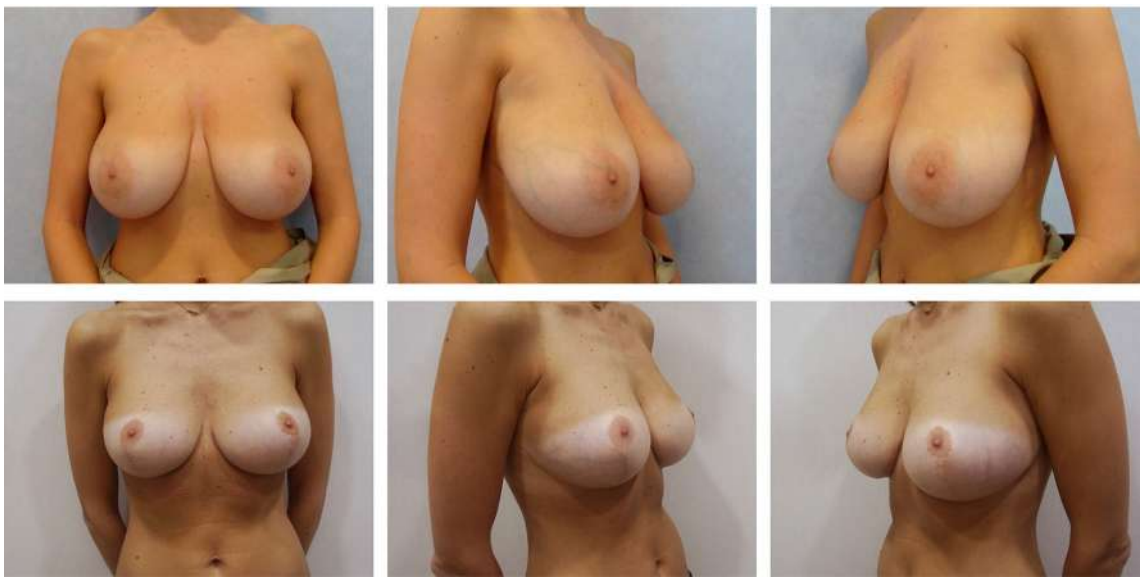

Fig. 9 Preoperative and 1-year postoperative result. Placement of 330-cc Sebbin LS70 implant with excision of 710 g from the right breast and 726 g from the left breast

simultaneous augmentation mastopexies support our belief that combined breast surgery does not necessarily predispose patients to a higher risk of complications, particularly considering that in some cases the difference between one procedure and the other is just a few grams of resected breast tissue. The complication and revision rates in our series are very similar to those described for breast reduction and single-stage augmentation mastopexy procedures. In an outcome analysis of 2142 breast reduction procedures published in 2015, the two most common complications reported were wounds (14.9%) and scars (14.5%); the reoperation rate for scars was 6.7% [68]. In our series, wound dehiscence occurred in 1.4% of patients and poor scarring in 4.9%. Breast or nipple asymmetry was observed in 13 patients (3.5%). In three cases, the slight pocket asymmetry resolved with time as the tissue stretched and the implant settled. The other 10 patients required revision surgery. This revision rate of 2.7% is comparable to rates reported in previous publications (4% [54], 3% [67], 2.94% [69]). Our overall revision rate of 12.6% is

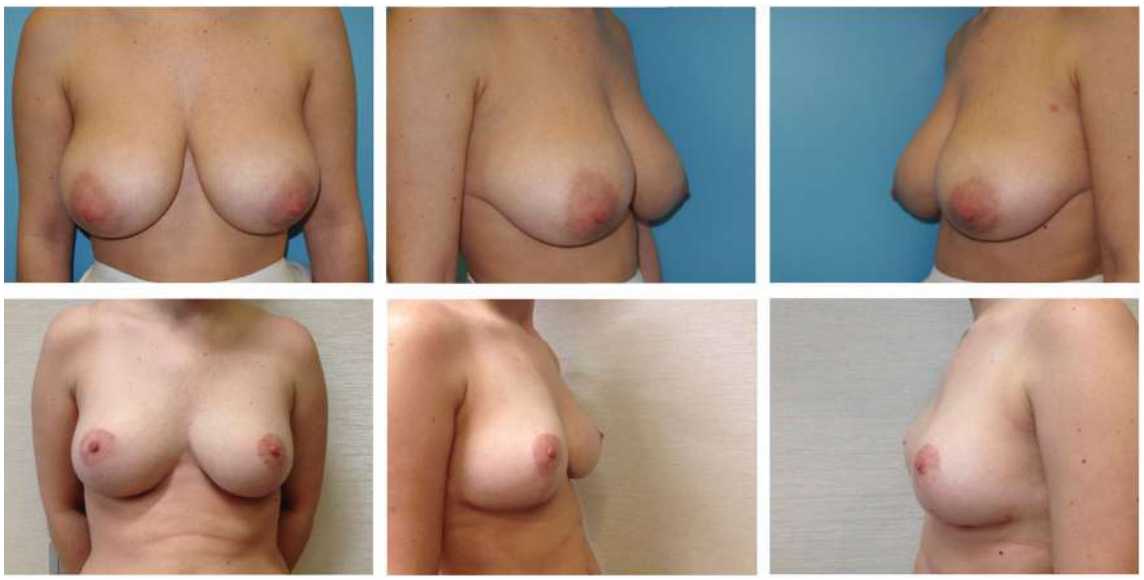

Fig. 10 Preoperative and 1-year postoperative result. Placement of 300-cc Sebbin LS70 implant with excision of 677 g from the right breast and 665 g from the left breast

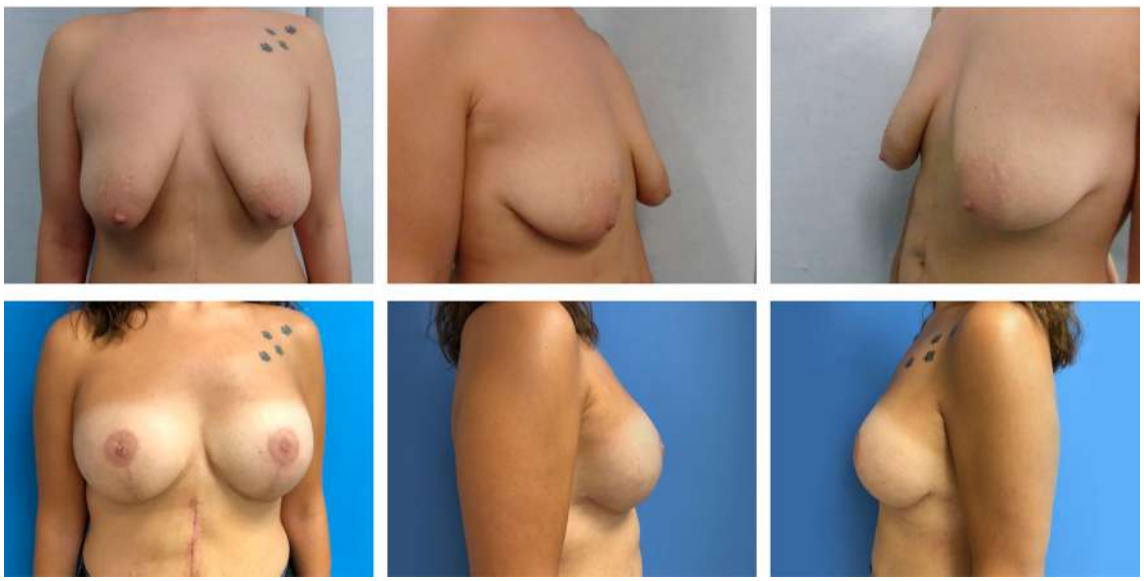

Fig. 11 Preoperative and 6-month postoperative result. Placement of 430-cc Sebbin LS70 implant with excision of 65 g from the right breast and 52 g from the left breast

also comparable to rates reported in other series of primary single-stage breast augmentation and mastopexy procedures (14% [53], 15% [54], 16.7% [70], and 10.7% [69]).

Implant-related complications were less common. The most common complication in this category was capsular contracture (0.8%), which is also the most common implant-related complication described in the literature (3%) [69]. A pooled incidence rate of less than 2% has been reported for hematoma and infections [69]. In our series, just 0.5% of patients experienced hematoma and there were no infections. Implant-related complications are due to the inherent nature of breast implants. Just three patients (0.8%) required revision surgery due to implant-related complications, and none of the 366 patients developed recurrent ptosis.

The use of reductive augmentation of the breast to improve upper pole fullness has been described in just one other publication to date [71]. The mean resection weights in that series, however, were 255 g in the primary surgery group and 227 g in the revision group. These weights are

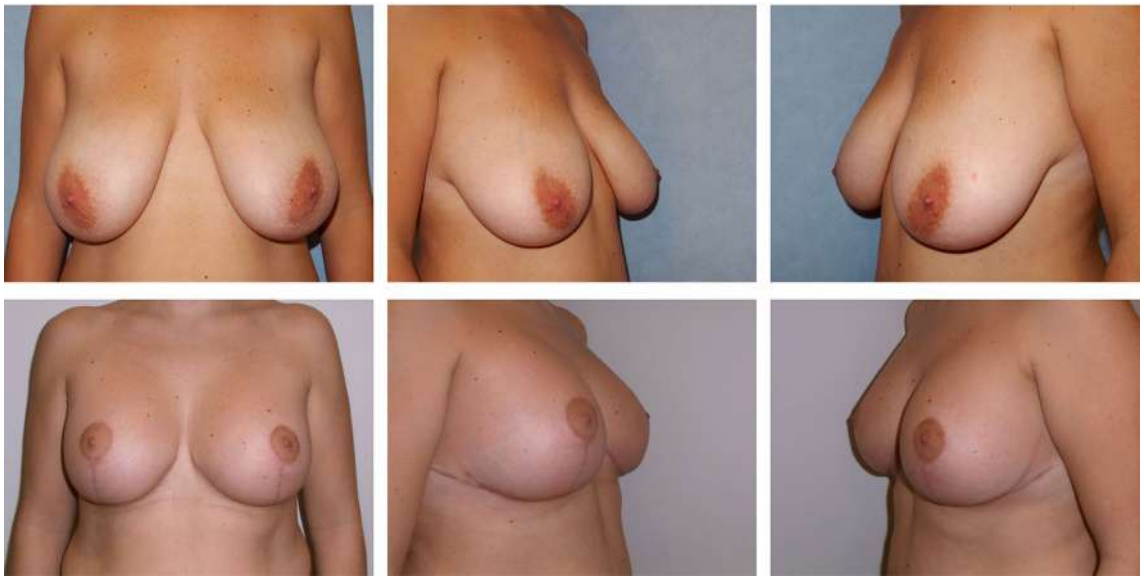

Fig. 12 Preoperative and 6-month postoperative result. Placement of 360-cc Sebbin LS70 implant with excision of 166 g from the right breast and 153 g from the left breast

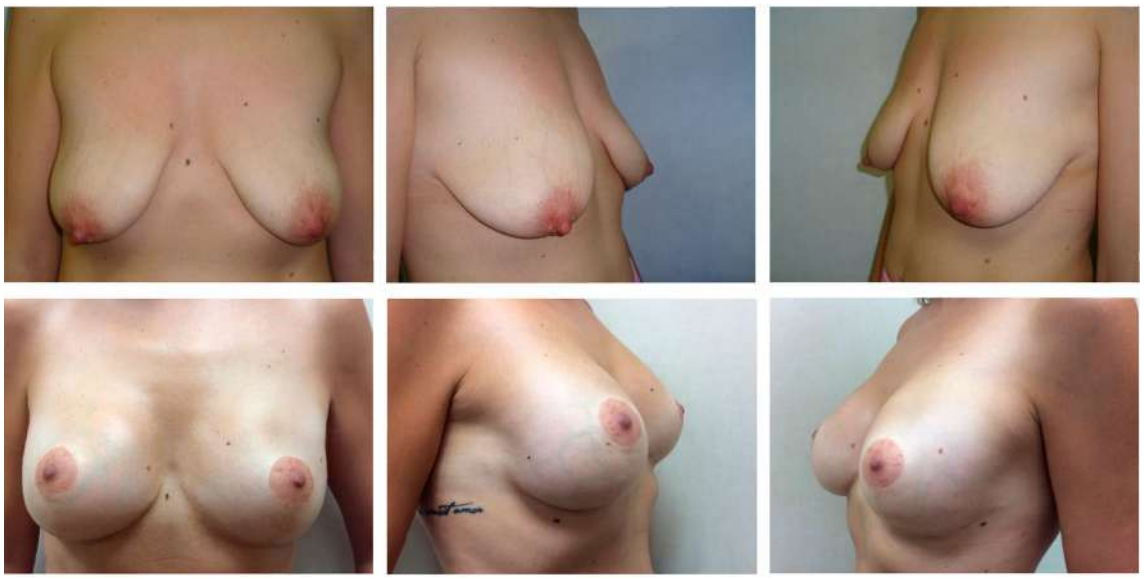

Fig. 13 Preoperative and 2-year postoperative result. Placement of 300-cc Sebbin LS70 implant with excision of 98 g from the right breast and 86 g from the left breast

comparable to those observed in our augmentation mastopexy group, and in our opinion the technique does not differ greatly from augmentation mastopexy techniques previously described. The main originality of our method lies in the combination of large parenchymal resection and implant placement (Figs. 7, 8, 9, 10). Another important difference between our technique and the reductive augmentation technique described by Chasan [71] is that we use a complete submuscular pocket rather than a dual-plane/partial submuscular pocket. Submuscular implant placement prevents bottoming out of the implant and offers an important safety advantage, as even if skin dehiscence or necrosis occurs, the implant will not be exposed. Additional advantages are maximization of implant soft-tissue coverage, a reduced risk of capsular contracture, and prevention of interference with future mammograms. Implant placement in the submuscular plane also reduces tension on the skin closure, thereby decreasing the incidence of skin necrosis and poor scarring.

Last but not least, our preoperative markings guide the skin resection during surgery without the need for intraoperative assessment. Tailor-tack mastopexy with the patient in an upright sitting position lengthens operating time, and secondary tailor-tack mastopexy makes for an even longer procedure, increasing both risks and costs.

In our experience, CBRA has proven to be an effective technique that can also be used to correct ptosis (Figs. 11, 12, 13). The safety and lasting esthetic outcomes of the CBRA technique described in this article are supported by the results from a large number of patients who have undergone this procedure.

Conclusions

Breast reduction with implants is a useful tool for obtaining lasting upper pole fullness. The procedure can be safely used in all cases, regardless of the degree of hypertrophy, ptosis, or asymmetry.

Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflicts of interest to disclose. None of the authors has a financial interest in any of the products, devices, or drugs mentioned in this manuscript.

Ethical Approval This article does not contain any studies with human participants or animals performed by any of the authors.

Informed Consent For this type of study, informed consent is not required.

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