

# Use of Absorbable Dermal Stapler in Reduction Mammoplasty: Assessing Technical, Quality-of-Life, and Aesthetics Outcomes

Viren Patel, MD\*  
 Jason L. Green, MD\*  
 Adrienne N. Christopher, MD\*†  
 Martin P. Morris, MBE\*  
 Eric S. Weiss, MD\*  
 Robyn B. Broach, PhD\*  
 Paris D. Butler, MD, MPH\*

**Introduction:** Reduction mammoplasty is a mainstay in the treatment of symptomatic macromastia, with a well-described positive impact on patient quality-of-life (QoL). Absorbable dermal staplers have the potential to improve the efficiency of skin closure in reduction mammoplasties, but a more comprehensive assessment of its impact on key outcomes has not been fully elucidated.

**Methods:** A retrospective review of patients undergoing reduction mammoplasty between November 2018 and December 2020 was conducted. Patients were included if they had undergone a wise-pattern reduction with a superomedial pedicle and completed 3 months of follow-up. Patient demographics, operative information, clinical and aesthetic outcomes, and QoL were compared between patients that had INSORB stapler-assisted and suture-only closures.

**Results:** Seventy-five patients met the inclusion criteria, with 34 patients (45%) in the stapler cohort. Total procedure time was significantly reduced with the use of the dermal stapler (stapler: 154 vs. suture: 170 minutes;  $p = 0.003$ ). The incidence of major complications was similar between cohorts (stapler: 8.8% vs. suture: 12%;  $p = 0.64$ ), as was the incidence of minor complications (stapler: 44% vs. suture: 41%;  $p = 0.82$ ). Regardless of closure technique, patients demonstrated significant increases in all QoL domains ( $p < 0.001$ ). Lastly, 10 independent raters found no difference in the cosmetic appearance of breasts from either cohort, when judging overall breast appearance, shape, scars, volume and the nipple-areolar complex (all  $p > 0.05$ ).

**Conclusions:** The dermal stapler improves efficiency of closure during reduction mammoplasty without increasing the incidence of wound healing complications. Additionally, cosmetic outcomes are not affected, and patients demonstrate similar post-operative satisfaction with the result regardless of closure technique. (*Plast Reconstr Surg Glob Open* 2021;9:e3784; doi: [10.1097/GOX.0000000000003784](https://doi.org/10.1097/GOX.0000000000003784); Published online 25 August 2021.)

## INTRODUCTION

Reduction mammoplasty is among the most common procedures in plastic surgery.<sup>1</sup> This is in part due to the prevalence of symptomatic macromastia, in which abnormally large breasts can result in significant functional, cosmetic, and psychological patient morbidity.<sup>2</sup> The signs and symptoms of macromastia can include neck and

shoulder pain, intertrigo, brassiere shoulder grooving, difficulty with exercise, difficulty with fitting clothing, and low self-esteem.<sup>3-6</sup> Through removal of excessive breast tissue, while addressing breast position and contour, reduction mammoplasty can alleviate these issues and improve patient quality-of-life (QoL).<sup>6-8</sup>

A limiting factor to the operative time required to complete a reduction mammoplasty is skin closure. Soft tissue closure following surgery is typically achieved in multiple layers: (1) reapproximation of breast parenchymal pillars, (2) closure of the dermis to restore the strength layer of the skin, and (3) juxtaposition of the epidermis to close the skin and minimize scar formation. Materials typically used to achieve closure include a variety of sutures with or without additional support with adhesive tapes and/or other skin

From the \*Division of Plastic Surgery, Department of Surgery, University of Pennsylvania, Philadelphia, Pa.; and †Department of Surgery, Thomas Jefferson University, Philadelphia, Pa.

Received for publication June 8, 2021; accepted July 1, 2021.

Copyright © 2021 The Authors. Published by Wolters Kluwer Health, Inc. on behalf of The American Society of Plastic Surgeons. This is an open-access article distributed under the terms of the [Creative Commons Attribution-Non Commercial-No Derivatives License 4.0 \(CCBY-NC-ND\)](https://creativecommons.org/licenses/by-nc-nd/4.0/), where it is permissible to download and share the work provided it is properly cited. The work cannot be changed in any way or used commercially without permission from the journal.

DOI: [10.1097/GOX.0000000000003784](https://doi.org/10.1097/GOX.0000000000003784)

**Disclosure:** The authors have no financial interest in relation to the content of this study. This study was funded in part by Cooper Surgical.

adhesives. The choice of materials is largely surgeon specific but is often dependent upon level of tension, incision length, and factors perceived to contribute to the patient's capacity to heal (eg, age, comorbidities, compliance). The ideal materials and/or devices used for closure are ones that maximize efficiency while maintaining quality, providing expediency without sacrificing strength and precision.<sup>9</sup>

Previous research has demonstrated that absorbable dermal staplers (DS) provide precision, strength, and efficiency in soft tissue closure.<sup>10,11</sup> These benefits are relevant in reduction mammoplasty, which not only requires significant time allocated to skin closure, but also demands a well opposed and high-integrity skin closure. This is because the breast envelope must adequately support the underlying breast tissue while maintaining breast position and contour, often combating a considerable amount of tension. Potential complications related to suboptimal skin closure include wound infection, wound dehiscence, delayed wound healing, excessive scar formation, and overall poor cosmesis.<sup>12</sup>

Given the inherent challenges of this operation, additional research is necessary to confirm the utility of DS in reduction mammoplasty before widespread implementation and endorsement. It is important to evaluate if the potential benefits of this device translate to reduction mammoplasty while ensuring that there is no increased risk of wound complications or poorer aesthetic outcomes. Prior studies evaluated an array of soft tissue closures with few being reduction mammoplasty.<sup>9,10</sup> Therefore, the purpose of this study was to comprehensively determine how the use of an absorbable DS affects operative time, clinical outcomes, QoL, and cosmetic appearance on reduction mammoplasty. We hypothesize that implementation of the DS will significantly reduce time of surgical closure and overall time of surgery, while maintaining similar safety and patient-reported outcomes.

## METHODS

An institutional review board approved retrospective chart review was conducted of all adult patients who underwent reduction mammoplasty with a single surgeon between November 2018 and December 2020. Patients were included if they had undergone a wise-pattern excision with a superomedial pedicle technique and completed their 3-month follow-up. Patients were excluded if they had undergone reduction with a different technique, an oncoplastic reduction, or did not meet the minimum follow-up requirement. The included patients were split into two groups based on method of dermal closure: INSORB dermal stapler (DS) (CooperSurgical, Trumbull, Conn.) or suture only (SO) (3-0 absorbable monofilament). In both groups, either the dermal staples or the interrupted dermal sutures were placed in 1.5-cm increments along the entire length of the closure. This was followed by a running subcuticular 4-0 absorbable monofilament suture as the finishing layer for both groups.

### Clinical Outcomes

The primary endpoint was to compare outcomes between patients who underwent closure with absorbable dermal staples to patients who underwent traditional suture

closure. Patient demographics (age, sex, race, and ethnicity), medical history (co-morbidities and smoking history), and operative details (operative time, operative technique, and weight of breast mass removed) were abstracted from the electronic medical record. The following postoperative complications were extracted from the electronic medical record for analysis: surgical site infection, seroma, hematoma, wound dehiscence, minor T-point delayed wound healing, other delayed wound healing (defined as wound healing issues outside of the T-point), fat necrosis, nipple-areolar complex (NAC) necrosis, hypertrophic scarring, keloid, persistent pain, hypersensitivity, and numbness. All were considered minor complications, except for surgical site infection, seroma, hematoma, wound dehiscence, and fat necrosis, which were considered major complications.

### Quality-of-Life

We aimed to determine if use of the DS affected patient-reported QoL and satisfaction with perioperative care. Patients were administered the modified BREAST-Q, Breast Reduction module preoperatively, and at their 3-month postoperative visits. The QoL module includes the following 10 domains: satisfaction with breasts, psychosocial well-being, sexual well-being, physical well-being, satisfaction with outcome, satisfaction with information, satisfaction with NAC, satisfaction with surgeon, satisfaction with medical staff, and satisfaction with office staff.<sup>9</sup> BREAST-Q responses were scored using Q-Score software, providing scores from 0 to 100 for each domain.

### Aesthetics

The final outcome was to determine how the use of the DS affects the cosmetic appearance of breasts after reduction mammoplasty. Standardized, front facing, de-identified patient torso photographs taken at the 3-month follow-up appointment were collected from the senior surgeon. The photographs were screened to exclude any with identifying tattoos or visible complications that could affect cosmetic ratings. After exclusion, 20 photographs remained for both groups. The Aesthetic Items Scale (a validated instrument for comparing cosmetic outcomes after breast surgery) was used to evaluate cosmesis.<sup>10</sup> The instrument consists of five questions regarding the breasts' volume, shape, symmetry, scars, and NAC, and is based on a five-point Likert Scale ranging from "very dissatisfied" to "very satisfied."<sup>13</sup> This scale was modified so that the answers ranged from "very poor" to "very good," and an additional question was included about the overall appearance of the breast. The cosmetic survey was administered to 10 independent raters of varying expertise in plastic surgery (two laypeople, two medical students, four plastic surgery advanced practice providers, two plastic surgery faculty members), and blinded to the closure technique of each patient. The survey was distributed individually and hosted on Qualtrics (Qualtrics International Inc, Seattle, Wash.).

### Statistical Analysis

Standard descriptive statistics were utilized. Categorical variables were compared using Fisher's exact tests while continuous variables were compared using Wilcoxon

rank sum test. Changes in QoL scores pre- to postoperatively were compared using Wilcoxon signed-rank test. Multivariate linear regression was constructed for procedure time for all covariates with a *P* value less than 0.1 to detect any confounders. Finally, aesthetic ratings for each area were compared using *t*-tests between the two cohorts. Statistical significance was set at a two-tailed *P* value less than 0.05, and all analyses were performed with StataMP14 (Statacorp, College Station, Tex.).

### RESULTS

A total of 75 patients met inclusion criteria, of which 34 underwent closure with the DS (45%) (Table 1). Median age was similar between groups (DS: 39.0 versus SO: 33.9 years; *P* = 0.39), as was body mass index (DS 28.3 versus SO: 30.3 kg/m<sup>2</sup>; *P* = 0.26). There were no significant differences in the incidences of comorbidities between the groups, specifically in terms of smoking status, immunosuppression, and diabetes mellitus (all *P* > 0.05). A greater mass of breast tissue was removed in the DS group, but this difference was not significant (*P* = 0.09). Regardless, procedure time was significantly decreased in the DS group when compared with SO patients (DS: 154 versus SO: 170 minutes; *P* = 0.003). In multivariate linear regression, when controlling for gigantomasia (defined as >1500 g per breast removed), use of the DS was significantly associated with a reduced procedure time with a 19.6-minute reduction (*P* < 0.001) (Table 2).

Overall, complication profiles were similar between cohorts. Major complications were rare, with 8.8% and 12% of patients developing major complications postoperatively in the DS and SO cohorts, respectively (*P* = 0.64). Minor complications were common and occurred in similar incidences in both cohorts, with 42.6% of patients overall developing a minor complication (*P* = 0.82). Generally,

**Table 1. Demographics, Medical History, and Operative Details of Women Undergoing Reduction Mammoplasty**

	DS (n = 34)	Suture (n = 41)	<i>P</i>
Age (y), median [IQR]	39.0 [28, 49]	33.9 [25, 39]	0.39
Body mass index (kg/m <sup>2</sup> ), median [IQR]	28.3 [26, 31]	30.3 [27, 33]	0.26
Race, n (%)			0.78
White	18 (53)	20 (49)	
Black/African American	15 (44)	18 (44)	
Mixed	1 (3.1)	1 (2.4)	
Other race	0 (0)	1 (2.4)	
Unknown	0 (0)	1 (2.4)	
Smoking status, n (%)			0.27
Never	29 (85)	32 (78)	
Former smoker	5 (15)	6 (15)	
Current smoker	0 (0)	3 (7.3)	
Diabetes, n (%)	0 (0)	0 (0)	1.0
Immunosuppression, n (%)	2 (5.9)	0 (0)	0.11
Significant weight loss, n (%)	0 (0)	2 (4.9)	0.12
Gigantomastia, n (%)	8 (24)	4 (9.8)	0.09
Degree of ptosis, n (%)			0.64
Grade 2	6 (18)	9 (22)	
Grade 3	28 (82)	32 (78)	
Bra notching, n (%)	32 (94)	40 (98)	0.20
Mass removed (g), median [IQR]	1808 [1250, 2677]	1583 [1252, 2130]	0.09
Operative time (min), median [IQR]	154 [141, 170]	170 [159, 183]	0.003

**Table 2. Multivariate Linear Regression of Factors Associated with Total Procedure Time**

	Coefficient	95% CI	<i>P</i>
Overall procedure time			
INSORB closure	-19.6	[-29, -10]	<0.001
Gigantomastia	-1.18	[-16, 14]	0.88
Total mass removed	0.01	[0.003, 0.02]	0.002

minor complications were T-point delayed wound healing, which occurred in 27% of patients in both cohorts (*P* = 0.97). The DS group did have a greater incidence of other delayed healing when compared with the SO group (17% versus 7.3%), but this difference did not reach significance (*P* = 0.30). There were no significant differences in scar related complications between the cohorts, including wide scar or keloid formation (both *P* > 0.05). There were no readmissions for either group; however, two patients in the SO group presented to the emergency department for a procedure related problem (2.4%). Follow-up was similar between cohorts, with a median of 3.1 months (*P* = 0.12) (Table 3).

QoL data were collected pre- and postoperatively for 28 patients in the DS group and 32 patients in the SO group, representing an 80% response rate in the entire cohort (Table 4). Median time of survey response was similar between groups at 90 days, reflecting the 3-month postoperative visit (*P* = 0.29). All patients, regardless of closure technique, showed significant increases in all BREAST-Q domains measured pre- and postoperatively (Fig. 1). Patients in both cohorts expressed high satisfaction with breasts (DS: 87 versus SO: 95; *P* = 0.25) and high satisfaction with the outcome (DS: 100 versus SO: 100; *P* = 0.82) (Table 5). Additionally, both groups expressed high and similar satisfaction levels for all other BREAST-Q domains (all *P* > 0.05).

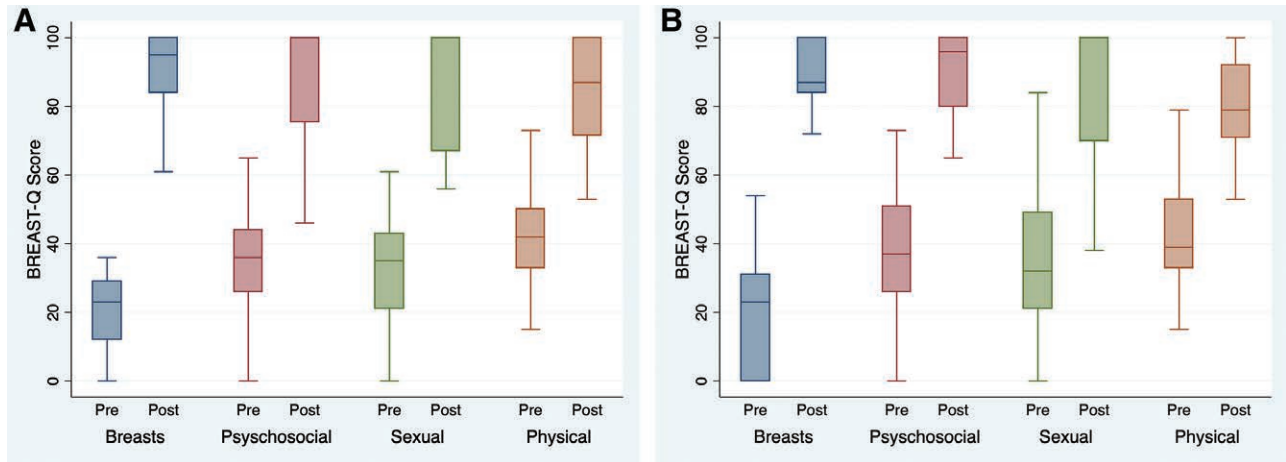
Ten independent raters completed the modified Aesthetics Items Scale,<sup>13</sup> for 20 DS and SO patient photographs at their 3-month postoperative visit, resulting in 200 ratings for each cohort. Overall appearance ratings

**Table 3. Clinical Outcomes of Reduction Mammoplasty**

	DS (n = 34)	Suture (n = 41)	<i>P</i>
Major complication, n (%)	3 (8.8)	5 (12)	0.64
Minor complication, n (%)	15 (44)	17 (41)	0.82
Surgical site infection, n (%) (major)	1 (2.9)	0 (0)	0.27
T-point delayed wound healing, n (%) (minor)	9 (27)	11 (27)	0.97
Other delayed wound healing, n (%) (minor)	5 (17)	3 (7.3)	0.30
Wound dehiscence, n (%) (major)	0 (0)	0 (0)	1.00
NAC necrosis, n (%) (major)	0 (0)	1 (2.4)	0.36
Wide scar, n (%) (minor)	4 (12)	3 (7.3)	0.51
Hematoma, n (%) (major)	0 (0)	0 (0)	1.00
Seroma, n (%) (major)	0 (0)	0 (0)	1.00
Fat necrosis, n (%) (major)	2 (5.9)	3 (7.3)	0.80
Keloid, n (%) (minor)	0 (0)	1 (2.4)	0.36
Hypersensitivity, n (%) (minor)	1 (2.9)	0 (0)	0.27
Numbness, n (%) (minor)	3 (8.6)	1 (2.4)	0.22
Readmitted, n (%)	0 (0)	0 (0)	1.00
ED visit, n (%)	0 (0)	2 (4.9)	0.19
Follow-up (months), median [IQR]	3.1 [2.9, 3.6]	3.1 [2.9, 6.2]	0.12

**Table 4. Pre- and Postoperative BREAST-Q Scores**

	DS			Suture Closure		
	Preoperative	Postoperative	P	Preoperative	Postoperative	P
Satisfaction with breasts, median [IQR]	23 [0, 31]	87 [84, 100]	<0.001	23 [12, 29]	95 [84, 100]	<0.001
Psychosocial function, median [IQR]	37 [26, 51]	96 [80, 100]	<0.001	36 [26, 4]	100 [76, 100]	<0.001
Sexual function, median [IQR]	32 [21, 49]	100 [70, 100]	<0.001	35 [21, 43]	100 [67, 100]	<0.001
Physical function, median [IQR]	39 [33, 53]	79 [71, 92]	<0.001	42 [33, 50]	87 [72, 100]	<0.001



**Fig. 1.** Box plot revealing change in preoperative and postoperative quality of life (QoL) domain scores using the BREAST-Q survey. A, Suture only. B, Dermal stapler.

were similar between groups (DS 3.35 versus SO 3.44;  $P = 0.41$ ). Mean NAC appearance scores were also similar between groups (DS: 3.43 versus SO: 3.51;  $P = 0.36$ ) (Table 6).

### DISCUSSION

In this study, we aimed to critically examine how the use of an absorbable DS affects outcomes in reduction mammoplasty. We found that use of the DS resulted in significantly reduced operative time when compared with more traditional suture closure. Importantly, there were no significant differences in major or minor complication rates when comparing the two cohorts. Regardless of closure technique, all patients included in this study demonstrated significant improvements in all QoL domains, as measured by the BREAST-Q survey. Finally, patients in the DS cohort demonstrated equivalent aesthetic outcomes

when compared with patients in the SO by independent evaluators. Taken together, use of the DS is safe and effective for patients undergoing reduction mammoplasty, with a significant reduction in operative time.

In an era of cost containment, plastic surgeons must make every effort to reexamine practices to ensure that treatment modalities are not only effective, but also cost-conscious. Currently, surgical care accounts for over a third of total health care expenditures in the United States, with operating room time comprising a substantial portion of total surgical costs.<sup>14,15</sup> At our institution, the overwhelming majority of reduction mammoplasty patients do not require an inpatient hospital stay, suggesting that operating time is the most significant contributor to costs for this subset of patients. In this study, we found that use of the DS reduces operative time for reduction mammoplasty patients by approximately 20 minutes, when compared with traditional suture closure. While this reduction in operative time may seem modest, it is likely associated with

**Table 5. Postoperative Quality-of-Life by BREAST-Q Domain**

	DS (n = 28)	Suture (n = 32)	P
Timing of survey (d), median [IQR]	87 [85, 98]	92 [85, 103]	0.29
Satisfaction with breasts	87 [84, 100]	95 [84, 100]	0.25
Psychosocial well-being	96 [80, 100]	100 [76, 100]	0.97
Sexual well-being	100 [70, 100]	100 [67, 100]	0.61
Physical well-being	79 [71, 92]	87 [72, 100]	0.21
Satisfaction with outcome	100 [100, 100]	100 [100, 100]	0.82
Satisfaction with information	100 [100, 100]	100 [100, 100]	0.54
Satisfaction with nipples	100 [100, 100]	100 [100, 100]	0.98
Satisfaction with surgeon	100 [100, 100]	100 [100, 100]	0.18
Satisfaction with medical staff	100 [100, 100]	100 [100, 100]	1.0
Satisfaction with office staff	100 [100, 100]	100 [100, 100]	0.34

**Table 6. Aesthetic Ratings at 3-month Postoperative Visit on Modified Dikmans Scale<sup>13\*</sup>**

	DS (n = 200)	Suture (n = 200)	P
Overall appearance, mean (SD)	3.35 (±0.99)	3.44 (±0.92)	0.41
Volume, mean (SD)	3.40 (±0.98)	3.42 (±0.96)	0.84
Shape, mean (SD)	3.16 (±1.1)	3.19 (±1.0)	0.77
Symmetry, mean (SD)	3.38 (±0.95)	3.34 (±0.99)	0.67
Scars, mean (SD)	3.47 (±0.98)	3.63 (±0.96)	0.11
NAC, mean (SD)	3.43 (±0.91)	3.51 (±0.93)	0.36

\*Scores represent aggregate of Likert Ratings, with 1 being very poor and 5 a very good cosmetic result.

cost-savings for the health system. Per our hospital's historical financial records, a 20-minute reduction in operative time equates to over \$1000 of cost savings, which is similar to other published estimates of costs per minute in the operating room in inpatient settings.<sup>16</sup> A single DS (\$43) was used on each breast, while an average of 4, 3-0 absorbable monofilament sutures (\$8/each) were used per breast in the SO group. Even when considering the slightly more expensive cost of the DS (\$86 versus \$64) per operation (two breasts), the reduced operative time in the DS group likely leads to overall savings in costs when compared with patients who underwent traditional SO closure.

From our analysis, we found that complication profiles between the DS and SO groups were similar. Overall, minor complications were common with over 40% of the cohort developing some complication. Although seemingly high, this complication rate was in line with the current literature, with reported complication rates between 30 and 53%.<sup>2,12,17</sup> Importantly, there was no difference in rates of T-point or other delayed wound healing between the DS and SO groups, with no wound dehiscence occurring in the entire cohort. In reduction mammoplasties, the dermal layer acts as the strength layer of the closure, maintaining the envelope of the breast. From our results, it is clear that the DS can effectively maintain this layer, resulting in acceptable rates of delayed wound healing.

In terms of operative time, previous studies have reported that patients with increased operative time could be at risk for increased major complications and wound complications, such as surgical site infection.<sup>18,19</sup> In these reports, it was found that even a 30 minute reduction in operative time could result in significantly reduced complication rates.<sup>18,19</sup> While patients in the DS cohort were in the operating room for a significantly shorter duration, we did not observe any differences in complication rates. This can likely be explained by our small sample size, when compared with the large pooled cohorts used in previous studies comparing operative time and complication rates.<sup>18,19</sup>

Overall, all patients demonstrated high satisfaction and reported improved QoL after reduction mammoplasty. In the entire cohort, patients reported significant improvement in all BREAST-Q domains measured pre- and postoperatively, including satisfaction with breasts and psychosocial, sexual, and physical well-being. This is in line with previous reports that have demonstrated similar improvements in domains measured preoperatively, and high scores on all domains overall.<sup>20,21</sup> This result intuitively makes sense, as method of dermal closure would not affect most of the domains measured by the BREAST-Q. Importantly, patients reported similar satisfaction levels with the outcome, nipples, and breast overall, suggesting the use of the DS led to equivalent satisfaction and QoL for patients.

Finally, the impact of the DS on the aesthetics of reduction mammoplasty has never been studied. In this study, we used responses from a variety of raters at varying training levels, to control for differences in how laypeople, medical personnel, and plastic surgeons judge aesthetic outcomes. After analyzing the responses from 10 raters,

no significant differences were detected in the overall appearance, volume, shape, symmetry, appearance of the scars, or NAC between the DS and SO cohort at 3-months postoperatively. This corresponded with outcomes data, which showed similar rates of scar hypertrophy and keloid formation between the cohorts. Furthermore, this is corroborated by other reports comparing DS and suture closure, which showed equivalent scar vascularity, pigmentation, and pliability at 1, 6, and 12 months following closure with an INSORB device, as measured by the modified Vancouver Scar Scale.<sup>9,22</sup>

### Limitations

This study is primarily limited by its retrospective design, which may introduce some bias into the results. However, during the study period, all data collected were based on records from one surgeon and one advanced practice provider, bolstering the validity of outcomes reported. Additionally, the assessment of postoperative aesthetics occurred 3-months postoperatively, which suggests the scar maturation process was still ongoing in the patient photographs used for the aesthetic evaluation.<sup>23</sup> Three months was chosen as the time point for pictures as many patients often elect not to follow-up after the 3-month visit if they have no lingering symptoms or complications requiring medical attention. While there may be additional changes to the scars over time, the authors would argue that any significant differences between scar appearance would be present at 3 months, and therefore the results presented in this study are likely valid for long-term aesthetic outcomes. In addition, this study assessed outcomes in reduction mammoplasties with use of the INSORB stapler for closure of the vertical and horizontal limbs of the wise-pattern incisions only. A future study may further contribute to our findings by determining the impact on outcomes if and when the stapler is used to inset the NAC.

## CONCLUSIONS

Reduction mammoplasty is an effective, and safe option to treat women with symptomatic macromastia. Controlling for total breast mass removed, dermal closure using an absorbable DS in place of sutures leads to approximately a 20-minute reduction in operative time, which is associated with reduced hospital costs. Additionally, complication rates and aesthetics outcomes are similar between patients closed with sutures versus the DS. Finally, all patients, regardless of closure technique, demonstrated significant improvement in QoL and reported high satisfaction levels. The use of an absorbable DS is a safe and efficient approach to expedite procedure time for patients undergoing reduction mammoplasty.

*Paris D. Butler, MD, MPH*

Division of Plastic Surgery, Department of Surgery  
University of Pennsylvania Health System  
800 Walnut St., 19th Floor  
Philadelphia, PA 19107  
E-mail: [paris.butler@pennteam.upenn.edu](mailto:paris.butler@pennteam.upenn.edu)  
Twitter: @DrParisButler

## REFERENCES

1. American Society of Plastic Surgeons. 2018 national plastic surgery statistics. Published online 2019. Available at: <https://www.plasticsurgery.org/documents/News/Statistics/2018/plastic-surgery-statistics-report-2018.pdf>. Accessed August 3, 2020.
2. Davis GM, Ringler SL, Short K, et al. Reduction mammoplasty: long-term efficacy, morbidity, and patient satisfaction. *Plast Reconstr Surg*. 1995;96:1106–1110.
3. Wise RJ. A preliminary report on a method of planning the mammoplasty. *Plast Reconstr Surg (1946)*. 1956;17:367–375.
4. Pitanguy I. Surgical treatment of breast hypertrophy. *Br J Plast Surg*. 1967;20:78–85.
5. Lejour M. Vertical mammoplasty and liposuction of the breast. *Plast Reconstr Surg*. 1994;94:100–114.
6. Borenstein A, Friedman O. Multilevel breast reduction: a retrospective study of 338 breast reduction surgeries. *Plast Reconstr Surg Glob Open*. 2019;7:e2427.
7. Antony AK, Yegiyants SS, Danielson KK, et al. A matched cohort study of superomedial pedicle vertical scar breast reduction (100 breasts) and traditional inferior pedicle wise-pattern reduction (100 breasts): an outcomes study over 3 years. *Plast Reconstr Surg*. 2013;132:1068–1076.
8. Morris MP, Christopher AN, Patel V, et al. Assessing disparities in reduction mammoplasty: there is room for improvement. *Aesthet Surg J*. 2021;41:NP796–NP803.
9. Bron T, Zakine G. Placement of absorbable dermal staples in mammoplasty and abdominoplasty: a 12-month prospective study of 60 patients. *Aesthet Surg J*. 2016;36:459–468.
10. Cross KJ, Teo EH, Wong SL, et al. The absorbable dermal staple device: a faster, more cost-effective method for incisional closure. *Plast Reconstr Surg*. 2009;124:156–162.
11. Madsen AM, Dow ML, Lohse CM, et al. Absorbable subcuticular staples versus suture for caesarean section closure: a randomised clinical trial. *BJOG*. 2019;126:502–510.
12. Ogunleye AA, Leroux O, Morrison N, et al. Complications after reduction mammoplasty: a comparison of wise pattern/inferior pedicle and vertical scar/superomedial pedicle. *Ann Plast Surg*. 2017;79:13–16.
13. Dikmans REG, Nene LEH, Bouman MB, et al. The aesthetic items scale: a tool for the evaluation of aesthetic outcome after breast reconstruction. *Plast Reconstr Surg Glob Open*. 2017;5:e1254.
14. Muñoz E, Muñoz W, Wise L. National and surgical health care expenditures, 2005-2025. *Ann Surg*. 2010;251:195–200.
15. Stey AM, Brook RH, Needleman J, et al. Hospital costs by cost center of inpatient hospitalization for Medicare patients undergoing major abdominal surgery. *J Am Coll Surg*. 2015;220:207–217.e11.
16. Childers CP, Maggard-Gibbons M. Understanding costs of care in the operating room. *JAMA Surg*. 2018;153:e176233.
17. Cunningham BL, Gear AJ, Kerrigan CL, et al. Analysis of breast reduction complications derived from the BRAVO study. *Plast Reconstr Surg*. 2005;115:1597–1604.
18. Cheng KKF, Clark AM. Qualitative methods and patient-reported outcomes: measures development and adaptation. *Int J Qual Methods*. 2017;16:160940691770298.
19. Cheng H, Clymer JW, Po-Han Chen B, et al. Prolonged operative duration is associated with complications: a systematic review and meta-analysis. *J Surg Res*. 2018;229:134–144.
20. Crittenden TA, Watson DI, Ratcliffe J, et al. Outcomes of breast reduction surgery using the BREAST-Q: a prospective study and comparison with normative data. *Plast Reconstr Surg*. 2019;144:1034–1044.
21. Cabral IV, da Silva Garcia E, Sobrinho RN, et al. Use of the BREAST-Q survey in the prospective evaluation of reduction mammoplasty outcomes. *Aesthetic Plast Surg*. 2018;42:388–395.
22. Verhaegen PDHM, van der Wal MBA, Middelkoop E, et al. Objective scar assessment tools: a clinimetric appraisal. *Plast Reconstr Surg*. 2011;127:1561–1570.
23. Bond JS, Duncan JAL, Sattar A, et al. Maturation of the human scar: an observational study. *Plast Reconstr Surg*. 2008;121:1650–1658.