ORIGINAL ARTICLE

Breast

Can a Breast Augmentation Procedure Improve the Appearance of Pectus Excavatum Deformity in Female Patients? A Prospective Study

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Background: This study evaluates a specific breast augmentation (BA) technique in patients with pectus excavatum (PE) and its results in improving this deformity, augmenting the breasts, and correcting the concurrent breast asymmetry.
Methods: Twenty-eight patients with PE were treated from 2017 to 2021. All patients who visited our private practice were aiming to augment their breasts, correct their breast asymmetry, and improve their PE. The mean age of the patients was 25 years. In most cases, the submuscular dual-plane technique was chosen. Patients' quality of life regarding their chest wall deformity was assessed using the Single Step Questionnaire (SSQ). Subjects' quality of life regarding general self-esteem, psychosocial well-being, and physical function were assessed at initial screening and 24-month follow-up using the BREAST-Q V2 questionnaire. Also, patients filled out a pain-evaluating questionnaire concerning the first 5 postoperative days to determine the recovery of this specific technique.
Results: No complications were observed. The SSQ revealed high satisfaction (mean score=73) and significant ($P = 0.001$) improvement following the operation. The improvements regarding psychosocial well-being, sexual well-being, and satisfaction with the BREAST-Q were also equally high ($P = 0.001$). The pain was minimal during the first five postoperative days. This is the first prospective study that evaluates the quality of life using both the SSQ, the validated BREAST-Q, and the pain score when performing BA in patients with PE and breast asymmetry using breast silicone implants.
Conclusions: BA is a procedure that can give excellent results both regarding chest wall deformity and BA in PE patients. *(Plast Reconstr Surg Glob Open 2024; 12:e5926; doi: 10.1097/GOX.0000000000005926; Published online 27 June 2024.)*

INTRODUCTION

Pectus excavatum (PE) is the most frequent congenital abnormality of the chest wall.[1] The current literature suggests that PE is identified as five times less common in women.[2,3] It is defined as an anterior chest wall deformity caused by excessive growth of the costal cartilage and characterized by a depressed sternum and a reduced distance between the sternum and the spine.[4] This deformity presents mostly as an aesthetic disturbance but can rarely lead to limitations in physical activity due to insufficient cardiopulmonary function.[5] Moreover, female adult patients with PE often present with concurrent breast asymmetry or breast hypoplasia.[6,7] Either way, PE can significantly and negatively influence a patient's cosmetic appearance and, thus, their psychosocial well-being and quality of life (QoL).[8] The majority of female patients with mild PE presented to our clinic with a primary goal to undergo breast augmentation (BA) and improve their chest deformity and their concurrent breast asymmetry.[9] The plastic surgeon must identify this group of patients because PE is associated with added operative complexity that could lead to symmastia[10] or even pneumothorax, and because the patient must be informed that although the visibility of the PE may be improved, the underlying deformity will only be camouflaged and not corrected.[11] The added challenges of the BA procedure in this group of patients have

Disclosure statements are at the end of this article, following the correspondence information.

received little medical attention in the literature. This article presents a treatment protocol and QoL assessment for female patients with PE deformity undergoing BA.

PATIENTS AND METHODS

A prospective study was conducted on female patients with concurrent PE deformity who underwent BA at the Central Clinic of Athens from January 2017 to September 2021. Twenty-eight patients with a mean age of 25 were treated by the senior plastic surgeon (E.K.). All patients were healthy and signed an informed consent. The institutional review board of the Central Clinic of Athens approved this study.

Patient Data and Clinical Evaluation

Patient demographics, chest wall and breast characteristics (PE severity, hypoplastic/tuberous/asymmetric breasts, nipple strabismus, breast ptosis/pseudoptosis), and surgical variables (type and implant size, surgical technique, complications) were collected. Chest wall evaluation was performed with the patient standing, to observe and palpate the shoulder, rib cage, sternum, scapula, and spine. Slight scoliosis was commonly present.

Regarding the PE severity, it can be estimated using two indexes:

1. The anthropometric index (AI), which can be measured easily using two standard rulers and with the patient lying supine. It is defined as the division of two measurements (AI = B/A; Fig. 1), where measurement A (depth of the chest) is the largest anteroposterior diameter at the level of the distal third of the sternum and measurement B (depth of the deformity) is the most significant depth (between the horizontal ruler and the chest's deformity) at the distal third of the sternum as described by Rebeis et al.[12]
2. The Haller index (HI) is defined as the division of the most significant transverse distance on computed tomography (CT) scan of the chest (A) and the smallest anterior-posterior distance between the vertebral body or its horizontal tangent and the posterior surface of the sternum (B) (HI = A/B; Fig. 2).

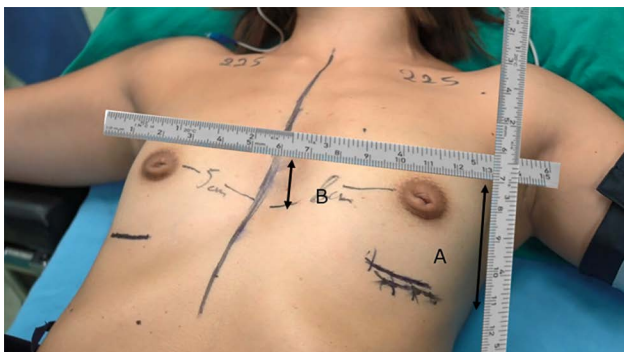We use AI as a guide since an AI of greater than 0.12 is equivalent to an HI of 3.1.[2,13] In cases where the AI is

Takeaways

Question: Can we simultaneously augment breasts, correct breast asymmetry, and improve the aesthetic appearance of the pectus excavatum deformity?

Findings: No complications were observed. The mean scores obtained with the SSQ were high. The mean scores obtained in the BREAST-Q Questionnaire were equally high. The pain was minimal postoperatively.

Meaning: With a single operation and minimal recovery, a surgeon can achieve augmentation of the breasts, improvement of the pectus excavatum deformity, and correction of breast asymmetry while providing high levels of satisfaction and improved quality of life.

greater than 0.12, a CT is recommended; however, in our study, all of our patients had an AI of less than 0.12, and thus, they did not undergo CT scan, and the HI was not calculated. This measurement is also essential because an HI of more than 3.25 indicates that the patient could undergo thoracic surgery.[2,13] Standardized chest radiographs, electrocardiography, and photographs were obtained as well.

Operative Steps

The procedure took place under general anesthesia in a supine position with both arms abducted at 90 degrees, and intravenous antibiotics were given 30 minutes before the operation. After scrubbing with a povidone-iodine solution, the papillae were taped to prevent bacterial contamination of the implant.

The midline and the inframammary fold were marked on both sides of the standing patient. For patients undergoing primary BA, the pinch test at the upper and the median pole of the breast was used as a guide to determine the appropriate surgical technique. Specifically, the subfascial technique was selected when the pinch test was more than 4 cm, and in all other cases, the dual-plane or muscle-splitting technique[14] was used. In most cases, the Tebbetts type I technique was used, while in pseudoptotic
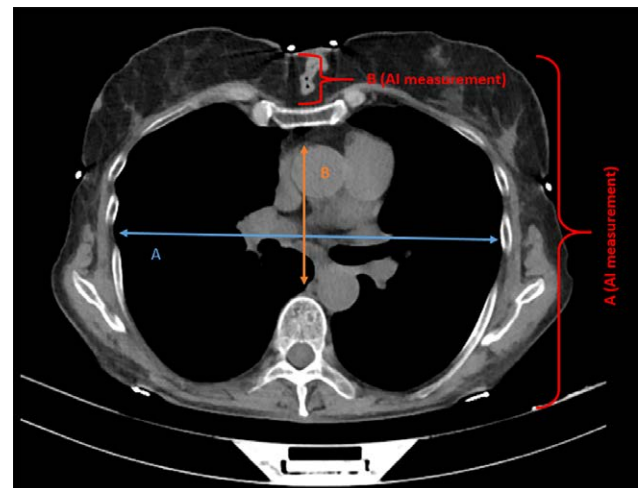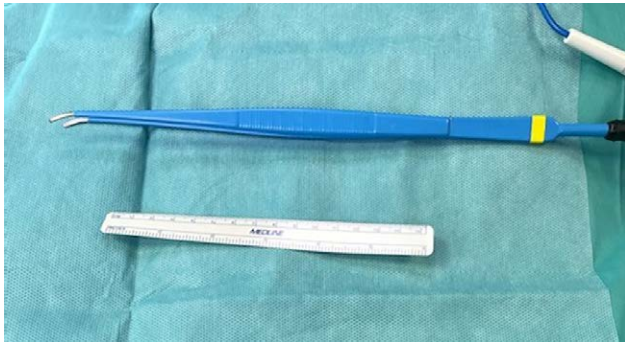

Fig. 1. AI measurement.

Fig. 2. HI measurement.

Fig. 3. Long diathermy with angular tip.

breasts, Tebbetts type II was chosen as the appropriate method.[15,16]

Creating the Pocket

Step 1: Appropriate Surgical Instruments
Access was gained through the inframammary incision. A long retractor instrument and long diathermy (23–28 cm) with an angular tip were used (Fig. 3). Dissection was only performed using a bipolar diathermy to avoid any bleeding.

Step 2: Traction
Dissection of the medial part of the muscle was more aggressively done in contrast to regular BA but was also performed meticulously to avoid symmastia and pneumothorax due to the irregular rib positioning.

Step 3: Lateral Border
Lateral dissection stopped at the frontal axillary line.

Step 4: Median Border
To ensure the creation of an aesthetically pleasing cleavage, the pocket's limit was close but did not exceed the medial limitation of the chest wall's depression.

Step 5: Correct Asymmetry
Sizers were used intraoperatively due to the underlying asymmetry. Implant size was decided after evaluating the patient both in supine and 90-degree position. After the complete dissection of the breast pocket, it was rinsed with isotonic saline, and four gauzes soaked with antibiotics were inserted. Vancomycin was used, as per our microbiology team's advice. The skin was disinfected, and the surgical team changed their gloves before inserting the implants. Round-textured silicone moderate profile implants with the same diameter as the breast width were used and were soaked into betadine solution before being placed into the breast pocket. No drains were used. The pocket was closed in three layers, with a 3/0 Monocryl suture in the first two layers and a 4/0 Monocryl suture in the subcutaneous layer.

Postoperative Results and Follow-up
Patients visited our practice at 5, 15, and 30 days; 6 months; and 1 and 2 years postoperative. During each visit, a detailed physical examination was performed, and all findings/complications mentioned by the patient or observed by the medical staff were recorded.

In this study, the subjects' QoL was evaluated using three questionnaires:

1. Subjects' QoL regarding the chest wall deformity was assessed using the Single Step Questionnaire (SSQ) introduced by Krasopoulos and coworkers. It was filled out at the 24-month follow-up visit.[17] It includes 16 questions measuring the physical and psychosocial effects of pectus surgery. Scores range between 13 and 84 for the overall score, with a higher score indicating better QoL. Any aggregated score above 41 was considered to be a satisfactory outcome.[17] In this study, question 13, which assesses the effect of the metallic bar, was removed because none of the patients underwent a Nuss procedure. Thus, the maximum score in our population was modified to 79.

2. Subjects' QoL regarding general self-esteem, psychosocial function, and physical function was assessed at initial screening and 24-month follow-up using the BREAST-Q V2.0 questionnaire.[18] Use of this questionnaire, authored by Drs. Klassen, Pusic, and Cano, was made under license from Memorial Sloan Kettering Cancer Center, New York. The BREAST-Q V2.0 questionnaire is a patient-reported outcomes tool designed to evaluate the results of women undergoing different types of breast surgery.

3. Postoperative pain regarding the first 5 postoperative days was assessed using a pain-evaluating questionnaire (scale 0–10). This aimed to examine whether the surgical technique, due to its increased complexity, was accompanied by an increased level of postoperative pain.

RESULTS

Table 1 summarizes the preoperative demographic characteristics of the 25 patients included in the statistical analysis. Three patients were excluded from the study because they could not complete all the follow-up questionnaires. All patients had the same low-rate complication profile. Hematomas or infections were not observed. Capsular contraction and implant leakage/rupture rate were 0%. Scar complication rate (hypertrophy, keloid, hyperchrosis, visibility due to malposition) was 4% (1 patient), and the revision rate was 0%.

Overall, the SSQ revealed a high level of satisfaction with a mean total score of 73 (range 69–75). Analysis of the median scores obtained for each question and the total score of the individual patients revealed a statistically significant ($P = 0.001$) improvement following the operation (Table 2). Domains for social function and self-esteem (questions 1—13) demonstrated a highly significant improvement following surgery ($P = 0.001—0.008$). Domains for physical condition (questions 14—16) also showed a statistically significant improvement. Overall, the SSQ revealed high satisfaction following the BA procedure (median for question 14 = 5, mean total score = 73, range: 69—76). When the

Table 1. Demographic and Clinical Characteristics

Age	Mean/Range: 25/21–53
BMI	Mean/range: 20.6/19–23
Concurrent breast deformities:	No. patients:
I. Unilateral hypoplastic breast	0
II. Bilateral hypoplastic breast	25
III. Breast asymmetry	25
IV. Nipple strabismus	25
V. Tuberus breast unilateral	0
VI. Tuberus breast bilateral	0
VII. Breast ptosis	0
VIII. Breast pseudoptosis	3
Type of implants:	No. implants:
I. Textured	25
II. Smooth	0
Size	Mean/range: 300/250–350
Surgical technique:	No. patients:
I. Subfascial	3
II. Dual plane:	14 (a:12, b: 2, c:0)
a) Tebbetts type I	
b) Tebbetts type II	
c) Tebbetts type III	
III. Muscle-splitting	8
Complications:	No. patients:
I. Infection	0
II. Hematoma	0
III. Scar deformities (keloid, discoloration, malposition)	1
IV. Implant rupture/leakage	0
V. Capsular contraction	0
VI. Revision surgery	0
Surgical time	Mean/range: 55 min/45–90 min
Hospitalization time	Mean/range: 4.2 h/3–11 h

patients were questioned about changes in their self-esteem through SSQ-questions 8 and 9, there was a statistically significant improvement after the surgery ($P = 0.001$). We subtracted the median score for SSQ question 9 from that for SSQ question 8 to assess the net gain in self-esteem. This evaluation revealed a mean increase of five points (range: 1–9).

We attempted to assess the impact of surgical wounds on the overall cosmetic result using our SSQ. It was evident (question 6) that most of our patients were very satisfied with their scars, scoring maximum points (median = 5, range = 3–5). None of the patients was disturbed (score = 1) by the appearance of the surgical scars. The median score for SSQ question 10 was 5, indicating that pain was barely evident.

Mean scores derived from the BREAST-Q V2.0 questionnaire are reported in Tables 3 and 4. The scales with the highest scores evaluate satisfaction with the care received: satisfaction with the surgeon, with a score of 98.88%, and satisfaction with the medical team, with a mean of 97.84%. Among the high scores were also satisfaction with the implants at 97.5% and surgical results at 91.44%. The improvements regarding psychosocial and sexual well-being and satisfaction with the breasts are statistically significant ($P = 0.001$).

Regarding the pain in the first 5 postoperative days, it was minimal. Mean scores ranged from 0.96 to 0.36 on a scale 1–10 (Table 5).

Clinical results can be seen in Figures 4–7. The patient in case 1 was 30 years old, with a BMI of 21. Implant sizes were 275 and 350 cm³, respectively. The patient in case 2 was 28 years old, with a BMI of 20. Implant sizes were 300 and 325 cm³, respectively.

DISCUSSION

PE is a congenital deformity characterized by a deep depression usually involving the lower two-thirds of the sternum and, in severe cases, can be associated with functional impairment. The main indications for adolescent surgery are primarily aesthetic because severe cases are recognized earlier and corrected during childhood.[1] Patients with PE, mostly mild cases, can sometimes be unaware of their thoracic wall deformity. In our study, all patients had noted and were displeased by their chest wall; therefore, they visited our practice with specific requests and questions. All wished to augment their breasts; they were speculating whether that would worsen their PE deformity and whether it would be feasible to correct their breast asymmetry with the same procedure.

The surgical technique involved the basic principles of BA, precisely 33 steps[19] for a safe and efficient BA. Specifically, a long retractor is used to create enough traction and to ensure adequate homeostasis will be obtained with the angular bipolar diathermy by using the coagulation mode at all times[16] during the dissection. A lot of traction is needed to dissect the tissues and always under maximum tension especially at the depressed medial part compared to the protruded ribs laterally. Another crucial step is the creation of the pockets' limits because this will secure the implant's position and will create an aesthetically pleasing décolleté while camouflaging the PE deformity. Using implants with the same diameter as the breast's width is an additional step to secure their position. In all cases in our study, sizers were used intraoperatively to ensure the underlying asymmetry, which was evident in all cases, would be corrected.

Until recently, outcomes of PE correction were assessed using the PE Questionnaire or the SSQ by Krasopoulos et al. Although this last questionnaire involves parameters such as the metal bar, we included it in our study to evaluate the psychological effect this deformity had on our patients. Interestingly, a publication points out that this questionnaire is phase-dependent because one of the main issues of traditional PE surgical procedures is the severity of pain patients are experiencing.[20] Our evaluation method considers changes in behavior and self-esteem, issues such as the impact of surgical scars on the cosmetic result, and short- and long-term pain. Patients considered the cosmetic result highly acceptable with minimal pain. Although multiple individual, social, and environmental factors interact in creating one's body image assessment, patients who are dissatisfied with their body image can experience a QoL improvement after receiving this operation, as shown by Roberts et al.[21] Evaluation of our series demonstrates similar satisfactory results as those found

Table 2. Single Step Questionnaire

Question Stem	Scoring	Median, Mean/SD, [Range]
1. Health in general after the operation	Much better now, 5; somewhat better, 4; about the same, 3; somewhat worse now, 2; much worse now, 1	5, 5/0, [0]
2. Exercise capacity after the operation	Much better now, 5; somewhat better, 4; about the same, 3; somewhat worse now, 2; much worse now, 1	5, 5/0, [0]
3. Extent that chest looks interfere with preoperative social activity	Extremely, 5; quite a bit, 4; moderately, 3; slightly, 2; not at all, 1	4, 4.04/0.73, [3–5]
4. Extent that chest looks interfere with postoperative social activity	Not at all, 5; slightly, 4; moderately, 3; quite a bit, 2; extremely, 1	5, 4.76/0.43, [4–5]
5. Satisfaction with the overall postoperative appearance	Extremely satisfied, 5; very satisfied, 4; satisfied, 3; dissatisfied, 2; very dissatisfied, 1	5, 5/0, [0]
6. Bothered by the surgical scars	Extremely satisfied, 5; very satisfied, 4; satisfied, 3; dissatisfied, 2; very dissatisfied, 1	5, 4.68/0.55, [3–5]
7. Impact operation had to social life	Major improvement, 5; improved, 4; no change, 3; worse now, 2; a lot worse now, 1	5, 5/0, [0]
8. Preoperative self-esteem	Score 1–10	4, 4.08/0.9, [3–6]
9. Postoperative self-esteem	Score 1–10	9, 8.92/0.75, [8–10]
10. Pain during hospital stay	None, 5; very mild, 4; mild, 3; moderate, 2; severe, 2; very severe, 1	5, 4.8/0.40, [4–5]
11. Pain interfering with day to day activity now (postoperative)	Not at all, 5; very slightly, 4; slightly, 3; a little bit, 2; a lot, 1	5, 5/0, [0]
12. Pain now (postoperative)	No, 5; occasionally, 4; mild–no painkillers, 3; mild–painkillers, 2; a lot, 1	5, 5/0, [0]
13. Conscious about the metallic bar	Not at all, 5; slightly, 4; moderately, 3; quite a bit, 2; extremely, 1	Not applicable
14. Overall satisfaction with the final result	Extremely satisfied, 5; very satisfied, 4; satisfied, 3; dissatisfied, 2; very dissatisfied, 1	5, 5/0, [0]
15. Chest looks different	Major improvement, 5; improved, 4; no change, 3; worse now, 2; a lot worse now, 1	5, 5/0, [0]
16. Going back would you have the operation again	Yes, 10; unsure, 5; no, 0	10, 10/0, [0]

Table 3. Preoperative Results of the BREAST-Q Questionnaire

BREAST-Q Questionnaire Scales	Minimum%	Maximum%	Mean%	SD
Psychosocial well-being	24	47	39.48	5.94
Sexual well-being	25	45	34.04	6.33
Satisfaction with breasts	17	44	32.6	6.61
Physical well-being: chest	0	19	2.36	5.09

Table 4. Postoperative Results of the BREAST-Q Questionnaire

| BREAST-Q Questionnaire Scales	Minimum%	Maximum%	Mean%	SD
Psychosocial well-being	74	89	83.84	4.77
Sexual well-being	62	84	77.4	6.13
Satisfaction with breasts	69	91	82.64	6.79
Physical well-being: chest	0	0	0	0
Satisfaction with implants	7	8	97.5	0.5
Satisfaction with surgical results	75	100	91.44	8.73
Satisfaction with information	81	100	93.72	6.67
Satisfaction with the surgeon	93	100	98.88	2.62
Satisfaction with the medical team	94	100	97.84	2.94
Satisfaction with the hospital	91	100	94.72	4.44

Table 5. Postoperative Pain Score

Postoperative Pain Score	Mean/Range
I. 1st postoperative day	0.96/0–4
II. 2nd postoperative day	0.8/0–4
III. 3rd postoperative day	0.76/0–2
IV. 4th postoperative day	0.6/0–2
V. 5th postoperative day	0.36/0–1

in literature: both the BA and PE QoL score outcomes were high, and the postoperative pain score was very low. Statistical significance was reached despite the small number of patients, underlining the substantial and uniform improvement in these domains.

Major thoracic surgery is performed nowadays in only patients with cardiovascular malfunction. Yet these procedures still lack solid evidence that there is an actual improvement in the QoL of these patients.[22,23] These procedures (the Nuss method and the Ravich method) have severe side effects, long hospitalization, and extended recovery time.[24,25] Minor thoracic surgery is used nowadays in most cases with functional impairment; however, it is still considered a major surgery.[26] Other less-invasive techniques, such as silicone thoracic implants have been described.[27] However, patients reported that they were aware of the prosthesis and felt discomfort during physical effort or intense sporting activity, and seromas were present in 30% to even 100% of the cases.[28,29] Moreover,

Fig. 4. Case 1 preoperatively. A, Frontal view. B, Three-quarter view. C, Side view.
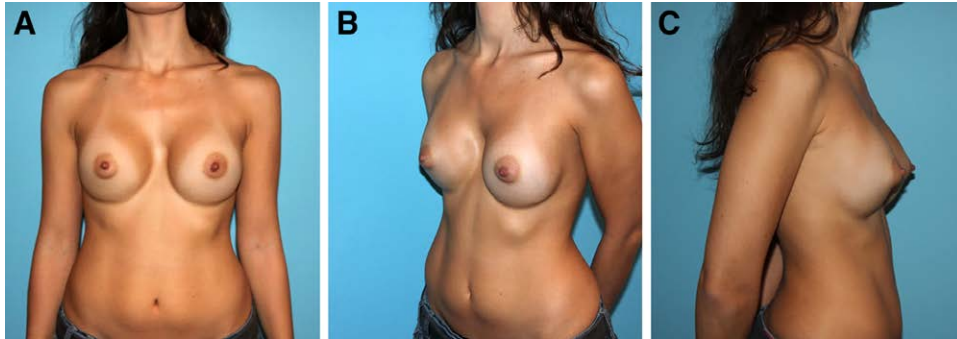
Fig. 5. Case 1 postoperatively. A, Frontal view. B, Three-quarter view. C, Side view.
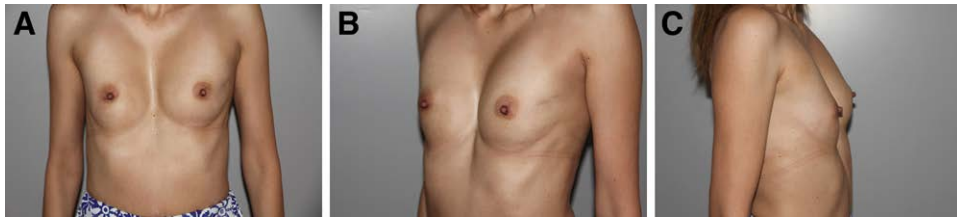
Fig. 6. Case 2 preoperatively. A, Frontal view. B, Three-quarter view. C, Side view.

Fig. 7. Case 2 postoperatively. A, Frontal view. B, Three-quarter view. C, Side view.

the capsular contracture of modern silastic flexible implant blocks is unknown to date.[11]Autologous cartilage may serve to correct minor deformities (cartilage chips), and although it is an alternative with long-lasting results, it leaves patients with an obvious vertical scar. Autologous transfer of fat tissue seems to be a promising technique to primarily fill in a funnel depression without major surgical trauma or scars.[30,31] However, it requires more research because of the unpredictable behavior of the transplanted fat cells, the ambiguous final breast volume result, its controversial lasting result that could require re-treatment for maintenance, and the absence of a standardized injection technique.[11,32] Another novel

method is the development of custom-made implants, using a three-diemnsional CT scan to secure a precise fitting of the implant.[28,33] These implants, though, have an increased cost and a less natural feeling due to their solid quality.[34] Lately, hyaluronic acid[35–37] has also been reported as a possible treatment option. However, it is a material that can be less stable in the thoracic area, leading to unpleasant under-the-skin visibility of the product, and it could require multiple sessions to achieve the desired result.[38]

Silicone implants have been reported to have several limitations regarding PE correction. One of the reasons is that this deformity is often accompanied by

breast hypoplasia, which is either true or secondary to the distorted anatomy. Consequently, performing BA in a depressed sternum may even enhance its optical depth and exacerbate the strabismus of the breasts.[11,31] By using different implants and several sizers during surgery, it is possible to overcome this issue. Once the hypoplastic side is corrected, the contralateral side is augmented using the ipsilateral side as a final volume and projection guide. Regarding the increased optical depth, we used this obstacle in our favor to create the illusion of bigger breasts and enhanced décolleté. However, in prominent cases, it is vital to avoid large implant sizes (>400 cm³) because that could look unnatural. We choose round implants in almost all our cases because there is always the risk of rotation with anatomic implants, and the aesthetic result can be identical, if not better, with round implants.[39–41] Moreover, capsular contracture is a possible side effect[11,32] in silicone implant procedures, but the risk, as found in the literature, is very low, especially with textured implants.[42]

Last but not least, breast implant-associated anaplastic large cell lymphoma (BIA-ALCL)[43] and squamous cell carcinoma[44] associated with the breast implant capsule are infrequent complications. Still, their capsular contracture rate is very low, and they maintain their position under the muscle. On the other hand, there are no confirmed cases of BIA-ALCL in patients in whom only smooth implants have been used.[45] However, these have a higher capsular contracture rate and risk of bottoming out.[46] In this study, all of our patients after the initial consultation chose textured implants and signed an informed consent including that these have been associated with BIA-ALCL (incidence rate is 0.33 per 1 million person-years in textured implants that use a negative-imprint stamping technique for texturization[43]).

The study's main limitation is the reduced sample size of 25 patients. In addition, by selecting patients operated on by the same surgical team, there may be a selection bias. However, this is also a strength of the study, as having been operated on by the same team, the surgical techniques are more comparable, and so are the results. Another limitation, is that the improvement in the PE appearance is not objective as there was no control group, and all patients underwent solely BA.

This prospective study evaluates the QoL using the validated SSQ, the BREAST-Q V2.0 questionnaire, and the pain level in patients with mild PE deformity (AI < 0.12) and breast asymmetry who wish to undergo BA. We believe that using a simple technique that provides a quick, safe, yet aesthetically pleasing result is the best option for this category of patients. This procedure does not intend to treat PE; instead, it aims to improve the chest appearance perception by the patients. Yet, complicated or costly procedures add a level of unnecessary complexity in most instances. Implant correction yields excellent results with markedly less morbidity.

CONCLUSIONS

BA is a safe and effective technique for camouflaging the PE deformity. With a single operation, a surgeon can achieve augmentation of the breasts, improvement of the chest's deformity, and correction of breast asymmetry while providing high levels of satisfaction and improved QoL.

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