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ORIGINAL ARTICLE

Breast

3D Volume Assessment as an Objective Tool in Breast Asymmetry Management

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Background: Throughout history, the female breast has been a universal symbol of femininity. The breast's normal symmetrical appearance is an important aspect of the female form. Female breasts are not perfectly symmetrical by nature, and minor differences in shape or volume are common. However, it can be psychologically distressing for patients and affect their perception of their bodies. Aesthetic breast surgeons strive to minimize these differences in order to make them more acceptable to patients. This study aimed to provide an objective and practical strategy for effectively managing breast asymmetry.

Method: This study was conducted between November 2017 and September 2021 on 20 female patients seeking breast asymmetry correction at Kasr El-Ainy Hospital. All patients had volumetric breast assessment using a three-dimensional (3D) imaging system (3D LifeViz, Quantificare system), and MRI breast volumetry was done preoperatively in all patients. The patients were managed with different single-stage surgical procedures depending on the objective assessment of the volume differences between their breasts.

Results: Breast volume assessment using the 3D camera was done preoperatively and postoperatively. The preoperative mean volume difference was 159.45 cm^3, and the postoperative mean difference was 16.75 cm^3 with an overall reduction in mean volume difference of 89.5%. Comparing the 3D camera and MRI in assessing breast volume difference showed no statistical significance.

Conclusions: The 3D technology is a useful objective tool to augment the surgeon's experience. It helped achieve an 84.57% reduction in volume difference in managing breast asymmetry with a single-stage procedure. *(Plast Reconstr Surg Glob Open 2023; 11:e4904; doi: 10.1097/GOX.0000000000004904; Published online 7 April 2023.)*

INTRODUCTION

The female breast is a common, iconic image of femininity and maternity, and plays a major role in women's body image and self-confidence.[1] Regular and symmetrical breast appearance is an essential pillar in defining attractiveness in the female form.[2]

Although some degree of breast asymmetry is normal, sometimes abnormalities of symmetry in size and shape may be seen as unattractive, negatively affecting a woman's self-esteem and quality of life.[3] Hence, the main goal of aesthetic and reconstructive breast surgery is to provide symmetrical breasts with an aesthetically acceptable form.[4]

Breast morphology mainly depends on the relationship between the volume of tissue, the surface area of the skin envelope, and glandular configuration.[5] The female breast is the most variable and deformable organ in the body, changing its shape in response to many factors, such as body posture. Therefore, a unique assessment tool is needed for breast evaluation to improve the management of breast asymmetry. Although many methods have been reported to be accurate in measuring breast volume, none has emerged as a standard for reasons such as cost, technical difficulty, and patient inconvenience. Thus, breast volume assessment remains a challenge for plastic surgeons.[1,6,7]

METHODOLOGY

This study was carried out between November 2017 and September 2021, on 20 female patients seeking breast asymmetry correction at Kasr El-Ainy Hospital.

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Their ages ranged from 18 to 45 years (mean age: 30.4 years).

The study included all patients complaining of various degrees of breast asymmetry and excluded patients who were candidates for partial or total breast reconstruction, and patients with unrealistic expectations. Patients with uncontrolled chronic comorbidities (eg, cardiac disease, diabetes, or chronic chest problems), those likely to have poor compliance for postoperative follow-up, and patients complaining of severe skin infections were also excluded.

All patients underwent preoperative evaluation, including clinical assessment for the presence of suspicious masses or axillary nodes. Skin quality was evaluated, including its tone, elasticity, scars, or deformations. The cause of the asymmetry (congenital or acquired breast or chest wall asymmetry) was determined. Additionally, the degree of breast ptosis was evaluated (a mild degree of ptosis may be improved by augmentation, but moderate or severe ptosis will need a formal mastopexy). Laboratory investigations were performed, and preoperative and postoperative photographs were taken in the standing position. Lateral, frontal, and oblique views were obtained. All patients were informed about the procedure, type of anesthesia, risks, and possible complications and provided written consent.

In this study, three-dimensional (3D) volume assessment (3D LifeViz, Quantificare system) was done for all patients preoperatively and 6 months postoperatively (Fig. 1). Magnetic resonance imaging (MRI) breast volumetry was performed preoperatively (to confirm the results of the 3D breast volumetry). The surgical management plan was decided according to the volume assessment and the calculated volume difference between the breasts. All procedures were performed under general anesthesia, and patients were given an IV dose of antibiotics on induction.

Ptotic breasts present a major challenge for 3D tools in defining breast volume. However, this was managed as follows:

1. During photography (Figs. 2 and 3)
   a. The patient was asked to raise her hands above her head.

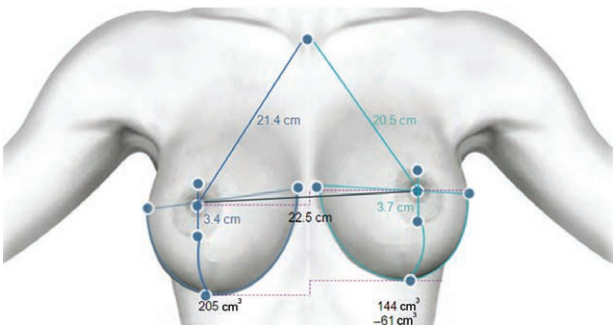

Fig. 1. 3D LifeViz, Quantificare system breast reports showing linear and volumetric measurements of both breasts preoperatively.

Takeaways

Question: Managing breast asymmetry in a single stage after objective assessment of the breast volume.

Findings: The three-dimensional technology is a particularly useful objective tool to augment the surgeon's experience. It helped achieve an 84.57% reduction in volume difference in managing breast asymmetry with a single-stage procedure.

Meaning: The use of a three-dimensional camera device is recommended not only for treating breast asymmetry, but also as a standardized assessment tool in all cosmetic breast procedures.

   b. Anthropometric measures between different anatomical landmarks were obtained manually, with the patient standing with her arms at her side and then above her. This had been considered when placing these landmarks on the simulated module in the software.
2. During software processing
   a. Anatomical landmarks were placed automatically by the software and were adjusted manually, including:
      - Suprasternal notch, right and left nipples;
      - Upper edge of the breast mound;
      - Inframammary crease.
   b. Measurements were obtained automatically and were adjusted according to the position of the anatomical landmarks as follows:
      - Linear measurements;
      - Breast volumes and the difference between them;
      - Difference and symmetry of the nipple level.
3. Erroneous results in the volume assessment of ptotic breasts did not affect the volume difference between the breasts, which was the main parameter measured in this study.

Breast augmentation was done unilaterally in two cases and bilaterally in two cases; for mastopexy, it was done unilaterally in four cases and bilaterally in one case, augmentation mastopexy was done unilaterally in two cases and bilaterally in two cases. Reduction mammoplasty was done unilaterally in two cases and bilaterally in two cases. Fat injection was done unilaterally in two cases and bilaterally in one case. Postoperatively, patients were kept on bed rest in a semi-recumbent position for the first 24 hours. The patients continued oral antibiotics for 1 week postoperatively. A medical bra was worn from the first postoperative day. The drains were evacuated every 24 hours, and the volume and color of the fluid were recorded. Patients were discharged on the second postoperative day, and follow-up was at 1, 2, and 4 weeks, and 3 and 6 months after discharge.

Where reduction of the breast volume was needed, the volume of the excised breast tissues was measured using the water displacement method to confirm the preassessed volume to be excised (Fig. 4).

A cross-sectional survey was given to all patients in the study 6 months after the procedure. The patients had to give a score from 1 to 10 for the following items:

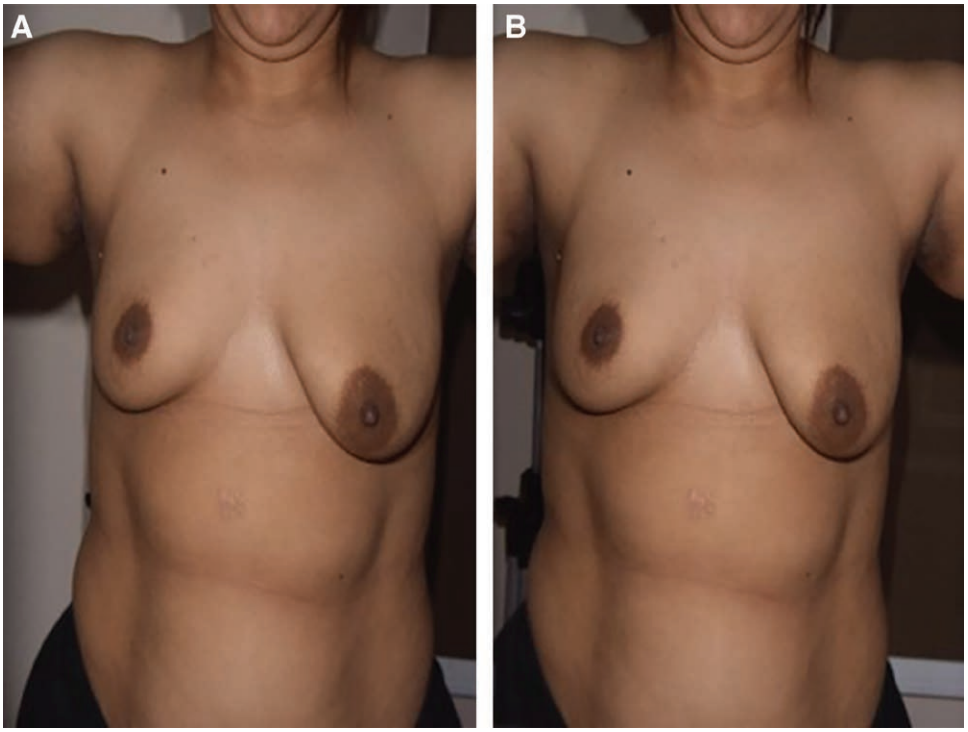

Fig. 2. Patient with ptotic breasts. Arms down. Parts A and B are not repeated; rather, they are the genuine SBS (side by side) images that the 3D camera provided in order to begin processing and building a 3D module.

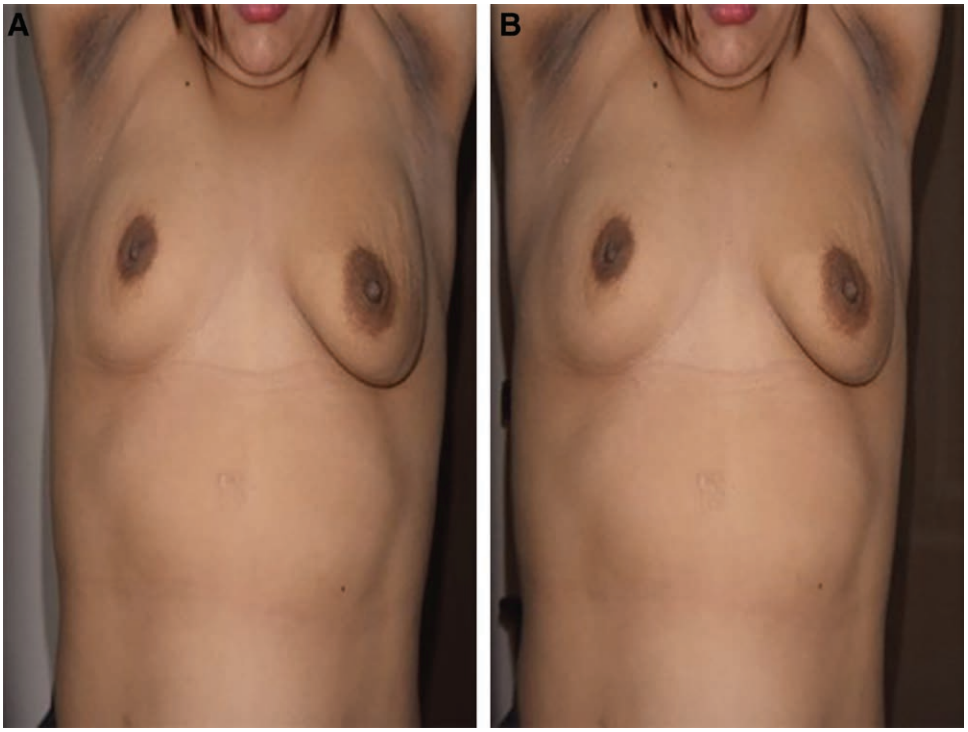

Fig. 3. Patient with ptotic breasts. Arms raised. Parts A and B are not repeated; rather, they are the genuine SBS (side by side) images that the 3D camera provided in order to begin processing and building a 3D module.

Fig. 4. Water displacement by the excised breast tissue in cases of breast reduction for volume confirmation intraoperatively.

1. Patient satisfaction and convenience during the 3D camera measurement procedure.
2. Feasibility (cost and procedure time), and
3. Patient satisfaction with the postoperative result in correction of the breast asymmetry.

STATISTICAL ANALYSIS METHODOLOGY

Statistical analysis was described in terms of mean (SD), median, and range when appropriate. The Shapiro-Wilk test was used to test the normal distribution of the acquired data. Wilcoxon's signed-rank test was used to compare the study groups for paired (matched) samples. Correlations between quantitative variables were done using Spearman correlation coefficient. A two-sided *P* values less than 0.05 was considered statistically significant. All statistical calculations were done using the computer program IBM SPSS (Statistical Package for the Social Science; IBM Corp, Armonk, N.Y.) release 22 for Microsoft Windows (Microsoft Corp, Redmond, Wash.).

RESULTS

Preoperative and postoperative bilateral breast volume assessment using the 3D camera was done in all 20 patients (Table 1 and Fig. 5). MRI breast volumetry was also performed preoperatively in all patients (to confirm the results of the 3D breast volumetry) (Tables 1 and 2; Fig. 5).

Preoperative correlation of right and left breast volumes in 3D camera and MRI showed significant strong positive correlation (Tables 2 and 3; Fig. 6).

The difference between 3D camera breast volume assessment and MRI volume assessment in the right breast preoperative readings ranged from 3 cm^3 to 12 cm^3 (average 7.1 cm^3), and that in the left breast preoperative readings ranged from 0 cm^3 to 15 cm^3 (average 6.3 cm^3). The

Table 1. 3D Camera Breast Volume Measurements

No.	Preoperative Volume		Preoperative Volume Difference	Preoperative Volume Difference Percentage	Postoperative Volume		Postoperative Volume Difference	Postoperative Volume Difference Percentage	Overall Difference Improvement
	Rt	Lt			Rt	Lt			
1	540	313	227	42.03%	356	313	43	12.07%	81.05%
2	153	296	143	48.31%	153	142	11	7.18%	92.3%
3	440	263	177	40.22%	388	359	29	7.47%	83.6%
4	460	112	348	75.65%	361	352	9	2.49%	97.4%
5	178	76	102	57.30%	399	403	4	0.99%	96 %
6	331	143	188	56.79%	425	441	16	3.62%	91.48%
7	205	144	61	29.75%	471	474	3	0.63%	95%
8	305	643	338	52.56%	409	430	21	4.88%	93.79%
9	243	206	37	15.21%	490	475	15	3.06%	59.45%
10	145	164	19	11.58%	405	420	15	3.57%	21%
11	200	252	52	20.63%	450	451	1	0.99%	98%
12	798	701	97	12.15%	429	404	25	5.82%	74.22%
13	729	607	122	16.73%	518	498	20	3.86%	83.6%
14	365	201	164	44.93%	460	448	12	2.60%	92.68%
15	624	452	172	27.56%	403	381	22	5.45%	87.2%
16	226	280	54	19.28%	499	506	7	1.38%	87%
17	163	596	433	72.65%	283	323	40	12.38%	90.76%
18	653	419	234	35.8%	431	419	12	2.78%	94.87%
19	155	67	88	56.77%	456	471	15	3.18%	82.95%
20	211	78	133	63.30%	407	422	15	3.55%	88.72%

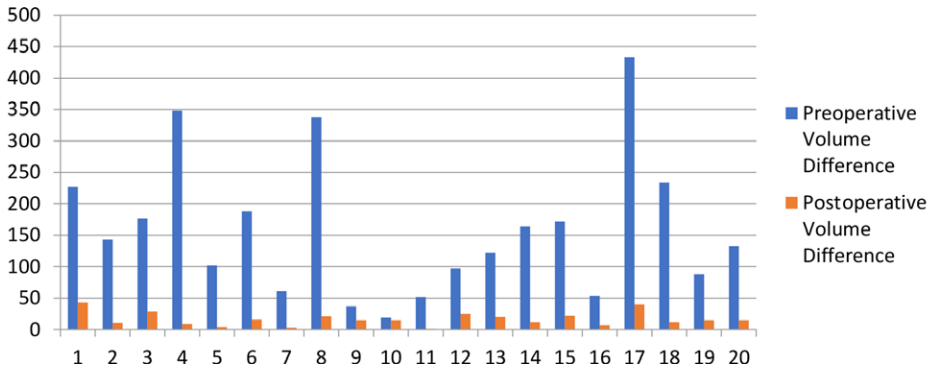

Fig. 5. Preoperative and postoperative volume difference by 3D camera volumetry.

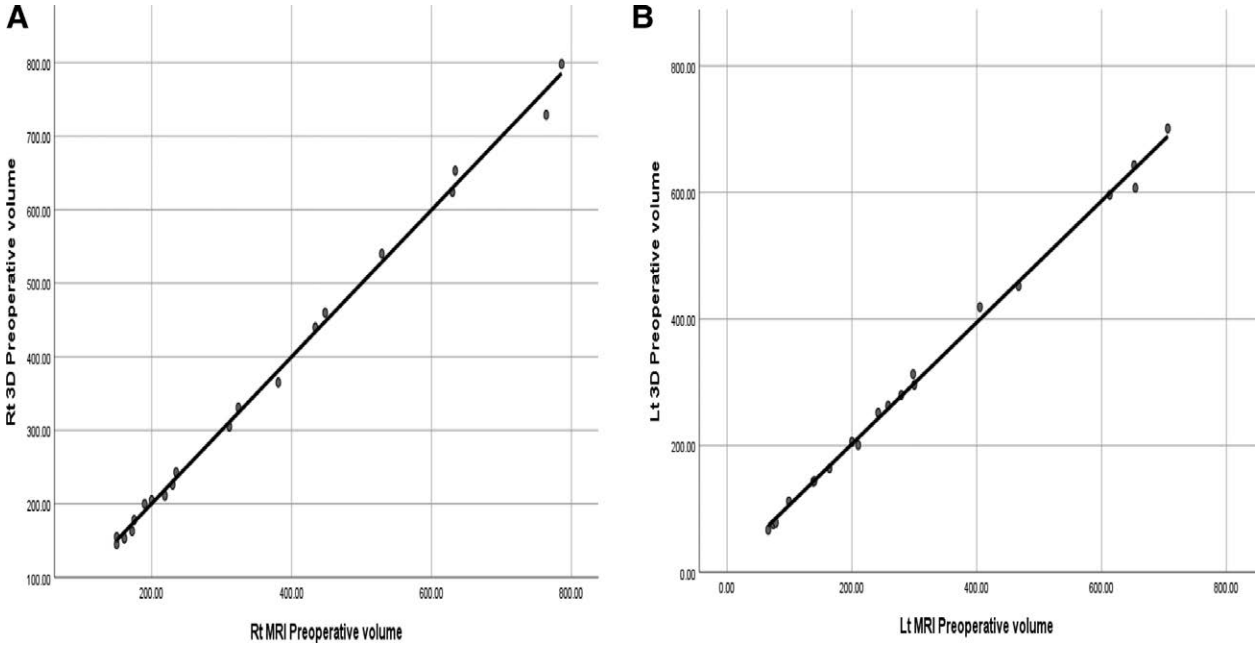

Fig. 6. A, Preoperative correlation of the right breast volumes in 3D camera and MRI. B, Preoperative correlation of the left breast volumes in 3D camera and MRI.

difference between both ranged from 1 cm^3 to 5 cm^3 (average 2.4 cm^3).

There was no statistically significant difference between the results from the 3D camera and the MRI as $P = 0.761$.

The mean improvement between the preoperative and postoperative results was 84.57%, with a minimum of 21% and a maximum of 98% (Figs. 7-8).

In the cross-sectional survey, patient satisfaction and convenience during the 3D camera measurement procedure ranged from 7 to 10, with a mean of 8.8. Feasibility (cost and procedure time), scored a minimum of 6 and a maximum of 9, with a mean of 8. Patient satisfaction with the postoperative result of the breast asymmetry correction ranged from 6 to 10 with a mean of 7.9.

Table 2. Preoperative Correlation of the Right Breast Volumes in 3D Camera and MRI

		Rt 3D Preoperative Volume
Rt MRI preoperative volume	Correlation Coefficient	0.997
	P	<0.001
	N	20

Table 3. Preoperative Correlation of the Left Breast Volumes in 3D Camera and MRI

		Lt 3D Preoperative Volume
Lt MRI preoperative volume	Correlation coefficient	0.995
	P	<0.001
	N	20

DISCUSSION

Female body image depends to a remarkable extent on the breasts. Breast symmetry is characterized by equivalence in size, shape, and the relative position of different

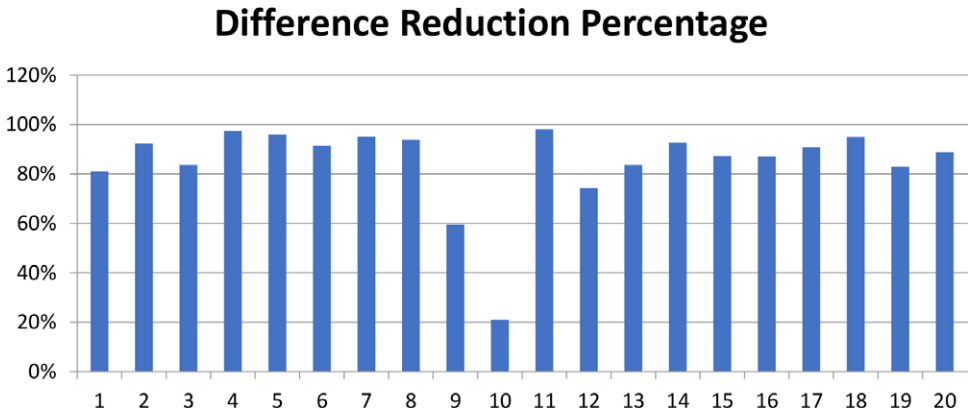

Fig. 7. Difference reduction percentage of breast asymmetry to breast volume.

Fig. 8. Postoperative frontal view. The patient was managed by right breast augmentation, 265 cm^3, and left circumvertical augmentation mastopexy, 325 cm^3. Postoperative result, 471 cm^3 and 474 cm^3 in the right and left breasts, respectively (difference, 3 cm^3), with an overall all reduction improvement of 98%.

parts of the breasts.[8] Currently, breast symmetry is deemed a cardinal feature of female beauty and is a major focus of attention for many people. Although minor variations were previously accepted, contemporary culture, new body images, and modern ideals of beauty have led people to believe that even minor asymmetries are aberrant. This causes a troublesome cosmetic problem negatively influencing women's quality of life.[4,9] Breast asymmetry management depends on several factors such as good training, experience, and artistic and surgical skills. It has long been viewed as more of an art than a science to achieve symmetrical breasts with an aesthetically acceptable shape.[10] Breast shape is principally reliant on the correlation between tissue volume, glandular configuration, and surface area of the skin envelope.[5] Numerous methods for evaluating breast volume subjectively and quantitatively have been proposed. These include linear anthropometric measurements, casts, the Grossman-Roudner measuring device, or more complex methods such as breast in situ water displacement, or more recently, radiological procedures such as ultrasound, mammograms, computed tomography, and MRI volume measurement. They remain subjective, cumbersome, or cost-prohibitive. Therefore, a simple, fast, and highly reliable assessment tool is needed for breast evaluation. The 3D camera provides this and can improve management planning for breast asymmetry.[7]

Several researchers have attempted to find the optimum method for objective breast volume assessment. Kovacs et al., in 2006, used 3D imaging of the breast region with laser scanners in five women. They observed that imaging of voluminous, and in particular, ptotic breasts with scanners could be difficult, as the submammary region is very difficult to image, which makes the limitations of the method clear.[11]

Many studies were done in objective breast volume analysis using the MRI and the 3D camera as Donfrancesco, Hoeffelin, Xi and Kim stated that the MRI and the 3D camera are the most preferred and reliable in breast volume assessment, but none of these studies used the volume assessment in managing the breast asymmetry either in the preoperative planning or in assessment of the postoperative outcome.[5,7,12–17]

Various studies have been done in classifying and managing breast asymmetry. These included Vandenbussche, in 1984 (on 150 patients), Morello et al in 2003, Reilley in 2006, Cruz et al in 2018 (on 304 patients), and De vita et al in 2019 (on 343 patients). None of these studies used objective volume measurements for assessment or surgical management.[4,10,18–20]

This study was done from November 2017 to September 2021 on 20 female patients aged 18 to 45 years, seeking breast asymmetry correction at Kasr el-Ainy Hospital. All patients had volumetric breast assessment using a 3D imaging system (3D LifeViz, Quantificare system) preoperatively and postoperatively. We used MRI volumetry, the most accurate and sensitive method of breast volume measurement, to confirm the 3D system preoperative results.[7,12,17,21] (Figs. 9–19).

The volumetry readings of the MRI and the 3D camera preoperatively showed no statistically significant differences. This confirmed that even if there were differences between the MRI and 3D camera readings, these did not affect overall volume difference calculations. The 3D camera is a reliable and more feasible tool in preoperative assessment and decision-making in the management of

Fig. 9. A 28-year-old patient with breast asymmetry. Oblique view. Right breast volume, 205 cm^3, and left breast volume, 144 cm^3 (difference, 61 cm^3).

Fig 10. A 28-year-old patient with breast asymmetry. Preoperative frontal view. Right breast volume, 205 cm^3, and left breast volume, 144 cm^3 (difference, 61 cm^3).

Fig. 11. Oblique view. The patient was managed by right breast augmentation, 265 cm^3, and left circumvertical augmentation mastopexy, 325 cm^3. Postoperative result, 471 cm^3 and 474 cm^3 in the right and left breasts, respectively (difference, 3 cm^3).

Fig. 12. A 36-year-old patient with breast asymmetry. Preoperative frontal. Right breast volume, 331 cm^3, and left breast volume, 143 cm^3 (difference, 188 cm^3).

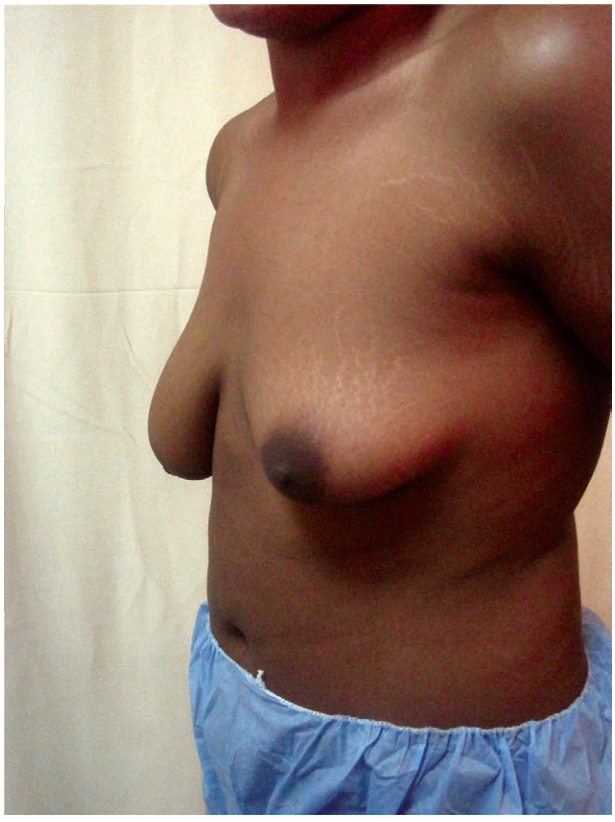

Fig. 13. A 36-year-old patient with breast asymmetry. Oblique view. Right breast volume, 331 cm^3, and left breast volume, 143 cm^3 (difference, 188 cm^3).

breast asymmetry. The method showed advantages financially and in patient convenience.

Multiple surgical techniques were used to correct breast asymmetries of the patients in the study. The decisions were made according to the volume difference measured by the 3D system and MRI. Breast augmentation was done in one breast in two cases and

Fig. 14. Postoperative frontal view. The patient was managed by right breast circumvertical mastopexy and left breast augmentation 300 cm^3. Postoperative result, 425 cm^3 and 441 cm^3 in the right and left breasts, respectively (difference, 16 cm^3).

Fig. 15. Oblique view. The patient was managed by right breast circumvertical mastopexy and left breast augmentation 300 cm^3. Postoperative result, 425 cm^3 and 441 cm^3 in the right and left breasts, respectively (difference, 16 cm^3).

both breasts with different size implants in two cases. Mastopexy was done in one breast in four cases and in both breasts in one case. Augmentation mastopexy was done in one breast in two cases and both breasts in two cases. Reduction mammoplasty was done in one breast in two cases and both breasts in two cases. Fat injection was done in one breast in two cases and both breasts in one case.

Breast volume assessment using the 3D camera was done in all patients for both breasts preoperatively and postoperatively. The overall improvement in mean difference percentage between the preoperative and postoperative results was 84.57%, with a minimum of 21% and a maximum of 98%.

Fig. 16. A 41-year-old patient with breast asymmetry due to a history of left-sided breast mass excision. Preoperative frontal view. Right breast volume, 440 cm^3, and left breast volume, 263 cm^3 (difference, 177 cm^3).

Fig. 17. A 41-year-old patient with breast asymmetry due to a history of left-sided breast mass excision. Oblique view. Right breast volume, 440 cm^3, and left breast volume, 263 cm^3 (difference, 177 cm^3).

Fig. 18. Postoperative frontal view. The patient was managed by right-wise pattern mastopexy and left circumvetical mastopexy with fat injection 100 cm^3. Postoperative result, 388 cm^3 and 359 cm^3, in the right and left breasts, respectively (difference, 30 cm^3).

The results show that good preoperative objective assessment of the volume differences enabled successful correction of the study patients' breast asymmetries with a very satisfying outcome of 84.57%. Further, this was achieved with a single-stage procedure, which has often proved

Fig. 19. Oblique view. The patient was managed by right-wise pattern mastopexy and left circumvertical mastopexy with fat injection 100 cm^3. Postoperative result, 388 cm^3 and 359 cm^3, in the right and left breasts, respecively (difference, 30 cm^3).

difficult, with many surgeons preferring to manage breast asymmetry in multiple stages to optimize their results.

A cross-sectional survey with rating-scale questions was given to all patients in the study 6 months after the procedure. Out of a maximum of 10, the mean patient satisfaction and convenience during the 3D camera measurement procedure was 8.8. For feasibility, it was 8, and for patient satisfaction with the postoperative result, it was 7.9. Therefore, the use of the 3D camera in breast asymmetry assessment improved the objective reduction of the mean volume difference and had excellent patient satisfaction in terms of patient convenience during the procedure and overall outcome of the surgery.

CONCLUSIONS

Because of its variety of applications in clinical practice, this technology appears to be promising. It eliminates the subjectivity of surgery, allowing for even more acceptable and defined outcomes and increasing patient satisfaction. The 3D imaging provides a realistic and comprehensive measurement method for the breast, including volume, shape, and surface area measurements, to enhance the quality of procedures and outcomes.

The use of a 3D camera device is recommended not only for treating breast asymmetry, but also as a standardized assessment tool in all cosmetic breast procedures.

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DISCLOSURE

The authors have no financial interest to declare.

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Ethical approval for this study was obtained from the Plastic Surgery Department of Cairo University.

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