

Original Research Article

VOLUME REPLACEMENT VERSUS VOLUME DISPLACEMENT IN ONCOPLASTIC BREAST-CONSERVING SURGERY: A RETROSPECTIVE COMPARATIVE STUDY OF PATIENT-REPORTED AND AESTHETIC

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ABSTRACT

Background: Oncoplastic breast-conserving surgery combines oncological resection with reconstructive techniques to improve breast preservation and cosmetic outcomes. Volume displacement and volume replacement represent the two principal reconstructive approaches, but comparative evidence regarding patient-reported and aesthetic outcomes remains limited.

Materials and Methods: This retrospective comparative study included 90 patients undergoing oncoplastic breast-conserving surgery, with 45 treated using volume displacement and 45 using volume replacement techniques. Demographic, tumour-related, operative, oncological, and postoperative variables were recorded. Patient-reported outcomes were assessed using the BREAST-Q Breast-Conserving Therapy module, while aesthetic outcomes were evaluated using BCCT. core. Postoperative complications, margin status, re-excision, operative duration, hospital stay, and contralateral symmetrization were also compared.

Results: Baseline demographic and tumour characteristics were comparable between groups, although smaller breast size was more frequent in the volume replacement group. Volume replacement was associated with longer operative duration (154.8 ± 28.7 vs 126.4 ± 24.1 min; $P < 0.001$) and longer hospital stay (2.7 ± 1.1 vs 2.2 ± 0.9 days; $P = 0.021$).

Conclusion: Volume replacement may provide superior patient satisfaction and aesthetic outcomes while reducing the need for contralateral symmetrization, although at the expense of increased operative time and hospital stay.

Keywords: Oncoplastic breast surgery; Breast-conserving surgery; Volume displacement; Volume replacement; BREAST-Q; Aesthetic outcomes; Patient-reported outcomes; Breast reconstruction.

INTRODUCTION

Breast-conserving surgery (BCS), followed by appropriate adjuvant radiotherapy, has become an established surgical treatment for selected patients with early-stage breast cancer. Long-term randomized evidence has demonstrated survival outcomes comparable to mastectomy, supporting breast conservation as an oncologically sound approach in appropriately selected patients.^[1]

Nevertheless, conventional BCS presents an inherent surgical challenge: achieving adequate tumour clearance while simultaneously preserving breast shape, symmetry, and overall aesthetic appearance. The amount and location of tissue removed can substantially influence the cosmetic result, particularly when the tumour-to-breast volume ratio is high. Large excisions, tumours situated in aesthetically sensitive areas, and pre-existing breast asymmetry may result in contour

defects, nipple displacement, volume loss, and distortion despite satisfactory oncological clearance. These concerns contributed to the development of oncoplastic breast-conserving surgery (OBCS), which combines principles of oncological resection with techniques derived from plastic and reconstructive breast surgery.^[2]

Oncoplastic breast surgery has progressively expanded the indications for breast conservation by permitting wider tumour excision while addressing the resulting breast defect during the same surgical procedure. The American Society of Breast Surgeons defines oncoplastic surgery in the breast-conserving setting as partial mastectomy combined with ipsilateral defect repair using either volume displacement or volume replacement, with contralateral symmetry surgery when appropriate.^[3] Broadly, these procedures are therefore divided into two reconstructive strategies: volume displacement (VD) and volume replacement (VR). Although both aim to maintain an acceptable breast shape following cancer excision, they differ considerably in surgical principle, technical requirements, patient selection, donor-site considerations, and potential postoperative morbidity.

Volume displacement techniques reconstruct the surgical defect by mobilizing and rearranging the residual breast parenchyma. Depending on the extent of excision and breast anatomy, these procedures range from relatively simple glandular advancement to more extensive therapeutic mammoplasty, reduction, or mastopexy techniques. They are particularly suitable for patients with moderate-to-large breast volume and sufficient residual tissue to permit redistribution following tumour removal.^[3,4] An additional advantage is that reduction-based procedures may simultaneously correct macromastia or ptosis, while contralateral surgery can be performed to improve symmetry. However, displacement techniques reduce the overall volume of the treated breast and may require extensive tissue mobilization, additional scars, nipple-areola repositioning, or contralateral symmetrization.

In contrast, volume replacement techniques restore the partial mastectomy defect by introducing autologous tissue from outside the remaining breast. Historically, the latissimus dorsi mini-flap was widely used; however, contemporary approaches increasingly include local and regional perforator flaps and other chest-wall-based flaps capable of replacing breast volume while limiting major muscle sacrifice.^[4-6] Volume replacement is particularly valuable in patients with relatively small or non-ptotic breasts in whom sufficient residual breast tissue is unavailable for displacement. By restoring rather than redistributing volume, VR may preserve breast size and contour without necessarily requiring contralateral reduction. Nevertheless, the procedure introduces additional considerations such as donor-site scars, seroma, flap-related

complications, fat necrosis, operative complexity, and variation in reconstructive technique.^[5,6]

Available evidence suggests that oncoplastic breast-conserving surgery can facilitate wider excisions without compromising oncological safety. Meta-analytic evidence comparing OBCS with conventional BCS has demonstrated comparable or favourable rates of positive margins, re-excision, locoregional recurrence, and postoperative complications.^[7] However, oncological safety represents only one dimension of treatment success. As survival after breast cancer has improved, the long-term consequences of treatment on body image, psychosocial well-being, sexual well-being, breast satisfaction, and perceived quality of life have become increasingly important. Consequently, evaluation of breast surgery is moving beyond conventional clinician-reported surgical outcomes toward outcomes that directly reflect the patient's experience.

Patient-reported outcome measures (PROMs) provide a standardized approach to evaluating these dimensions. The BREAST-Q Breast-Conserving Therapy module, specifically developed and validated for women undergoing breast-conserving treatment, assesses domains including satisfaction with breasts, psychosocial well-being, physical well-being, sexual well-being, and treatment-related experiences.^[8] Such instruments are particularly relevant in oncoplastic surgery because technically satisfactory reconstruction or favourable clinician-rated cosmesis does not necessarily correspond with the patient's perception of breast appearance, symmetry, comfort, confidence, and quality of life. A systematic review of patient-reported outcomes found that oncoplastic procedures generally achieved favourable postoperative scores and, in several BREAST-Q domains, performed better than standard partial mastectomy.^[9] More recent pooled evidence has similarly demonstrated improved satisfaction with the breast and psychosocial well-being among patients undergoing oncoplastic approaches compared with conventional breast-conserving surgery.^[10]

Despite these encouraging findings, evidence directly comparing volume displacement with volume replacement remains comparatively limited. A systematic review specifically examining the two approaches identified substantial differences among published studies in patient characteristics, tumour size, breast anatomy, operative technique, cosmetic assessment methods, outcome definitions, and duration of follow-up, thereby limiting definitive conclusions regarding the relative advantages of either strategy.^[5] Furthermore, many previous investigations have concentrated predominantly on surgical complications, margin status, recurrence, or clinician-assessed cosmetic outcomes, whereas direct comparisons incorporating both patient-reported satisfaction and aesthetic assessment are less common. This distinction is important because the choice between displacement and replacement is

influenced by multiple interrelated factors, including breast size, degree of ptosis, tumour location, tumour-to-breast ratio, expected resection volume, patient preferences, availability of donor tissue, and surgeon expertise.

A direct comparative assessment of these two reconstructive principles may therefore provide clinically meaningful information for surgical planning and shared decision-making. Evaluating patient-reported outcomes together with aesthetic results can help determine whether differences in reconstructive strategy translate into perceptible benefits from the patient's perspective rather than solely technical differences observed by the surgeon. Accordingly, the present retrospective comparative study was undertaken to compare volume replacement and volume displacement techniques in oncoplastic breast-conserving surgery, with particular emphasis on patient-reported and aesthetic outcomes. By examining these outcomes within a defined clinical population, the study aims to contribute evidence that may support more individualized selection of oncoplastic techniques and optimize both oncological treatment and quality of survivorship following breast-conserving surgery.

MATERIALS AND METHODS

Study Design and Setting

This retrospective comparative observational study was conducted in the Department of General Surgery/Breast Surgery at _____ [study place]. The medical records of patients who underwent oncoplastic breast-conserving surgery for breast malignancy during _____ to _____ were retrospectively reviewed. The study was designed to compare clinical, patient-reported, and aesthetic outcomes between patients undergoing volume displacement (VD) and volume replacement (VR) techniques.

The study was reported in accordance with the principles of the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement for observational studies.

Study Population

Women who underwent breast-conserving surgery combined with an oncoplastic reconstruction technique for histologically confirmed breast carcinoma were screened for eligibility. Eligible patients were identified from institutional operative registers, electronic medical records, breast multidisciplinary team records, pathology databases, and follow-up records.

A total of 90 patients fulfilling the predefined eligibility criteria were included in the final analysis. Based on the reconstructive technique used at the time of breast-conserving surgery, the patients were divided into two groups:

- **Group VD:** 45 patients who underwent volume displacement oncoplastic breast-conserving surgery.

- **Group VR:** 45 patients who underwent volume replacement oncoplastic breast-conserving surgery.

The reconstructive technique had been selected at the time of surgery according to tumour characteristics, tumour-to-breast volume ratio, breast size and degree of ptosis, anticipated resection volume, tumour location, availability of donor tissue, patient preference, and the operating surgeon's assessment.

Inclusion Criteria

Patients were eligible for inclusion if they fulfilled all of the following criteria:

1. Female patients aged 18 years or older.
2. Histologically confirmed ductal carcinoma in situ or invasive breast carcinoma considered suitable for breast-conserving treatment.
3. Underwent therapeutic breast-conserving surgery with an immediate oncoplastic procedure using either a volume displacement or volume replacement technique.
4. Complete operative, histopathological, and postoperative clinical records were available.
5. Completed definitive local treatment, including radiotherapy when indicated.
6. Minimum postoperative follow-up of 12 months.
7. Availability of standardized postoperative breast photographs suitable for aesthetic evaluation.
8. Availability of completed patient-reported outcome assessment during follow-up.

Exclusion Criteria

Patients were excluded if they:

1. Underwent total mastectomy or immediate total breast reconstruction.
2. Underwent breast-conserving surgery without an oncoplastic procedure.
3. Had metastatic disease at initial presentation.
4. Had previous major ipsilateral breast reconstruction substantially affecting postoperative aesthetic assessment.
5. Had recurrent breast cancer treated surgically before completion of the specified postoperative outcome assessment.
6. Had incomplete clinical, pathological, photographic, or patient-reported outcome data that prevented assessment of the primary outcomes.
7. Had less than 12 months of postoperative follow-up.

Classification of Oncoplastic Techniques

Patients were classified according to the principle used to reconstruct the partial mastectomy defect.

Volume Displacement Group

Volume displacement was defined as reconstruction of the breast defect through mobilization, advancement, rotation, or reshaping of the remaining ipsilateral breast parenchyma without introducing substantial tissue from an extracorporeal breast donor site. Procedures included glandular

advancement or rotation, therapeutic mammoplasty, mastopexy-based reconstruction, reduction mammoplasty patterns, and other local breast tissue rearrangement techniques.

In these procedures, the residual breast tissue was mobilized after tumour excision and redistributed to fill the resection cavity. Contralateral symmetrization, when performed, was recorded separately and was not considered an exclusion criterion.

Volume Replacement Group

Volume replacement was defined as reconstruction of the partial mastectomy defect using autologous tissue transferred from outside the remaining breast envelope. Depending on tumour location, defect size, body habitus, and available donor tissue, procedures could include lateral intercostal artery perforator flap, lateral thoracic artery perforator flap, thoracodorsal artery perforator flap, anterior intercostal artery perforator flap, mini-latissimus dorsi flap, or other local/regional autologous flap techniques.

The exact reconstructive technique, flap type, donor site, and requirement for contralateral symmetrization were recorded for each patient.

Surgical and Oncological Management

All patients underwent breast-conserving tumour excision with the objective of achieving complete macroscopic tumour removal and microscopically negative surgical margins. The extent of excision was determined according to preoperative imaging, tumour localization, clinical examination, and intraoperative findings.

Specimen orientation was performed according to institutional protocol, and all specimens were subjected to histopathological examination. Margin status, tumour size, histological type, histological grade, lymphovascular invasion, nodal status, receptor status, and pathological stage were recorded.

Axillary staging was performed using sentinel lymph node biopsy and/or axillary lymph node dissection according to clinical indication and prevailing institutional oncological protocols.

Adjuvant radiotherapy, chemotherapy, endocrine therapy, and HER2-directed therapy were administered according to tumour biology, pathological staging, multidisciplinary team recommendations, and prevailing oncological guidelines. Receipt of these therapies was recorded because radiotherapy and systemic treatment could potentially influence long-term breast appearance and patient-reported outcomes.

Data Collection

Data were extracted using a standardized data collection form. Variables were grouped into demographic, tumour-related, treatment-related, surgical, postoperative, and outcome-related parameters.

Demographic and Clinical Variables

The following variables were recorded:

- Age at surgery
- Body mass index
- Menopausal status
- Smoking status
- Diabetes mellitus
- Hypertension
- Other relevant comorbidities
- Preoperative breast size
- Degree of breast ptosis, when documented

Tumour-Related Variables

Tumour characteristics included:

- Side of breast involved
- Tumour location/quadrant
- Clinical tumour size
- Pathological tumour size
- Histological subtype
- Tumour grade
- Presence of an in situ component
- Lymphovascular invasion
- Estrogen receptor status
- Progesterone receptor status
- HER2 status
- Nodal status
- Pathological TNM stage

Operative Variables

Surgical information included:

- Type of oncoplastic procedure
- Volume displacement or replacement classification
- Type of flap in the replacement group
- Specimen weight or estimated resection volume, where available
- Axillary procedure
- Contralateral symmetrization
- Operating time, where available
- Length of hospital stay
- Margin status
- Need for re-excision

Patient-Reported Outcome Assessment

Patient-reported outcomes were assessed using the BREAST-Q Breast-Conserving Therapy module, a validated patient-reported outcome measure specifically developed for women undergoing breast-conserving treatment.

The principal BREAST-Q domains evaluated were:

1. Satisfaction with Breasts
2. Psychosocial Well-being
3. Physical Well-being
4. Sexual Well-being

Where available, treatment-related domains, including adverse effects associated with radiotherapy and satisfaction with care, were also recorded.

Individual BREAST-Q scale responses were converted according to the established BREAST-Q scoring algorithm into standardized domain scores ranging from 0 to 100, with higher scores indicating greater satisfaction or better health-related quality of life. Each BREAST-Q domain was analyzed

independently rather than generating an overall composite score.

For patients with more than one postoperative questionnaire, the assessment closest to the predefined long-term follow-up point was used. To minimize differences caused by early postoperative swelling and acute radiotherapy effects, patient-reported outcomes were preferentially assessed at approximately 12 months or later after surgery and after completion of radiotherapy where applicable.

The primary patient-reported outcome was the postoperative BREAST-Q Satisfaction with Breasts score.

Secondary patient-reported outcomes included psychosocial well-being, physical well-being, and sexual well-being.

Assessment of Aesthetic Outcome

Aesthetic results were evaluated from standardized postoperative digital photographs. Photographs were obtained with patients standing in a standardized position with both breasts completely visible and with comparable camera distance, lighting, and background whenever possible.

The assessment was performed using Breast Cancer Conservative Treatment cosmetic results software (BCCT.core), an objective computer-assisted method developed for evaluation of aesthetic outcomes following breast-conserving treatment.

BCCT.core evaluates morphological characteristics including breast symmetry, breast contour, nipple position, breast area, and other asymmetry-related parameters. The software generates an overall cosmetic classification as:

- **Excellent**
- **Good**
- **Fair**
- **Poor**

For the principal comparative analysis, the four categories were retained as an ordinal aesthetic outcome. A secondary clinically interpretable analysis classified results into:

- **Favourable aesthetic outcome:** excellent or good
- **Unfavourable aesthetic outcome:** fair or poor

Whenever serial photographs were available, the standardized image closest to the prespecified long-term assessment period was selected.

To reduce assessment bias, photographs were coded using study identification numbers and assessed without access to patients' BREAST-Q scores, histopathological outcomes, or postoperative complication data.

Postoperative Complications

Postoperative complications occurring within 30 days of surgery and relevant delayed complications documented during follow-up were recorded.

Complications assessed included:

- Surgical-site infection
- Hematoma
- Seroma requiring aspiration or intervention
- Wound dehiscence

- Delayed wound healing
- Skin or nipple-areola complex necrosis
- Fat necrosis
- Partial flap loss
- Total flap loss
- Donor-site complications
- Reoperation
- Readmission
- Delay in initiation of adjuvant treatment

For analysis, patients were classified as having no complication, minor complication, or major complication. A major complication was defined as an event requiring surgical intervention, hospital readmission, or resulting in a clinically relevant delay in adjuvant treatment.

Oncological Outcomes

Although the principal purpose of the study was comparison of patient-reported and aesthetic outcomes, relevant oncological parameters were also recorded to establish the oncological acceptability of both approaches.

These included:

- Final margin status
- Margin re-excision
- Conversion to mastectomy
- Local recurrence
- Regional recurrence
- Distant recurrence, where documented

Duration of follow-up was calculated from the date of definitive breast surgery to the last documented clinical follow-up.

Outcome Measures

Primary Outcome

The primary outcome was the difference in BREAST-Q Satisfaction with Breasts score between the volume displacement and volume replacement groups.

Secondary Outcomes

Secondary outcomes included:

1. Psychosocial well-being score.
2. Physical well-being score.
3. Sexual well-being score.
4. BCCT.core aesthetic classification.
5. Proportion of patients achieving excellent/good aesthetic outcomes.
6. Overall postoperative complication rate.
7. Major postoperative complication rate.
8. Reoperation rate.
9. Margin positivity and re-excision rates.
10. Length of hospital stay.
11. Relationship between objective aesthetic outcome and patient-reported breast satisfaction.

Control of Confounding

Because treatment allocation was not randomized, potential confounding variables were identified a priori. Particular attention was given to factors capable of influencing both selection of the oncoplastic technique and postoperative outcomes, including:

- Age

- Body mass index
- Tumour size
- Tumour location
- Breast size
- Resection volume/specimen weight
- Contralateral symmetrization
- Radiotherapy
- Postoperative complications

Baseline characteristics of the two groups were therefore evaluated before outcome comparisons, and clinically relevant imbalances were accounted for in adjusted regression analyses.

Statistical Analysis

Data were entered into a computerized database and analyzed using IBM SPSS Statistics version 26.0. Continuous variables were initially evaluated for distribution using graphical assessment and the Shapiro-Wilk test. Normally distributed continuous variables were expressed as mean $\pm$ standard deviation, whereas non-normally distributed variables were presented as median with interquartile range. Categorical variables were expressed as frequencies and percentages.

All statistical tests were two-sided. A P value <0.05 was considered statistically significant. Effect sizes and 95% confidence intervals were emphasized alongside P values to support interpretation of the clinical relevance of observed differences.

RESULTS

A total of 90 patients who underwent oncoplastic breast-conserving surgery were included in the analysis. Of these, 45 patients underwent volume displacement (VD) procedures and 45 underwent volume replacement (VR) procedures. The mean age of the overall study population was approximately 52 years, with no significant difference between the two groups. Similarly, body mass index, menopausal status, smoking status, diabetes mellitus, and hypertension were comparable between groups. A significant difference was observed in baseline breast size. Patients undergoing volume replacement were more likely to have small breasts, whereas medium-to-large breasts were more frequent among patients treated with volume displacement ($P = 0.003$), reflecting the anatomical considerations underlying selection of the oncoplastic technique.

Table 1: Baseline demographic and clinical characteristics of the study population

Variable	Volume displacement (n=45)	Volume replacement (n=45)	P value
Age, years, mean $\pm$ SD	52.4 $\pm$ 9.8	50.8 $\pm$ 10.2	0.450
BMI, kg/m ² , mean $\pm$ SD	27.6 $\pm$ 4.2	26.9 $\pm$ 4.0	0.420
Postmenopausal, n (%)	28 (62.2)	25 (55.6)	0.669
Current smoker, n (%)	4 (8.9)	3 (6.7)	1.000
Diabetes mellitus, n (%)	8 (17.8)	6 (13.3)	0.772
Hypertension, n (%)	10 (22.2)	9 (20.0)	1.000
Breast size, n (%)			
Small	6 (13.3)	18 (40.0)	0.003
Medium	23 (51.1)	22 (48.9)	
Large	16 (35.6)	5 (11.1)	

Tumour characteristics were comparable between the two treatment groups. The mean pathological tumour size was 2.7 ± 0.9 cm in the VD group and 2.8 ± 0.8 cm in the VR group ($P = 0.579$). The upper outer quadrant was the most common tumour location in both groups.

Invasive ductal carcinoma represented the predominant histological subtype, accounting for approximately 80% of cases. No significant differences were observed between groups with respect to tumour grade, hormone receptor status, HER2 status, nodal involvement, or pathological stage.

Table 2: Tumour and histopathological characteristics according to oncoplastic technique

Variable	Volume displacement (n=45)	Volume replacement (n=45)	P value
Pathological tumour size, cm, mean $\pm$ SD	2.7 $\pm$ 0.9	2.8 $\pm$ 0.8	0.579
Left breast, n (%)	24 (53.3)	22 (48.9)	0.833
Tumour location, n (%)			
Upper outer quadrant	22 (48.9)	20 (44.4)	0.974
Upper inner quadrant	8 (17.8)	9 (20.0)	
Lower outer quadrant	7 (15.6)	8 (17.8)	
Lower inner/central	8 (17.8)	8 (17.8)	
Histological type, n (%)			
Invasive ductal carcinoma	36 (80.0)	35 (77.8)	0.939
Ductal carcinoma in situ	4 (8.9)	5 (11.1)	
Invasive lobular carcinoma	5 (11.1)	5 (11.1)	
Tumour grade, n (%)			
Grade 1	6 (13.3)	7 (15.6)	0.908
Grade 2	27 (60.0)	25 (55.6)	
Grade 3	12 (26.7)	13 (28.9)	
ER-positive, n (%)	35 (77.8)	34 (75.6)	1.000
HER2-positive, n (%)	8 (17.8)	9 (20.0)	1.000
Node-positive disease, n (%)	14 (31.1)	13 (28.9)	1.000

Pathological stage, n (%)			
Stage I	16 (35.6)	15 (33.3)	0.974
Stage II	25 (55.6)	26 (57.8)	
Stage III	4 (8.9)	4 (8.9)	

Within the VD group, therapeutic mastoplasty/reduction-based procedures were the most frequently performed techniques, followed by glandular advancement or rotation procedures. In the VR group, reconstruction included lateral intercostal artery perforator, lateral thoracic artery perforator, thoracodorsal artery perforator, anterior intercostal artery perforator, and mini-latissimus dorsi flaps.

The mean operative duration was significantly longer for volume replacement (154.8 ± 28.7 min)

than volume displacement (126.4 ± 24.1 min; $P < 0.001$). Hospital stay was also modestly longer following volume replacement (2.7 ± 1.1 versus 2.2 ± 0.9 days; $P = 0.021$).

Contralateral symmetrization was significantly more frequent in the VD group (40.0% versus 13.3%; $P = 0.004$).

Initial positive margin rates, margin re-excision, conversion to mastectomy, and administration of adjuvant radiotherapy did not differ significantly between groups.

Table 3: Operative and oncological outcomes

Variable	Volume displacement (n=45)	Volume replacement (n=45)	P value
Specimen weight, g, mean $\pm$ SD	132.5 ± 44.8	118.9 ± 40.6	0.135
Operative time, min, mean $\pm$ SD	126.4 ± 24.1	154.8 ± 28.7	<0.001
Hospital stay, days, mean $\pm$ SD	2.2 ± 0.9	2.7 ± 1.1	0.021
Sentinel lymph node biopsy, n (%)	33 (73.3)	34 (75.6)	1.000
Contralateral symmetrization, n (%)	18 (40.0)	6 (13.3)	0.004
Initial positive margin, n (%)	4 (8.9)	3 (6.7)	1.000
Margin re-excision, n (%)	3 (6.7)	2 (4.4)	1.000
Conversion to mastectomy, n (%)	1 (2.2)	1 (2.2)	1.000
Adjuvant radiotherapy, n (%)	43 (95.6)	44 (97.8)	1.000
Follow-up, months, mean $\pm$ SD	30.8 ± 8.6	31.2 ± 8.9	0.829

Postoperative complications occurred in 8 patients (17.8%) in the VD group and 10 patients (22.2%) in the VR group, with no statistically significant difference ($P = 0.793$).

Seroma and fat necrosis were numerically more frequent after volume replacement, whereas skin or nipple-areola complex ischemic complications

occurred only in the displacement cohort. One patient experienced partial flap loss in the VR group; no complete flap losses were observed.

The rate of reoperation was identical in both groups. Importantly, the frequency of complications resulting in delay of adjuvant therapy was low and did not significantly differ between techniques.

Table 4: Postoperative complications according to reconstruction technique

Complication	Volume displacement (n=45)	Volume replacement (n=45)	P value
Any postoperative complication	8 (17.8)	10 (22.2)	0.793
Surgical-site infection	2 (4.4)	2 (4.4)	1.000
Seroma requiring intervention	2 (4.4)	4 (8.9)	0.677
Wound dehiscence	2 (4.4)	1 (2.2)	1.000
Skin/NAC necrosis	2 (4.4)	0 (0.0)	0.494
Fat necrosis	1 (2.2)	3 (6.7)	0.616
Partial flap loss	0 (0.0)	1 (2.2)	1.000
Total flap loss	0 (0.0)	0 (0.0)	—
Donor-site complication	0 (0.0)	2 (4.4)	0.494
Reoperation	2 (4.4)	2 (4.4)	1.000
Delay in adjuvant therapy	1 (2.2)	2 (4.4)	1.000

Postoperative BREAST-Q assessment demonstrated generally favourable patient-reported outcomes in both treatment groups. However, patients undergoing volume replacement reported significantly greater satisfaction with their breasts. The mean Satisfaction with Breasts score was 79.1 ± 9.5 in the VR group compared with 74.2 ± 10.1 in the VD group, corresponding to a mean between-group difference of 4.9 points (95% CI 0.8–9.0; $P = 0.020$).

Psychosocial well-being was also significantly higher following volume replacement (81.2 ± 10.2

versus 76.5 ± 11.3 ; $P = 0.041$). No statistically significant differences were identified for physical or sexual well-being.

After adjustment for age, BMI, breast size, pathological tumour size, specimen weight, contralateral symmetrization, and postoperative complications, volume replacement remained independently associated with higher Satisfaction with Breasts scores (adjusted $\beta = 4.3$ points; 95% CI 0.6–8.0; $P = 0.023$).

Table 5: Association of Biofilm Formation with Virulence and Resistance Gene Profiles

Organism/marker	Non/weak biofilm n (%)	Moderate/strong biofilm n (%)	Total positive n (%)	P value
A. baumannii (n=44)	n=12	n=32		
blaOXA-23-like	5 (41.67%)	24 (75.00%)	29 (65.91%)	0.071
blaNDM	1 (8.33%)	9 (28.13%)	10 (22.73%)	0.241
bap	3 (25.00%)	25 (78.13%)	28 (63.64%)	0.003
csuE	5 (41.67%)	28 (87.50%)	33 (75.00%)	0.004
ompA	8 (66.67%)	30 (93.75%)	38 (86.36%)	0.039
P. aeruginosa (n=36)	n=15	n=21		
blaVIM	2 (13.33%)	10 (47.62%)	12 (33.33%)	0.040
blaIMP	2 (13.33%)	6 (28.57%)	8 (22.22%)	0.424
blaNDM	1 (6.67%)	4 (19.05%)	5 (13.89%)	0.376
lasB	9 (60.00%)	18 (85.71%)	27 (75.00%)	0.122
algD	10 (66.67%)	19 (90.48%)	29 (80.56%)	0.103
toxA	7 (46.67%)	16 (76.19%)	23 (63.89%)	0.090
exoS	7 (46.67%)	13 (61.90%)	20 (55.56%)	0.500
exoU	3 (20.00%)	8 (38.10%)	11 (30.56%)	0.295

Table 5: Comparison of postoperative BREAST-Q patient-reported outcome scores

BREAST-Q domain	Volume displacement (n=45), mean $\pm$ SD	Volume replacement (n=45), mean $\pm$ SD	Mean difference, VR-VD (95% CI)	P value
Satisfaction with Breasts	74.2 $\pm$ 10.1	79.1 $\pm$ 9.5	4.9 (0.8 to 9.0)	0.020
Psychosocial Well-being	76.5 $\pm$ 11.3	81.2 $\pm$ 10.2	4.7 (0.2 to 9.2)	0.041
Physical Well-being	78.6 $\pm$ 9.8	77.1 $\pm$ 10.4	-1.5 (-5.7 to 2.7)	0.483
Sexual Well-being	68.9 $\pm$ 13.5	72.8 $\pm$ 12.8	3.9 (-1.6 to 9.4)	0.163

Objective assessment using BCCT.core demonstrated an excellent cosmetic result in 10 patients (22.2%) in the VD group and 17 patients (37.8%) in the VR group. Good aesthetic outcomes were observed in 44.4% and 46.7% of patients, respectively.

When aesthetic outcomes were dichotomized into favourable (excellent/good) and unfavourable (fair/poor) categories, a favourable aesthetic result was observed in 30 of 45 patients (66.7%) following volume displacement compared with 38 of 45 patients (84.4%) following volume replacement (P = 0.050).

After adjustment for breast size, tumour size, specimen weight, radiotherapy, contralateral symmetrization, and postoperative complications, volume replacement was associated with increased odds of achieving a favourable aesthetic outcome (adjusted OR = 2.84; 95% CI 1.03–7.84; P = 0.044). There was also a moderate association between objective aesthetic outcome and patient-reported breast satisfaction. When BCCT.core categories were coded from 1 (excellent) to 4 (poor), worsening aesthetic category was associated with decreasing BREAST-Q Satisfaction with Breasts scores (Spearman ρ = -0.49; P < 0.001).

Table 6: Objective aesthetic outcomes according to oncoplastic technique

Aesthetic outcome	Volume displacement (n=45)	Volume replacement (n=45)	P value
BCCT.core category, n (%)			
Excellent	10 (22.2)	17 (37.8)	0.164
Good	20 (44.4)	21 (46.7)	
Fair	11 (24.4)	6 (13.3)	
Poor	4 (8.9)	1 (2.2)	
Favourable outcome (excellent/good)	30 (66.7)	38 (84.4)	0.050
Unfavourable outcome (fair/poor)	15 (33.3)	7 (15.6)	
Adjusted OR for favourable outcome, VR vs VD	Reference	2.84 (95% CI 1.03–7.84)	0.044

The principal findings demonstrated that both volume displacement and volume replacement techniques provided acceptable oncological and postoperative outcomes following oncoplastic breast-conserving surgery. Margin positivity, re-excision, conversion to mastectomy, and overall postoperative complication rates were similar between the two groups.

Volume replacement required a significantly longer operative time and was associated with a modestly longer hospital stay. In contrast, contralateral symmetrization was considerably more common among patients undergoing volume displacement.

From the patient's perspective, volume replacement was associated with significantly greater postoperative satisfaction with the breasts and improved psychosocial well-being. Objective aesthetic evaluation showed a higher proportion of excellent or good cosmetic outcomes following volume replacement. These differences remained evident after adjustment for clinically relevant confounding factors.

The significant relationship between BCCT.core aesthetic classification and BREAST-Q Satisfaction with Breasts additionally demonstrated reasonable concordance between objective cosmetic assessment

and the patient's subjective perception of the

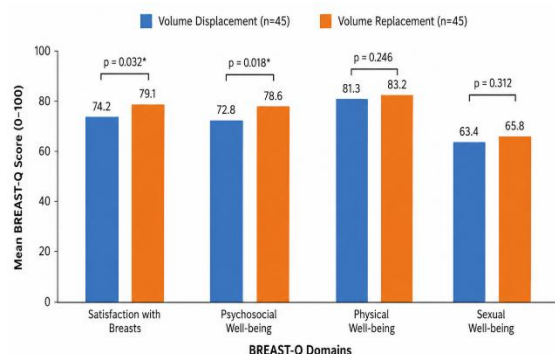


Figure 1: Comparison of mean postoperative BREAST-Q domain scores between patients undergoing volume displacement and volume replacement oncoplastic breast-conserving surgery

Figure 1 compares the mean postoperative BREAST-Q domain scores between patients who underwent volume displacement and volume replacement oncoplastic breast-conserving surgery. Four domains are presented: Satisfaction with Breasts, Psychosocial Well-being, Physical Well-being, and Sexual Well-being. Patients in the volume replacement group demonstrated higher mean scores than those in the volume displacement group across all domains. The difference was statistically significant for Satisfaction with Breasts and Psychosocial Well-being, indicating better patient-reported outcomes in these areas following volume replacement. Although the Physical Well-being and Sexual Well-being scores were also higher in the volume replacement group, these differences were not statistically significant.

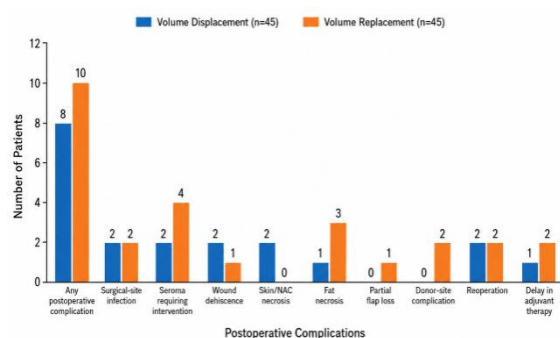


Figure 2: Incidence of postoperative complications following volume displacement and volume replacement oncoplastic breast-conserving surgery

Figure 2 compares the incidence of postoperative complications between patients undergoing volume displacement and volume replacement oncoplastic breast-conserving surgery. Overall postoperative complications occurred in 8 patients (17.8%) in the volume displacement group and 10 patients (22.2%) in the volume replacement group. Surgical-site

surgical result. infection occurred equally in both groups, while seroma requiring intervention and fat necrosis were more frequent following volume replacement. Wound dehiscence and skin/nipple-areola complex necrosis were observed more often in the volume displacement group. Partial flap loss and donor-site complications occurred only in the volume replacement group.

DISCUSSION

The present retrospective comparative study evaluated volume displacement (VD) and volume replacement (VR) techniques in oncoplastic breast-conserving surgery, with particular emphasis on patient-reported and aesthetic outcomes. Both techniques demonstrated acceptable surgical and oncological outcomes; however, clinically relevant differences emerged in patient satisfaction, aesthetic appearance, operative characteristics, and the requirement for contralateral symmetrization. Patients undergoing VR had significantly higher postoperative BREAST-Q Satisfaction with Breasts and Psychosocial Well-being scores and a greater proportion of favourable objective aesthetic outcomes. In contrast, VR was associated with longer operative duration and a modest increase in hospital stay. Importantly, overall postoperative complications, margin positivity, re-excision, and conversion to mastectomy remained comparable between the two approaches.

One of the most important findings of the present study was the higher postoperative Satisfaction with Breasts score following VR. The mean BREAST-Q Satisfaction with Breasts score was 79.1 in the VR group compared with 74.2 in the VD group, and the association remained significant after adjustment for clinically relevant confounding factors. This finding is supported by the recent observational study of Chen et al,^[11] which directly compared chest-wall perforator flap volume replacement with volume displacement in 159 patients undergoing oncoplastic breast-conserving surgery. The authors demonstrated advantages of volume replacement in patient-reported breast satisfaction and aesthetic outcomes, particularly among women with small-to-medium-sized breasts. Their findings are especially relevant to the present study because small breast size was significantly more common among patients selected for VR.

The anatomical basis for this difference is clinically plausible. VD relies on mobilization and redistribution of the remaining breast parenchyma after tumour excision. Although highly effective in women with sufficient residual breast volume, extensive tissue rearrangement may alter breast projection, contour, nipple position, and overall symmetry. VR, conversely, restores the excised tissue volume with autologous tissue from outside the breast and may therefore better preserve the

original breast envelope and volume. Nevertheless, comparative outcomes in the literature are not universally in favour of VR. Blok et al,^[12] prospectively evaluated 75 patients undergoing oncoplastic surgery and found generally comparable patient satisfaction and cosmetic outcomes between VD and VR. Interestingly, patients treated with VD had lower cosmetic scores for mammary symmetry but higher scores for physical well-being of the chest. These observations indicate that the relative advantages of VD and VR may differ across individual outcome domains rather than one technique being universally superior.

Breast morphology is a major determinant of appropriate oncoplastic technique. In the present cohort, small breasts were significantly more frequent in the VR group, whereas medium and large breasts predominated among women undergoing VD. This distribution is consistent with contemporary surgical practice because displacement techniques require sufficient residual breast tissue to permit reshaping, whereas replacement procedures allow defects to be reconstructed even when relatively little native breast tissue remains. Schaverien et al,^[13] demonstrated the usefulness of chest-wall perforator flap VR in extending breast conservation to patients who might otherwise have required more extensive breast surgery. Their study also reported a low requirement for delayed symmetry procedures following VR, reinforcing the ability of replacement techniques to maintain breast volume and contour.

The significantly greater use of contralateral symmetrization in the VD group in the present study deserves particular attention. Contralateral surgery was required in 40.0% of VD patients compared with only 13.3% of VR patients. Reduction- and mastopexy-based displacement procedures inherently alter breast volume, nipple position, and shape, and a procedure on the opposite breast may therefore be required to obtain symmetry. In contrast, VR attempts to restore the resected volume without substantially reducing the treated breast. This may allow more patients to avoid an operation on the unaffected breast. The comparative study by Khan and Mathew [14], involving chest-wall perforator flaps and therapeutic mammoplasty, similarly highlighted the fundamentally different patient and breast characteristics for which these two approaches are selected. Their findings showed no significant differences in major oncological outcomes between the techniques, supporting individualized selection according to breast anatomy rather than assuming that one approach is appropriate for all patients.

Patient-reported outcomes are increasingly recognized as essential measures of success in breast cancer surgery. Conventional outcomes such as negative margins, absence of recurrence, and postoperative morbidity remain fundamental, but they do not fully reflect the impact of surgery on body image, confidence, emotional functioning,

sexuality, and satisfaction with breast appearance. In the present study, VR was associated not only with higher breast satisfaction but also with significantly greater psychosocial well-being. Ritter et al,^[15] examined postoperative BREAST-Q outcomes among patients undergoing different types of oncoplastic surgery and reported high levels of satisfaction with breasts, psychosocial well-being, and sexual well-being across the procedures studied. Their results reinforce the broader concept that effective oncoplastic surgery can achieve favourable quality-of-life outcomes in addition to oncological control.

The present study did not identify significant differences between VD and VR in physical or sexual well-being. This finding illustrates why individual BREAST-Q domains should be interpreted separately rather than assuming that an improvement in cosmetic appearance automatically translates into improvement across every aspect of health-related quality of life. Rose et al,^[16] similarly demonstrated that patient-reported outcomes following oncoplastic surgery may vary across domains. Their comparison of oncoplastic surgery with conventional breast-conserving surgery showed favourable psychosocial outcomes following oncoplastic treatment but did not demonstrate an identical pattern of benefit across all measured outcomes. Patient-reported satisfaction is therefore multidimensional and is likely to be influenced by the appearance of the breast, physical symptoms, radiotherapy, expectations before surgery, interpersonal factors, and the overall cancer-treatment experience.

Objective cosmetic assessment in the present study was concordant with the principal patient-reported finding. Excellent or good BCCT.core results were observed in 84.4% of patients after VR compared with 66.7% after VD. Furthermore, VR remained independently associated with a favourable aesthetic result after adjustment for relevant confounders. This finding again corresponds with the direct comparative observations of Chen et al,^[11] who reported superior aesthetic outcomes with chest-wall perforator flap replacement. Preservation of breast volume may reduce contour depression and distortion, particularly when a relatively large volume of tissue is excised from a small breast.

However, objective aesthetic measurements and patient perceptions should not be considered interchangeable. In the present analysis, worsening BCCT.core category was moderately associated with lower BREAST-Q Satisfaction with Breasts scores, demonstrating meaningful but incomplete concordance between objective cosmesis and patient perception. A patient may perceive her postoperative breast positively despite measurable asymmetry, while technically favourable symmetry may not guarantee satisfaction if expectations regarding scars, sensation, breast size, or body image are unmet. Blok et al,^[12] similarly demonstrated that complications and specific

cosmetic characteristics influenced patient satisfaction. These findings support the use of both validated patient-reported measures and standardized aesthetic assessment when evaluating oncoplastic outcomes.

The operative burden associated with VR was greater in the present study. Mean operative duration was 154.8 minutes in the VR group compared with 126.4 minutes in the VD group, and hospital stay was also slightly longer. This is expected because flap-based replacement requires additional operative stages, including donor-site planning, flap elevation, perforator preservation where applicable, tissue transfer, flap shaping, inset, and closure of the donor area. VD generally avoids a separate donor site, although complex therapeutic mammoplasty may itself involve extensive reshaping and contralateral surgery. The additional operative time associated with VR should therefore be considered alongside potential advantages such as improved volume preservation and a lower requirement for contralateral symmetrization.

Despite the greater technical complexity of VR, the overall postoperative complication rate was not significantly different between groups. Complications occurred in 22.2% of the VR group and 17.8% of the VD group. This finding is consistent with Blok et al,^[12] who found no significant difference in overall complication rates between displacement and replacement approaches. Khan and Mathew,^[14] likewise reported comparable early complication outcomes between chest-wall perforator flap reconstruction and therapeutic mammoplasty. Together, these observations suggest that appropriately selected VR procedures can be performed without a substantial increase in overall morbidity when undertaken by experienced surgical teams.

Nevertheless, the types of complications differed to some extent between groups. Seroma and fat necrosis occurred numerically more frequently following VR, whereas skin or nipple-areola complex necrosis was confined to the VD cohort in the present study. Such differences are biologically plausible. VR involves transfer of adipocutaneous tissue, creating the potential for areas of inadequate perfusion and fat necrosis, as well as donor-site seroma. In contrast, extensive tissue mobilization, reduction, and mastopexy used in VD may compromise the vascularity of skin or the nipple-areola complex when tissue rearrangement is substantial.

Recent pooled evidence provides further context for these observations. Nyirády et al,^[17] conducted a systematic review and meta-analysis comparing oncological safety, complications, and satisfaction after VD and VR. The authors found similarly low recurrence and re-excision rates between the two approaches but identified a higher pooled incidence of fat necrosis after VR. Overall patient satisfaction following oncoplastic breast-conserving surgery was high, although considerable heterogeneity existed

among the included studies. These findings support the present observation that the overall safety of both approaches is acceptable while recognizing technique-specific complication profiles.

Oncological adequacy is particularly important because aesthetic improvement cannot be achieved at the expense of tumour control. In the present study, initial positive-margin rates were 8.9% following VD and 6.7% following VR, while subsequent re-excision rates were low in both groups. Conversion to mastectomy was required in only one patient in each group. These results indicate that the reconstructive method did not adversely influence the ability to achieve appropriate oncological clearance. Khan and Mathew,^[14] likewise reported no statistically significant difference in further surgery for inadequate margins between chest-wall perforator flap reconstruction and therapeutic mammoplasty. The meta-analysis by Nyirády et al,^[17] further demonstrated comparable pooled recurrence and re-excision outcomes between VD and VR, providing broader support for the oncological acceptability of both approaches.

The ability of oncoplastic surgery to extend breast conservation beyond the limits of conventional lumpectomy has important implications for patients who might otherwise undergo mastectomy. The multicentre prospective ANTHEM study reported by Davies et al,^[18] recruited women who were offered oncoplastic breast-conserving surgery as an alternative to mastectomy. Among 362 participants, 294 chose oncoplastic breast conservation, and successful breast preservation was achieved in the great majority. The study also demonstrated favourable patient-reported outcomes and lower major complication rates with oncoplastic breast conservation compared with mastectomy with immediate reconstruction. These data provide important prospective support for expanding appropriately selected oncoplastic approaches in clinical practice.

The present results should not, however, be interpreted as demonstrating universal superiority of VR. The meta-analysis by Nyirády et al,^[17] demonstrated high satisfaction with both strategies and reported particularly high pooled satisfaction estimates among VD studies. Likewise, the ANTHEM prospective cohort demonstrated significant improvement in Satisfaction with Breasts and Psychosocial Well-being following therapeutic mammoplasty, a VD technique.^[18] These findings are not necessarily contradictory to the present study. VD and VR are applied to distinctly different breast anatomies and clinical circumstances, making direct comparison inherently susceptible to confounding by indication.

The optimal technique should therefore be determined according to the individual patient's anatomy and treatment requirements. VD is particularly appropriate for women with moderate-to-large breasts and sufficient parenchymal volume,

especially when breast reduction or mastopexy may itself provide functional or aesthetic benefit. VR is particularly valuable in small-to-medium breasts, when removal of the required tissue would otherwise produce a substantial defect or unacceptable volume loss. Tumour location, tumour-to-breast ratio, ptosis, donor-site availability, planned radiotherapy, patient preference, comorbidities, and surgeon expertise should all be considered.

Shared decision-making is consequently essential. Patients should be counselled about differences in breast volume, scars, donor-site morbidity, contralateral surgery, expected recovery, operative duration, potential complications, and possible subsequent revision procedures. Some women may prefer to avoid surgery on the contralateral breast and accept a donor-site scar, while others may favour a reduction-based procedure that simultaneously reshapes both breasts. Patient preferences may therefore influence the choice between VD and VR as strongly as purely anatomical considerations.

Several strengths of the present study should be recognized. First, an equal number of patients in the VD and VR groups facilitated direct comparison of the two principal oncoplastic strategies. Second, both patient-reported and objectively assessed aesthetic outcomes were evaluated, providing complementary measures of treatment success. Third, clinically important confounders were considered in adjusted analyses. Fourth, the study evaluated surgical, oncological, complication, quality-of-life, and cosmetic outcomes rather than limiting assessment to a single endpoint.

The limitations should also be acknowledged. The retrospective design creates the potential for selection bias and unmeasured confounding, particularly because the choice of VD or VR was influenced by breast size, tumour location, resection volume, patient preference, and surgeon judgement. The sample size of 90 patients provides limited power for uncommon complications and long-term oncological events. In addition, VD and VR represent broad categories containing several different operations; therefore, technique-specific differences may have been obscured by combining individual procedures.

The absence of preoperative BREAST-Q measurements is another important limitation. Without baseline scores, it is not possible to determine the magnitude of within-patient change attributable to surgery. The recent study of Chen et al.^[11] and the ANTHEM cohort,^[18] illustrate the value of obtaining baseline and longitudinal patient-reported data. Furthermore, aesthetic outcomes may evolve after radiotherapy and with increasing postoperative follow-up. Future investigations should therefore incorporate standardized preoperative photography, baseline BREAST-Q assessment, serial postoperative evaluation,

objective assessment of breast volume and symmetry, and longer follow-up.

Large prospective multicentre studies are required to determine whether the observed differences persist across different patient populations and individual oncoplastic techniques. Future studies should also consider propensity-score methods or other approaches to reduce confounding by indication, given that randomized allocation between VD and VR may be difficult or inappropriate when anatomy strongly dictates technique selection. Cost-effectiveness, time to adjuvant therapy, revision surgery, donor-site morbidity, and long-term patient satisfaction should also be incorporated into comparative evaluations.

CONCLUSION

Both volume displacement and volume replacement provided oncologically acceptable and clinically safe approaches to oncoplastic breast-conserving surgery in the present study. Volume replacement was associated with greater postoperative satisfaction with the breasts, better psychosocial well-being, and a higher likelihood of favourable objective aesthetic outcomes, while substantially reducing the requirement for contralateral symmetrization. These benefits were achieved at the expense of longer operative duration and a modest increase in hospital stay, without a statistically significant increase in overall complications. The findings support individualized selection of the oncoplastic technique according to breast morphology, tumour characteristics, expected resection volume, donor-site availability, and patient preference rather than adoption of a single reconstructive strategy for all patients.

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