ORIGINAL ARTICLE

Pre-Operative and Post-Operative Breast Volume Measurement: Predicting Residual Breast Tissue and Cancer Recurrence: A Pilot Study

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Abstract

This cross-sectional observational study aimed to correlate preoperative breast volume with mastectomy specimen volume to predict residual breast tissue and cancer recurrence. Fifty female patients with unilateral breast carcinoma undergoing mastectomy were included. Preoperative volume was measured anthropometrically using a specific formula, while postoperative volume was assessed by water displacement (Archimedes principle). Volumes ranged from 220 cc to 820 cc, with postoperative measurements being more accurate. A significant correlation was found between the two methods ($p<0.05$). The findings suggest that accurately measuring the mastectomy specimen volume can help in determining residual breast tissue and assessing the risk of cancer recurrence.

Keywords: Breast volume, Carcinoma breast, Mastectomy, Recurrence

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Graphical Abstract

Title :Pre-Operative and Post-Operative Breast Volume Measurement: Predicting Residual Breast Tissue and Cancer Recurrence- A Pilot Study.
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Background
Preoperative breast volume assessment is vital, considering the shift towards breast conservation over mastectomy. In India, Modified Radical Mastectomy constitutes the most common procedure for carcinoma breast, with a 10% margin positivity rate. Reliable, cheap, and reproducible methods for confirming clearance are needed. This study examines correlating preoperative and postoperative breast volumes as an alternative to existing methods.

Methods
Setting: Department of Surgery, NRSMCH
Population: Newly diagnosed and existing cases of Breast cancer planned for MRM
Measures: Preoperative antropometry and post operative volume displacement
Statistics: Correlation assessed by Regression analysis and Chi square test. (p <0.01, CI 99%, p>0.10, CI 90%)
Ethical Approval: IEC No NMC/617/11.02.2021

Results: main table

Variable	Number (n)	Mean	Percentage 9%)
Age (y)			
25 - 40	17	45.80 (y)	34
41 - 55	32		64
56 - 70	1		2
Co-morbidity			
T2DM	6		12
HTN	4		8
Family history			
Present	2		4
Absent	48		96
Side			
Right	22		44
Left	28		56
Stage			
EBC	26		52
LABC	24		48
Histo-pathology			
IDC	41		82
DCIS	8		16
LC	1		2
NACT			
No	26		52
Yes	24		48
IHC			
TNBC	17		34
Others	26		52
Not done	7		14
Breast Volume			
(A)Anthropometry (Preoperative)	220 - 880 cc	380.82 cc	
(B) Archimedes' weight (Post-operative)	240 – 840 cc	395.72 cc	
Residual Volume (A-B)			
-ve	42 (-36 to -7 cc)	-25 cc	84
+ve	8 (12 – 28.6 cc)	14.9 cc	16
Positive Margin	1/42		2.38
	2/8		25

Conclusions: Preoperative anthropometric breast volume measurement is reliable, correlates with actual volume, and predicts residual tissue post-mastectomy, thus indicating recurrence risk.

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Introduction

Preoperative breast volume assessment is crucial for all breast surgeries, especially with the shift from mastectomy to breast conservation and reconstruction [1]. In India, most breast surgeries address carcinoma, with Modified Radical Mastectomy (MRM) being the most common [2]. Ensuring complete removal of breast tissue is essential to prevent local recurrence, but due to the breast's unencapsulated nature, achieving total excision can be challenging, resulting in a 10% margin positivity rate [3]. Limited access to frozen sections necessitates a reliable method for confirming adequate clearance. Comparing preoperative anthropometric measurements of the diseased breast with the postoperative specimen volume offers a dependable, cost-effective, quick, and reproducible solution. This study aims to examine the correlation between preoperative breast volume estimates using anthropometry and the actual specimen volumes in MRM patients, measured by volume displacement.

Patients and Methods

A cross-sectional observational study was conducted in the Department of General Surgery in a tertiary referral centre after approval by the Institutional Ethics Committee. Fifty female patients, aged 25 to 80 years, diagnosed with unilateral sporadic breast carcinoma (BC) and attending the surgery outpatient department between December 2020 and February 2022, were included in the study. This encompassed both newly diagnosed and existing cases, regardless of stage or neo-adjuvant treatment, all planned for MRM and willing to give consent. Bilateral, recurrent, and familial BC were excluded. Patients with pregnancy and breast cancer, male breast cancer, bilateral breast cancer, hereditary breast cancer, and patients willing to undergo breast conservation and oncoplastic reconstruction were also excluded from the

study. Data was collected on a predesigned and pretested standard case record form.

In the preoperative setting, breast volume measurement was done by the anthropometric method using the formula $(V_{pre}) = 1/3 \times \pi \times MP^2 \times (MR + LR + IR - MP)$ [5], where V_{pre} is the preoperative volume, MP is the mammillary projection, MR is the medial radius of the breast, LR is the lateral radius of the breast, and IR is the inferior radius of the breast. The measurements were taken with a Vernier calliper in a warm room with subjects in an erect position with arms placed by their sides. To increase the reproducibility of the data, all the measurements were taken by two investigators, and the average of these measurements was taken for each subject (Figure 1).
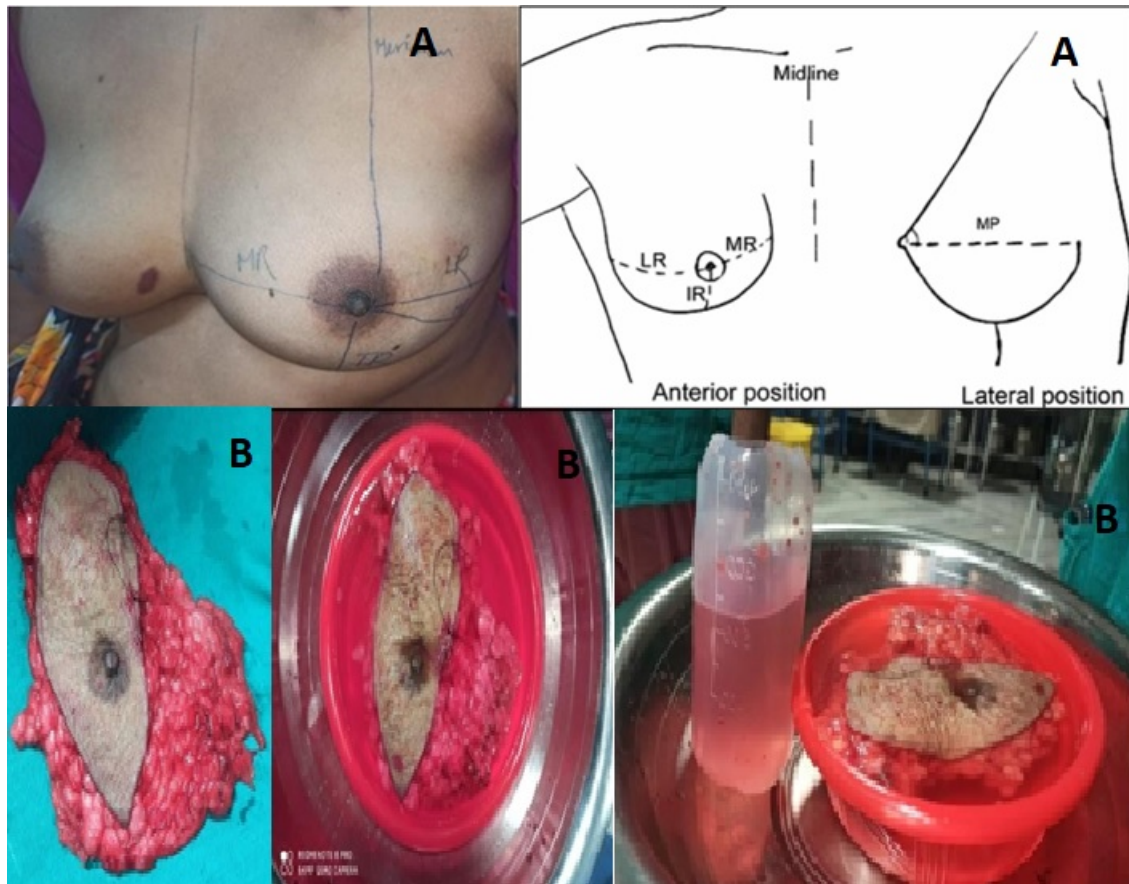

Figure 1. **A**: Anthropometric measurement of breast volume; **B**: Postoperative breast specimen volume measurement by liquid displacement

In the postoperative setting, a small vessel filled with water was placed inside a larger, empty vessel. The specimen of the mastectomy was submerged completely in the water contained in the smaller vessel. The volume of water displaced by the specimen of the mastectomy was measured, which revealed the actual postoperative volume (Vpost) of the excised breast (Figure 2).
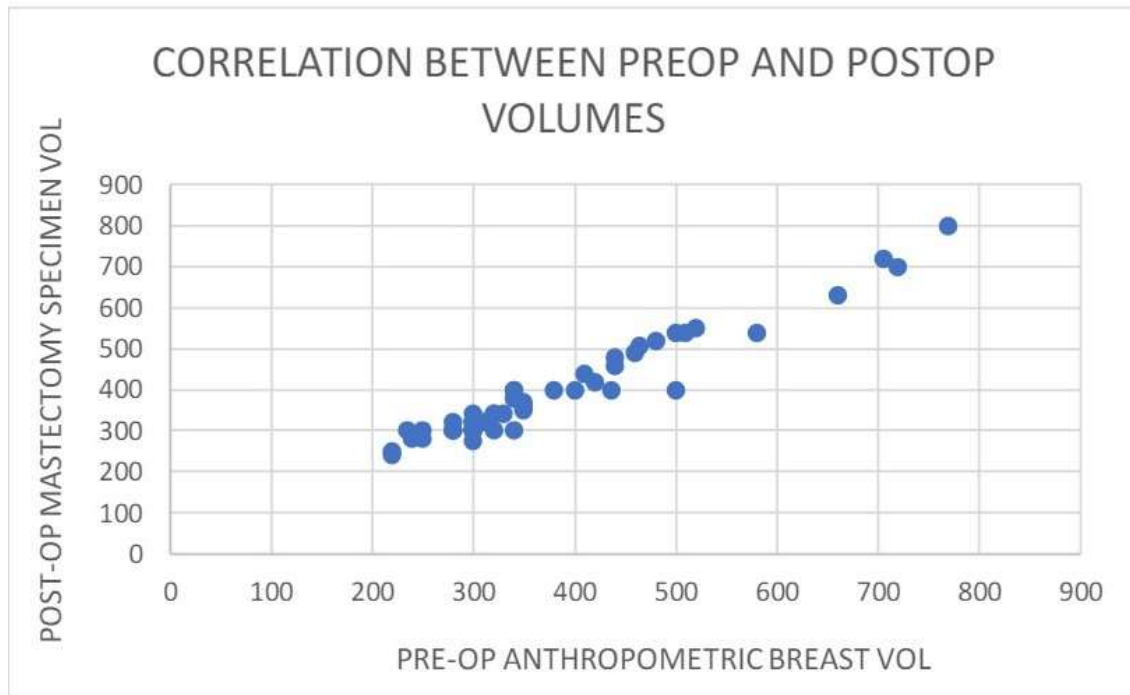
Figure 2. Correlation between preoperative and postoperative breast volumes

Residual breast tissue (V_{res}) left after mastectomy was estimated by subtracting post-operative volume from pre-operative volume (Vres = Vpre – Vpost)

The collected data was compiled using a Microsoft Excel worksheet. The preoperative and postoperative breast volumes were evaluated based on the mean and standard deviations. The correlation was studied by regression analysis. For other correlations, a chi square test was performed and a p value was calculated. For a p-value <0.01, the confidence interval was 99%, and for a p-value < 0.10 confidence interval was 90% (Table 1).

Results

Fifty female patients in the age range of 25 to 80 years with unilateral breast cancer, irrespective of stage, and planned for MRM were selected as study participants. Seventeen (34%) patients were aged 25–40 years, 32 (64%) were in the age group 41–55 years, and 2% (1 patient) were between 56–70 years, respectively. The youngest patient was 27 years old, and the oldest patient was 65 years old. Twenty six (52%) patients had early breast cancer, 24 (48%) patients had locally advanced breast cancer. Twenty four patients with locally advanced breast cancer received neoadjuvant chemotherapy (NACT) to downstage the tumour and qualify for modified radical mastectomy (MRM)

Table 1. Table showing demographic profile and variables of the patients (n=50)

Variable	Number (n)	Mean	Percentage 9%)
Age (y)			
25 - 40	17	45.80 (y)	34
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Only two (4%) patients had a positive family history of breast cancer. 41 (82%) patients were diagnosed with infiltrating ductal carcinoma (IDC), 8 (16%) had ductal carcinoma in situ (DCIS), and only 1 (2%) patient had lobular carcinoma. 10 patients had comorbidities, of which diabetes mellitus (DM) was present in 6 patients and hypertension (HTN) in 4 patients. Seven patients had triple negative breast carcinoma (TNBC).

The range of preoperative breast volumes measured anthropometrically was

220 cc to 820 cc (average 380.82 cc). The range of postoperative breast volumes was 240 cc to 840 cc (average 395.72 cc). The majority of patients (42, or 84%) had negative residual volumes in the range of –36 cc to –7 cc, indicating the specimen volume was greater than the estimated breast volume, and 8 (16%) patients had residual breast tissue (positive Vres) left after mastectomy. The mean residual breast tissue volumes were 14.9 cc, respectively.

The correlation between postoperative mastectomy specimen volume and preoperative anthropometric breast volume was significant ($p < 0.05$). The anthropometric method of breast volume measurement correlated with the water displacement method (using Archimedes' principle) in terms of accuracy ($p < 0.05$).

Two out of eight (25%) patients with positive Vres had positive margins compared to one out of 42 (2.38%) patients with negative Vres. All these patients underwent revision surgery with a negative margin on repeat histology. Chi-square test was performed to assess the correlation between residual breast volume and post-operative margin status ($p < 0.0135$). Hence, we can conclude that residual volume after mastectomy was associated with the margin status postoperatively. So, the less residual breast tissue there is after mastectomy, the higher the chances of a post-operative negative margin on histopathological examination. The patients were sent to medical oncology for further adjuvant treatment. At one year follow-up, all the patients are doing well.

Discussion

Accurate breast volume measurement is crucial for effective breast reconstruction after cancer surgery and in benign breast conditions. [4,5,6]. With the increasing trend towards breast conservation and oncoplastic reconstruction, precise volume assessment is essential. Currently, surgeons often rely on visual estimation, which is subjective, unreliable, and prone to inter-observer variability [7]. This study evaluates the accuracy, reproducibility, and practicality of correlating preoperative breast volume measured by the anthropometric method with specimen volume using the volume displacement technique, addressing the need for a clinically useful, objective breast volume assessment method [8-10].

Since Modified Radical Mastectomy (MRM) remains the most common breast surgery in India (79.1%) [2, 5] and at our institute, we compared preoperative volume with specimen volume to assess the technique's completeness and potentially predict recurrence due to incomplete removal.

Our study found that preoperative and postoperative breast volume measurements can estimate residual breast tissue after a modified radical mastectomy, though the anthropometric technique often underestimates volume in hypertrophic breasts. Additionally, the volume displacement technique proved to be cost-effective and convenient.

The chi-square test showed a significant correlation between residual breast volume and postoperative margin status ($p < 0.01$), indicating that less residual tissue after mastectomy is associated with higher chances of a negative margin and reduced local recurrence.

Volumetric breast measurement in our study had two key findings: a) Anthropometric volume estimation accurately predicted breast volume, and b) The difference between preoperative anthropometric volume and postoperative specimen volume could predict positive margins. Additionally the study offers significant benefits by enhancing surgical precision, optimizing cosmetic outcomes, and reducing healthcare costs, particularly in settings where resources are limited. By providing an alternative to resource-intensive techniques and improving the planning and execution of breast conservation surgery, it supports better patient outcomes and advances in breast cancer treatment. The major drawback of our study was the small number of patients and short follow-up.

Conclusion

Preoperative anthropometric breast volume measurement is reliable, correlates with actual volume, and predicts residual tissue post-mastectomy, thus indicating recurrence risk.

Authors Contribution

The manuscript has been read and approved by all the authors and the requirements for authorship as stated in this document have been met, and each author believes that the manuscript represents honest work.

Ethical Approval

Ethical approval received from the institute. The number IEC No- NMC/ 617 dated 11.02.21

Conflicts of interest

The authors declares that they do not have conflict of interest.

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