

Comparison of Flap Fixation and Conventional Wound Closure Following Modified Radical Mastectomy: A Prospective Cohort Study

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ABSTRACT

Introduction: Seroma formation is the most common postoperative complication following Modified Radical Mastectomy (MRM), resulting from disruption of lymphatic channels and persistence of dead space. Although suction drains are routinely used, seroma formation remains a significant challenge. Flap fixation with quilting sutures has been proposed to obliterate dead space and reduce seroma formation.

Aim: To compare the effectiveness of flap fixation and conventional wound closure in reducing postoperative drain output, duration of drainage, seroma formation, aspiration requirements, and wound-related complications following MRM.

Materials and Methods: This prospective observational cohort study was conducted in the Department of General Surgery at a tertiary care centre in Chennai, Tamil Nadu, India, from July 2024 to January 2026. A total of 62 female patients with histologically confirmed operable breast carcinoma undergoing MRM were included. Patients were allocated into two groups: Group A-flap fixation (n=31) and Group B-conventional closure (n=31). In the flap fixation group A, absorbable quilting sutures were used to secure the mastectomy skin flaps to the underlying pectoral fascia, thereby eliminating dead space. Conventional wound closure was performed in the control, group B. Closed

suction drains were placed in all patients. Outcomes assessed included total and mean daily drain output, duration of drainage, incidence of seroma, aspiration requirements, and postoperative complications. Statistical analysis was performed using Student's t-test and Chi-square test, with $p < 0.05$ considered significant.

Results: Baseline demographic and clinical characteristics, including age, Body Mass Index (BMI), co-morbidities, tumour size, tumour laterality, histopathological diagnosis, and disease stage, were comparable between group A and the conventional wound closure group B ($p > 0.05$ for all). Group A demonstrated significantly lower total drain output (410.7 ± 97.4 mL vs 612.8 ± 115.6 mL), mean daily drain output (85.2 ± 17.6 vs 118.4 ± 22.9 mL/day), and shorter drain duration (4.8 ± 1.2 vs 7.1 ± 1.5 days) ($p < 0.001$ for all). Seroma incidence was significantly lower in the flap fixation group {4/31 (12.9%) vs 12/31 (38.7%); $p = 0.018$ }. Clinically significant seroma requiring aspiration was also reduced {4/31 (12.9%) vs 10/31 (32.2%); $p = 0.049$ }.

Conclusion: Flap fixation is a safe and effective technique that significantly reduces seroma formation, postoperative drainage, drain duration, and aspiration requirements following MRM without increasing complications. Routine incorporation of this technique may improve postoperative outcomes.

Keywords: Breast cancer, Dead space closure, Postoperative complications, Quilting sutures, Seroma

INTRODUCTION

Breast cancer remains the most commonly diagnosed malignancy among women worldwide and is a leading cause of cancer-related mortality. According to the World Health Organisation (WHO), it accounts for a significant proportion of global cancer burden, with rising incidence in both developed and developing countries [1].

Despite improvements in surgical techniques, postoperative complications remain a major concern. Among these, seroma formation is one of the most common complications following mastectomy and axillary lymph node dissection [2]. Seroma is defined as abnormal accumulation of serous fluid in a dead space containing plasma and lymphatic fluid. It is a common complication of breast cancer surgery, plastic surgery, and abdominal wall hernia repair, with rates ranging between 15 and 85% following mastectomy and a global prevalence of 10.9% following abdominoplasty [2]. Seroma contributes to patient discomfort, delayed wound healing, repeated outpatient aspirations, and may delay the initiation of adjuvant therapy, thereby adversely affecting overall treatment outcomes [3].

Various preventive strategies have been explored to reduce seroma formation. Closed suction drainage remains the standard approach; however, evidence suggests that drains may only evacuate fluid rather than prevent its formation. Prolonged use of

drains is associated with discomfort, infection risk, and delayed recovery [4].

Recent research has focused on surgical techniques aimed at obliterating dead space. Quilting sutures or flap fixation techniques involve suturing the mastectomy skin flaps to the underlying chest wall to reduce dead space and minimise shear forces. Studies have demonstrated that such techniques significantly reduce postoperative drainage and the incidence of seroma [5,6].

Evidence indicates that quilting sutures significantly reduce the incidence of seroma, drain output, and the need for repeated aspirations compared with conventional closure [7]. More recent randomised trials have demonstrated consistent benefits, including reduced postoperative drainage and shorter hospital stay, without an increase in complications [8].

Furthermore, flap fixation has been shown to reduce healthcare burden by decreasing hospital stay, outpatient visits, and associated costs, without compromising patient comfort or aesthetic outcomes [9]. These findings underscore the importance of incorporating dead-space closure techniques into routine surgical practice. In this context, the present study was undertaken to evaluate the effectiveness of flap fixation in closing dead space in reducing seroma formation following MRM.

MATERIALS AND METHODS

This hospital-based prospective observational cohort study was conducted in the Department of General Surgery at Sree Balaji Medical College and Hospital, Chennai, Tamil Nadu, India, from July 2024 to January 2026. Ethical committee approval was obtained for the study (Ref No: 002/SBMCH/IHEC/2024/2225).

Inclusion criteria: Female patients aged ≥ 18 years with histologically confirmed primary operable breast carcinoma undergoing MRM and fit for general anaesthesia.

Exclusion criteria: Male patients with breast cancer, recurrent or metastatic disease before breast surgery or chest irradiation, pregnancy, and patients lost to follow-up before drain removal were excluded.

Sample size: Eligible patients meeting the inclusion criteria were enrolled consecutively during the study period from July 2024 to January 2026 until 62 participants were recruited (31 in the flap fixation group and 31 in the conventional wound closure group).

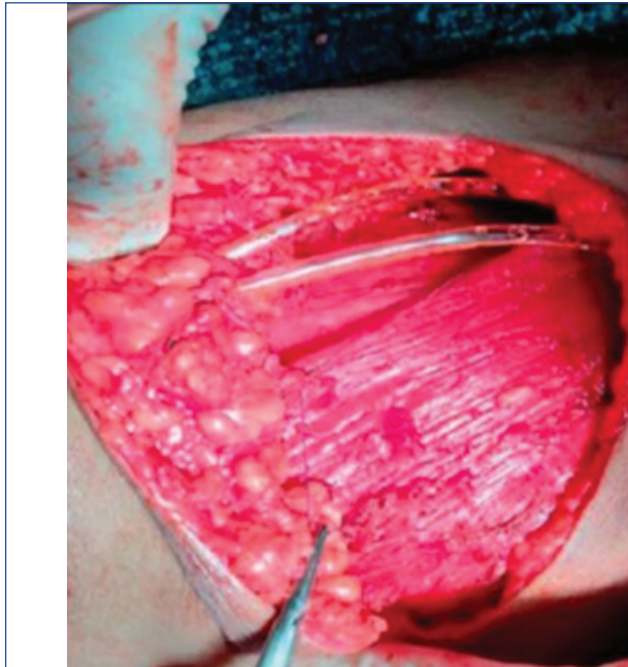
Study Procedure

A total of 62 patients were included and divided into two groups:

- Group A (Flap fixation group, $n=31$) and
- Group B (Conventional closure group, $n=31$).

Patients were assigned to either group according to the surgical technique adopted by the operating surgeon during the study period. All patients underwent standard preoperative evaluation. Surgeries were performed under general anaesthesia by experienced surgeons following a uniform operative protocol.

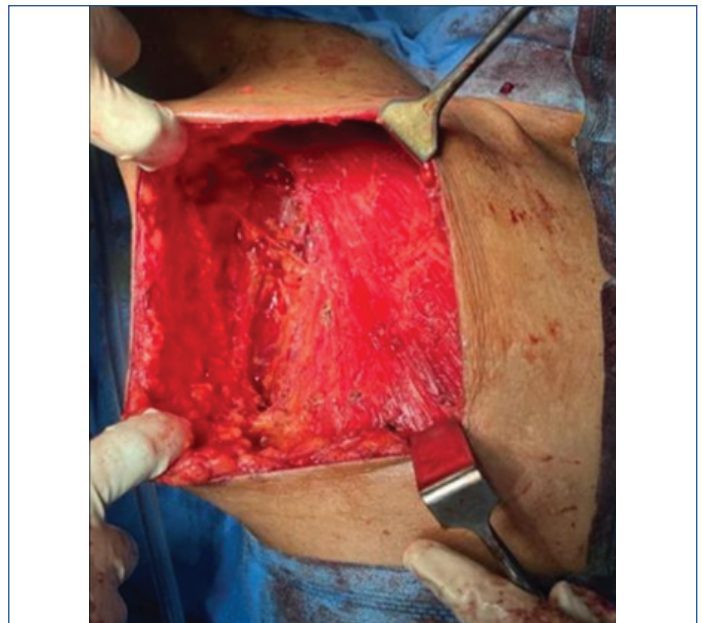
Group A: In the intervention group, flap fixation (quilting sutures) was performed using multiple interrupted absorbable sutures (2-0 Vicryl) placed between the mastectomy skin flaps and pectoral fascia at intervals of 2-3 cm to obliterate dead space [Table/Fig-1].



[Table/Fig-1]: Intraoperative photograph showing quilting sutures securing the mastectomy skin flaps to the underlying pectoral fascia.

Group B: In the control group, conventional wound closure without flap fixation was performed. In both groups, a single closed suction drain was placed in the axilla [Table/Fig-2].

Postoperatively, patients received standard care including antibiotics and analgesics. Drain output was recorded daily, and drains were removed when the output was <30 mL for two consecutive days based on institutional practice. Patients were followed-up weekly for four weeks and subsequently up to six weeks to assess for seroma formation and complications.



[Table/Fig-2]: Intraoperative photograph showing conventional wound closure without flap fixation.

Data collected included demographic variables; tumour characteristics {mean tumour size, tumour side, histopathology-Invasive Ductal Carcinoma (IDC), Clinical stage (American Joint Committee on Cancer [AJCC] 8th edition)} [10]; operative details; drain output; duration of drainage; incidence of seroma; number of aspirations; and postoperative complications. Seroma was defined as a clinically detectable fluid collection confirmed by aspiration [2].

STATISTICAL ANALYSIS

Statistical analysis was performed using Statistical Package for Social Sciences (SPSS) version 25.0. Continuous variables were expressed as mean $\pm$ standard deviation and compared between the two groups using an Independent Student's t-test. Categorical variables were expressed as frequencies and percentages and compared using the Chi-square test. A p -value <0.05 was considered statistically significant.

RESULTS

The mean age was 50.7 ± 8.3 years in group A and 51.9 ± 7.6 years in group B ($p=0.61$). Mean BMI was similar between groups (25.8 ± 3.2 vs 26.1 ± 3.6 kg/m²; $p=0.74$) [Table/Fig-3].

Parameters	Group A (n=31)	Group B (n=31)	p-value
Age distribution			
≤ 40 years	4 (12.9%)	3 (9.7%)	0.68 (NS)
41-60 years	21 (67.7%)	22 (71.0%)	—
>60 years	6 (19.4%)	6 (19.3%)	—
Mean age (years) (Mean $\pm$ SD)	50.7 ± 8.3	51.9 ± 7.6	0.61 (NS)
BMI (kg/m ²) (Mean $\pm$ SD)	25.8 ± 3.2	26.1 ± 3.6	0.74 (NS)
Co-morbidities			
Hypertension	9 (29.0%)	8 (25.8%)	0.78 (NS)
Diabetes mellitus	7 (22.6%)	6 (19.3%)	0.77 (NS)
Menopausal status			
Post-menopausal	18 (58.1%)	19 (61.3%)	0.80 (NS)

[Table/Fig-3]: Detailed demographic profile of study participants (N=62). Independent Student's t-test used (For continuous variables); Chi-square test used (For categorical variables); p -value <0.05 - Significant

The mean tumour size was 3.6 ± 1.1 cm in group A and 3.8 ± 1.3 cm in the conventional group B ($p=0.56$) [Table/Fig-4]

The mean operative time was significantly longer in group A (108.3 ± 11.2 minutes) compared to group B (98.4 ± 10.8 minutes) ($p=0.001$) [Table/Fig-5].

Parameters	Group A (n=31)	Group B (n=31)	p-value
Tumour size (cm) (Mean±SD)	3.6±1.1	3.8±1.3	0.56
Tumour side - right	18 (58%)	16 (52%)	0.63
Tumour side - left	13 (42%)	15 (48%)	—
Histopathology -IDC	19 (61%)	20 (65%)	0.77
Clinical stage (AJCC 8 th edition)			
Stage I	4 (13%)	3 (10%)	—
Stage II	19 (61%)	18 (58%)	0.87
Stage III	8 (26%)	10 (32%)	—

[Table/Fig-4]: Baseline clinical characteristics.
Independent Student's t-test used (for continuous variables); Chi-square test used (for categorical variables); p-value <0.05 - significant

Parameters	Group A (n=31)	Group B (n=31)	p-value
Operative time (min) (Mean±SD)	108.3±11.2	98.4±10.8	0.001
Blood loss (mL) (Mean±SD)	172.1±36.5	168.8±40.2	0.72
Axillary nodes removed (mean±SD)	17.2±4.1	16.8±3.7	0.64

[Table/Fig-5]: Operative parameters.
Independent student's t-test used; p-value <0.05 - Significant

The flap fixation group A had lower total drain output (410.7±97.4 mL vs 612.8±115.6 mL), lower mean daily drain output (85.2±17.6 mL/day vs 118.4±22.9 mL/day), and a shorter duration of drain placement (4.8±1.2 days vs 7.1±1.5 days), with all differences being highly significant (p<0.001) [Table/Fig-6].

Parameters	Group A (n=31)	Group B (n=31)	p-value
Total drain output (mL) (Mean±SD)	410.7±97.4	612.8±115.6	<0.001
Mean daily output (mL/day) (Mean±SD)	85.2±17.6	118.4±22.9	<0.001
Duration of drain (days) (Mean±SD)	4.8±1.2	7.1±1.5	<0.001

[Table/Fig-6]: Postoperative drain characteristics.
Independent Student's t-test used; p-value <0.05 - Significant

The earliest drain removal was on postoperative day 4 in the flap fixation group A compared to day 5 in the conventional group. No patient in the flap fixation group required drain reinsertion, whereas two patients (6.4%) in the conventional group required reinsertion [Table/Fig-7].

Parameters	Group A (n=31)	Group B (n=31)	p-value
Mean day of drain removal (days) (Mean±SD)	5.1±1.1	7.3±1.4	<0.001
Earliest removal (day)	4	5	—
Latest removal (day)	7	10	—
Reinsertion required n (%)	0	2 (6.4%)	0.15

[Table/Fig-7]: Comparison of drain removal.
Independent student's t-test used (for continuous variables); Chi-square test used (for categorical variables); p-value <0.05 - significant

Seroma developed in only 12.9% of patients in the flap fixation group A compared to 38.7% in the conventional closure group B (p=0.018) [Table/Fig-8].

The mean aspirated seroma volume was significantly lower in the flap fixation group (58.3±22.6 mL) compared with the conventional group (132.7±48.4 mL) (p<0.001) [Table/Fig-9].

Parameters	Group A n (%)	Group B n (%)	p-value
Seroma present	4 (12.9%)	12 (38.7%)	0.018
Seroma absent	27 (87.1%)	19 (61.3%)	—
Clinically significant (aspiration required)	4 (12.9%)	10 (32.2%)	0.049
Insignificant (self-resolving)	0	2 (6.5%)	—

[Table/Fig-8]: Incidence of seroma formation.
Chi-square test used; p-value <0.05 - Significant

Parameters	Group A	Group B	p-value
Mean seroma volume (mL) (Mean±SD)	58.3±22.6	132.7±48.4	<0.001
Mean no. of aspirations	1.2±0.4	2.1±0.8	0.004
Maximum volume aspirated (mL)	90	190	—
Patients with >2 aspirations, n (%)	0	4 (12.9%)	0.039

[Table/Fig-9]: Volume and number of seroma aspirations.
Independent student's t-test used (For continuous variables); Chi-square test used (For categorical variables); p-value <0.05 - Significant

Rates of wound infection (3.2% vs 6.4%), flap edge necrosis (6.4% vs 9.7%), haematoma (0% in both groups), wound dehiscence (0% vs 3.2%), and re-operation (0% in both groups) were comparable, with no statistically significant differences [Table/Fig-10].

Complications	Group A n (%)	Group B n (%)	p-value
Wound infection	1 (3.2%)	2 (6.4%)	0.55
Flap edge necrosis	2 (6.4%)	3 (9.7%)	0.64
Haematoma	0	0	—
Wound dehiscence	0	1 (3.2%)	0.31
Re-operation required	0	0	—

[Table/Fig-10]: Postoperative complications.
Chi-square test used; p-value <0.05 - Significant

DISCUSSION

In the present study, the incidence of seroma was significantly lower in the flap fixation group compared to the conventional closure group. Bhagchandani M et al., reported that quilting sutures significantly reduced the incidence of seroma formation from 58% in the conventional closure group to 23% in the quilting group (p<0.05). The quilting group also demonstrated a shorter time to seroma resolution (4 vs. 9 days; p<0.001), reduced hospital stay (4 vs. 9 days; p<0.001) [11].

The present study also demonstrated a significant reduction in total drain output, mean daily output, and duration of drainage. Mirza W et al., including seven randomised controlled trials involving 1,412 patients demonstrated that quilting sutures significantly reduced the incidence of seroma (RR 0.36, 95% CI 0.23–0.55), the need for seroma aspiration (RR 0.29, 95% CI 0.20–0.42), the number of aspirations (MD -1.03, 95% CI -1.58 to -0.47), and total postoperative drainage volume (MD -214 mL, 95% CI -402 to -27 mL), with moderate-certainty evidence [12]. Furthermore, the recent network meta-analysis by Spiekerman van Weezenburg MA et al., which included 25 studies involving 3,423 patients, demonstrated that flap fixation using sutures was superior to tissue glue in reducing clinically significant seroma formation. The analysis also suggested that running sutures were more effective than interrupted sutures for preventing seroma, supporting flap fixation as one of the most effective strategies for dead-space closure following mastectomy [13]. These findings closely parallel the results of the present study. Larger multicentre randomised controlled trials with longer follow-up are warranted to validate these findings.

Limitation(s)

First, it was conducted at a single tertiary care centre with a relatively small sample size, which may limit the generalisability of the findings. Second, as a prospective observational study without randomisation, selection bias cannot be completely excluded. Third, the follow-up period was limited to the early postoperative phase, and long-term outcomes, cosmetic results, patient-reported satisfaction, and quality-of-life measures were not assessed.

CONCLUSION(S)

The present study demonstrates that closure of dead space by flap fixation significantly reduces seroma formation following MRM.

These findings support flap fixation as a simple, safe technique that can be routinely incorporated into surgical practice to improve postoperative outcomes in breast cancer patients undergoing mastectomy.

REFERENCES

- [1] World Health Organization. Breast cancer [Internet]. Geneva: World Health Organization; 2024 [cited 2026 Apr 29]. Available from: <https://www.who.int/news-room/fact-sheets/detail/breast-cancer>.
- [2] Kazzam ME, Ng P. Postoperative seroma management. [Updated 2023 Aug 14]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2026 Jan-. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK585101/>.
- [3] Santos DVA, Fabro EAN, Costa RM, Lucena RN, Venda MA, Torres DM. Strategies for preventing seroma in patients undergoing breast cancer surgical treatment: Systematic literature review. *Rev Bras Cancerol*. 2024;70(2):e-164616.
- [4] Scomacao I, Cummins A, Roan E, Duraes EFR, Djohan R. The use of surgical site drains in breast reconstruction: A systematic review. *J Plast Reconstr Aesthet Surg*. 2020;73(4):651-62.
- [5] Wu Y, Wang S, Hai J, Mao J, Dong X, Xiao Z. Quilting suture is better than conventional suture with drain in preventing seroma formation at pectoral area after mastectomy. *BMC Surg*. 2020;20(1):65.
- [6] Myint ST, Khaing KS, Yee W, Mon SM, Lwin T. Quilting suture versus conventional closure in prevention of seroma after total mastectomy and axillary dissection in breast cancer patients. *ANZ J Surg*. 2020;90(7-8):1408-13.
- [7] Velotti N, Limite G, Vitiello A, Berardi G, Musella M. Flap fixation in preventing seroma formation after mastectomy: An updated meta-analysis. *Updates Surg*. 2021;73(4):1307-14.
- [8] Parikshith Manjunath P, Yelamanchi R, Agrawal H, Ekta Yadav E, Gupta N, Gupta AK, et al. Effect of mastectomy flap fixation on post-operative fluid drainage and seroma formation in breast cancer patients a double-blinded randomised control trial. *Pol Przegl Chir*. 2022;95(2):01-08.
- [9] van Zeelst LJ, Ten Wolde B, van Eekeren RRJP, Volders JH, de Wilt JHW, Strobbe LJA. Quilting following mastectomy reduces seroma, associated complications and health care consumption without impairing patient comfort. *J Surg Oncol*. 2022;125(3):369-76.
- [10] Amin MB, Greene FL, Edge SB, Compton CC, Gershenwald JE, Brookland RK, et al. The Eighth Edition AJCC Cancer Staging Manual: Continuing to build a bridge from a population-based to a more "personalized" approach to cancer staging. *CA Cancer J Clin*. 2017;67(2):93-99.
- [11] Bhagchandani M, Shukla V, Maurya RK, Chaudhary A, Kumar K. A comparative study between mastectomy flap quilting sutures with axillary drain versus conventional sutures with axillary and pectoral drain in reducing post-modified radical mastectomy seroma formation. *Indian J Surg*. 2023:1-6.
- [12] Mirza W, Khan ME, Iqbal H, Khan A, Moeen-Ud-Din MB, Khan HM. Quilting sutures versus conventional closure after modified radical mastectomy with axillary dissection: A GRADE-assessed systematic review and meta-analysis of randomized controlled trials with pre-specified subgroups by quilting extent. *World J Surg Oncol*. 2026;24(1):160.
- [13] Spiekerman van Weezenburg MA, Daemen JHT, van Kuijk SMJ, van Haaren ERM, Janssen A, Vissers YLJ et al. Seroma formation after mastectomy: A systematic review and network meta-analysis of different flap fixation techniques. *J Surg Oncol*. 2024;129(6):1015-24. Doi: 10.1002/jso.27589. Epub 2024 Jan 21. PMID: 38247263.

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