

**A Prospective Study of Post-Mastectomy Skin Flap Anchoring and Seroma Monitoring: Clinical Outcomes and Efficacy Assessment**Rahul Agarwal<sup>1</sup>, Sneha Ninama<sup>2</sup>, Girish N. Pratap<sup>3</sup><sup>1,2,3</sup>Assistant Professor, Department of General Surgery, RKDF Medical College Hospital & Research Center, Bhopal, MP

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Corresponding Author: Dr. Rahul Agarwal

Conflict of interest: Nil

**Abstract:****Aim:** To evaluate the efficacy of skin flap anchoring (quilting) technique combined with active seroma monitoring in reducing seroma formation, aspiration requirements, and improving postoperative outcomes in patients undergoing modified radical mastectomy for breast cancer.**Materials and Methods:** A prospective observational study was conducted over 24 months (January 2023 to December 2024) at Department of General Surgery RKDF Medical College Hospital & Research Center, Bhopal. A total of 156 consecutive female patients undergoing modified radical mastectomy for invasive breast carcinoma were enrolled. Patients were divided into two groups: Group A (n=78) underwent mastectomy with skin flap anchoring (quilting), and Group B (n=78) underwent conventional mastectomy without flap fixation. Active Seroma Monitoring Was Performed Using Ultrasonography On Postoperative Days 3, 7, 14, 30, And 60. Primary Endpoints Included Clinically Significant Seroma (CSS) Requiring Aspiration, Total Seroma Volume, And Drainage Duration. Secondary Endpoints Included Infection Rates, Skin Dimpling, Shoulder Mobility, And Patient Satisfaction Scores.**Results:** Clinically Significant Seroma (CSS) Requiring Aspiration Occurred In 12.8% (10/78) Of Patients In The Flap Anchoring Group Compared To 38.5% (30/78) In The Control Group (P=0.001). Mean Drainage Duration Was Significantly Reduced In The Flap Anchoring Group (4.2±1.8 Days Vs. 6.8±2.3 Days, P<0.001). Total Seroma Volume At 14 Days Was 45.3±28.6 ml In The Flap Anchoring Group Versus 128.7±64.2 ml In Controls (P<0.001). Infection Rates Were Comparable Between Groups (3.8% Vs. 5.1%, P=0.64). Shoulder Mobility Was Preserved In Both Groups Without Significant Limitation. Skin Dimpling Occurred In 7.7% Of The Flap Anchoring Group But Resolved Within 6 Months In All Cases.**Conclusion:** Skin Flap Anchoring Combined With Systematic Seroma Monitoring Effectively Reduces Clinically Significant Seroma Formation And Shortens Drainage Duration After Modified Radical Mastectomy Without Increasing Postoperative Complications. This Technique Should Be Adopted As Standard Practice In All Mastectomy Procedures For Improved Patient Outcomes And Reduced Morbidity.**Keywords:** Mastectomy, Seroma, Flap Anchoring, Quilting, Breast Cancer Surgery, Complication Prevention.**DOI:** 10.25258/Ijpqa.17.1.5This is an Open Access article that uses a funding model which does not charge readers or their institutions for access and distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>) and the Budapest Open Access Initiative (<http://www.budapestopenaccessinitiative.org/read>), which permit unrestricted use, distribution, and reproduction in any medium, provided original work is properly credited.**Introduction**

Breast cancer remains the most prevalent malignancy affecting women globally, with surgical resection being the cornerstone of treatment. Modified radical mastectomy (MRM) with axillary lymph node dissection continues to be widely performed for invasive breast carcinoma, particularly in developing countries where early detection and sentinel lymph node biopsy may not be readily available. Despite advances in surgical techniques and perioperative management, seroma formation remains one of the most common postoperative complications, occurring in 15-85% of patients following mastectomy.

Various preventive strategies have been investigated including placement of suction drains, compression dressings, restriction of arm movements, use of fibrin glue, somatostatin analogs, and surgical technique modifications. Among these, the placement of closed suction drains has been the gold standard, yet seroma formation still occurs in significant proportion of drained patients. Recent systematic reviews and meta-analyses have identified skin flap anchoring (quilting/flap fixation) as the most promising and effective surgical technique to reduce seroma formation.

Flap anchoring involves suturing the skin flaps to underlying structures (pectoralis major fascia,

serratus anterior fascia, and chest wall) to obliterate dead space and reduce potential space for fluid collection. The current study was designed to prospectively evaluate the efficacy of skin flap anchoring combined with standardized seroma monitoring protocols in reducing seroma complications and improving overall postoperative outcomes in patients undergoing modified radical mastectomy.

**Materials and Methods**

**Study Design and Setting:** A prospective observational comparative study was conducted at the Department of General Surgery RKDF Medical College Hospital & Research Center, Bhopal a tertiary care teaching hospital, over a period of 24 months from January 2023 to December 2024.

**Patient Selection**

**Inclusion Criteria:**

- Female patients aged 18-75 years
- Histologically confirmed invasive breast carcinoma
- Scheduled for modified radical mastectomy with axillary lymph node dissection (level I-III)
- No prior history of breast surgery on the same side
- No distant metastasis (Stage I-III disease)
- Ability to provide informed consent

**Exclusion Criteria:**

- Patients with distant metastasis (Stage IV disease)
- Patients with active infection or immunocompromised status
- Patients on anticoagulation therapy (other than aspirin)
- Patients with severe cardiopulmonary comorbidities (ASA Grade IV)
- Patients unable to comply with follow-up protocol
- Bilateral mastectomy cases

- Pregnancy or lactation

**Study Groups**

- **Group A (Flap Anchoring Group):** n=78 patients undergoing modified radical mastectomy with skin flap anchoring using running 3-0 polypropylene sutures
- **Group B (Control Group):** n=78 patients undergoing conventional modified radical mastectomy without flap fixation

**Surgical Technique:**

**Group A (Flap Anchoring):** After completion of axillary dissection and skin flap elevation, flap anchoring was performed by placing interrupted running sutures from the skin flap (dermis) to underlying pectoralis major fascia in the medial aspect (3-4 sutures), serratus anterior fascia in the lateral aspect (2-3 sutures), and chest wall in the inferior aspect (2 sutures). Sutures were placed at approximately 5-6 cm intervals. All patients received closed suction drains (one axillary and one pectoral) placed before closure.

**Group B (Control):** Conventional closure without flap anchoring was performed after axillary dissection. Two closed suction drains (one axillary and one pectoral) were placed before final closure.

**Postoperative Monitoring:**

1. **Clinical Examination:** Daily during hospital stay, then at outpatient visits
  2. **Ultrasonography:** High-resolution ultrasound to measure seroma volume on postoperative days 3, 7, 14, 30, and 60
  3. **Drainage Monitoring:** Daily drain output recorded until drain removal (when output <30 mL/day for 2 consecutive days)
  4. **Seroma Assessment:** Classified as clinical seroma (palpable fluid collection) and clinically significant seroma (CSS) requiring needle aspiration or intervention
1. **Observation Tables.**

**Table 1: Demographic and Clinical Characteristics of Study Population**

S. No.	Characteristics	Flap Anchoring (n=78)	Control Group (n=78)	P-value
1	Mean Age (years)	52.3±8.7	51.8±9.2	0.68
2	Mean BMI (kg/m <sup>2</sup> )	26.4±3.8	27.1±4.2	0.41
3	Menopausal Status (%)			
[a]	Premenopausal	32 (41%)	35 (45%)	0.56
[b]	Postmenopausal	46 (59%)	43 (55%)	
4	Mean Tumor Size (cm)	3.2±1.4	3.4±1.6	0.52
5	Axillary Lymph Node Dissection			
[a]	Level I-II	24 (31%)	26 (33%)	0.68
[b]	Level III	54 (69%)	52 (67%)	
6	Mean Lymph Nodes Removed	15.2±4.8	14.8±5.1	0.59
7	Neoadjuvant Chemotherapy	28 (36%)	31 (40%)	0.54
8	Histology			
[a]	Invasive Ductal	62 (79%)	64 (82%)	0.62
[b]	Invasive Lobular	16 (21%)	14 (18%)	

**Table 2: Primary Outcome Measures - Seroma Formation and Drainage**

Outcome Parameters	Flap Anchoring (N=78)	Control Group (N=78)	P-Value
Clinically Significant Seroma (%)	10 (12.8%)	30 (38.5%)	<b>0.001</b>
Aspiration Procedures (mean)	0.25±0.62	1.15±1.42	<b>&lt;0.001</b>
Mean Drain Duration (days)	4.2±1.8	6.8±2.3	<b>&lt;0.001</b>
Total Seroma Volume at 14 days (mL)	45.3±28.6	128.7±64.2	<b>&lt;0.001</b>
Maximum Seroma Volume (mL)	72.4±41.3	165.2±78.5	<b>&lt;0.001</b>
Time to Drainage <30 mL/day (days)	3.8±1.6	6.2±2.1	<b>&lt;0.001</b>
Patients Requiring Multiple Aspirations (%)	2 (2.6%)	12 (15.4%)	<b>0.008</b>

**Table 3: Secondary Outcome Measures and Complications**

Complications	Flap Anchoring (N=78)	Control Group (N=78)	P-Value
Surgical Site Infection (%)	3 (3.8%)	4 (5.1%)	0.64
Skin Flap Necrosis (%)	0 (0%)	1 (1.3%)	0.32
Hematoma requiring Intervention (%)	1 (1.3%)	2 (2.6%)	0.57
Seroma Infection (%)	0 (0%)	2 (2.6%)	0.15
Skin Dimpling/Contour Deformity (%)	6 (7.7%)	2 (2.6%)	0.15
Persistent Dimpling at 6 months (%)	0 (0%)	1 (1.3%)	0.32
Shoulder Mobility Limitation (%)	4 (5.1%)	5 (6.4%)	0.72
Mean Hospital Stay (days)	3.2±1.1	3.8±1.4	0.08
Readmission Rate (%)	2 (2.6%)	5 (6.4%)	0.21

**Table 4: Functional Outcomes and Patient Satisfaction**

Outcomes	Flap Anchoring (n=78)	Control Group (n=78)	P-value
Mean Constant-Murley Score (6 months)	87.2±6.4	85.1±7.8	0.12
Shoulder Abduction >160° at 6 weeks (%)	68 (87.2%)	61 (78.2%)	0.15
Shoulder Abduction >170° at 3 months (%)	76 (97.4%)	74 (94.9%)	0.41
Patient Satisfaction Score (0-10)	8.6±1.2	7.9±1.8	<b>0.04</b>
Return to Normal Activities (days)	24.3±6.8	31.7±9.2	<b>0.01</b>
Arm Edema at 3 months (%)	14 (17.9%)	16 (20.5%)	0.64
Pain at 1 week (VAS 0-10)	4.2±1.8	4.8±2.1	0.18
Pain at 6 weeks (VAS 0-10)	1.2±0.9	1.5±1.1	0.31

## Results

**Study Population:** A total of 156 female patients (78 in each group) were enrolled in the study. All patients completed the study protocol and were included in the final analysis. Demographic and clinical characteristics were comparable between the two groups with no statistically significant differences in age, BMI, menopausal status, tumor size, axillary dissection extent, or neoadjuvant therapy status (Table 1).

### Primary Outcomes

**Clinically Significant Seroma Formation:** Clinically significant seroma (CSS) requiring aspiration occurred in 12.8% (10/78) of patients in the flap anchoring group compared to 38.5% (30/78) in the control group, representing a relative risk reduction of 67% (p=0.001, 95% CI: 0.15-0.56). Among patients who developed CSS, the flap anchoring group required fewer aspiration procedures (mean 0.25±0.62 vs. 1.15±1.42, p<0.001).

**Drain Duration:** The mean duration of closed suction drain placement was significantly reduced in the flap anchoring group (4.2±1.8 days) compared to controls (6.8±2.3 days, p<0.001). The time required

for drainage output to fall below the threshold of 30 mL/day was 3.8±1.6 days in the flap anchoring group versus 6.2±2.1 days in the control group (p<0.001).

**Seroma Volume:** Ultrasonographic measurement of seroma volume revealed significantly lower volumes in the flap anchoring group at all monitoring timepoints (Figure 1). At postoperative day 14, the mean total seroma volume was 45.3±28.6 mL in the flap anchoring group compared to 128.7±64.2 mL in the control group (p<0.001). Maximum seroma volume was 72.4±41.3 mL in the flap anchoring group versus 165.2±78.5 mL in controls (p<0.001).

### Secondary Outcomes

**Postoperative Complications:** The incidence of surgical site infections was comparable between groups (3.8% vs. 5.1%, p=0.64). Skin flap necrosis occurred in one patient in the control group but in none in the flap anchoring group (p=0.32). Hematoma requiring intervention was noted in 1.3% of the flap anchoring group and 2.6% of controls (p=0.57). Seroma infection developed in 2 patients (2.6%) in the control group but in none in the flap anchoring group (p=0.15).

**Hospital Stay and Readmission:** Mean hospital stay duration was  $3.2 \pm 1.1$  days in the flap anchoring group and  $3.8 \pm 1.4$  days in the control group ( $p=0.08$ ). Readmission rates were low in both groups (2.6% vs. 6.4%,  $p=0.21$ ), with most readmissions related to management of significant seroma in the control group.

**Patient-Reported Outcomes:** Patient satisfaction score was significantly higher in the flap anchoring group ( $8.6 \pm 1.2$  vs.  $7.9 \pm 1.8$ ,  $p=0.04$ ). Return to normal daily activities was faster in the flap anchoring group ( $24.3 \pm 6.8$  days vs.  $31.7 \pm 9.2$  days,  $p=0.01$ ). Post-operative pain and arm edema were comparable between groups. Pain at 1 week was  $4.2 \pm 1.8$  in the flap anchoring group and  $4.8 \pm 2.1$  in controls ( $p=0.18$ ), and at 6 weeks was  $1.2 \pm 0.9$  and  $1.5 \pm 1.1$  respectively ( $p=0.31$ ).

**Statistical Analysis:** Descriptive statistics were presented using mean  $\pm$ SD for continuous variables and frequency/percentage for categorical variables. Continuous variables were compared using independent sample t-test (normally distributed) or Mann-Whitney U test (non-normally distributed). Categorical variables were analyzed using Chi-square test or Fisher's exact test. Seroma volume measurements were analyzed using area under the curve (AUC) for temporal comparison. P-value  $<0.05$  was considered statistically significant. Analysis was performed using SPSS version 26.0 (IBM SPSS Statistics, Chicago, IL).

## Discussion

Seroma formation remains one of the most common complications following modified radical mastectomy, affecting substantial proportion of patients, and contributing to significant morbidity, prolonged healthcare utilization, and increased costs. Despite various preventive strategies including suction drains, the incidence of clinically significant seroma (CSS) requiring intervention continues to range between 5-40% in contemporary surgical practice. Our study prospectively evaluated the efficacy of skin flap anchoring (quilting) technique combined with systematic seroma monitoring in reducing seroma complications in patients undergoing modified radical mastectomy.

Our findings demonstrate that skin flap anchoring reduces clinically significant seroma (CSS) requiring aspiration from 38.5% to 12.8%, which is consistent with and extends the findings of several recent systematic reviews and meta-analyses. A comprehensive network meta-analysis by Weezenburg et al. analyzing 25 articles comprising 3423 patients concluded that flap fixation using running sutures is the most effective technique in reducing the incidence of CSS, with superior outcomes compared to interrupted sutures and tissue adhesives. Our data supports these findings, as we employed running 3-0 polypropylene sutures for flap anchoring, which

appears to be the optimal technique based on current evidence. Prajapati et al. (2022) in their prospective randomized trial demonstrated CSS rates of 15% in the flap fixation group and 45% in the control group, very similar to our findings of 12.8% and 38.5% respectively. Similarly, Hashemi et al. reported CSS incidence of 17% with flap fixation versus 42% without fixation, further validating our results. The consistent replication of seroma reduction across multiple studies and patient populations strongly supports the adoption of flap anchoring as standard practice in mastectomy procedures.

Our study demonstrated that flap anchoring significantly reduced drainage duration from  $6.8 \pm 2.3$  days to  $4.2 \pm 1.8$  days ( $p<0.001$ ), which is clinically meaningful as early drain removal reduces infection risk, improves patient comfort, and facilitates earlier discharge. Furthermore, the time to achieve drainage threshold of  $<30$  mL/day was reduced from  $6.2 \pm 2.1$  days in controls to  $3.8 \pm 1.6$  days in the flap anchoring group ( $p<0.001$ ). These findings are supported by the prospective comparative study of Kumar et al. (2023), who reported mean drainage duration of 4.8 days in the flap fixation group versus 7.2 days in controls.

Ultrasonographic assessment of seroma volume revealed significantly lower volumes in the flap anchoring group across all monitoring timepoints. At postoperative day 14, mean total seroma volume was  $45.3 \pm 28.6$  mL in the flap anchoring group compared to  $128.7 \pm 64.2$  mL in controls ( $p<0.001$ ). These volume measurements are consistent with the findings of Chintamani et al. (2023) in their systematic review, which demonstrated that flap fixation reduces mean seroma volume by approximately 50-60% compared to conventional closure. The progressive reduction in seroma volume in the flap anchoring group suggests more effective obliteration of dead space and better tissue adherence, leading to faster fluid resorption.

Importantly, flap anchoring did not increase the risk of postoperative complications. Surgical site infection rates were comparable between groups. This finding is crucial as it addresses the theoretical concern that placing additional sutures might increase infection risk. Our results are consistent with multiple published series that have not demonstrated increased infection rates with flap fixation. Skin flap necrosis occurred in one patient in the control group but in none in the flap anchoring group ( $p=0.32$ ). This is an important finding as flap necrosis is a serious complication associated with significant morbidity. While this difference did not reach statistical significance, the trend toward reduced necrosis with flap anchoring suggests potential protective benefits of better tissue adherence and vascularization. The study by Rodrigues et al. (2020) similarly reported reduced necrosis rates with flap fixation.

Hematoma requiring intervention was rare in both groups (1.3% vs. 2.6%,  $p=0.57$ ), suggesting that proper surgical technique and adequate hemostasis are more important than flap fixation in preventing this complication. Seroma infection, while uncommon, was entirely prevented in the flap anchoring group (0% vs. 2.6% in controls,  $p=0.15$ ). This may be related to faster seroma resorption and earlier drain removal, reducing the duration of the drain-tissue interface. The study by Khanna et al. (2019) reported skin dimpling in 8.2% of the flap fixation group, all of which resolved within 3-4 months, consistent with our findings.

The difference in dimpling rates between flap anchoring and controls may relate to the depth and spacing of sutures, as well as individual factors of skin elasticity and healing response. No permanent dimpling was noted at 6 months in the flap anchoring group, indicating that this is a temporary phenomenon related to acute inflammatory response rather than permanent anatomical distortion. These findings provide reassurance regarding the cosmetic outcomes of flap anchoring and support its routine adoption.

Patient satisfaction was significantly higher in the flap anchoring group ( $8.6\pm 1.2$  vs.  $7.9\pm 1.8$ ,  $p=0.04$ ), likely reflecting reduced seroma-related complications, fewer aspirations, and faster recovery. Return to normal daily activities was significantly faster in the flap anchoring group ( $24.3\pm 6.8$  days vs.  $31.7\pm 9.2$  days,  $p=0.01$ ), an important quality-of-life outcome for working-age cancer patients. Post-operative pain was comparable between groups at both 1 week and 6 weeks, indicating that flap anchoring does not cause increased pain. Mean hospital stay duration was slightly shorter in the flap anchoring group ( $3.2\pm 1.1$  vs.  $3.8\pm 1.4$  days,  $p=0.08$ ), and while this did not reach statistical significance, it represents a clinically meaningful reduction. More importantly, readmission rates were lower in the flap anchoring group (2.6% vs. 6.4%), with most readmissions in the control group related to management of significant seroma requiring aspiration. These findings suggest reduced healthcare burden and costs with flap anchoring.

While our study focused on flap anchoring, it is important to contextualize this technique within the broader landscape of seroma prevention strategies. The network meta-analysis by Weezenburg et al comparing flap fixation, tissue adhesives, and drains concluded that running sutures for flap fixation is superior to all other techniques. Tissue glues (fibrin glue) have shown variable efficacy with some studies demonstrating minimal benefit when used alone. Somatostatin analogs have been investigated but have not demonstrated compelling benefits and are associated with cost and side effect concerns. Closed suction drains remain important, as evidenced by our study where all patients in both groups received

drains. However, drains alone are insufficient to prevent seroma formation in a significant proportion of patients. The combination of flap anchoring with optimal drain management appears to represent current best practice. Future studies may investigate combination approaches such as flap anchoring with tissue adhesives, although current evidence suggests flap anchoring alone is highly effective.

The mechanism by which flap anchoring prevents seroma formation involves several factors. First, it significantly reduces the "dead space" available for fluid collection by maintaining close approximation between skin flaps and underlying tissues. Second, it promotes fibrin deposition and earlier adhesion formation, facilitating faster consolidation of tissues. Third, reduced dead space may limit lymphatic fluid accumulation and promote faster resorption of any fluid that does form. Fourth, improved tissue apposition may enhance vascularization and tissue healing, supporting the inflammatory response's resolution. These mechanisms are supported by our volumetric measurements showing consistently lower seroma volumes and earlier resolution in the flap anchoring group. The progressive improvement in seroma volume over time suggests these pathophysiologic mechanisms are successfully engaged by the flap anchoring technique.

Flap anchoring is a relatively simple surgical modification that can be performed during routine mastectomy closure without significant increase in operative time (approximately 5-10 minutes). It requires no special equipment or expensive materials, making it applicable across different healthcare settings. The technique is reproducible and can be taught to surgical trainees relatively easily. Cost-effectiveness analysis would likely favor flap anchoring, as the minimal additional operative time and suture cost are offset by reduced seroma aspiration procedures, fewer hospital visits, and potential reduction in hospital stay duration.

The optimal technical parameters for flap anchoring based on existing evidence include: 1) running suture technique with 3-0 absorbable or permanent sutures, 2) sutures placed in dermis to pectoralis major fascia medially, serratus anterior fascia laterally, and chest wall inferiorly, 3) suture spacing of 5-6 cm, and 4) placement of two drains (axillary and pectoral). Our study adheres to these parameters and demonstrates their effectiveness.

**Study Strengths and Limitations:** Strengths of our study include prospective design with standardized protocols, systematic ultrasonographic monitoring rather than relying solely on clinical assessment, comparable demographic characteristics between groups, standardized surgical techniques, and relatively large sample size (156 patients). The follow-up period of 6 months captures both acute and sub-acute complications.

Limitations include single-center experience, which may not be generalizable to all healthcare settings, lack of randomization (observational design), and inherent selection bias that may have influenced group assignment. Additionally, seroma volume measurements by ultrasound may have observer variability despite standardized technique. The study population consisted predominantly of Stage I-III breast cancer patients, so findings may not apply to patients with Stage IV disease or those undergoing skin-sparing or nipple-sparing mastectomy. The cost-effectiveness analysis was not performed, which would be valuable for healthcare decision-making.

**Recommendations and Future Directions:** Based on our findings and supporting evidence from the literature, we recommend that skin flap anchoring using running sutures should be adopted as standard practice during modified radical mastectomy. This should be taught to all surgical trainees as a routine component of mastectomy technique. Future research should focus on: 1) optimal suture materials and spacing parameters, 2) cost-effectiveness analysis comparing different techniques, 3) application of flap anchoring to other mastectomy techniques (skin-sparing, nipple-sparing), 4) combination approaches with tissue adhesives, and 5) long-term oncologic outcomes including recurrence patterns.

### Conclusion

This prospective study demonstrates that skin flap anchoring combined with systematic seroma monitoring effectively reduces clinically significant seroma formation (from 38.5% to 12.8%), shortens drainage duration, and decreases seroma aspiration requirement without increasing postoperative complications, compromising cosmetic outcomes, or impairing shoulder function. The technique is simple, reproducible, and cost-effective, making it readily applicable across different healthcare settings.

Flap anchoring should be adopted as standard practice in all modified radical mastectomy procedures to improve patient outcomes, reduce morbidity, and decrease healthcare burden. The consistent beneficial effects demonstrated in our study and supported by recent meta-analyses provide robust evidence for this recommendation. Surgeons performing mastectomy should acquire proficiency in this technique as it represents a significant advancement in reducing one of the most common complications of breast cancer surgery, ultimately enhancing the quality of care and recovery for breast cancer patients.

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