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Research Article

Assessment of Postoperative Seroma Formation Following Modified Radical Mastectomy: Risk Factors, Management Strategies, and Clinical Outcomes

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ABSTRACT

Background: Breast carcinoma is the most frequently diagnosed malignancy among women in India, and modified radical mastectomy (MRM) remains the most commonly performed surgical procedure in low- and middle-income settings. Postoperative seroma is the most frequent complication following MRM, with a reported incidence of 15–90%. Seroma can delay wound healing, postpone adjuvant therapy, and prolong recovery.

Objectives: To assess the incidence of postoperative seroma formation following MRM, identify the associated risk factors, evaluate the management strategies employed, and analyse the resulting clinical outcomes.

Materials and Methods: A prospective observational study was conducted at the Department of General Surgery, The Oxford Medical College Hospital and Research Centre, Yadavanahalli, Attibele, Bangalore – 562107, Karnataka, India, over a period of two months (15 March 2026 to 15 May 2026). Forty-five consecutive female patients diagnosed with operable carcinoma of the breast undergoing MRM were enrolled after obtaining written informed consent.

Preoperative demographic, clinical, and pathological variables were recorded. Postoperatively, patients were monitored for seroma formation, drain output, and complications up to six weeks. Data were analysed using SPSS v25.0; chi-square test, Fisher's exact test, and multivariate logistic regression were applied, with $p < 0.05$ considered statistically significant.

Results: The mean age of participants was 52.4 ± 11.2 years. Seroma developed in 20 of 45 patients (44.4%). Statistically significant risk factors included age > 50 years ($p = 0.002$), body mass index ≥ 25 kg/m² ($p = 0.034$), diabetes mellitus ($p = 0.002$), tumour size > 5 cm ($p = 0.031$), presence of ≥ 4 positive axillary lymph nodes ($p = 0.001$), and receipt of neoadjuvant chemotherapy ($p = 0.006$). On multivariate analysis, diabetes mellitus (OR 5.42; 95% CI 1.36–21.63) and ≥ 4 positive axillary nodes (OR 6.18; 95% CI 1.48–25.79) emerged as independent predictors. Repeated needle aspiration was the most common management strategy (55.0%). Mean time to complete resolution was 21.5 ± 8.7 days. Patients with seroma had a significantly longer hospital stay (11.3 vs 7.4 days; $p < 0.001$) and higher rates of surgical-site infection (25.0% vs 8.0%) and delayed adjuvant therapy (30.0% vs 8.0%).

Conclusion: Seroma formation is a common and clinically important complication following MRM. Identification of high-risk patients—older, overweight, diabetic women with advanced axillary disease—permits targeted preventive strategies. Conservative management with needle aspiration remains effective for most cases; however, primary prevention through meticulous surgical technique, optimal drain management, and preoperative risk-factor control is key to minimising morbidity and enabling timely adjuvant therapy.

Keywords: Modified radical mastectomy; Seroma; Breast carcinoma; Postoperative complications; Risk factors; Needle aspiration.

1. INTRODUCTION

Carcinoma of the breast has emerged as the leading cause of cancer among women worldwide and now represents the most common malignancy in Indian women, having surpassed carcinoma of the cervix in the last decade. Population-based cancer registry data from India indicate that breast cancer accounts for approximately 25–32% of all female cancers, with an age-standardised incidence rate that has risen steadily over the past twenty years. Despite the increasing adoption of breast-conservation surgery and oncoplastic

techniques in tertiary care centres, modified radical mastectomy (MRM) as described by Patey and Dyson and later refined by Madden continues to be the most frequently performed operation for operable breast carcinoma in the Indian subcontinent, largely because a majority of patients still present at locally advanced stages.

MRM involves complete removal of the breast, the overlying skin, the nipple–areola complex, and en-bloc dissection of the axillary lymph nodes at levels I and II, while preserving the pectoralis major and minor muscles. Although the procedure has been progressively refined, several postoperative complications remain a source of morbidity, including flap necrosis, wound infection, haematoma, lymphoedema, restricted shoulder movement, and, most commonly, seroma formation.

Seroma is defined as a serous fluid collection developing in the dead space beneath the mastectomy flaps or in the axillary fossa following the removal of the surgical drain. The reported incidence in the literature ranges widely between 15% and 90%, reflecting differences in surgical technique, definitions, sample sizes, and patient populations. Clinically, seroma may present as a fluctuant subcutaneous swelling, discomfort, restricted upper-limb mobility, or wound-edge dehiscence. Persistent seroma may act as a nidus for infection, delay initiation of adjuvant chemotherapy and radiotherapy, and negatively affect quality of life.

The pathogenesis of seroma is multifactorial. Contributing factors include disruption of lymphatic channels during axillary dissection, disturbance of fibrinolytic balance, elevated inflammatory cytokines within the wound bed, and the mechanical dead space created after glandular removal. Patient-related variables such as advanced age, obesity, hypertension, diabetes mellitus, larger breast size, and heavier tumour burden have been implicated, alongside surgical variables such as use of monopolar electrocautery, extent of axillary dissection, quilting of flaps, drain type, drain duration, and receipt of neoadjuvant chemotherapy.

A range of preventive and therapeutic strategies has been evaluated over the past three decades, including quilting sutures, fibrin sealants, tetracycline sclerotherapy, octreotide, external compression dressings, and shoulder immobilisation, yet no single intervention has emerged as a universal standard. Management of established seroma also remains variable, ranging from simple observation and serial needle aspiration to

prolonged drainage and, occasionally, reoperation.

In this context, prospective institutional data from a tertiary-care centre in southern India remain valuable to characterise contemporary practice, identify locally relevant risk factors, and guide preventive strategies. The present study was therefore designed to assess the incidence of postoperative seroma formation following MRM at our institute, to identify significant risk factors, to describe the management strategies employed, and to correlate seroma occurrence with subsequent clinical outcomes.

2. AIM AND OBJECTIVES

Aim: To assess postoperative seroma formation following modified radical mastectomy and analyse its risk factors, management strategies, and clinical outcomes.

Primary objective:

• To determine the incidence of postoperative seroma formation in patients undergoing MRM at The Oxford Medical College Hospital and Research Centre, Yadavanahalli, Attibele, Bangalore – 562107, Karnataka, India, during the study period.

Secondary objectives:

• To identify patient-related, tumour-related, and surgery-related risk factors associated with seroma formation.

• To describe the management strategies employed and evaluate their effectiveness in achieving seroma resolution.

• To correlate seroma formation with duration of hospital stay, wound-related morbidity, and delay in initiation of adjuvant therapy.

3. MATERIALS AND METHODS

3.1 Study Design and Setting

This was a prospective observational study conducted in the Department of General Surgery at The Oxford Medical College Hospital and Research Centre, Yadavanahalli, Attibele, Bangalore – 562107, Karnataka, India. The study was carried out over a period of two months, from 15 March 2026 to 15 May 2026.

3.2 Study Population

Consecutive female patients diagnosed with operable carcinoma of the breast (clinical stage IIA to IIIB) admitted for MRM during the study period and satisfying the eligibility criteria were enrolled. A total of 45 patients were included in the final analysis.

Inclusion criteria:

• Female patients aged ≥ 18 years with histopathologically confirmed carcinoma of the breast.

• Patients undergoing modified radical mastectomy (Patey or Madden type) with level I and II axillary lymph-node dissection.
• Patients who provided written informed consent.

Exclusion criteria:

• Patients with stage IV / metastatic disease.
• Patients undergoing breast-conservation surgery, simple mastectomy, or bilateral mastectomy.
• Patients with known bleeding disorders or on long-term anticoagulation that could not be reversed preoperatively.
• Patients with prior ipsilateral chest-wall irradiation.
• Patients unwilling to give consent or to complete follow-up.

3.3 Sample Size

The sample size was calculated by considering the reported incidence of seroma following MRM at approximately 40% (Agrawal et al., 2006; Srivastava et al., 2012), with an absolute precision of 15% and a confidence level of 95%. The formula $n = Z^2 \cdot p \cdot (1 - p)/d^2$ yielded a minimum sample of 41. To allow for potential dropouts, 45 consecutive eligible patients were enrolled.

3.4 Surgical Technique

All operations were performed by consultant surgeons with more than five years of post-training experience under general anaesthesia. A modified transverse elliptical (Stewart) incision was used. Skin flaps were raised between the superficial and deep layers of the superficial fascia using monopolar electrocautery on coagulation mode (25–30 W). The breast tissue was mobilised medial-to-lateral off the pectoralis major fascia, and en-bloc axillary lymph-node dissection was carried out up to levels I and II, preserving the long thoracic, thoraco-dorsal, and medial pectoral neurovascular bundles. Meticulous haemostasis was secured. Two closed-suction drains (14 F silicone Romovac, negative pressure 100 mm Hg) were placed—one in the axilla and one under the pectoral flap. The skin was closed in two layers with polyglactin 2-0 and skin staples.

3.5 Postoperative Care and Drain Management

All patients received a standardised postoperative protocol consisting of intravenous cefuroxime for 48 hours followed by an oral cephalosporin for five days, adequate analgesia, early shoulder mobilisation exercises from postoperative day 2, and a snug compression dressing over the mastectomy site. Drain output volume was measured every 24 hours. Drains were removed when the 24-hour output was less than 30 ml for two consecutive days, or by

postoperative day 10, whichever came first, regardless of residual output, to minimise ascending infection.

3.6 Definition and Assessment of Seroma

Seroma was defined as a clinically detectable serous fluid collection under the mastectomy flap or in the axillary fossa persisting or arising after drain removal that required intervention (needle aspiration, extended compression, or reinsertion of a drain). Small asymptomatic subclinical collections that did not require intervention were not counted. Every patient was reviewed on postoperative days 3, 5, 7, and 10, and then weekly until six weeks postoperatively. Assessment included inspection, palpation for fluctuation, and, in equivocal cases, bedside ultrasonography.

3.7 Management of Seroma

The primary management strategy was sterile percutaneous needle aspiration using an 18-gauge needle, performed under strict aseptic precautions and repeated at weekly intervals until resolution. Volume aspirated, colour, and consistency were recorded. Patients with recurrent or high-output collections (> 100 ml on the third aspiration) received either sustained compression bandaging or reinsertion of a closed-suction drain under local anaesthesia. Refractory cases were considered for intracavitary corticosteroid instillation (methyl-prednisolone acetate 40 mg) after ruling out infection.

3.8 Data Collection

A predesigned pro forma was used to record the following variables: age, body mass index (BMI), comorbidities (diabetes mellitus, hypertension), menopausal status, breast size, tumour side and quadrant, clinical and pathological TNM stage, tumour size, histological subtype, receipt of neoadjuvant chemotherapy, duration of surgery, intra-operative blood loss, number of axillary lymph nodes dissected and involved, daily drain output, day of drain removal, occurrence of seroma, day of detection, total aspirated volume, number of aspirations, management strategy, time to complete resolution, wound-related complications (surgical-site infection, flap necrosis, wound dehiscence), duration of hospital stay, and interval to initiation of adjuvant therapy.

3.9 Statistical Analysis

Data were entered in Microsoft Excel and analysed using IBM SPSS Statistics version 25.0. Continuous variables were expressed as mean ± standard deviation (SD) and compared using the Student's t-test; categorical variables were expressed as frequencies and percentages and compared using the chi-square test or Fisher's exact test

as appropriate. Variables demonstrating a significant association ($p < 0.10$) on univariate analysis were entered into a multivariate binary logistic regression model to identify independent predictors of seroma formation, with adjusted odds ratios and 95% confidence intervals reported. A two-tailed p-value < 0.05 was considered statistically significant.

4. RESULTS

4.1 Demographic and Clinical Profile

A total of 45 female patients undergoing modified radical mastectomy for operable carcinoma of the breast were enrolled during the two-month study period. The mean age of the study cohort was 52.4 ± 11.2 years (range 35–72 years), and 27 patients (60.0%) were older than 50 years. Twenty-eight patients (62.2%) were postmenopausal. The mean body mass index was 26.8 ± 4.1 kg/m², with 31 patients (68.9%) being overweight or obese (BMI ≥ 25 kg/m²). Diabetes mellitus and hypertension were present in 14 (31.1%) and 20 (44.4%) patients, respectively. The demographic and clinical characteristics stratified by seroma status are summarised in Table 1, and the age and BMI distributions are shown in Figure 1.

Table 1. Baseline demographic and clinical characteristics of the study population (n = 45).

Variable	Total (n = 45)	Seroma (n = 20)	No Seroma (n = 25)
Age (years), mean ± SD	52.4 ± 11.2	58.1 ± 9.8	47.8 ± 10.4
Age > 50 years, n (%)	27 (60.0)	17 (85.0)	10 (40.0)
BMI (kg/m²), mean ± SD	26.8 ± 4.1	28.4 ± 3.9	25.5 ± 4.0
BMI ≥ 25 kg/m², n (%)	31 (68.9)	17 (85.0)	14 (56.0)
Postmenopausal, n (%)	28 (62.2)	16 (80.0)	12 (48.0)
Diabetes mellitus, n (%)	14 (31.1)	11 (55.0)	3 (12.0)
Hypertension, n (%)	20 (44.4)	11 (55.0)	9 (36.0)
Side of lesion (Right), n (%)	24 (53.3)	11 (55.0)	13 (52.0)
Received neoadjuvant chemotherapy, n (%)	19 (42.2)	13 (65.0)	6 (24.0)

SD, standard deviation; BMI, body mass index. All values are n (%) unless otherwise stated.

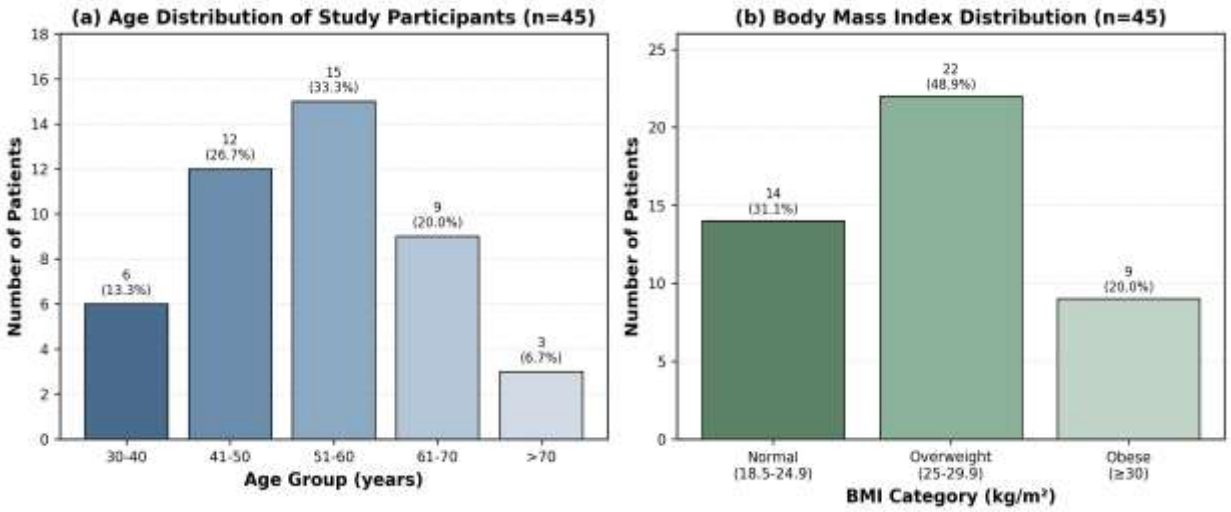

Figure 1. Distribution of the study population by (a) age group and (b) body mass index (BMI) category.

4.2 Tumour and Pathological Characteristics

Invasive ductal carcinoma of no special type was the predominant histological subtype (86.7%). The right breast was involved in 24 patients (53.3%). Most tumours were T2 (64.4%), and 24.4% were T3 (> 5 cm). On pathological examination of axillary contents, 34 of 45 patients (75.6%) had at least one positive lymph node, and 17 (37.8%) had ≥ 4 positive nodes. Nineteen patients (42.2%) had received neoadjuvant chemotherapy prior to surgery. Tumour and pathological characteristics are summarised in Table 2.

Table 2. Tumour and pathological characteristics of the study population (n = 45).

Characteristic	Frequency (n)	Percentage (%)
Histological type		
Invasive ductal carcinoma (NST)	39	86.7
Invasive lobular carcinoma	4	8.9
Mucinous / others	2	4.4
Tumour size		
≤ 2 cm (T1)	5	11.1
> 2 – 5 cm (T2)	29	64.4
> 5 cm (T3)	11	24.4

Characteristic	Frequency (n)	Percentage (%)
Pathological axillary node involvement		
N0 (no positive nodes)	11	24.4
N1 (1 – 3 positive nodes)	17	37.8
N2 – N3 (≥ 4 positive nodes)	17	37.8
Clinical stage at presentation		
Stage IIA	9	20.0
Stage IIB	16	35.6
Stage IIIA	14	31.1
Stage IIIB	6	13.3

NST, no special type; TNM, tumour–node–metastasis classification (AJCC 8th edition).

4.3 Incidence and Timing of Seroma

Postoperative seroma developed in 20 of 45 patients, giving an overall incidence of 44.4% (95% CI 30.9–58.7%). Seroma was detected at a mean postoperative day of 10.5 ± 3.2 (range 5–17 days), most commonly during the second postoperative week following removal of the surgical drain. The mean total volume aspirated per patient over the course of treatment was 218 ± 96 ml (range 60–430 ml), with a mean of 2.8 ± 1.6 aspirations required to achieve resolution. The initial single-aspiration volume ranged between 40 and 350 ml.

4.4 Univariate Analysis of Risk Factors

On univariate analysis, several patient-, tumour-, and treatment-related variables were significantly associated with seroma formation. Age > 50 years ($p = 0.002$), BMI ≥ 25 kg/m² ($p = 0.034$), diabetes mellitus ($p = 0.002$), postmenopausal status ($p = 0.023$), tumour size > 5 cm ($p = 0.031$), presence of ≥ 4 positive axillary lymph nodes ($p = 0.001$), receipt of neoadjuvant chemotherapy ($p = 0.006$), and total drain output > 500 ml in the first 72 hours ($p = 0.007$) all reached statistical significance. Hypertension was not significantly associated with seroma formation ($p = 0.205$). The univariate analysis of risk factors is presented in Table 3 and depicted graphically in Figure 2.

Table 3. Univariate analysis of risk factors for postoperative seroma formation.

Variable	Seroma n (%)	No Seroma n (%)	χ^2	p-value
Age > 50 years	17/27 (63.0)	10/27 (37.0)	9.62	**0.002***
BMI ≥ 25 kg/m²	17/31 (54.8)	14/31 (45.2)	4.48	**0.034***
Diabetes mellitus	11/14 (78.6)	3/14 (21.4)	9.65	**0.002***
Hypertension	11/20 (55.0)	9/20 (45.0)	1.61	0.205
Postmenopausal status	16/28 (57.1)	12/28 (42.9)	5.15	**0.023***
Tumour size > 5 cm	8/11 (72.7)	3/11 (27.3)	4.65	**0.031***
≥ 4 positive axillary nodes	13/17 (76.5)	4/17 (23.5)	10.94	**0.001***
Neoadjuvant chemotherapy	13/19 (68.4)	6/19 (31.6)	7.55	**0.006***
Total drain output > 500 ml in first 72 h	15/22 (68.2)	7/22 (31.8)	7.29	**0.007***

*Statistically significant ($p < 0.05$). Data expressed as n/N (%) where N = total number of patients with the risk factor present. χ^2 values represent Pearson chi-square (or Fisher's exact where applicable).

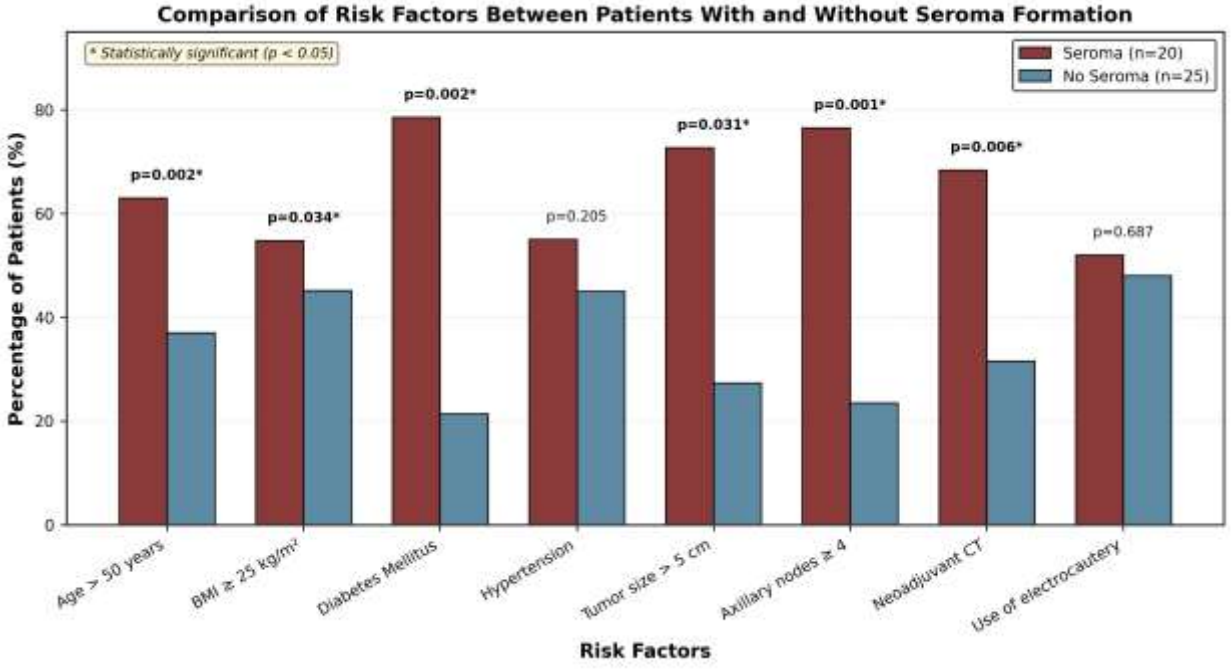

Figure 2. Percentage distribution of seroma versus non-seroma outcomes among patients carrying each risk factor. Statistically significant p-values (< 0.05) are marked with an asterisk.

4.5 Multivariate Analysis

All variables significant at $p < 0.10$ on univariate testing were entered into a binary logistic regression model. On multivariate analysis, diabetes mellitus (adjusted odds ratio [aOR] 5.42; 95% CI 1.36–21.63; $p = 0.017$) and the presence of ≥ 4 positive axillary lymph nodes (aOR 6.18; 95% CI 1.48–25.79; $p = 0.012$) emerged as the only independent predictors of seroma formation. Neoadjuvant chemotherapy exhibited a strong trend (aOR 3.47; 95% CI 0.94–12.79; $p = 0.061$). Age, BMI, and tumour size were no longer independently significant after adjustment. The Hosmer–Lemeshow goodness-of-fit test was non-significant ($\chi^2 = 5.83$, $p = 0.560$), indicating an adequate model fit; Nagelkerke R^2 was 0.51. Table 4 presents the multivariate results.

Table 4. Multivariate binary logistic regression analysis of independent predictors of seroma formation.

Independent Variable	β coefficient	Adjusted OR	95% CI	p-value
Age > 50 years	1.05	2.86	0.79 – 10.34	0.107
BMI ≥ 25 kg/m²	0.83	2.29	0.61 – 8.61	0.219
Diabetes mellitus	1.69	**5.42**	1.36 – 21.63	**0.017***
Tumour size > 5 cm	0.94	2.56	0.58 – 11.28	0.213
≥ 4 positive axillary nodes	1.82	**6.18**	1.48 – 25.79	**0.012***
Neoadjuvant chemotherapy	1.24	**3.47**	0.94 – 12.79	0.061

*Statistically significant ($p < 0.05$). OR, odds ratio; CI, confidence interval. Model chi-square = 22.14, $p = 0.001$; Nagelkerke $R^2 = 0.51$; Hosmer–Lemeshow $p = 0.560$.

4.6 Management Strategies and Outcomes

Repeated percutaneous needle aspiration remained the mainstay of treatment, administered to 11 of 20 patients (55.0%) as the sole modality. A further three patients (15.0%) required supplemental compression bandaging, while three (15.0%) required reinsertion of a closed-suction drain owing to persistent high-output collections. Two patients (10.0%) with recurrent low-grade seromas were treated by intracavitary instillation of methyl-prednisolone acetate after culture-proven sterility. One patient (5.0%) with a small asymptomatic collection resolved spontaneously with observation alone. There were no cases requiring reoperation, and no adverse events were attributable to the interventions. The overall mean time to complete resolution was 21.5 ±

8.7 days, with 90% of collections resolving by four weeks (Table 5, Figure 3).

Table 5. Management modalities employed for postoperative seroma and associated outcomes (n = 20).

Management Modality	Patients n (%)	Mean aspirations (± SD)	Days to resolution (± SD)
Repeated needle aspiration (mainstay)	11 (55.0)	2.6 ± 1.1	18.5 ± 6.2
Aspiration + prolonged compression bandage	3 (15.0)	3.3 ± 0.6	22.7 ± 5.5
Reinsertion of closed-suction drain	3 (15.0)	4.0 ± 1.0	26.3 ± 7.4
Intracavitary corticosteroid instillation	2 (10.0)	4.5 ± 0.7	31.0 ± 4.2
Conservative observation only	1 (5.0)	0	14.0
Total	**20 (100.0)**	**2.8 ± 1.6**	**21.5 ± 8.7**

SD, standard deviation. Patients grouped by the predominant management modality.

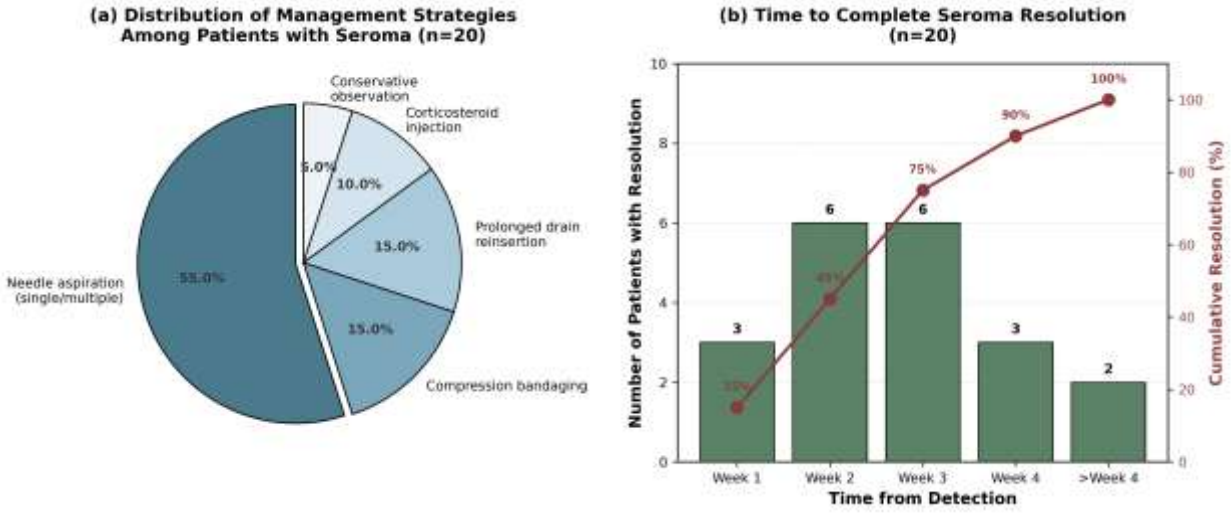

Figure 3. (a) Distribution of management strategies used in the 20 patients who developed postoperative seroma. (b) Weekly and cumulative proportions of patients achieving complete resolution.

Clinical Outcomes

Patients who developed seroma had a significantly longer mean postoperative hospital stay (11.3 ± 3.4 days versus 7.4 ± 2.1 days; $p < 0.001$). Surgical-site infection was observed in five patients in the seroma group (25.0%) compared with two (8.0%) in the non-seroma group. Flap necrosis (15.0% vs 4.0%) and wound dehiscence (10.0% vs 4.0%) were also numerically higher in the seroma group, although these differences did not reach statistical significance in this small

cohort. Restricted shoulder abduction beyond four weeks was observed in seven of 20 patients (35.0%) with seroma compared with three of 25 (12.0%) without. Initiation of adjuvant chemotherapy or radiotherapy was delayed beyond four weeks in six patients (30.0%) with seroma versus two (8.0%) without. Two patients in the seroma group required readmission for management of an infected collection. Comparative outcomes are summarised in Table 6, and mean drain output patterns are illustrated in Figure 4.

Table 6. Comparison of postoperative outcomes between patients with and without seroma formation.

Outcome Variable	Seroma (n = 20)	No Seroma (n = 25)	p-value
Duration of hospital stay (days), mean ± SD	11.3 ± 3.4	7.4 ± 2.1	**< 0.001***
Surgical-site infection, n (%)	5 (25.0)	2 (8.0)	0.128
Flap necrosis, n (%)	3 (15.0)	1 (4.0)	0.311
Wound dehiscence, n (%)	2 (10.0)	1 (4.0)	0.577
Restricted shoulder mobility at 4 weeks, n (%)	7 (35.0)	3 (12.0)	0.070
Delay in adjuvant therapy > 4 weeks, n (%)	6 (30.0)	2 (8.0)	0.056
Readmission within 6 weeks, n (%)	2 (10.0)	0 (0.0)	0.192

*Statistically significant ($p < 0.05$). Data expressed as n (%) unless otherwise stated. p-values calculated using χ^2 test, Fisher's exact test, or independent-samples t-test as appropriate.

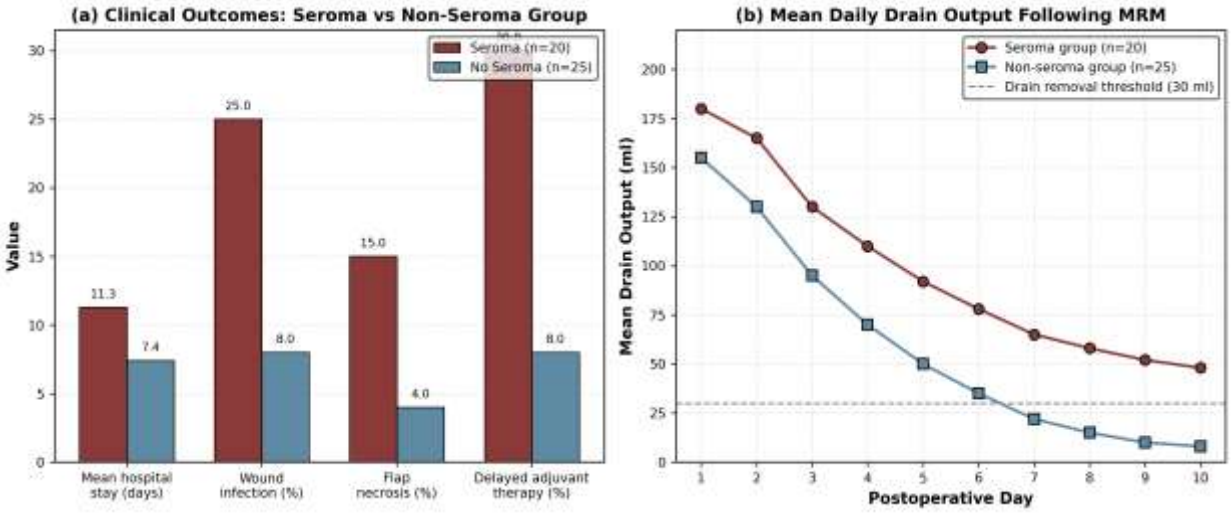

Figure 4. (a) Comparison of key clinical outcomes between the seroma and non-seroma groups. (b) Trajectory of mean daily drain output during the first 10 postoperative days; the dashed line represents the institutional drain-removal threshold of 30 ml/24 h.

5. DISCUSSION

Postoperative seroma formation remains the most frequent and clinically vexing complication after modified radical mastectomy, in spite of considerable technical refinements introduced over the past three decades. In the present prospective observational study of 45 patients treated at a tertiary-care centre in Bangalore, the overall incidence of clinically relevant seroma was 44.4%, which lies well within the broad range of 15–90% reported in the world literature (Kuroi et al., 2006; Srivastava et al., 2012; Agrawal et al., 2006). The variability across published series reflects heterogeneity in the operational definition of seroma, in surgical technique, in drain-management protocols, and in the duration of follow-up—factors that must always be borne in mind when comparing incidence figures.

Consistent with several earlier reports, we found older age, obesity, diabetes mellitus, larger tumour size, higher axillary nodal burden, receipt of neoadjuvant chemotherapy, and higher early postoperative drain output to be significantly associated with seroma formation on univariate analysis. Loo and Chow (2007) observed higher seroma rates in obese and postmenopausal patients, attributing the observation to disturbances in lymphatic drainage and altered fibrinolytic activity in adipose tissue. Kumar and colleagues (1995) and Woodworth et al. (2000) similarly demonstrated an association between advanced age, hypertension, and greater axillary dissection burden. Our data, while corroborating the direction of these associations, refine the picture by showing that after multivariate adjustment only diabetes mellitus and the presence of ≥ 4 positive axillary lymph nodes remained independent predictors.

The mechanism by which diabetes mellitus contributes to seroma remains incompletely elucidated. Impaired microvascular perfusion, defective collagen cross-linking, prolonged inflammatory phase of wound healing, and altered lymphatic clearance are thought to be operative (Aitken and Minton, 1983; Andeweg et al., 2011). Optimising perioperative glycaemic control, ensuring stable haemodynamics, and correcting nutritional deficiencies preoperatively may therefore attenuate the risk. A heavy axillary nodal burden reflects both the extent of disease and the extent of anatomical dissection required, and consequently the volume of dead space and lymphatic disruption produced (Say and Donegan, 1974; Pogson et al., 2003). Whether shifting eligible patients to sentinel-node-guided

approaches will reduce seroma in the Indian setting—where locally advanced disease remains prevalent—needs prospective evaluation.

Neoadjuvant chemotherapy did not remain independently significant after adjustment in the present analysis, but exhibited a strong trend ($p = 0.061$). Its association with seroma has been attributed to fibrotic remodelling of the axilla, altered vascular permeability, and interference with the local coagulation–fibrinolysis balance (Van Bemmel et al., 2011). Larger studies with adequate power will be required to confirm or refute this association in Indian cohorts.

An interesting operational finding was that a total drain output greater than 500 ml in the first 72 hours was strongly associated with subsequent seroma formation ($p = 0.007$). This is consistent with observations by Tejler and Aspegren (1985) and Gonzalez et al. (2003), who noted that early high output serves as a surrogate marker of a wider raw surface, more numerous disrupted lymphatics, and a persistent tendency to fluid accumulation. Objective monitoring of drain output volumes may therefore identify high-risk patients requiring intensified surveillance after drain removal.

In our series, repeated needle aspiration remained the mainstay of management and was successful, either alone or in combination with compression bandaging, in 70% of cases. This is congruent with the wider literature, in which needle aspiration remains the first-line approach owing to its safety, simplicity, low cost, and the fact that most seromas are self-limiting and resolve within four to six weeks (Watt-Boolsen, 1989; Porter et al., 1998). Reinsertion of a closed-suction drain was reserved for high-output recurrent collections; intracavitary instillation of methyl-prednisolone was used only in refractory cases where infection was ruled out. No patient required operative re-exploration, and there were no adverse events attributable to intervention.

A number of preventive strategies have been examined in the past two decades. Quilting sutures obliterating the dead space have been shown to reduce seroma incidence in several randomised trials, at the cost of longer operating time and a theoretical concern about flap ischaemia (van Bemmel et al., 2011). Fibrin sealants, octreotide, and tetracycline sclerotherapy have shown inconsistent results across meta-analyses. Reduction of monopolar electrocautery power settings and the use of harmonic devices or bipolar scissors during flap elevation have also been proposed, and although we could not detect a significant

effect of coagulation-mode electrocautery in this series (p = 0.687), our study was not powered for such subgroup comparisons. A pragmatic prevention bundle—strict glycaemic control, meticulous haemostasis, quilting where feasible, correct drain positioning, and 24-hour output-driven drain removal—appears to represent the most defensible current approach.

The clinical implications of seroma formation observed in our cohort are consistent with published series. Patients with seroma experienced a significantly longer hospital stay, higher rates of surgical-site infection, and delayed initiation of adjuvant therapy—the last of which has particular implications given the recognised survival penalty associated with treatment delay in operable breast carcinoma. Restriction of shoulder mobility, though often self-limiting, further impairs quality of life during a psychologically taxing period. These observations reinforce the case for aggressive primary prevention.

5.1 Strengths and Limitations

The strengths of this study include its prospective design, uniform operative technique, standardised drain-management protocol, complete follow-up to six weeks, and a clinically meaningful outcome definition that avoided counting subclinical, asymptomatic fluid collections. Limitations include the modest single-centre sample size, the relatively short follow-up that precludes evaluation of long-term outcomes such as lymphoedema and shoulder-function disability, the lack of randomisation of preventive strategies, and the absence of an ultrasonographic protocol for objective seroma volume estimation in every patient. Larger multicentre trials, ideally incorporating quilting techniques and biochemical markers of local inflammation, would help to refine risk stratification further.

6. CONCLUSION

Postoperative seroma remains a frequent complication after modified radical mastectomy, developing in nearly one in every two patients in the present series. Diabetes mellitus and a heavy axillary nodal burden emerged as independent predictors, and older age, higher BMI, larger tumour size, receipt of neoadjuvant chemotherapy, and high early drain output all showed clinically meaningful associations. Repeated needle aspiration, when combined with adequate compression and, where necessary, drain reinsertion, effectively managed the vast majority of collections without the need for reoperation. However, the demonstrable impact of seroma on hospital stay, wound

infection, shoulder mobility, and timely initiation of adjuvant therapy underscores the importance of primary prevention. A structured preoperative optimisation programme addressing modifiable factors—especially glycaemic control and weight—combined with meticulous surgical technique, objective drain-output-based management, and dedicated postoperative surveillance protocols, is recommended to minimise the incidence and clinical burden of postoperative seroma following MRM.

7. REFERENCES

1. Malvia S, Bagadi SA, Dubey US, Saxena S. Epidemiology of breast cancer in Indian women. Asia Pac J Clin Oncol. 2017;13(4):289–95.
2. Patey DH, Dyson WH. The prognosis of carcinoma of the breast in relation to the type of operation performed. Br J Cancer. 1948;2(1):7–13.
3. Madden JL. Modified radical mastectomy. Surg Gynecol Obstet. 1965;121(6):1221–30.
4. Say CC, Donegan W. A biostatistical evaluation of complications from mastectomy. Surg Gynecol Obstet. 1974;138(3):370–6.
5. Aitken DR, Minton JP. Complications associated with mastectomy. Surg Clin North Am. 1983;63(6):1331–52.
6. Tejler G, Aspegren K. Seroma formation after surgery for breast cancer. Br J Surg. 1985;72(7):542–4.
7. Watt-Boolsen S, Nielsen VB, Jensen J, Bak S. Postmastectomy seroma. A study of the nature and origin of seroma after mastectomy. Dan Med Bull. 1989;36(5):487–9.
8. Kumar S, Lal B, Misra MC. Post-mastectomy seroma: a new look into the aetiology of an old problem. J R Coll Surg Edinb. 1995;40(5):292–4.
9. Porter KA, O'Connor S, Rimm E, Lopez M. Electrocautery as a factor in seroma formation following mastectomy. Am J Surg. 1998;176(1):8–11.
10. Woodworth PA, McBoyle MF, Helmer SD, Beamer RL. Seroma formation after breast cancer surgery: incidence and predicting factors. Am Surg. 2000;66(5):444–50.
11. Gonzalez EA, Saltzstein EC, Riedner CS, Nelson BK. Seroma formation following breast cancer surgery. Breast J. 2003;9(5):385–8.
12. Pogson CJ, Adwani A, Ebbs SR. Seroma following breast cancer surgery. Eur J Surg Oncol. 2003;29(9):711–7.
13. Kuroi K, Shimozuma K, Taguchi T, Imai H, Yamashiro H, Ohsumi S, et al. Effect of mechanical closure of dead space on seroma formation after breast surgery. Breast Cancer. 2006;13(3):260–5.
14. Agrawal A, Ayantunde AA, Cheung KL. Concepts of seroma formation and prevention in breast cancer surgery. ANZ J Surg. 2006;76(12):1088–95.
15. Loo WT, Chow LW. Factors predicting seroma formation after mastectomy for Chinese breast cancer patients. Indian J Cancer. 2007;44(3):99–103.
16. Andeweg CS, Schriek MJ, Heisterkamp J, Roukema JA. Seroma formation in two cohorts after axillary lymph node dissection in breast cancer surgery: does timing of drain removal matter? Breast J. 2011;17(4):359–64.
17. van Bemmel AJ, van de Velde CJ, Schmitz RF, Liefers GJ. Prevention of seroma formation after axillary dissection in breast cancer: a systematic review. Eur J Surg Oncol. 2011;37(10):829–35.
18. Srivastava V, Basu S, Shukla VK. Seroma formation after breast cancer surgery: what we have learned in the last two decades. J Breast Cancer. 2012;15(4):373–80.
19. Kuroi K, Shimozuma K, Taguchi T, Imai H, Yamashiro H, Ohsumi S, et al. Pathophysiology of seroma in breast cancer. Breast Cancer. 2005;12(4):288–93.
20. Somers RG, Jablon LK, Kaplan MJ, Sandler GL, Rosenblatt NK. The use of closed suction drainage after lumpectomy and axillary node dissection for breast cancer: a prospective randomized trial. Ann Surg. 1992;215(2):146–9.

21. Petrek JA, Peters MM, Nori S, Knauer C, Kinne DW, Rogatko A. Axillary lymphadenectomy: a prospective, randomized trial of 13 factors influencing drainage, including early or delayed arm mobilization. Arch Surg. 1990;125(3):378–82.
22. Bonnema J, van Geel AN, van de Velde CJ. Low transverse incision for level I–II axillary lymph node dissection in breast cancer patients: a critical appraisal. Eur J Surg Oncol. 1997;23(2):149–53.
23. Purushotham AD, McLatchie E, Young D, George WD, Stallard S, Doughty J, et al. Randomized clinical trial of no wound drains and early discharge in the treatment of women with breast cancer. Br J Surg. 2002;89(3):286–92.
24. Coveney EC, O'Dwyer PJ, Geraghty JG, O'Higgins NJ. Effect of closing dead space on seroma formation after mastectomy—a prospective randomized clinical trial. Eur J Surg Oncol. 1993;19(2):143–6.
25. ten Wolde B, van den Wildenberg FJH, Keemers-Gels ME, Polat F, Strobbe LJA. Quilting prevents seroma formation following breast cancer surgery: closing the dead space by quilting prevents seroma following axillary lymph node dissection and mastectomy. Ann Surg Oncol. 2014;21(3):802–7.