



Comparative Analysis of Harmonic Scalpel versus Electrocautery in Skin Flap Raising during Modified Radical Mastectomy.

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Abstract

Background: Modified radical mastectomy remains a commonly performed surgical procedure for breast carcinoma. Skin flap raising during MRM (Modified Radical Mastectomy) is traditionally performed using electrocautery; however, thermal tissue injury may contribute to postoperative complications such as flap necrosis, seroma formation, and increased blood loss. The harmonic scalpel, an ultrasonic dissection device, has been proposed as an alternative with improved hemostasis and reduced tissue damage. This study compared postoperative outcomes of harmonic scalpel and electrocautery in skin flap raising during MRM. **Methods:** This prospective observational study was conducted in the Department of General Surgery, FAME Hospital and Research Institute, Mysuru, Karnataka, over one year. Sixty female patients undergoing MRM for biopsy-proven breast carcinoma were included and allocated into two groups: the electrocautery group (n=30) and the harmonic scalpel group (n=30). Outcomes assessed included operative time, flap-raising time, intraoperative blood loss, drain output, duration of drain placement, hospital stay, flap necrosis, seroma formation, and surgical site infection. Patients were followed up on postoperative days 3, 7, and 30. **Results:** The mean age of participants was 49.63±11.82 years. The harmonic scalpel group had significantly longer flap-raising time (38.50±7.67 vs. 30.33±3.92 min; p<0.001) and operative time (140.67±28.55 vs. 122.00±19.16 min; p=0.004). However, intraoperative blood loss was significantly lower in the harmonic scalpel group (138.50±28.53 vs. 178.33±21.06 mL; p<0.001). Flap necrosis occurred in 1 (3.3%) patient in the harmonic scalpel group and 5 (16.7%) patients in the electrocautery group. No significant differences were observed in drain output, drain duration, seroma formation, surgical site infection, or hospital stay between the groups. **Conclusion:** Harmonic scalpel provides superior hemostasis and is associated with a lower incidence of flap necrosis compared with electrocautery. However, it increases operative duration and does not significantly improve other postoperative outcomes. Considering its higher cost, routine use of harmonic scalpel in MRM may not be cost-effective in resource-limited settings.

Keywords: Breast Cancer, Modified Radical Mastectomy, Harmonic Scalpel, Electrocautery, Flap Necrosis, Intraoperative Blood Loss.



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INTRODUCTION

Approximately 25% of all female cancers are breast cancer, making it the most prevalent disease among women globally.[1] With an age-adjusted incidence rate of 25.8 per 100,000 women and a fatality rate of 12.7 per 100,000 women, breast cancer has overtaken cervical cancer as the most common cancer among women in India.[2,3] Several factors contribute to its increasing incidence, including advancing age, obesity, reproductive and hormonal factors, lack of physical activity, radiation exposure, atypical hyperplasia, and a family history of breast carcinoma.[4]

Management of breast cancer involves a multidisciplinary approach comprising surgery, chemotherapy, radiotherapy, and targeted therapies. MRM (Modified Radical Mastectomy) is still one of the most popular surgical procedures, especially for invasive and locally advanced breast malignancies. In order to reduce the risk of residual disease and local recurrence, the main goal of a mastectomy is to remove all tumor-bearing breast tissue, including the ductolobular units.[5]

MRM involves excision of the entire breast along with the nipple-areola complex and ipsilateral axillary lymph node dissection. A crucial step in this procedure is the raising of skin flaps, which can be performed using a scalpel, monopolar electrocautery, or harmonic scalpel. Despite its widespread usage, conventional electrocautery has been linked to increased blood loss, seroma formation, wound infection, flap necrosis, haematoma, and delayed drainage because it damages healthy tissue and disrupts the subdermal vascular plexus.[6]

Skin flap-related complications following MRM occur in approximately 5–30% of patients and can significantly affect postoperative recovery.[6,7] The harmonic scalpel, an ultrasonic dissection device, has emerged as an alternative technique that provides simultaneous cutting and coagulation with minimal lateral thermal damage. Compared with monopolar electrocautery, it offers advantages such as improved hemostasis, reduced tissue trauma, absence of smoke generation, and lower risk of nerve stimulation.[8,9]

AIMS AND OBJECTIVES

The present study aimed to compare the postoperative outcomes of skin flap raising using harmonic scalpel versus electrocautery during modified radical mastectomy. Specifically, the study evaluated the incidence of flap necrosis and other postoperative complications, while also comparing intraoperative blood loss, duration of surgery, incidence of seroma formation, total drain output, and the time required for skin flap elevation and overall operative procedure between the two techniques.

MATERIALS AND METHODS

Study Design

This prospective observational study was conducted in the Department of General Surgery, FAME Hospital and Research Institute, Mysuru, Karnataka, after obtaining approval from the IEC-HR (Institutional Ethics Committee–Human Research). The study was carried out over a period of one year following ethical clearance and included female patients aged more than 18 years with biopsy-proven carcinoma of the breast who fulfilled the eligibility criteria. The study was designed to evaluate and compare the outcomes of skin flap raising using harmonic scalpel and electrocautery during a modified radical mastectomy.

Inclusion and Exclusion Criteria

The study included female patients aged more than 18 years with biopsy-proven carcinoma of the breast or phyllodes tumor who were planned for modified radical mastectomy and provided informed consent for participation. Patients were excluded if they had a previous history of breast surgery, completion mastectomy with axillary nodal dissection following prior lumpectomy, breast tuberculosis, coexisting breast skin infections such as dermatitis or eczema, breast injuries or burns, or inoperable advanced breast malignancies. Additionally, immunocompromised patients, those on long-term steroid therapy, individuals with collagen vascular diseases or uncorrected coagulopathy, pregnant women, patients unfit for general anesthesia, and those unwilling to provide informed consent were excluded from the study.

Sample Size Calculation

A convenience sampling method was employed for the study. Following approval of the study protocol by the Institutional Research and Ethics Committee, all eligible patients with biopsy-proven carcinoma of the breast who were planned for surgery during the one-year study period were consecutively recruited. A total of 60 patients were included in the study and allocated into two groups, with 30 patients undergoing skin flap raising using electrocautery and 30 patients undergoing skin flap raising using harmonic scalpel during modified radical mastectomy.

Data Collection Procedure

Eligible female patients aged above 18 years with biopsy-proven breast carcinoma who fulfilled the inclusion criteria were enrolled in the study after obtaining informed consent. Detailed demographic information, clinical history, comorbidities, and relevant hematological, biochemical, and radiological investigations were recorded. Patients were alternately allocated into two groups: Group 1 underwent MRM with skin flap raising using electrocautery, while Group 2 underwent MRM with skin flap raising using harmonic scalpel. All procedures were performed under general anesthesia following preoperative assessment and administration of prophylactic antibiotics. Intraoperative parameters including time taken for flap raising, total operative time, and blood loss were documented. Postoperatively, drain output and duration of drainage were recorded, and patients were monitored for complications such as flap necrosis, seroma formation, surgical site infection, hematoma, and upper limb lymphedema. Wound assessments were carried out on postoperative days 3, 7, and 30, and patients were followed up for one month after surgery. Comparative analysis of operative outcomes and postoperative complications was performed between the two study groups.

Statistical Analysis

The SPSS (Statistical Package for the Social Sciences) version 22.0 (IBM Corporation, USA) was used to analyse the data. Whereas continuous variables were displayed as mean $\pm$ standard deviation (SD), categorical variables were given as frequencies and percentages. When comparing categorical variables between groups, the chi-square test or Fisher's exact test was used, depending on the situation. After determining if the data distribution was normal, continuous variables were compared using the independent sample t-test. Statistical significance was defined as a p-value of less than 0.05. For improved visualisation and explanation, the results were displayed in both tabular and graphical formats.

RESULTS

Table 1. Baseline Characteristics of Study Participants (N=60)

Variable	Overall (N=60)
Mean Age (in years)	49.63 ± 11.82
BMI (kg/m ²)	23.48 ± 3.25
Received NACT	19 (31.7%)
No NACT	41 (68.3%)

Table 1 illustrates the baseline demographic characteristics of the study population. The mean age was approximately 50 years and one-third of patients received neoadjuvant chemotherapy prior to surgery.

Table 2. Distribution of Age Groups and Comorbidities

Variable		n (%)
Age Group	<30 years	3 (5.0)
	31–40 years	12 (20.0)
	41–50 years	23 (38.3)
	51–60 years	10 (16.7)
	61–70 years	10 (16.7)
	>70 years	2 (3.3)
Comorbidity	None	40 (66.7)
	Hypertension	10 (16.7)
	Diabetes Mellitus	5 (8.3)
	Diabetes + Hypertension	5 (8.3)

Table 2 shows the age and comorbidity profile of the study participants. Most patients belonged to the 41–50 years age group. Hypertension was the most common comorbidity, while two-thirds of patients had no associated medical illness.

Table 3. Comparison of Baseline Characteristics between Study Groups

Variable	Electrocautery (n=30)	Harmonic Scalpel (n=30)	P-value
Age (in years)	48.63 ± 11.89	49.43 ± 11.94	0.796
BMI (kg/m ²)	23.02 ± 3.30	23.97 ± 3.18	0.270
Received NACT, n (%)	12 (40.0)	7 (23.3)	NS

Table 3 demonstrates comparability between the two study groups. No significant differences were observed regarding age, BMI, or receipt of neoadjuvant chemotherapy, indicating that both groups were well matched before surgery.

Table 4. Operative Outcomes

Variable	Electrocautery	Harmonic Scalpel	P-value
Time for Flap Raising (min)	30.33 ± 3.92	38.50 ± 7.67	0.001*
Total Operative Time (min)	122.00 ± 19.16	140.67 ± 28.55	0.004*
Intraoperative Blood Loss (mL)	178.33 ± 21.06	138.50 ± 28.53	0.001*
*Statistically significant			

Table 4 compares intraoperative parameters between the two techniques. Electrocautery significantly reduced flap raising time and total operative duration, whereas harmonic scalpel significantly reduced intraoperative blood loss.

Table 5. Drain-Related Outcomes

Variable	Electrocautery	Harmonic Scalpel	P-value
Drain Output POD-1 (mL)	87.17 ± 24.73	74.93 ± 32.93	0.109
Total Drain Output (mL)	310.83 ± 88.93	298.20 ± 127.87	0.659
Drain Removal Day	6.83 ± 0.75	7.43 ± 2.27	0.174

Table 5 presents postoperative drainage characteristics. Although drain output tended to be lower in the harmonic scalpel group, none of the differences reached statistical significance.

Table 6. Skin Flap Status During Follow-up

Follow-up Day	Electrocautery Healthy n (%)	Harmonic Healthy n (%)	P-value
Day 3	27 (90.0)	29 (96.7)	0.612
Day 7	25 (83.3)	29 (96.7)	0.195
Day 30	30 (100)	30 (100)	0.999
Follow-up Day	Electrocautery Unhealthy n (%)	Harmonic Unhealthy n (%)	
Day 3	3 (10.0)	1 (3.3)	
Day 7	5 (16.7)	1 (3.3)	
Day 30	0	0	

Table 6 illustrates postoperative flap viability. Flap necrosis was more frequent in the electrocautery group, particularly by postoperative day 7, although the difference was not statistically significant. All flaps healed by day 30.

Table 7. Post-Operative Complications

Complication	Electrocautery (n=30)	Harmonic Scalpel (n=30)
Flap Necrosis	5 (16.7%)	1 (3.3%)
Seroma	1 (3.3%)	1 (3.3%)
Surgical Site Infection	1 (3.3%)	0
Lymphedema	0	0

Table 7 summarizes postoperative complications. Flap necrosis was the most common complication and occurred predominantly in the electrocautery group. Seroma and SSI rates were low in both groups, and no patient developed lymphedema.

Table 8. Factors Associated with Flap Necrosis

Variable	Flap Necrosis Present (n=6)	Flap Necrosis Absent (n=54)	P-value
Age (years)	49.00 ± 13.62	49.04 ± 11.75	0.99
BMI (kg/m ²)	25.28 ± 2.43	23.28 ± 3.28	0.16
Intraoperative Blood Loss (mL)	193.33 ± 15.06	154.53 ± 31.02	0.004*
Hospital Stay (days)	9.83 ± 1.60	8.35 ± 1.14	0.005*
*Statistically significant			

Table 8 identifies factors associated with flap necrosis. Patients who developed flap necrosis experienced significantly higher intraoperative blood loss and longer hospital stay. Age, BMI, comorbidities, and neoadjuvant chemotherapy were not significantly associated with flap necrosis.

DISCUSSION

One of the most popular treatments for breast cancer is still MRM. However, postoperative complications such as flap necrosis, seroma, wound infection, and prolonged drainage continue to be major concerns. Harmonic scalpel has been introduced as an alternative to electrocautery because of its ability to provide simultaneous cutting and coagulation with minimal lateral thermal injury, thereby potentially reducing postoperative morbidity.[6,10]

Our study's mean patient age was 49.63 ± 11.82 years, which is similar to Mittal et al., study, where the electrocautery group's mean age was 52 ± 11.19 years and the harmonic scalpel group's mean age was 50.36 ± 11.04 years.[11] Confounding influences were reduced because the two groups' baseline characteristics, such as age and BMI, were similar. The mean time required for skin flap raising was significantly lower in the electrocautery group (30.33 ± 3.92 min) compared with the harmonic scalpel group (38.50 ± 7.67 min; p=0.001). Similarly, the total operative time was significantly shorter with electrocautery (122.00 ± 19.16 min) than with harmonic scalpel (140.67 ± 28.55 min; p=0.004). "These findings are consistent with those reported by Mittal et al., who observed longer operative times with harmonic scalpel (140.40 ± 29.96 vs. 99.80 ± 24.00 min; p<0.001).[11] The prolonged operative duration with harmonic scalpel may be attributable to the slower cutting mechanism and the learning curve associated with its use." [12]

The harmonic scalpel group experienced considerably less intraoperative blood loss (138.50 ± 28.53 mL) than the electrocautery group (178.33 ± 21.06 mL; p=0.001). Similar results have been reported by Mittal et al., Deo et al., and Kozomara et al., who showed that using a harmonic scalpel improved haemostasis due to less lateral heat damage and efficient vessel sealing.[11,13,14] Huang et al. also reported significantly reduced blood loss in their meta-analysis of 702 patients.[10]

The harmonic scalpel group had decreased postoperative day-1 drain output and total drain volume, but these differences were not statistically significant. Total drain output was 298.20 ± 127.87 mL in the harmonic scalpel group compared with 310.83 ± 88.93 mL in the electrocautery group. These findings are similar to those reported by Burdette et al [7] although several studies and meta-analyses have demonstrated significantly lower drainage volumes with harmonic scalpel.[6,10,11,13]

Flap necrosis remains one of the most important complications following MRM. In the present study, flap necrosis occurred in 5 patients (16.7%) in the electrocautery group compared with 1 patient (3.3%) in the harmonic scalpel group. Although this difference did not reach statistical significance, the trend favors harmonic scalpel. Similar observations were reported by Khan et al. and Mittal et al.[6,11] Furthermore, the meta-analyses by Huang et al. and Zhang et al. concluded that harmonic scalpel significantly reduces wound complications, including flap necrosis.[10,15] The reduced thermal damage associated with harmonic scalpel may contribute to improved preservation of the subdermal vascular plexus.

Analysis of factors associated with flap necrosis revealed significantly higher intraoperative blood loss (193.33 ± 15.06 mL vs. 154.53 ± 31.02 mL; $p=0.004$) and longer hospital stay (9.83 ± 1.60 vs. 8.35 ± 1.14 days; $p=0.005$) among patients who developed flap necrosis. Age, BMI, comorbidities, and receipt of neoadjuvant chemotherapy were not significantly associated with flap necrosis. These findings support previous reports highlighting surgical factors as major determinants of wound complications.[16,17]

The incidence of seroma and surgical site infection was low in both groups. Only one patient in each group developed seroma, while surgical site infection occurred in a single patient in the electrocautery group. Adwani et al., Galatius et al., Deo et al., and Mittal et al., reported similar findings, finding no discernible difference in seroma production between the two methods.[8,11,13,18]

The mean duration of drain removal was 6.83 ± 0.75 days in the electrocautery group and 7.43 ± 2.27 days in the harmonic scalpel group, while the mean hospital stay was 8.57 ± 0.77 days and 8.43 ± 1.61 days, respectively. Neither parameter differed significantly between the groups. Comparable findings have been reported by Huang et al., Mittal et al., and Deo et al.[10,11,13] No patient developed upper limb lymphedema during the follow-up period, although longer follow-up would be required for meaningful assessment of this complication.

Despite its clinical advantages, the widespread use of harmonic scalpel remains limited because of its higher cost. The approximate cost of a harmonic scalpel handpiece is around ₹35,000 compared with approximately ₹500 for a monopolar diathermy pen. Therefore, cost-effectiveness remains an important consideration, particularly in resource-limited settings.[11]

LIMITATIONS

The comparatively small sample size, single-center design, brief 30-day follow-up period, and possible impact of surgeon experience with harmonic scalpel are the main limitations of this study. Larger multicentric studies with longer follow-up are required to establish the definitive advantages of harmonic scalpel over electrocautery in MRM.

CONCLUSION

The present study suggests that the harmonic scalpel offers certain advantages over electrocautery during modified radical mastectomy by significantly reducing intraoperative blood loss and lowering the incidence of flap necrosis. However, these benefits are offset by a longer operative time, and no significant differences were observed between the two techniques regarding drain output, drain duration, hospital stay, or other postoperative complications. Considering its substantially higher cost, the routine use of harmonic scalpel may not be cost-effective in resource-limited settings, where electrocautery continues to remain a practical and widely accepted alternative.

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