IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 24, Issue 6 Ser.5 (June 2025), PP 57-66
www.iosrjournals.org

Comparative Study of Electrocautery and Harmonic Scalpel in Raising Flaps in Mastectomy

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Abstract
Aim: *To compare the intraoperative parameters and postoperative complications of flap raising with harmonic scalpel and electrocautery.*
Methods: *A prospective randomised controlled trial done on 60 cases of breast carcinoma undergoing Modified radical mastectomy in Guru Nanak Dev hospital, Amritsar. 30 patients were operated using harmonic scalpel (Group A) and thirty patients were operated using electrocautery (Group B).*
Results: *The mean intraoperative blood loss was significantly lower with harmonic scalpel (107.33+38.44ml v/s 241.00+75.76 ml, p value=0.00). There was no statistically significant difference between mean operative time between group A and B (76.73+10.13 min v/s 85.26+13.95 min, p=0.067). The mean drain volume was significantly less in harmonic scalpel group (376.66+158.85 ml v/s 528.33 + 234.68 ml, p=0.038) and mean day of drain removal (4.60+1.6 days v/s 6.53+1.8 days, p=0.005). There is no significant difference of incidence of seroma formation, flap necrosis, postoperative complications like wound dehiscence, wound infection and wound disruption and postoperative pain on VAS between two groups. The stitch removal day and final healing time is also almost same in both groups.*
Key Words: *Harmonic scalpel, Electrocautery, Modified radical mastectomy*

Date of Submission: 06-06-2025 Date of Acceptance: 16-06-2025

I. Introduction

The most common modalities for dissection during mastectomy include sharp scalpel and scissors dissection, blunt dissection with high frequency electrocautery and harmonic scalpel.

Electrocautery is the most common surgical instrument for dissection and haemostasis in MRM which works on the principal when an electrical current passes through conductor, some of its energy converts into heat. The effect of that heat can be used for:

- Coagulation- the heating effect cause sealing of blood vessels by cell death due to protein denaturation and dehydration. Bleeding is stopped by coagulation of plasma proteins, distortion of vessel wall, stimulation of clotting mechanism and dried and shrunken tissue.
- Cutting- the heating effect is used to cut through tissues during bloodless surgery. It is achieved when sufficiently high temperature is applied to cells causing cell water to explode.
- Fulguration- the heating effect causes tissue charring.

The risk of collateral and accidental damage due to heat in case of diathermy is a concern. The burn injury creates three zones- zone of coagulation, zone of stasis and zone of hyperaemia. The high temperature protein denaturation causes coagulation. The zone of stasis and hyperaemia needs should be prevented from converting into non-viable area which in turn can decrease the side effects due to thermal energy. The cells in zone of stasis are viable but high temperature and inflammation can transmit and can cause necrosis.

The harmonic scalpel is relatively newer device to be used in surgical practice for dissection and haemostasis. It adds the advantage of eliminating heat related side effects of diathermy. Harmonic scalpel works on the principal of ultrasonic technology to simultaneously cut as well as sealing them. The harmonic scalpel denatures protein by ultrasonic vibration at a frequency of 55,500 Hz with a vibratory excursion of 50–100 μm[1]. It can cut through scarred tissue better and due to less smoke produced visibility is better than electrocautery.

The use of ultrasonic energy uses mechanical energies of cavitation and coaptation instead of using electrical energy to achieve haemostasis. Cavitation causes vaporisation cell fluid and rupture at areas of blade tip. When jaw pressure is applied, coaptation seals the tissue with mechanical frictional pressure and heat. A sticky coagulum is formed due to disruption of cells causing protein denaturation and breakage of hydrogen bonds, which seals the vessels. This coagulation takes less than 7 seconds and results in decreased charring and lateral tissue damage with minimal smoke. The contact time of electrosurgical device is one to three seconds

more than harmonic energy device. The initial sealing of vessels with harmonic energy was limited to 2mm and smaller but now has increased upto 7mm in newer advanced devices. The lateral collateral damage is less with harmonic energy than electrosurgical devices.

II. Materials And Methods

The present prospective study was done on patients admitted to the surgery wards at Guru Nanak Dev Hospital, attached to Govt. Medical College, Amritsar who underwent any sort of Mastectomy due to carcinoma Breast. All the patients were subjected to thorough history, detailed clinical examination and all the necessary radiological and pathological investigations. All the patients were operated by same surgical team, under general anaesthesia after obtaining informed consent from all the patients.

METHOD OF DATA COLLECTION:

Total of 60 patients were randomly divided in two groups of 30 each-

Group A- 30 patients underwent Modified radical mastectomy in which skin flap raising and axillary dissection done with harmonic scalpel

Group B- 30 patients underwent modified radical mastectomy in which skin flap raising and axillary dissection done with electrocautery.

The study was done after approval of Institutional Ethics Committee, Government Medical College, Amritsar. Informed consent of the patient obtained before inclusion in the study.

Data was collected and appropriate statistical analysis done.

Operative time was recorded in minutes starting from incision to closure. Blood loss during the surgery was estimated by weighing the dry sponges preoperatively and subtracting the weight from the weight of postoperative used sponges. Suction was not used in the surgery. The amount of blood loss was calculated as ml. Two suction drains no. 16 were placed, one under the flap and the other in the axilla.

Clinical assessment of the wound was done on each postoperative morning for flap necrosis and local wound infection till the patient was discharged and on the follow-up visits. The volume of suction drain (in mL) on each POD till the drain was removed and the duration of drain was documented. The drains were removed when the volume was less than 20 mL in 24 hours. Postoperatively, wound-related pain was assessed using visual analogue scales (VAS) scored on each postoperative morning till Postoperative Day (POD) 5. Patients discharged after the removal of drains were followed up weekly for up to five weeks. The presence of seroma was assessed during each postoperative visit and the number of aspirations required for the seroma was also documented.

INCLUSION CRITERIA:

- All female cases of Breast cancer reporting in the OPD.
- All male cases of Breast Cancer.
- All cases of Recurrent Breast Cancer in both males and females.
- All cases of Gynaecomastia in males.

EXCLUSION CRITERIA:

- Cases of Carcinoma Breast for Breast conservation Surgery (BCS).
- Patients who were diabetics or immunocompromised.
- Patients on Neo Adjuvant Chemotherapy.
- Patients undergoing immediate breast reconstruction surgery.
- Pregnant Patients.

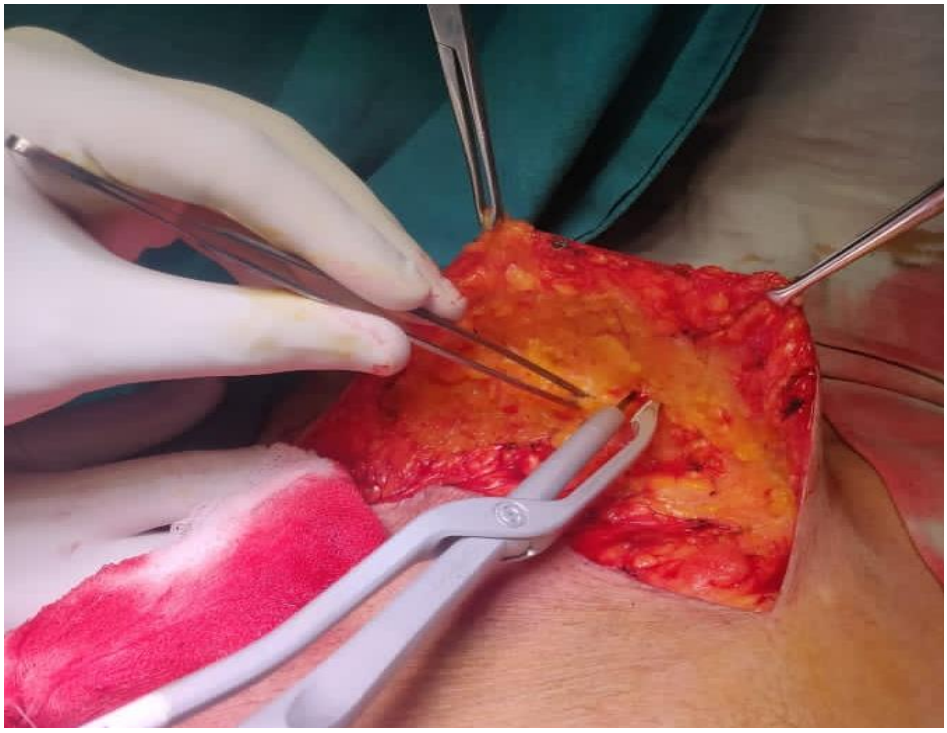


Fig I showing dissection with harmonic focus

Fig II showing bloodless filed after dissection with harmonic focus

III. Observations And Results

OPERATIVE TIME:

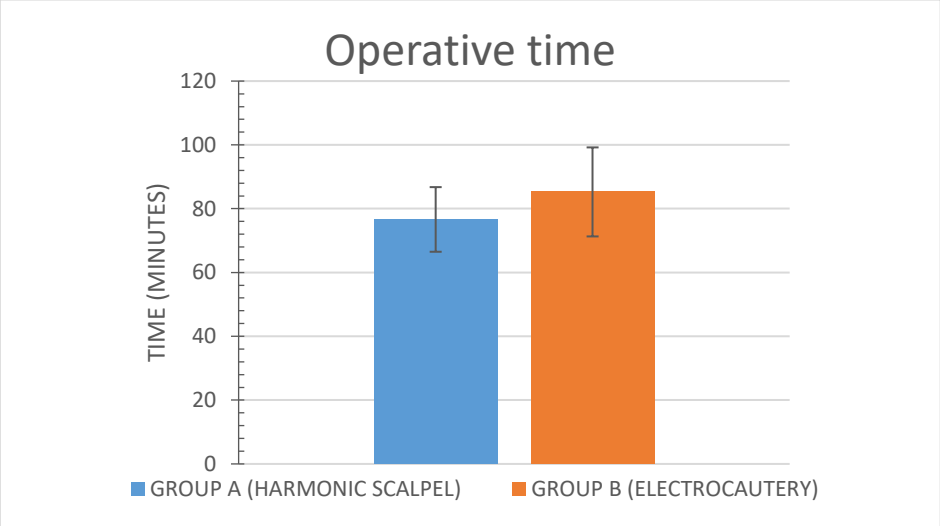
The difference between operative time was 76.73 minutes (group A) v/s 85.26 minutes (group B) which was statistically insignificant with p value of 0.067.

The following table shows the difference in the operative times in two procedure:

Table III
Showing comparison between operative time of two groups

Intraoperative parameter	Group A (harmonic scalpel)	Group B (electrocautery)	P value
Operative time	76.73 + 10.13 mins	85.26 + 13.95 mins	0.067

GRAPH I
SHOWING OPERATIVE TIME IN TWO GROUPS

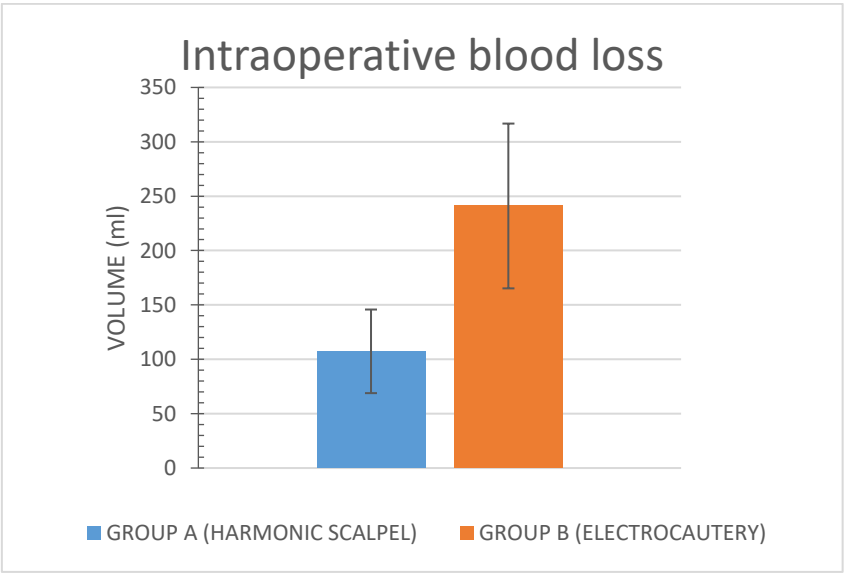


INTRAOPERATIVE BLOOD LOSS:
The mean intraoperative blood loss in group A was 107.3 ml and 241 ml in group B. There was significant statistical heterogeneity with p value of 0.00.
The Following table shows mean blood loss during surgery in two groups:

Table IV
Showing comparison of intraoperative blood loss

Intraoperative parameter	Group A (harmonic scalpel)	Group B (electrocautery)	p value
Intraoperative blood loss	107.33+ 38.44 ml	241.00+ 75.76 ml	0.00

GRAPH II
SHOWING INTRAOPERATIVE BLOOD LOSS

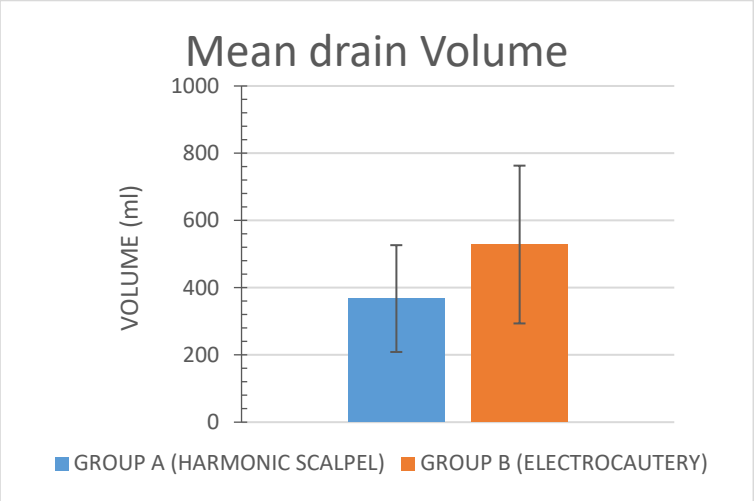


MEAN DRAIN VOLUME:
The cumulative drain volume was measured and compared. The mean cumulative drain volume for group A was 367 ml and 538 ml for group B with p value of 0.038 which was statistically significant.
The following table shows difference between mean drain volume in group A and group B:

Table V
Showing mean cumulative drain volume

Postop parameter	Group A (harmonic scalpel)	Group B (electrocautery)	p value
Mean drain Volume	367.66 + 158.85 ml	528.33 + 234.68 ml	0.038

GRAPH III
SHOWING MEAN DRAIN VOLUME IN GROUPS

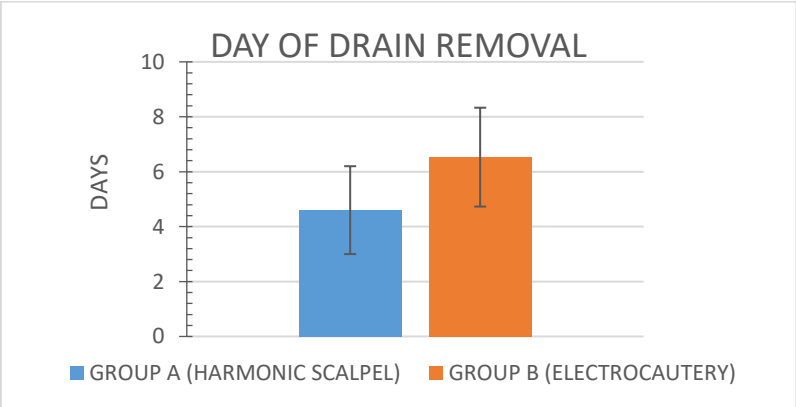


DAY OF DRAIN REMOVAL:
The day of removal of drain in group A was 4.6 days and group B was 6.5 days. The p value was 0.005 which was statistically significant.
The following table shows the average day of drain removal:

Table VI
Showing comparison of mean day of drain removal

Postop parameter	Group A (harmonic scalpel)	Group B (Electrocautery)	P value
Day of drain removal	4.60 + 1.6days	6.53 + 1.8days	0.005

GRAPH IV
SHOWING DRAIN REMOVAL DAY IN GROUPS



SEROMA FORMATION:

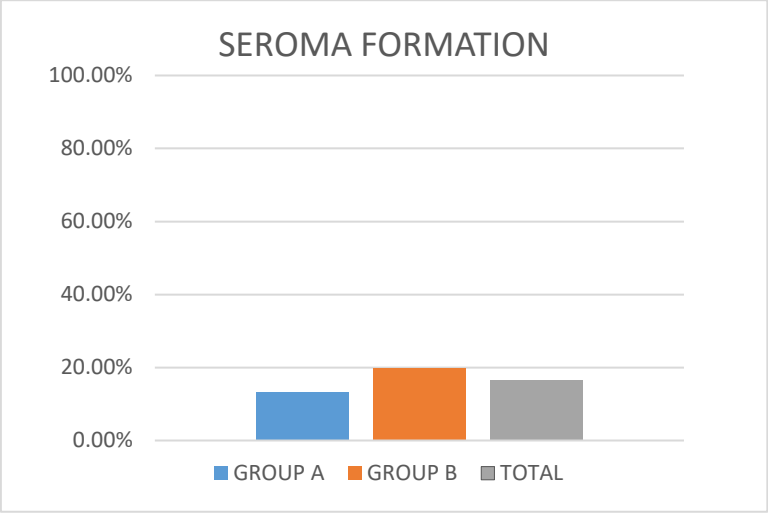
Seroma formation was one of the most common complication encountered. There were total 10 patients who developed seroma postoperatively, four in group A and six in group B. The seroma developed in patients in group A required aspiration once in two patients (total volume 30ml) on POD-8 and POD-10and twice in other two patients draining total of 50 ml each on POD-4, 6 and POD-5, 8 respectively. In group B, six patients needed aspirations, first two patients needed aspiration on POD-9 and POD-10 respectively aspirating 30 ml each , three patients needed aspiration twice on POD-4,6 , POD-5,7 and POD-8,9 respectively and two patients needed three aspirations on POD-9, 10 and 12 aspirating 60 ml of serous fluid. Total of 13.3% patients in group A and 20% in group B developed seroma. Low statistical heterogeneity was found between the two groups with p value of 0.733.

The following table shows the comparison of seroma formation in two groups:

Table VII
Seroma formation

Group	Number of patients	Percentage
A	4	13.3%
B	6	20%
Total	10	16.6%

GRAPH V
SHOWING SEROMA FORMATION IN TWO GROUPS



FLAP NECROSIS:

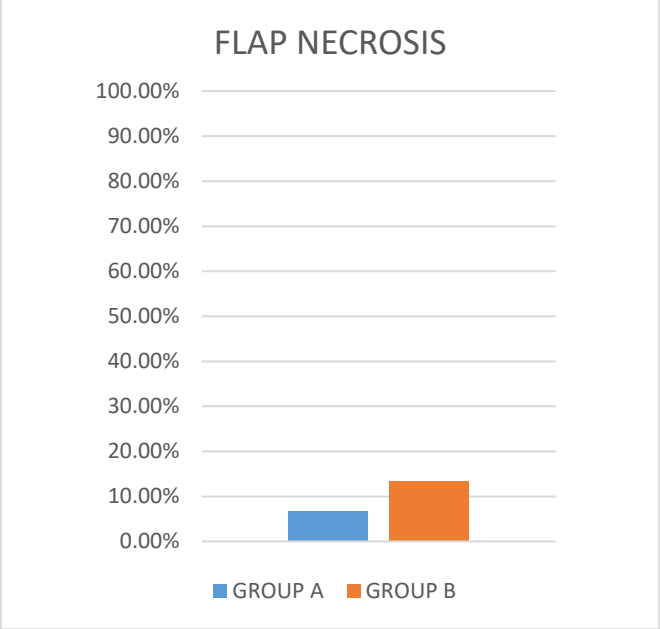
Flap necrosis was seen in six patients out of 60 patients. Two patients in group A had superficial necrosis of about less than 1/3rd of the upper flap which healed on its own. In group B, there was necrosis of lower flap which was superficial and healed of its own in two patients and two patients had flap necrosis in about half of the upper flap which needed resuturing. There was increased incidence of flap necrosis in group B (13.3%) than group A (6.7%) but statistically insignificant (p value 0.543).

The following table shows the comparison of incidence of necrosis between group A and group B:

Table VIII
flap necrosis

Flap necrosis	Group A	Group B
Number (n)	2	4
Percentage (%)	6.7%	13.3%

GRAPH VI
SHOWING FLAP NECROSIS IN TWO GROUPS



WOUND DEHISCENCE AND DISRUPTION:
There was increased incidence of localised wound dehiscence in group B. it was observed in 6(20%) patients v/s 2(6.7%) in group A, but was statistically insignificant (p value 0.28). Wound disruption was observed in two patients in group B while in none of cases in group A (6.7% vs 0%) and the difference was statistically insignificant with p value of 0.309.
The following table shows comparison of incidence of wound dehiscence in both groups:

Table IX
Wound dehiscence

Localised wound dehiscence	Group A	Group B	Total
Number (n)	2	6	8
Percentage (%)	6.7%	20%	13.3%

Showing incidence of wound disruption

Complete wound disruption	Group A	Group B	Total
Number (n)	0	2	2
Percentage (%)	0%	6.7%	3.3%

TYPE OF DISCHARGE IN DRAIN:
The following table shows the type of discharge in drain in two groups:

Table XI
Type of drain content

Type of wound discharge	Group A	Group B	Total
Serosanguineous	28 (93.3%)	24(80%)	52(86.7%)
Sero-purulent	2(6.7%)	6(20%)	8(13.3%)

STITCH REMOVAL:
There was no statistically significant difference between day of stitch removal in two groups. The mean in group A was 12.47 + 1.3 and 12.87 + 1.45 with p value of 0.435.

Table XII
Day of stitch removal

Post op parameter	Group A	Group B
Day of stitch removal	12.47	12.87

FINAL HEALING TIME

The mean healing time group A was 15.5 + 2.2 days and in group B was 16.20+ 2.7 days. The p value was 0.48 which was statistically insignificant.

The following table shows the mean days of final healing time in two groups:

Table XIII
FINAL HEALING TIME

Postop parameter	Group A	Group B
Final healing time	15.5 days	16.2 days

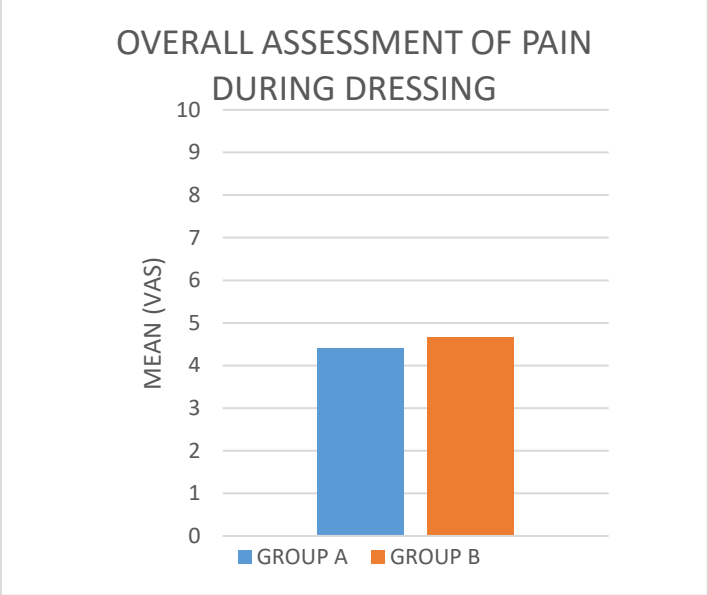
OVERALL ASSESSMENT OF PAIN DURING DRESSING:

This was assessed using Visual analogue scale. There was no significant difference in both groups. The mean in group A was 4.40 ±1.4 and in group B was 4.67 ± 1.3 and p value was 0.60

Table XIV
Showing comparison of pain score in groups

Overall assessment of pain during dressing	Group A	Group B
Mean (VAS)	4.40	4.67

GRAPH VII
SHOWING COMPARISON OF PAIN SCORE IN GROUPS



IV. DISCUSSION

The primary aim of this study was to study and compare the intraoperative parameters and postoperative complications of flap raising in modified radical mastectomy with harmonic scalpel and monopolarelectrocautery.

In this study, most of the patients were between 41 to 60 years of age (34/60). Out of these, maximum were in age group of 41-50 i.e, 18 cases (30%). Youngest patients was 32 years of age and the oldest patient was 80 years. The average age in two groups was comparable, 54.6 years in group A and 53.13 years in group. There was no statistically significant difference between two age groups. This is similar to study done by Chilson et al who concluded that age is not a risk factor for seroma formation whenhe assessed the risk factors for seroma formation after mastectomy[2]. This is however is inconclusive as various studies have reported a positive relationship between age and seroma formation.

In our study, the presenting complaints of maximum patients were lump in the breast in 86.4%, 40% (24 cases) in right breast and 46.7% (28 cases) in left breast. Other presented with ulcer in breast, breast pain, dimpling of skin over breast and retracted nipple.

In this study, the mean operative time with harmonic scalpel was 76.73 minutes and 85.26 minutes with electrocautery. Average operative time was less with harmonic scalpel but the difference was not statistically significant (p=0.067). Initially, procedure with harmonic scalpel took longer time but it decreased with experience. This was comparable to other studies by ShireenRamzanaliDamani et al (p=0.264) and S V S Deo et al (p=0.0837)[3, 4]. The studies by Parveen S et al. and Galatius H et al. reported a significant decrease in

intraoperative time with the harmonic scalpel when compared to electrocautery[5, 6]. Our results were in contrast to studies done by Rohaizak[7]et al and Khan et al[8]. Rohaizak *et al* concluded that this could be explained by the lack of experience in using the ultracision[7].

In our study, the intraoperative blood loss was less in harmonic scalpel (107.33 ml) than electrocautery (241 ml) which was statistically significant difference(p=0.00). The results were in similar to various studies done by Deo and Shukla[4], Khan et al[8], Huang J et al[9], Archana A et al[10]and Mittal P. et al[11]. Harmonic scalpel cuts and coagulates simultaneously and it can seal vessels upto 7mm in diameter. Harmonic scalpel results in lesser intraoperative blood loss as well as less lateral injury without increasing operative time.

The studies by Parveen S et al.[12] and Porter KA et al.[13] show that the total drainage volume was lesser with the use of the harmonic scalpel when compared to electrocautery. This is in agreement with most of literatures as reported by Deo et al[4], Adwani and Ebbs[14], Sunil Pabri et al[15]andArchana et al[10]. Similar results were obtained in our study, the mean drain volume was significantly less in group A (367.6 ml) than group B (528.33 ml) which is statistically significant (p value 0.038). Harmonic scalpel works on the principal of breakage of hydrogen binds and formation of denatured protein coagulum. The coagulum seals off the lymphatics and vessels irreversibly unlike electrocautery resulting in decreased drain volume and blood loss. This led to decrease in mean number of drain days after which drain was removed which was statistically significant (p=0.005). These results were similar to all the above studies where drain volume was less in harmonic scalpel.

Seroma formation is considered more of side effect of MRM rather than complication which is attributed to extensive dissection and creation of dead space. In our study, the incidence of seromafroamtion was less with harmonic scalpel but was statistically insignificant. These results are comparable to other studies done by SVS Deo et al[4] (p=0.738), Sunil pabri et al[15] (p=0.999), A Khater et al[16] (p=0.2) and Huang et al[9] (p=0.77). Porter et al. found that the use of electrocautery was significantly associated with increased seroma formation in a randomized controlled trial[13].

In our study, incidence of flap necrosis was less with harmonic scalpel than electrocautery but not statistically significant (p=0.543). This can be attributed to less lateral thermal injury by harmonic scalpel. The extent of lateral thermal injury with harmonic is limited to 2-3mm. This is comparable to studies done by SVS Deo et al[4], Khattar et al[16], Sunil Pabri et al[15]and Damini et al[17]. However, Khan et al reported flap necrosis was higher with electrocautery[8]. Rebeiro et al also reported a lower incidence of flap necrosis with the use of the harmonic scalpel[18]. The increased incidence of flap necrosis with electrocautery is due to uncontrolled heat delivery leading to flap thinning.

In this study, although less number of postoperative complications were observed with harmonic scalpel but there is no statistically significant difference between two groups regarding postoperative complications like wound dehiscence, wound disruption and wound infection. These results are comparable to studies done by Kozomara et al[19] and Mohammad Faisal et al[20]. No statistical heterogeneity was observed regarding stitch removal day and final healing time between two groups. The postoperative pain was assessed using Visual analogue scale (VAS) while changing the dressing. There was no significant difference between two groups and was similar to study done by Kozomara et al[19]. Khater observed significantly lower pain in harmonic scalpel group[16]. However pain perception is subjective and varies from patient to patient.

V. Conclusion

- Electrocautery is a widely accepted tool used in dissection and haemostasis in modified radical mastectomy.
- Harmonic scalpel is comparatively newer device which works on the principal of ultrasonic vibration and being used for dissection and haemostasis in MRM. It cuts and coagulates simultaneously and is easy to use.
- Intraoperative blood loss is lesser with harmonic scalpel as compared to electrocautery.
- Harmonic scalpel is a better haemostatic tool than electrocautery as hemostasis can be achieved without clamp, cautery or ligature
- The intraoperative time is comparable in both instruments. With a steep learning curve, it decreases with harmonic scalpel.
- Harmonic scalpel decreases the total cumulative drain volume or discharge significantly.
- The average day of drain removal were also significantly less in harmonic scalpel group.
- There is no significant difference in incidence of seroma formation in both groups.
- There is no significant difference in incidence of flap necrosis in either groups.
- There is no significant difference in postoperative complications in two groups including postoperative pain, wound dehiscence, wound disruption and wound infection.
- The mean stitch removal time and final healing time is almost similar in two groups.

CONCLUSION

In summary, harmonic scalpel results in significant decrease in intraoperative blood loss, total cumulative drain volume and shorter duration before drain removal without increase in operative time. The cost of equipment is more but it can be recommended as preferential energy source in MRM

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