The Egyptian Journal of Hospital Medicine (April 2025) Vol. 99, Page 1459-1464

Safety and Efficiency of Electrocautery De-Epithelization in Mammoplasty: A Randomized Controlled Trial

EI-Hefnawy, Ahmed A.; El-Sayed, Ibrahim M.; Elghazaly, Mohamed H. *
Plastic and Reconstructive Surger Departmenty, Faculty of Medicine, Tanta University, Tanta, Egypt
*** Corresponding Author:** Elghazaly, Mohamed H., **Email:** mohamed.elghazaly@med.tanta.edu.eg,
Telephone: 01002807655, **ORCID:** 0009-0009-5363-1977

ABSTRACT

Background: Despite electrocautery's potential benefits in surgical procedures, its application in mammoplasty remains controversial due to concerns about tissue damage and healing outcomes.

Objectives: This study aimed to assess the efficacy and safety of electrocautery de-epithelization in mammoplasty compared to traditional surgical methods. **Patients and methods:** This prospective, randomized, single-blinded controlled trial was executed on 100 females scheduled for mammoplasty. Patients were randomly equally assigned to either electrocautery or traditional scalpel de-epithelization. In the electrocautery group, a low-setting electrocautery tool in "cutting" mode was used in a sweeping motion for precise epidermal removal. In the control group, a size 15 surgical blade was used, with the surgeon following their usual technique for de-epithelization under normal conditions.

Results: Electrocautery significantly reduced operative time (77.9 ± 13.93 vs 84.6 ± 16.87 minutes, p=0.033), de-epithelialization time (3.26 ± 1.12 vs 13.2 ± 3.12 minutes, p<0.001), and blood loss (172.4 ± 48.47 vs 193.6 ± 26.63 ml, p=0.008) compared to traditional methods. Both groups showed comparable postoperative pain scores, wound healing time, and complication rates (hematoma formation, surgical site infection, or nipple-areolar necrosis).

Conclusions: Electrocautery de-epithelization demonstrated superior efficacy in mammoplasty while maintaining comparable safety profiles to traditional surgical methods.

Keywords: Mammoplasty, Electrocautery, De-epithelization, Efficacy, Safety.

INTRODUCTION

Mammoplasty represents a critical surgical intervention in modern plastic surgery, addressing both functional and aesthetic concerns associated with macromastia. As the fifth most prevalent procedure performed by plastic surgeons globally, breast reduction surgery addresses a range of physiological and psychological challenges [1, 2]. Patients with macromastia frequently experience debilitating symptoms, including chronic neck and shoulder pain, bra strap-induced skin grooving, persistent headaches, and recurrent intertriginous skin rashes [3, 4].

Beyond the immediate physical symptoms, breast reduction procedures demonstrate profound therapeutic potential. Surgical intervention not only alleviates physical discomfort but also substantially improves patients' psychological well-being, including enhanced self-esteem, body image, and overall quality of life [5].

Traditional de-epithelization methods, such as manual dissection and mechanical scraping, present significant operational challenges. These techniques are particularly time-consuming and labor-intensive, especially when managing larger breast volumes or working without surgical assistance [6]. Recognizing these limitations, plastic surgery researchers have actively investigated alternative approaches to optimize the de-epithelization process, with specific emphasis on reducing operative time and minimizing blood loss while maintaining critical parameters such as tissue vascularity and nipple sensation [7].

Electrocautery offers a sophisticated technological approach to tissue manipulation [8]. This method uses a metal wire electrode with resistance to generate precise heat by passing direct or alternating electrical current, allowing for selective tissue modification to achieve hemostasis or controlled necrosis [9]. While, electrocautery demonstrated versatility across multiple surgical disciplines including dermatology, ophthalmology, otolaryngology, and urology, its application in plastic surgical procedures, particularly mammoplasty, remains controversial [10]. Despite the method's apparent efficiency, electrocautery has not gained widespread adoption in plastic surgery as it is linked to a greater frequency of postoperative seroma compared to other surgical techniques, emphasizing concerns about postoperative healing outcomes and tissue damage [11]. Consequently, this study aimed to comprehensively estimate the efficacy and safety of electrocautery de-epithelization in mammoplasty, addressing critical gaps in current surgical understanding and potentially offering surgeons an evidence-based alternative to traditional techniques.

PATIENTS AND METHODS

This prospective, randomized, single-blinded, controlled study was conducted on 100 females aged 18 years or older who were listed to undergo mammoplasty .

Exclusion criteria: Patients with active infections, open wounds, hypersensitivity to electrocautery, pregnancy, lactation, uncontrolled diabetes, coagulation disorders, psychiatric illness, and those undergoing secondary or repeated breast reduction procedures.

Randomization and blindness: Randomization was performed using an online randomization program (http://www.randomizer.org), which generated a random list of patient codes. Each code was placed in an opaque, sealed envelope to maintain allocation concealment. Women got randomly assigned in a 1:1

Received: 01/01/2025
Accepted: 01/03/2025

ratio to one of two parallel groups: The electrocautery group (standard surgical de-epithelization was performed using an electrocautery device) or the control group (de-epithelization was carried out using a surgical blade (scalpel)). To ensure blinding, patients were not informed about which surgical device was used on each breast.

Preoperative procedures: A comprehensive preoperative assessment was conducted for each patient, clinical examinations were performed, and routine laboratory investigations were carried out to assess the patients' overall health and suitability for surgery. The resection pattern and estimated resection weight were also documented to standardize the surgical approach.

Intraoperative procedures: The surgical area was meticulously marked and mapped to ensure precise incisions with general anesthesia based on the extent of the procedure. The surgical site was sterilized and draped to maintain aseptic conditions throughout the procedure.

In the electrocautery group, the electrocautery tool was set to a low setting, typically in "cutting" mode, to allow for precise and controlled removal of the epidermal layer. The surgeon applied the cautery tip in a sweeping motion along the marked lines on the skin flap to achieve de-epithelization. In the control group, a size 15 surgical blade was used for the same purpose, with the surgeon replicating their natural technique under normal conditions (Figure 1).

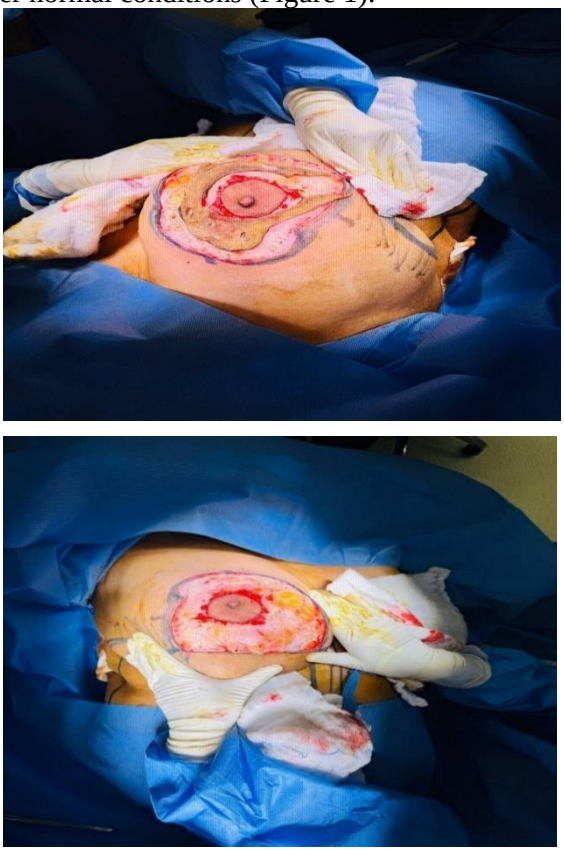

Figure (1): Deepithelized pedicle in reduction mammoplasty was done by standard monopolar diathermy with a blade electrode tip.

Intraoperative measurements: The time required to complete resection and achieve hemostasis was recorded for each breast using stopwatches and wall clocks. Timing began immediately after de-epithelization and concluded when the surgeon completed the resection and hemostasis. The volume of serous fluid drainage was measured using 15-French round silicone Blake drains, which were placed on each side. Drains were removed simultaneously for all patients, and the total drainage volume in milliliters, as well as the total indwelling time in hours, were recorded. Blood loss was quantified by weighing surgical swabs before and after use during the pedicle de-epithelization process. A standard scientific scale was employed to measure the weight of the swabs in grams, which was then converted to milliliters (1 g = 1 mL). The difference in weight before and after the procedure was used to estimate blood loss. To ensure accuracy, both visual assessment by anesthetists and the swab-weighing method were utilized, with a correction factor applied to account for differences in blood loss rates between the two surgical methods.

Postoperative assessment: Postoperative pain was determined via a standard 10-point visual analogue scale (VAS) [(12)]. The average VAS was recorded with 1st 24 hours. Nipple viability and sensation were assessed preoperatively and at multiple postoperative intervals, including one day, two weeks, and one month after the procedure. For patients who experienced a loss of sensation, further assessments were executed at three and six months postoperatively. The Semmes-Weinstein Monofilament test was employed to measure nipple sensation, providing a quantitative assessment of tactile sensitivity.

The primary outcome measure was operative time, which was recorded for each breast. **The Secondary outcomes** included VAS, de-epithelization time, time to achieve hemostasis, duration of drain placement, blood loss, wound healing time, and the incidence of postoperative events as flap necrosis, hematoma, seroma, and surgical site infection. These complications were monitored for a period of six weeks following surgery.

Sample size calculation: The sample size determination was conducted through G*Power 3.1.9.2 software (Universität Kiel, Germany). A preliminary study was carried out, encompassing five cases in each group. The results indicated that the mean operative time was 84 ± 8.2 minutes in electrocautery group and 90 ± 9.35 minutes in control group. The sample size was calculated accordant with subsequent parameters: an effect size of 0.682, a 95% confidence interval, 90% statistical power for the study, a group ratio of 1:1, and an additional three cases were brought in each group to account for potential dropouts. Consequently, a total of 50 patients were enrolled in each group.

Ethical consideration: The institutional ethical committee approved the study protocol (ID: 36264PR1061/1/25). Written informed consent was taken from all participants. The study adhered to the Helsinki Declaration throughout its execution.

Statistical analysis

The statistical analysis was executed through SPSS version 27 (IBM©, Armonk, NY, USA). The Shapiro-Wilks test and histograms were occupied to assess the normality of the data distribution. For quantitative parametric data, the mean and standard deviation (SD) were used for presentation and were evaluated via unpaired Student's t-test. Quantitative non-parametric data were expressed as the median and interquartile range (IQR) and were inspected through the Mann-Whitney U test. Qualitative variables were displayed as frequency and percentage and were explored utilizing the Chi-square test or Fisher's exact test, as appropriate. A two-tailed P value ≤ 0.05 was considered statistically significant.

RESULTS

In this study, a total of 123 females were evaluated for eligibility. Among them, 16 females did not meet the inclusion criteria, and seven females declined to participate. The remaining eligible females were randomly assigned into two groups, with 50 females in each group. All patients who were assigned to the groups were subsequently followed up and included in the statistical analysis (Figure 2).

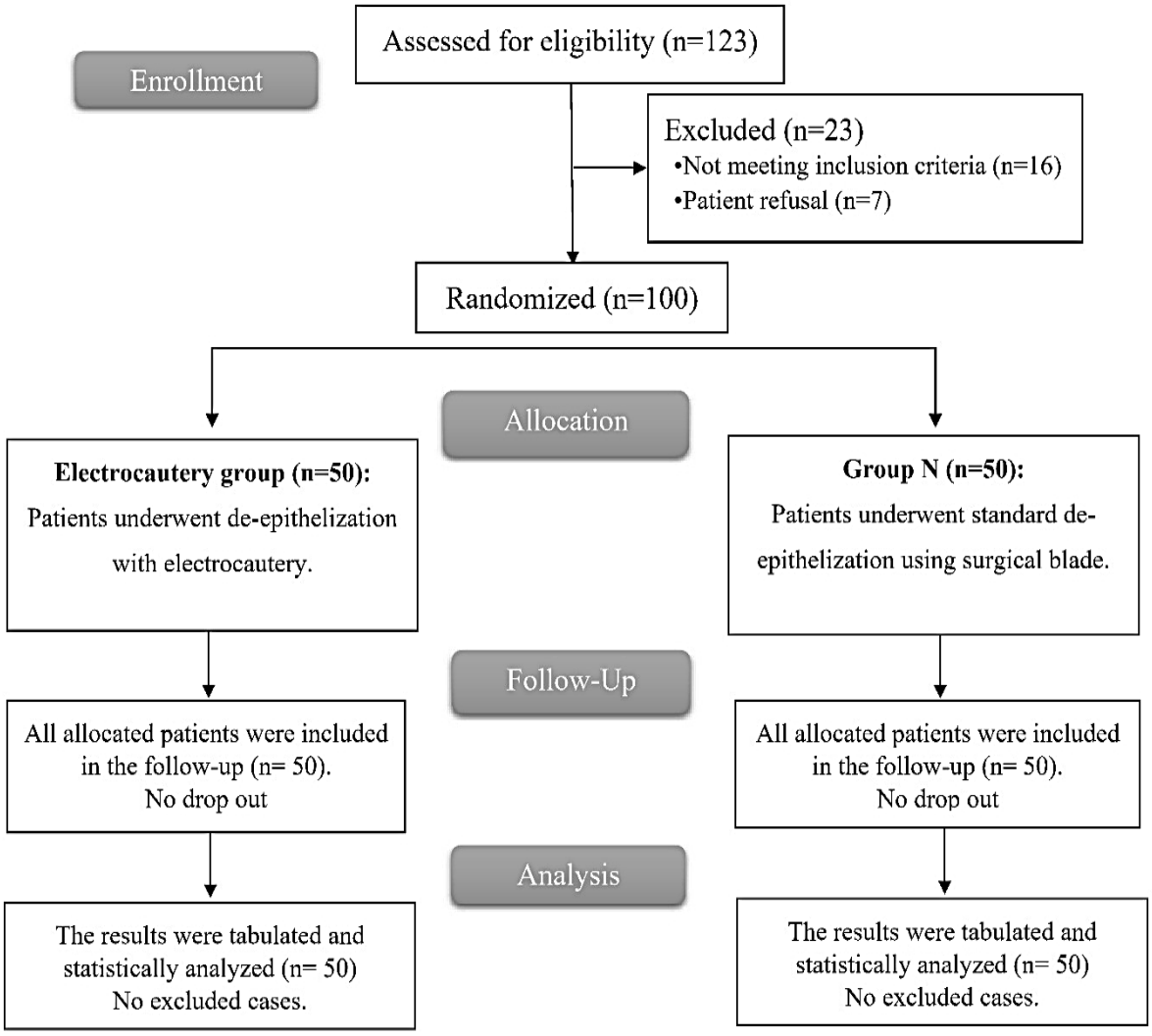

Figure (2): CONSORT flowchart of the enrolled patients.

Demographic data and comorbidities were insignificantly different between both groups (Table 1).

Table (1): Preoperative data of the studied groups

		Electrocautery group (n=50)	Control group (n=50)	P value	Mean difference/ RR (95%CI)
Age (years)		46.48 ± 8.99	48.26 ± 9.14	0.329	-1.78(-5.38: 1.82)
Weight (kg)		76.22 ± 10.11	75.42 ± 7.7	0.657	0.8(-2.77: 4.37)
Height (cm)		165.16 ± 5.43	163.54 ± 5.75	0.151	1.62(-0.6: 3.84)
BMI (Kg/m^2)		28.04 ± 4.24	28.33 ± 3.73	0.718	-0.29(-1.88: 1.3)
Comorbidities	**Hypertension**	14 (28%)	11 (22%)	0.488	1.27(0.64:2.53)
	DM	12 (24%)	6 (12%)	0.118	2(0.81:4.91)

Data were presented as mean ± SD or frequency (%). BMI: Body mass index, DM: Diabetes mellitus. RR: Relative risk, CI: Confidence interval.

The electrocautery technique resulted in a shorter overall operative time per side than control (77.9 ± 13.93 vs 84.6 ± 16.87 minutes, p=0.033). Most notably, the de-epithelialization time was markedly reduced in the electrocautery group (3.26 ± 1.12 vs 13.2 ± 3.12 minutes, p<0.001). Hemostasis was achieved significantly faster in electrocautery group, requiring only 43.84 ± 8.28 seconds compared to 121.52 ± 17 seconds in control group (p<0.001). Furthermore, the electrocautery technique demonstrated superior outcomes in terms of fluid management, with significantly lower total drain volume (507.8 ± 173.54 vs 699.2 ± 73.42 ml, p<0.001) and reduced blood loss (172.4 ± 48.47 vs 193.6 ± 26.63 ml, p=0.008) (Table 2).

Table (2): Intraoperative data of the studied groups

	Electrocautery group (n=50)	Control group (n=50)	P value	Mean difference/ median (95%CI)
Operative time per side (min)	77.9 ± 13.93	84.6 ± 16.87	**0.033***	-6.7(-12.84: -0.56)
De-epithelialization time (min)	3.26 ± 1.12	13.2 ± 3.12	**<0.001***	-9.94(-10.87: -9.01)
Time of hemostasis of de-epithelialized area (sec)	43.84 ± 8.28	121.52 ± 17	**<0.001***	-77.68(-82.99: -72.37)
Total drain volume (ml)	507.8 ± 173.54	699.2 ± 73.42	**<0.001***	-191.4(-244.28: -138.52)
Blood loss (ml)	172.4 ± 48.47	193.6 ± 26.63	**0.008***	-21.2(-36.72: -5.68)

Data are presented as mean ± SD. *: Significant when P value ≤ 0.05. CI: Confidence interval.

Postoperative pain scores (VAS), drain removal time, wound healing time, and complication rates were comparable between groups. Patient satisfaction levels were favorable in both groups without statistical significance (Table 3).

Table 3: Postoperative data of the studied groups

	Electrocautery group (n=50)	Control group (n=50)	P value	RR (95%CI)
Postoperative pain by VAS	3 (2 - 4.75)	3 (2 - 4)	0.304	0 (-1:0)
Time of drain removal (days)	2.46 ± 0.5	2.62 ± 0.49	0.111	-0.16 (-0.36: 0.04)
Wound healing time (weeks)	2.6 ± 0.7	2.84 ± 0.91	0.143	-0.24 (-0.56: 0.08)
Complications				
Hematoma	1 (2%)	3 (6%)	0.617	0.33(0.04:3.1)
Surgical site infection	1 (2%)	1 (2%)	1	1 (0.06:15.55)
Nipple-areolar necrosis	0 (0%)	1 (2%)	1	---
Patient satisfaction				
Extermely satisfied	20 (40%)	15 (30%)	0.687	---
Satisfied	21 (42%)	20 (40%)		
Neutral	5 (10%)	8 (16%)		
Unsatisfied	3 (6%)	5 (10%)		
Extermely unsatisfied	1 (2%)	2 (4%)		

Data are presented as frequency (%). RR: Relative risk, CI: Confidence interval. VAS: Visual analogue scale.

DISCUSSION

The application of electrocautery in surgical operations has been extensively investigated, with varying outcomes depending on the specific technique and context of its application [13, 14].

Our findings indicated a significant decrease in operative time for electrocautery group (77.9 ± 13.93 minutes) compared to control group (84.6 ± 16.87 minutes) (P=0.033). This finding aligns with numerous reports that showed shorter operative times with the use of electrocautery. For instance, **Ranjan and Kumar** [14] found that incision time was notably reduced in electrocautery group than scalpel group ($P < 0.001$). Similarly, **Khaled *et al.*** [15] informed that the Harmonic Focus group, which used a form of advanced electrocautery, the operative times were significantly shorter in the group using the bipolar electrocautery compared to the monopolar electrocautery group (101.32 ± 27.3 minutes versus 139.3 ± 31.9 minutes; $P < 0.001$). The decrease in operative time can be ascribed to the simultaneous cutting and coagulation capabilities of electrocautery, which streamline the surgical process by reducing the need for frequent instrument changes and additional hemostatic measures.

Nevertheless, it is crucial to acknowledge that not all investigations have reported shorter operative times with electrocautery. **Faisal *et al.*** [16] found that the average operative time was significantly greater for harmonic dissection than for electrocautery (2.63 ± 0.41 hours versus 1.75 ± 0.26 hours; $P < 0.0001$). This discrepancy may be due to differences in the specific type of electrocautery device used or the intricacy of the surgical procedur. In our study, the use of a standard electrocautery device likely contributed to the observed reduction in operative time, highlighting the importance of device selection in achieving optimal surgical efficiency.

Our study found that de-epithelialization time, time of hemostasis, total drain volume, and blood loss were significantly lower in electrocautery group than in control group ($P < 0.05$). These findings corroborate those of **Ranjan and Kumar** [14] who reported notably lower blood loss in the electrocautery group than the scalpel group (6.53 ± 3.84 mL vs. 18.16 ± 7.36 mL; $P < 0.001$). Similarly, **Anlar *et al.*** [13] observed that intraoperative blood loss was notably lower in electrocautery group (560 mL) than the scalpel group (750 mL; $P = 0.001$).

The reduced blood loss and improved hemostasis observed in our study can be attributed to the coagulative properties of electrocautery [17], which minimize bleeding during tissue dissection. This is particularly advantageous in procedures such as mammoplasty, where maintaining a clear surgical field is crucial for precision and safety. Additionally, the reduced total drain volume in the electrocautery group suggests that the device's ability to seal small blood vessels and lymphatics may contribute to decreased postoperative fluid accumulation [18].

However, it is worth noting that some studies have reported conflicting results regarding drain volume and seroma formation. **Anlar *et al.*** [13] found that total drainage amounts were extensively higher in the electrocautery group (1,113 mL) than the scalpel group (894 mL; $P = 0.0033$). This discrepancy may be due to differences in surgical technique or patient population. In our study, the reduced drain volume in the electrocautery group may reflect the device's effectiveness in minimizing tissue trauma and fluid leakage, which are key factors in postoperative recovery.

Our results indicated that the time of drain removal, VAS scores for pain, and wound healing time showed no substantial differences between the electrocautery and control groups. This finding align with various studies that reported no significant differences in wound healing or drain removal times between electrocautery and traditional methods. For example, **Ranjan and Kumar** [14] found no statistically significant difference in wound closure time between the electrocautery and scalpel groups ($P = 0.206$). Similarly, **Samal *et al.*** [19] reported no significant differences in drain duration or wound healing amid the electrocautery and harmonic scalpel groups.

Our study showed no significant differences in the incidence of hematoma, surgical site infection, or nipple-areolar necrosis between the electrocautery and control groups. This is in accordance with numerous studies that demonstrated comparable rates of postoperative complications between electrocautery and traditional methods. For instance, **Ranjan and Kumar** [14] found no significant differences in wound infection rates between the electrocautery and scalpel groups. Similarly, **Anlar *et al.*** [13] reported no significant differences in hematoma, flap necrosis, or infection rates among the electrocautery, scalpel, and harmonic scalpel groups.

The comparable rates of postoperative complications observed in our study suggest that electrocautery is a safe alternative to traditional surgical blades in mammoplasty. However, it is important to consider that the risk of complications may vary relying on the specific type of electrocautery device used and the surgeon's experience. For example, **Yilmaz *et al.*** [20] reported that the electrocautery group had a higher incidence of seroma, which led to delayed arm mobilization. This highlights the need for careful patient selection and surgical technique to minimize the risk of complications.

LIMITATIONS

The study had several limitations, including its single-center design and restricted sample size. Additionally, there was a scarcity of long-term data concerning the safety and intervention efficacy, particularly in relation

to outcomes such as nipple sensation and scar healing. Further studies are recommended to compare the outcomes of this technique with those of harmonic surgeries.

CONCLUSION

Electrocautery de-epithelization significantly reduced operative time, de-epithelization time, hemostasis time, blood loss, and drain volume compared to traditional scalpel techniques, without increasing complications. These findings suggest that electrocautery is a safe and efficient alternative for mammoplasty, offering potential benefits in surgical efficiency and patient outcomes.

Acknowledgments: Nil.
Funding: Non to be declared.
Conflict of Interest: Non to be declared.

REFERENCES

1. **Innocenti A, Paderi M, Dreassi E (2024):** Structural mastopexy: Volume displacement in breast reshaping. Aesthetic Plast Surg., 5: 1-13
2. **Oliveira J, Eskandar K, Gontijo L *et al.* (2025):** Shifting the paradigm on tissue removal and postoperative complications in breast reduction: A systematic review and meta-analysis. J Plast Reconstr Aesthet Surg., 102: 197-203
3. **Netshiongolwe T, Elias N, Fru P (2021):** Safety of diathermy for pedicle de-epithelialization in breast reduction surgery in comparison to surgical blade use. Wits J Clin Med., 3 (3): 155-60
4. **Liu D, Wu M, Xu X *et al.* (2023):** Risk factors and complications in reduction mammaplasty: A systematic review and meta-analysis. Aesthetic Plast Surg., 47 (6): 2330-44
5. **Widmark-Jensen E, Bernhardsson S, Eriksson M *et al.* (2021):** A systematic review and meta-analysis of risks and benefits with breast reduction in the public healthcare system: priorities for further research. BMC Surg., 21: 343
6. **Ovadia S, Bishop E, Zoghbi Y *et al.* (2018):** Pedicle de-epithelialization in reduction mammoplasty: A systematic review of the literature. Aesthetic Plast Surg., 42: 100-11
7. **Mun H, Kim Y (2023):** Bloodless de-epithelialization in reduction mammoplasty with hydrodissection using a digital automatic anesthesia injector: case series. Arch Aesthetic Plast Surg., 29 (4): 217-20
8. **Chavan R, Chikkala B, Mondal P *et al.* (2017):** Comparison study between scalpel and electrocautery, in causation of seroma after modified radical mastectomy. Indian J Surg., 79 (5): 423-6.10.1007/s12262-016-1501-2
9. **Faulkner H, Merceron T, Wang J *et al.* (2023):** Safe reproducible breast reduction. Plast Reconst Surg., 11 (9): e5245
10. **Koplay T (2024):** Comparison of two different electrosurgical devices in reduction mammoplasty: Monopolar electrocautery versus plasmakinetic cautery. World J Surg., 48 (8): 1929-33
11. **Hashemi E, Kaviani A, Najafi M *et al.* (2004):** Seroma formation after surgery for breast cancer. World J Surg Oncol., 2: 44
12. **Myles P, Myles D, Galagher W *et al.* (2017):** Measuring acute postoperative pain using the visual analog scale: The minimal clinically important difference and patient acceptable symptom state. Br J Anaesth., 118 (3): 424-9
13. **Anlar B, Karaman N, Dogan L *et al.* (2013):** The effect of harmonic scalpel, electrocautery, and scalpel use on early wound complications after modified radical mastectomy. Eur Surg., 45: 286-90
14. **Ranjan S, Kumar S (2019):** Comparative Evaluation of Wound Outcome between Electrocautery and Scalpel Incision. Academia J Surg., 2: 23-6
15. **Khaled I, Saad I, Soliman H *et al.* (2021):** Intraoperative and postoperative outcomes of Harmonic Focus versus monopolar electrocautery after neoadjuvant chemotherapy in breast conservative surgery: a comparative study. World J Surg Oncol., 19: 325
16. **Faisal M, Fathy H, Shaban H *et al.* (2018):** A novel technique of harmonic tissue dissection reduces seroma formation after modified radical mastectomy compared to conventional electrocautery: a single-blind randomized controlled trial. Patient Safety Surg., 12: 8
17. **Horton T, Coombs P, Ha Y *et al.* (2025):** Electrosurgical devices used during laparoscopic hysterectomy. JSLS., 28 (3): e2024
18. **Ketu N, Kumar S, Prakash P *et al.* (2021):** A comparative study of intraoperative and postoperative complication in modified radical mastectomy using harmonic scalpel and electrocautery. Int J Sci Res., 10: 434-6
19. **Samal S, Ramchandani R, Mohanty D (2024):** Comparison of intraoperative and postoperative outcomes with skin flaps raised using either harmonic scalpels or electrocautery during modified radical mastectomy. Cureus,16 (6): e62320
20. **Yilmaz K, Dogan L, Nalbant H *et al.* (2011):** Comparing scalpel, electrocautery and ultrasonic dissector effects: the impact on wound complications and pro-inflammatory cytokine levels in wound fluid from mastectomy patients. J Breast Cancer,14 (1): 58-63.