Original Article

Sahel Journal of Veterinary Sciences

Sahel J. Vet. Sci. Vol. 23, No. 1, Pp 16-22 (2026)
https://doi.org/10.54058/74e0nz73

Article History
Received: 06-03-2026
Revised: 22-03-2026
Accepted: 15-04-2026
Published: 30-04-2026

Differential Modulation of IL-6 and IL-1β by Scalpel versus Electrocautery Excision Influences Wound Healing with Topical Metronidazole in Mice

[1*]Saidu, A. M., [1]Noah, C.C., [2]Idrisa, J. A., [1]Zarma, A. S., [3]Girgiri, I. A., [1]Yusuf, A. K. and [4]Bukbuk, D. N.

[1]Department of Veterinary Surgery and Radiology, University of Maiduguri
[2]Department of Medicine, College of Medical Sciences, University of Maiduguri
[3]Department of Veterinary Anatomy, Faculty of Veterinary Medicine, University of Maiduguri
[4]Department of Microbiology, Faculty of Life Science University of Maiduguri

[*] *Author for Correspondence: abubakarsm51@gmail.com*

ABSTRACT

This study investigated the inflammatory and histopathological outcomes of scalpel versus electrocautery skin excisions with adjunct topical metronidazole in mice. Group A underwent scalpel excision, Group B electrocautery excision, and Group C served as the control. All wounds received topical metronidazole. Systemic levels of interleukin-6 (IL-6) and interleukin-1β (IL-1β) were assayed by ELISA at multiple time points, and histopathological analysis of wound tissues was performed. Significant differences in inflammatory response and tissue healing were observed between groups. Group A exhibited a significant but transient increase in IL-6 at 48 hours that resolved rapidly, suggesting a controlled inflammatory profile. In contrast, Group B showed a significant and sustained increase in IL-1β, indicating a more intense and prolonged inflammatory reaction. Histological analysis confirmed that scalpel incisions resulted in superior tissue repair with enhanced collagen deposition and epithelialization, whereas electrocautery caused greater tissue disruption consistent with thermal damage. Topical metronidazole supported healing in both groups but did not fully mitigate the heightened inflammatory response triggered by electrocautery. Further investigation is warranted to elucidate the immunomodulatory role of metronidazole in surgical wound healing. In conclusion, the choice of surgical instrument significantly impacts the biological pathway of healing. Scalpel incisions promote a more favorable, self-limiting inflammatory response with superior tissue regeneration, whereas electrocautery incisions induce a stronger pro-inflammatory state and delayed repair. These findings suggest that scalpel incisions may facilitate a more advantageous healing response when reducing inflammation is essential.

Keywords: Scalpel excision; Electrocautery excision; IL-6 and IL-1β; Metronidazole; Wound healing

INTRODUCTION

The initial surgical incision is a fundamental step in countless medical and veterinary procedures, setting the stage for subsequent tissue repair and overall patient recovery. The choice of surgical instrument is therefore a critical decision, balancing the benefits of precision against those of haemostasis. The scalpel, long regarded as the gold standard, operates through mechanical force, enabling clean, precise incisions with minimal thermal damage to surrounding tissues (Coll *et al*., 2013; Jeschke *et al*., 2020) (Shahmoradi *et al*., 2020). This facilitates straightforward wound healing, though its primary drawback is a lack of inherent haemostasis, which can lead to significant intraoperative blood loss (Ann *et al*., 2019). In contrast, electrocautery (or diathermy) utilizes high-frequency electrical current to simultaneously cut and coagulate tissue, effectively minimizing blood loss (Leong Tan *et al*., 2006; Vahabi *et al*., 2020a). However, this advantage is counterbalanced by the risk of collateral thermal damage, which can cause tissue necrosis, impair healing, and lead to poorer cosmetic outcomes such as larger scars (Ammar *et al*., 2017; AbdElaal *et al*., 2019).

The biological sequelae of these techniques are profoundly influenced by the inflammatory response, a cornerstone of the healing process. Key mediators of this response are the cytokines Interleukin-6 (IL-6) and Interleukin-1β (IL-1β), (Lacina *et al*., 2024). These multipotent signaling molecules are crucial for orchestrating tissue repair but, when produced in excess, can disrupt the equilibrium of extracellular matrix remodeling and promote adverse outcomes like hypertrophic scarring (Zhu *et al*., 2016, Yameny, 2025). The nature of the initial tissue injury, clean mechanical division versus thermal coagulation, directly influences the magnitude and duration of IL-6 and IL-1β expression, thereby shaping the entire healing trajectory (Reinke and Sorg, 2012; Medzhitov, 2021). A comprehensive comparison that correlates these systemic inflammatory biomarkers with local histopathological changes is essential for a complete understanding of how each technique affects wound repair.

Despite the well-documented role of these cytokines in human medicine, a significant gap exists in the veterinary literature. There is a notable scarcity of species-specific data, particularly comparative studies that directly assess the inflammatory and histopathological outcomes of scalpel versus electrocautery incisions in common veterinary models and procedures (Vahabi *et al*., 2020b). This lack of evidence-based research limits the ability of surgeons to make informed decisions tailored to the unique physiology of their patients, potentially impacting recovery times, complication rates, and overall welfare. Therefore, this study was designed to address this critical knowledge gap.

This study aims to investigate the impact of scalpel and electrocautery excisions on key inflammatory parameters in mice. The study specifically assessed the systemic levels of IL-6 and IL-1β following scalpel and electrocautery excisions treated with topical metronidazole, and also evaluated the corresponding histopathological changes in the healing of excisional wounds in mice. By elucidating the distinct biological responses elicited by each technique, this research seeks to provide a scientific foundation for optimizing surgical protocols, ultimately leading to improved patient outcomes in veterinary surgery and offering valuable translational insights.

MATERIALS AND METHODS

The Research Station

The study was conducted at the Department of Veterinary Surgery and Radiology, University of Maiduguri, Borno State, Nigeria. Ethical approval for the experiment was obtained from Animal Use and Ethics Committee, Faculty of Veterinary Medicine, University of Maiduguri, with reference number FVM/UNIMAID/AUEC/FYP/2024/00 1.

Study Design

The study employed a controlled experimental design to compare the effects of scalpel and electrocautery excision based on interleukin-6 (IL-6), inerleukin-1βeta (IL-1β) profiles as well as histopathological outcomes.

Grouping of experimental Animals:

Total sample size: 65 adult male mice (Mus musculus).

- Group A (scalpel + metronidazole): n=30 (5 per time point × 6 time points)
- Group B (electrocautery + metronidazole): n=30 (5 per time point × 6 time points)
- Group C (untreated control): n=5 (sacrificed once at 72 hours; values applied to all six time points based on ethical approval and the assumption of temporal stability, approved by FVM/UNIMAID/AUEC/FYP/2024/001.

No surgical or pharmacological manipulation occurred, any temporal change in IL-6, IL-1β, or histology would reflect only diurnal or handling variation, and were minimized through standardized housing and sampling at the same hour. The ethical benefit of sparing 25 animals outweighed the minimal risk of temporal drift; thus, the study explicitly states this limitation.

Pre-operative Preparation of Animals

Prior to the surgical procedure, sixty-five adult mice (Mus musculus), weighing between 20-25 grams, were subjected to a 2-hour fast with ad libitum access to water. Body weight was recorded using a manual portable gram scale. Anaesthesia was induced via intraperitoneal injection of a ketamine-xylazine combination, administered at dosages of 80 mg/kg (Ketamine hydrochloride, ROTEXMEDICA, Germany) and 10 mg/kg (Xylased, bioveta, A. S. Czech Republic), respectively. Following anaesthetic induction, the dorsum of each mouse was shaved using a razor blade, and the surgical site was aseptically prepared with chlorhexidine disinfectant.

Scalpel Excision

Following surgical site preparation, a full-thickness circular skin excision, 1 cm in diameter and extending through the panniculus carnosus, was created on the dorsum of each mouse using a sterile No. 10 scalpel blade (Figure 1A). The circular skin flap was reflected from the underlying muscle layer and completely transected. During anaesthetic recovery, the excision site received a topical application of metronidazole (Metrone® 500mg/100ml, Fidson, Healthcare plc. Nigeria), and post-operative analgesia was initiated with a subcutaneous injection of ketorolac tromethamine (Ketolac, Amriya Pharmacy, India) at 2 mg/kg.

Electrocautery excision

In a separate cohort of animals, an identical full-thickness circular skin excision of 1 cm diameter, including the panniculus carnosus, was performed on the dorsum. This excision was executed using an electrocautery unit set to a power output of 40W, which simultaneously cut and reflected the circular skin flap from the underlying muscle layer, resulting in its complete removal (Figure 1B).

Wound closure

All excision wounds, from both scalpel and electrocautery techniques, were left unsutured to heal by secondary intention. The wound diameter was standardized to 1 cm for all subjects in both experimental groups.

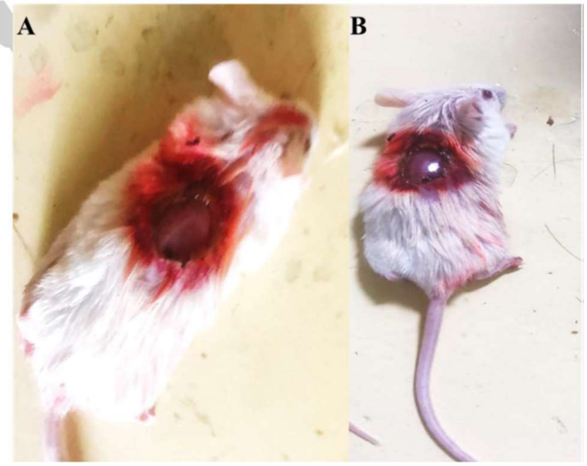

Figure 1: Gross images of murine skin excision margins taken immediately following scalpel (A) versus electrocautery (B) excision at matched post-procedural time points demonstrate markedly more extensive hemorrhage in the scalpel-excised margin (A) reflecting the disparate haemostatic properties of the two techniques.

Post-operative Care

Post-operatively, animals were monitored for signs of pain. Analgesia was maintained with daily administration of ketorolac (2 mg/kg) for three days. To prevent infection and support the healing process, metronidazole was applied topically to the excision sites twice daily for five days. This regimen commenced 24 hours post-surgery, with subsequent applications at 48 hours and continuing at 12-hour intervals thereafter. At predetermined intervals, tissue samples were collected for downstream analysis. Quantification of inflammatory cytokines (IL-6 and IL-1β) was performed using specific ELISA kits (Biotech Co., Ltd.), and histological evaluation was conducted on formalin-fixed, haematoxylin and eosin (H&E) stained sections.

Serum Samples

Serum samples were collected at the following intervals: 0 hours (pre-surgery), 24 hours, 48 hours, 72 hours, 1 week, and 2 weeks post-surgery. Samples were collected via decapitation (different cohort of animals was used for each time point). The severing approach through the ventral aspect of the neck was done to quickly and humanely collect whole blood into plain sample bottles. The already labelled sample bottles were eventually kept in slanting position and allowed to clot, until serum was collected.

Analytical Techniques

Cytokine Analysis

Following the manufacturer's protocol, Serum IL-6 and IL1β levels were quantified using enzyme-linked immunosorbent assay (ELISA) kits obtained from eiyue®, Wuhan, Feiyue Biotechnology, Co. LTD, China. according to the manufacturer's protocols and guide. Absorbance was measured at 450 nm using a microplate reader.

Histological samples

Tissues samples were collected from site of Excision (wound site) at day 7(1wk) fixed in 10% formalin for 7days and viewed under microscope.

Data Analysis

Data were analysed using GraphPad Prism version 10.4.1. To compare the three groups (scalpel, electrocautery, control) at each time point, one way ANOVA was performed separately at 0h, 24h, 48h, 72h, 1 week, and 2 weeks, followed by Tukey's test for multiple comparisons. Additionally, to evaluate the effects of time and excision method (scalpel vs. electrocautery) as well as their interaction, two-way ANOVA was conducted on the two surgical groups only (excluding the control group, which had no excision method). Results were expressed as mean ± standard deviation. A p value < 0.05 was considered statistically significant.

RESULTS

The systemic inflammatory response to the two surgical techniques was evaluated by measuring serum concentrations of Interleukin-6 (IL-6) and Interleukin-1β (IL-1β) at 48- and 72-hours post-excision. The findings are summarized in Tables 1 and 2.

At 48 hours post-surgery, the scalpel excision group (Group A) demonstrated a serum IL-6 level of 1012.8 ± 317.3 pg/mL. This value was markedly elevated compared to the control group (Group C), which recorded a level of 755.8 ± 137.0 pg/mL at the same time point (Table 1). This initial elevation indicates an expected acute-phase inflammatory response to the surgical trauma.

By 72 hours post-excision, however, a distinct reversal in this trend was observed. The scalpel group (Group A) exhibited a substantial decline in IL-6 concentration, falling to 190.0 ± 76.2 pg/mL. In contrast, the control group (Group C) showed a sustained elevation, with IL-6 levels reaching 1332.6 ± 154.3 pg/mL at the 72-hour mark. This sharp decrease in the scalpel group suggests a rapid resolution of the systemic inflammatory peak.

At 72 hours post-surgery, analysis of IL-1β revealed a different pattern between the groups. The electrocautery group (Group B) exhibited a mean serum IL-1β level of 215.3 ± 89.4 pg/mL. This was substantially higher than the mean level observed in the control group (Group C), which measured 143.6 ± 94.3 pg/mL (Table 2). The elevated IL-1β in the electrocautery group points to a prolonged or amplified inflammatory stimulus associated with this technique. The large standard deviations recorded for both groups (89.4 for Group B and 94.3 for Group C) reflect considerable intra-group variability in the individual inflammatory responses to the surgical interventions.

Table 1: The Mean± SE Serum IL-6 Concentration following Scalpel and Electrocautery Excisional Wounds Treated with Metronidazole in Mice

SAMPLING TIME	GROUP A(pg/ml)	GROUP B(pg/ml)	GROUP C(pg/ml)
OHR	1458.3±1046.3	2934.5±2343.7	755.8±137.0
24HR	1062.0±376.2	1010.1±539.4	1332.6±154.3
48HR	1012.8±317.3^{a}	233.7±150.5	755.8±137.0^{b}
72HR	190.0±76.2^{a}	960.8±209.0	1332.6±154.3^{b}
1WK	690.2±236.1	646.5±334.7	755.8±137.0
2WK	743.95±1050.1	3166.9±1306.6	1332.6±154.3

Values with different superscripts within rows significantly ($p < 0.05$) differ

Table 2: The Mean± SE Serum IL-1β Concentration following Scalpel and Electrocautery Excisional Wounds Treated with Metronidazole in Mice

SAMPLING TIME	GROUP A METRO (Pg/ml)	GROUP B METRO (Pg/ml)	CONTROL (Pg/ml)
OHR	155.5±81.3	284.9±56.9	143.6±94.3
24HR	47.4±4.7	128.8±24.0	76.9±38.0
48HR	45.1±17.1	215.3±89.4^{a}	143.6±94.3^{b}
72HR	177.9±83.5	123.4±72.3	76.9±38.0
1WK	114.4±61.9	791.2±277.1	143.6±94.3
2WK	232.5±47.4	239.7±99.8	76.9±38.0

Values with different superscripts within rows significantly ($p < 0.05$) differ

Histological analysis of skin samples following excision revealed distinct morphological differences between the scalpel and electrocautery techniques.

Following scalpel excision, transverse sections (Figure 2) demonstrated a complete disruption of epidermal continuity. This defect exposed the underlying primary hair follicles and subcutaneous fat, indicating the full-thickness nature of the wound

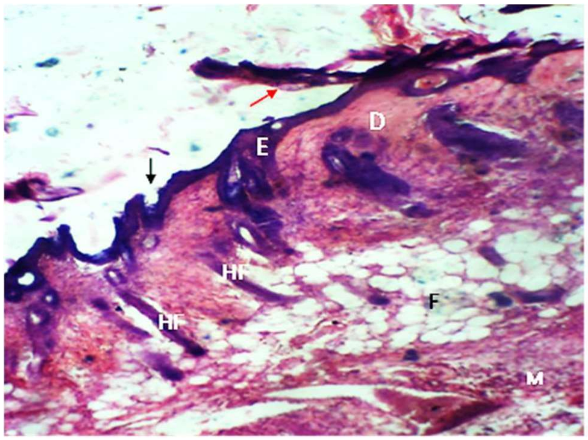

Figure 2: Transverse section of Skin in Mice subjected to scalpel excision: showing; E. epidermis, D. dermis, HF. clusters of primary hair follicles, G. sebaceous gland, SG. Apocrine sweat gland, F. subcutaneous fat, H. sinus of hair follicle, M. cutaneous trunci muscle, (red arrow) complete disruption of the continuity of the epidermis, exposing the cross-sections of the primary hair follicles and the subcutaneous fat. H & E x100

In contrast, longitudinal sections from later time points (Figure 6) showed restored epidermal integrity, with organized dermis, hair follicles, sweat glands, and the cutaneous trunci muscle visible. In some transverse sections (Figure 7), the epidermis appeared excessively thickened, resulting in a narrowed dermis. A large sub-epithelial blood vessel and a prominent fat cushion were also observed in the subcutaneous tissue.

Tissue from electrocautery sites exhibited distinct features. Longitudinal sections (Figure 3) revealed desquamation of the free surface of the epidermis, along with open hair shafts. The underlying dermis contained primary hair follicles and subcutaneous fat. Higher magnification (Figure 4) highlighted disrupted areas of connective tissue fiber density within the deeper reticular layer of the dermis. Evidence of tissue repair was observed in other sections (Figure 5), characterized by an area of re-epithelialization, with hair follicles extending from the subcutaneous fat towards the free surface.

Overall, scalpel wounds consistently showed better-organized dermal architecture and complete epithelial restoration, whereas electrocautery wounds exhibited persistent thermal damage markers including connective tissue disruption and delayed re-epithelialization.

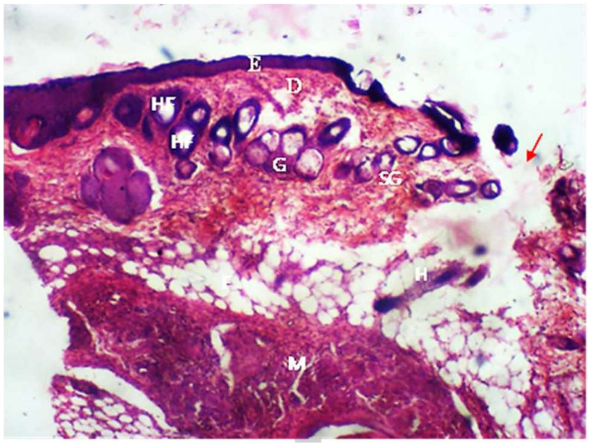

Figure 3: Longitudinal section of Skin in Mice subjected to electrocautery excision: showing; E. epidermis, (black arrow) opening of hair shaft, (red arrow) desquamation of free surface of the epidermis, D. dermis, HF. primary hair follicles, F. subcutaneous fat, M. cutaneous trunci muscle, H & E ×100.

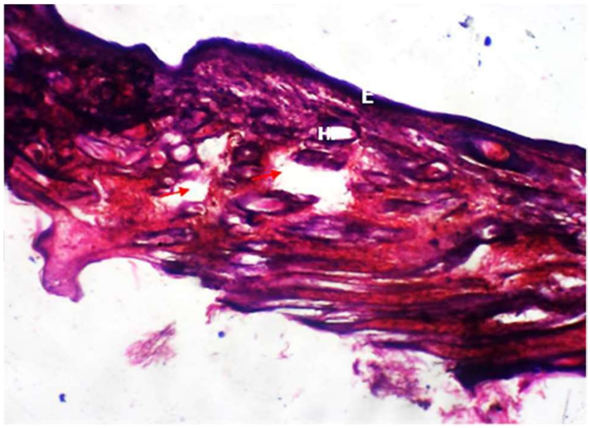

Figure 4: Longitudinal section of Skin in Mice subjected to electrocautery excision: showing; E. epidermis, D. dermis, HF. Hair follicle, (red arrows) disrupted areas of the density of the connective tissue fibers of deeper reticular layer of dermis H & E × 100.

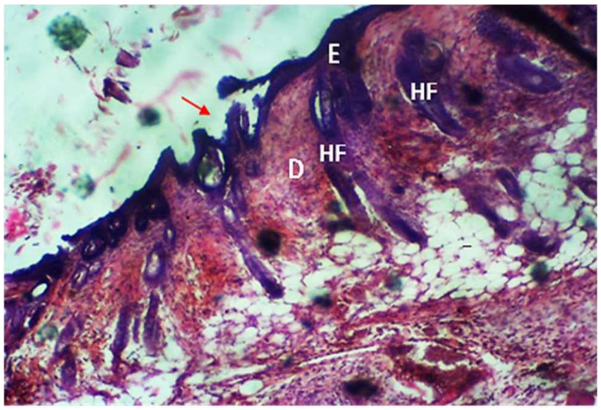

Figure 5: Longitudinal section of Skin in Mice subjected to electrocautery excision: showing; E. epidermis, (red arrow) area of re-epithelization, D. dermis, HF. Hair follicle extending from the subcutaneous fat towards the free surface, F. subcutaneous fat H & E ×100.

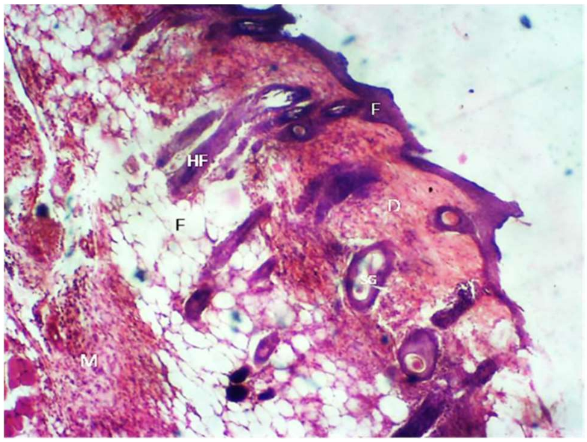

Figure 6: Longitudinal section of Skin in Mice subjected to scalpel excision: showing; E. epidermis, (restored), D. dermis, HF. Hair follicles, SG. Sweat gland, F. subcutaneous fat, M. cutaneous trunci muscle H & E × 100.

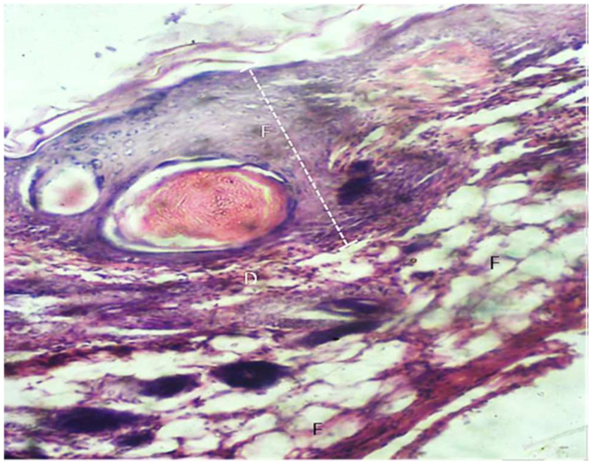

Figure 7: Transverse section of Skin in Mice subjected to scalpel excision**:** showing; E. epidermis, (excessively thickened), resulting in narrowed D. dermis, (white arrow) large sub epithelial blood vessel, F. subcutaneous fat, and (fat cushion) H & E × 100.

DISCUSSION

The study investigated the inflammatory response to different surgical excision techniques, scalpel and electrocautery, in mice, with topical application of metronidazole to all surgical wounds. The data for Group A (scalpel) reveals a distinct inflammatory profile with an initial, significant elevation of IL-6 at 48 hours post-excision compared to the control. This peak aligns with the expected early inflammatory phase following mechanical tissue injury (Cavaillon, 2001), where IL-6 is rapidly released to recruit immune cells and initiate repair (Medzhitov, 2010, Albeniz *et al*., 2024). Crucially, this response was self-limiting. By 72 hours, IL-6 levels in the scalpel group dropped dramatically and significantly compared to the control. This rapid resolution suggests that the clean mechanical trauma of the scalpel, combined with the topical metronidazole treatment, promoted a tightly regulated inflammatory process that was effectively moderated, preventing a prolonged pro-inflammatory state. The IL-1β levels in Group A remained relatively low and stable throughout the study period, further supporting the notion of a controlled local reaction without a systemic cytokine storm.

In stark contrast, Group B (electrocautery) exhibited a markedly different cytokine signature, indicative of a more severe and dysregulated inflammatory response. The most striking finding is the significant and substantial surge in IL-1β at 48 hours vs. control group C. IL-1β is a potent pyrogen and a central mediator of the response to tissue damage and necrosis (Dinarello, 2011). This pronounced elevation strongly implies that the thermal coagulation and collateral tissue necrosis caused by electrocautery acted as a powerful, sustained trigger for inflammasome activation and IL-1β release. While the IL-6 response in Group B appeared more variable, the dramatic late-phase increase in IL-1β at 1 week suggests a secondary or persistent inflammatory insult, likely related to the clearance of thermally denatured tissue, which was not observed in the scalpel group.

The control group data provides essential context. The significant differences noted at 48 and 72 hours for IL-6 highlight that the interventions (excision type + metronidazole) actively modulated the inflammatory timeline compared to an untreated baseline state. The fact that both surgical groups received topical metronidazole is a critical unifying factor. Its known anti-inflammatory and immunomodulatory properties (Trindade *et al.,* 2010) likely contributed to mitigating infection and modulating the response in both groups (Sampaio *et al.*, 2009). However, its effect was not sufficient to override the fundamentally more provocative nature of the electrocautery injury, as evidenced by the persistently high IL-1β. This suggests that the physical nature of the initial injury (thermal vs. mechanical) is a primary driver of the subsequent cytokine profile.

Elevated levels of IL-6 in the control group, uncontrolled inflammatory response was indicated by the considerably higher IL-6 level in the control group. This illustrates how inflammation develops naturally in the absence of treatment.

It draws attention to how crucial anti-inflammatory medications are for regulating how the body reacts to surgical wounds and maybe enhancing the healing process.

The mean IL-1β level is substantially greater in Group B than in Group C, this shows that there is significant diversity in IL-1β levels within each group, as seen by the large standard deviations for both groups (89.4 for Group B and 94.3 for Group C). The increased IL-1β levels in comparison to the control group indicate that electrocautery causes a noticeably greater inflammatory response. A statistically significant difference ($p < 0.05$) would indicate that electrocautery results in a more intense inflammatory response, which may have an impact on the healing process of wounds (Johnson *et al.,* 2020).

Both surgical groups received topical metronidazole as part of the post-operative protocol. The absence of surgical control groups without metronidazole means that the specific role of metronidazole in modulating the inflammatory or healing responses was not elucidated from the effects of the surgical technique itself.

The histological section demonstrates a well-preserved tissue architecture with clear demarcations of the epidermis, dermis, connective tissue, and underlying adipose tissue. Hair follicles are evident within the dermal layer, indicating normal structural integrity. Comparing scalpel and electrocautery excisions, differences in histological outcomes such as inflammatory cell infiltration, epithelial regeneration, and connective tissue remodelling may be observed (Seaton *et al*., 2015).

These cytokine findings provide a robust molecular explanation for the observed histopathological differences. The controlled, resolving IL-6 response in the scalpel group correlates with the histological evidence of superior tissue regeneration, organized collagen deposition, and reduced inflammation. Conversely, the intense and prolonged IL-1β response in the electrocautery group offers a clear mechanistic link to the observed thermal damage, delayed epithelialization, and increased inflammatory cell infiltration seen on histology. Elevated and persistent IL-1β is directly associated with impaired healing, increased risk of fibrosis, and poorer scar quality (Salgado *et al*., 2012, Miller *et al*., 2019).

In electrocautery excisions, thermal damage typically results in coagulative necrosis, delayed epithelial regeneration, and increased inflammatory infiltration compared to scalpel excisions, which usually cause minimal tissue trauma and promote faster wound healing. The presence of intact or disrupted hair follicles and connective tissue in this image could suggest the impact of excision modality on dermal repair (Ali *et al*., 2020).

In summary, the cytokine data robustly supports the hypothesis that surgical excision technique dictates the quality of the inflammatory phase of healing. Scalpel excision, followed by metronidazole treatment, induces a predictable, acute-phase IL-6 response that resolves efficiently. Electrocautery, however, triggers a more damaging and persistent inflammatory state, characterized by a significant and prolonged elevation of IL-1β, which is mechanistically linked to its thermal mode of action and its suboptimal histopathological outcomes. Overall, scalpel wounds consistently showed better-organized dermal architecture and complete epithelial restoration, whereas electrocautery wounds exhibited persistent thermal damage markers including connective tissue disruption and delayed re-epithelialization.

Conclusion

This study demonstrates that surgical excision techniques, particularly electrocautery, can significantly impact inflammatory responses. Understanding these alterations is crucial for optimizing postoperative care and minimizing complications. Histological analysis highlights distinct tissue responses between scalpel and electrocautery excisions. Scalpel excision demonstrates minimal tissue disruption and faster healing, while electrocautery shows evidence of thermal damage and delayed repair. These findings, supported by the IL-6 and IL-1β data obtained, suggest that scalpel excisions may be more favorable for optimized wound healing. Further research is needed to elucidate the underlying mechanisms and long-term implications of these changes, as well as the specific role of metronidazole in modulating inflammatory response.

Limitations of the study

The authors acknowledge some methodological limitations. First, both surgical groups received topical metronidazole, and no surgical control groups without metronidazole were included; therefore, the independent contribution of metronidazole to the observed outcomes was not fully determined. Second, the cross-sectional design used different cohorts of animals at each time point, which prevents tracking of individual inflammatory trajectories over time. Third, the sample size was small (n=5 per group per time point), reducing statistical power and increasing the risk of Type II errors. Fourth, histopathological evaluation and ELISA measurements were performed without blinding to group allocation, introducing potential observer bias, particularly for subjective histological assessments. Additional limitations include the use of only male mice (limiting generalizability to females), a two-week observation period (which may not capture late-phase healing), and a single electrocautery power setting (40W).

Recommendation

Further research is needed to elucidate the long-term consequences of these inflammatory responses and to optimize surgical techniques and antibiotic or antimicrobial regimens to minimize adverse effects following scalpel and electrocautery excision. The study recommends that surgeons integrate a nuanced risk-benefit analysis into their practice when selecting between scalpel and electrocautery, prioritizing the scalpel to leverage its favourable IL-6 profile for rapid healing and reduced inflammatory burden. For procedures necessitating electrocautery, the findings urge clinicians to optimize its use by employing the lowest effective power settings (ideally below 40W) and minimizing application duration to limit thermal necrosis and the associated prolonged IL-1β response, which in turn suggests the need for tailored post-operative care, such as monitoring for persistent inflammation in the first 72 hours and potentially utilizing IL-1β antagonists for these patients. To build on a clinical insight, further research should focus on correlating these early cytokine markers with long-term histological outcomes, comparing electrocautery's performance against alternative technologies like harmonic scalpels, and establishing evidence-based power guidelines through dose-response studies.

Conflict of Interest

The authors have no conflict of interest to declare

Authors Contribution

AMS: Conceptualization; Methodology; Investigation; Data analysis; Review & editing. CCN: Investigation, Data curation; Writing original manuscript, & Literature review. JAI: Conceptualization; Methodology; Data curation, Validation; & editing manuscript. ASZ: Data curation & editing manuscript. IAG: Supervised the preparation of histology slides and provided interpretations of the slides. AKY: Review & editing the manuscript. BDN: Laboratory Investigation & Analysis. All authors read, reviewed, and approved the final manuscript

REFERENCE

Abdelaal, N., Ellakwa, H., Elhalaby, A., Shaheen, A. and Aish, A. (2019). Scalpel versus diathermy skin incisions in cesarean sections. *Menoufia Medical Journal,* 32 453.

Albeniz, G., Akıncı, O. and Tosun, Y. (2024). Comparison of the Results of Electrocautery and Scalpel Use in Abdominal Midline Incisions. *Akdeniz Tıp Dergisi,* 10 (1): 53-57.

Ali, M., Murtaza, M., Aleem-Ud-Din, M., Ud Din, M. B., Sarwar, A. and Aslam, A. (2020). Comparison of Harmonic Scalpel versus conventional hemostasis in Thyroid surgery in terms of per-operative and postoperative outcome. *The Professional Medical Journal,* 27 (01): 68-73 DOI: 10.29309/tpmj/2019.27.01.3278.

Ammar, I., Abdelrahman Ibrahim, A., Ahmed, E., Amr, M., Esraa, M., Mahmoud, I., Esraa, S., Anas, K., Hagar, Z., Abdelrahman, E.-T. and Esraa, G. (2017). Cutting electrocautery versus scalpel for surgical incisions: a systematic review and meta-analysis. *Journal of Surgical Research,* 220 147-163 DOI: https://doi.org/10.1016/j.jss.2017.06.093.

Ann, B. Z., Yu, B., John, B. H. and John, R. H. 2019. 40 - Hemorrhage Control and Thrombosis Following Severe Injury. *In:* Craig, S. K., Craig, M. K., Barbara, A. K., Michael, B. S. and David, A. G. (eds.) *Consultative Hemostasis and Thrombosis (Fourth Edition).* Fourth Edition ed. Philadelphia: Elsevier.

Cavaillon, J.-M. (2001). Pro- versus anti-inflammatory cytokines: Myth or reality. *Cellular and molecular biology,* 47 (4): 1-8.

Coll, A., Mahgoob, N., Tahir, E., Alsaffar, S., Muna, M. and Ahmed, M. (2013). Harmonic versus electrocautery in the dissection of gall bladder in laparoscopic cholecystectomy. *Annals of the College of Medicine, Mosul,* 39 107-112 DOI: 10.33899/mmed.2013.81304.

Dinarello, C. A. (2011). Interleukin-1 in the pathogenesis and treatment of inflammatory diseases. *Blood, The Journal of the American Society of Hematology,* 117 (14): 3720-3732.

Jeschke, M. G., Van Baar, M. E., Choudhry, M. A., Chung, K. K., Gibran, N. S. and Logsetty, S. (2020). Burn injury. *Nat Rev Dis Primers,* 6 (1): 11 DOI: 10.1038/s41572-020-0145-5.

Johnson, B. Z., Stevenson, A. W., Prêle, C. M., Fear, M. W. and Wood, F. M. (2020). The Role of IL-6 in Skin Fibrosis and Cutaneous Wound Healing. *Biomedicines,* 8 (5): DOI: 10.3390/biomedicines8050101.

Lacina, L., Kolář, M., Pfeiferová, L., Gal, P. and Smetana Jr, K. (2024). Wound healing: insights into autoimmunity, ageing, and cancer ecosystems through inflammation and IL-6 modulation. *Frontiers in Immunology,* 15 1403570.

Leong Tan, A. K., Hsu, P. P., Eng, S. P., Ng, Y. H., Sun Lu, P. K., Tan, S. M., Say, J. H. and Chan, Y. H. (2006). Coblation vs electrocautery tonsillectomy: Postoperative recovery in adults. *Otolaryngology–Head and Neck Surgery,* 135 (5): 699-703 DOI: 10.1016/j.otohns.2006.03.008.

Medzhitov, R. (2010). Inflammation 2010: new adventures of an old flame. *Cell,* 140 (6): 771-776.

Medzhitov, R. (2021). The spectrum of inflammatory responses. *Science,* 374 (6571): 1070-1075 DOI: doi:10.1126/science.abi5200.

Miller, E. D., Song, F., Smith, J. D., Ayan, A. S., Mo, X., Weldon, M., Lu, L., Campbell, P. G., Bhatt, A. D. and Chakravarti, A. (2019). Plasma-based biomaterials for the treatment of cutaneous radiation injury. *Wound Repair and Regeneration,* 27 (2): 139-149.

Reinke, J. M. and Sorg, H. (2012). Wound Repair and Regeneration. *European Surgical Research,* 49 (1): 35-43 DOI: 10.1159/000339613.

Salgado, R. M., Alcántara, L., Mendoza-Rodríguez, C. A., Cerbón, M., Hidalgo-González, C., Mercadillo, P., Moreno, L. M., Álvarez-Jiménez, R. and Krötzsch, E. (2012). Post-burn hypertrophic scars are characterized by high levels of IL-1β mRNA and protein and TNF-α type I receptors. *Burns,* 38 (5): 668-676.

Sampaio, C. P. P., Biondo-Simões, M. D. L. P., Trindade, L. C. T., Farias, R. E., Pierin, R. J. and Martins, R. C. (2009). Inflammatory alterations provoked by metronidazole in wounds: an experimental study in rats. *Jornal Vascular Brasileiro,* 8 232-237.

Seaton, M., Hocking, A. and Gibran, N. S. (2015). Porcine Models of Cutaneous Wound Healing. *ILAR Journal,* 56 (1): 127-138 DOI: 10.1093/ilar/ilv016.

Shahmoradi, M. K., Mehri, J. and Taheri, H. R. (2020). Comparison of hemorrhoidectomy using harmonic scalpel and electrocautery: A randomized controlled trial. *International Journal of Surgery Open,* 27 39-42 DOI: 10.1016/j.ijso.2020.10.006.

Trindade, L. C. T., Biondo-Simões, M. D. L. P., Sampaio, C. P. P., Farias, R. E., Pierin, R. J. and Netto, M. C. (2010). Evaluation of topical metronidazole in the healing wounds process: an experimental study. *Revista do Colégio Brasileiro de Cirurgiões,* 37 358-363.

Vahabi, S., Karimi, A., Beiranvand, S., Moradkhani, M. and Hassanvand, K. (2020a). Comparison of the Effect of Different Dosages of Celecoxib on Reducing Pain after Cystocele and Rectocele Repair Surgery. *The Open Anesthesia Journal,* 14 (1): 30-34 DOI: 10.2174/2589645802014010030.

Vahabi, S., Veiskarami, P., Roozbahani, M., Lashani, S. and Farzan, B. (2020b). Cross-sectional study on hearing loss and auditory reaction time before and after spinal anesthesia with marcaine 0.5% in patients undergoing elective surgery. *Annals of Medicine and Surgery,* 60 236-240 DOI: 10.1016/j.amsu.2020.10.046.

Yameny, A. A. (2025). IL-6, TNF-α, IL-1β, and IFN-γ Cytokines as Core Inflammatory Biomarkers: Biological Roles, Diagnostic Utility, and Clinical Applications. *Journal of Bioscience and Applied Research,* 11 (3): 1055-1061.

Zhu, Z., Ding, J. and Tredget, E. E. (2016). The molecular basis of hypertrophic scars. *Burns Trauma,* 4 2 DOI: 10.1186/s41038-015-0026-4.