



Research Article

Haematological Trade-Offs in Scalpel and Electrocautery Excisional Wounds Treated with Topical Metronidazole in Murine Model

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ABSTRACT

The choice between scalpel and electrocautery for surgical incisions involves a critical trade-off: precision with blood loss versus haemostasis with thermal injury. This study compared the systemic haematological effects of these techniques in a murine model, with all surgical wounds receiving topical metronidazole to model a pragmatic clinical practice. Sixty-five mice were divided into scalpel incision (Group A, n = 30), electrocautery incision (Group B, n=30), and non-surgical control (Group C, n = 5) groups. Haematological parameters were assessed pre-surgery, immediately post-surgery; 0 hours and post surgery; 24 hours, 48 hours, 72 hours, week-1, and week-2. Electrocautery incisions induced a significant early rise in packed cell volume (PCV) at 72 hours, indicating haemoconcentration, followed by a decline by week two. Neutrophil responses were delayed and prolonged in this group, suggesting sustained inflammation. Conversely, scalpel incisions elicited an earlier neutrophil mobilization and a more rapid lymphocyte recovery, reflecting a different immune engagement. Scalpel incisions were associated with a haematological profile indicative of acute blood loss but promoted rapid adaptive repair. In contrast, electrocautery achieved haemostasis while inducing a prolonged inflammatory state, potentially delaying systemic recovery. These findings highlight that haematological parameters act as a systemic biosignature for the type of surgical injury. The evidence suggests instrument selection should consider desired postoperative immune and haematological outcomes, with electrocautery mitigating bleeding at the cost of a more demanding recovery, and the scalpel potentially facilitating a more efficient recovery trajectory despite perioperative blood loss.

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INTRODUCTION

The surgical incision is a fundamental step in both medical and veterinary practice, creating the initial wound that dictates the subsequent cascade of tissue repair and systemic response. Two primary instruments are employed for this purpose; the traditional scalpel and modern electrocautery, each with distinct mechanisms and physiological consequences (Ismail *et al.*, 2017).

The scalpel, long considered the gold standard, operates via mechanical force, allowing for clean and precise incisions with minimal collateral thermal damage to surrounding tissues (Jeschke *et al.*, 2020; Shahmoradi *et al.*, 2020; Soni *et al.*, 2024). This precision facilitates straightforward wound healing with clearly demarcated wound margins (Shahmoradi *et al.*, 2020). However, its principal limitation is the inability to achieve haemostasis during the cut, which can lead to significant intraoperative blood loss (Ann *et al.*, 2019). In contrast, electrocautery (diathermy) uses high-frequency electrical current to simultaneously cut and coagulate tissue, thereby reducing immediate blood loss and postoperative discomfort (Leong Tan *et al.*, 2006; Vahabi *et al.*, 2020). Yet, this haemostatic advantage is counterbalanced by the risk of collateral thermal damage, which can induce tissue necrosis, impair the healing process, and potentially lead to poorer scar formation (AbdElaal *et al.*, 2019; Ismail *et al.*, 2017; Leong Tan *et al.*, 2006).

The choice between these techniques therefore presents a critical trade-off: mechanical precision versus thermal haemostasis. This choice extends beyond the surgical site, as the nature of the initial tissue injury, clean mechanical division versus coagulation-induced necrosis, fundamentally shapes the systemic inflammatory and haematological response (Leong Tan *et al.*, 2006). Postoperative variations in haematological parameters, such as haemoglobin concentration, leukocyte count, and platelet indices, serve as vital biomarkers of systemic stress, inflammation, and the body's capacity for recovery.

Despite the clinical importance of these systemic effects, a significant research gap exists, particularly in veterinary contexts. The existing literature heavily relies on extrapolating findings from human medicine, overlooking critical interspecies differences in

wound healing dynamics and haematological responses (Ismail *et al.*, 2017). Furthermore, there is a paucity of comparative studies that directly assess how scalpel versus electrocautery incisions influence haematological profiles in animal models, leaving veterinary practitioners without evidence-based guidance for tool selection in common procedures like spaying or tumour excision. A comprehensive understanding of these systemic haematological alterations is essential for optimizing postoperative care, anticipating complications, and enhancing overall patient welfare.

Beyond the instrument choice, postoperative wound management practices vary significantly across clinical settings. In resource-limited and rural environments common in some developing nations, topical application of antimicrobials like metronidazole is a pragmatic, cost-effective strategy attempted for wound decontamination, despite a scarcity of formal evidence supporting its efficacy via this route. To model a clinically relevant scenario reflective of such practices, the present study incorporated standardized topical metronidazole treatment across all surgical wounds

To address this gap, the present study aimed to investigate the impact of scalpel and electrocautery surgical incision techniques treated with topical metronidazole on haematological parameters in a murine model. The specific objective was to evaluate key haematological parameters following scalpel and electrocautery incisional wounds treated with topical metronidazole in mice. By correlating instrument choice with measurable systemic blood markers, this research seeks to provide a scientific basis for refining surgical protocols to minimize systemic stress and promote more efficient recovery in veterinary patients.

MATERIALS AND METHODS

The Research Station

This study was conducted at the Department of Veterinary Surgery and Radiology, University of Maiduguri, Maiduguri, Borno State. Following Surgery and phlebotomy, blood samples were analysed at the Haematology laboratory, Department of Veterinary Pathology, University of Maiduguri. Ethical approval for the study was obtained from the University of Maiduguri Research Ethics

Committee.:

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Study Design

The study employed a controlled experimental design to compare the effects of scalpel and electrocautery incisions on haematological parameters.

Groups:

Group A: Mice subjected to scalpel incision and wounds treated with topical metronidazole.

Group B: Mice subjected to electrocautery incision and wounds treated with topical metronidazole.

Group C: Control (Served as Control group; the mice in this group had no surgeries and were also not treated with metronidazole but sampled at the same time points with the experimental groups A and B)

Inclusion Criteria:

Clinically healthy mice of similar weight and age (6-8 weeks old).

Exclusion Criteria:

Subjects with pre-existing health conditions or infections were excluded from the study.

Topical Antibiotic:

Metronidazole (Metrone® 500mg/100ml, Fidson, Healthcare plc. Sango-Ota Ogun State Nigeria) (IV) topically applied to the incision sites based on the intervals of the procedure.

Analgesic Agent:

Ketorolac Tromethamine (Ketolac®, Amriya Pharmacy, India) (2 mg/kg) was administered to provide post-operative pain relief.

Animals:

Sixty-five adult mice (*Mus musculus*) weighing 20-25 grams were used in the study.

Methodology

Preparation: Subjects were fasted for 2 hours before surgery (no water restrictions). The surgical area was shaved and disinfected using chlorhexidine. A manual portable weighing balance that provided measurements in grams (g) was used to determine the body weights of the mice before anaesthesia. Ketamine hydrochloride (Rotexmedica, Trittau Germany®) at a dosage of 80 mg/kg and xylazine (10 mg/kg; Xylased®, bioveta, a. s. Czech Republic) administered intraperitoneally were used to chemically restrain and anesthetize the mice. Using a razor blade, the surgical site was shaved. There were three (3) groups of mice, each consisting of five mice per sampling time of six (0h, 24h, 48h, 72h, Week 1 and Week 2).

Scalpel Excisions: Following anaesthesia and surgical site preparation, a scalpel blade size 10 was used to make a circular skin excision on the dorsum (Figure 1A). A full-thickness circular skin excision of 1 cm diameter, including the *panniculus carnosus*, was made on the dorsum. The circular skin flap was lifted (reflected) from the underlying muscle layer and then completely excised.

Electrocautery Excisions: After administering proper anaesthesia. A full-thickness circular skin excision of 1 cm diameter, including the *panniculus carnosus*, was made on the dorsum as that of the scalpel excision was made using an electrocautery unit at 40W and the circular skin flap was lifted (reflected) from the underlying muscle layer and then completely excised Figure 1(B).



FIG. 1: A 1 cm diameter circular skin excision made on the dorsum using a size 10 scalpel blade (A) and electrocautery unit (B)

Wound Closure:

Excision wounds were left open without closure to heal by secondary intention and until sampling time, as the case may be.

Post-operative Care:

Animals were monitored for pain and provided with intraperitoneal administration of ketorolac (2 mg/kg) daily for 3 days as the case may be to manage pain. Metronidazole 5mg/kg was applied topically to the excision sites twice daily for up to 5 days as the case may be to prevent bacterial infection and promote healing. The topical metronidazole to all surgical wounds was to standardize postoperative care and model a specific clinical practice. The topical route for metronidazole, particularly for managing potentially contaminated wounds, is anecdotally reported in resource-constrained veterinary and human medical settings in developing regions. This study design choice allows the investigation of haematological responses to different surgical techniques within the context of this pragmatic, investigative treatment approach.

Blood Samples:

Blood samples were collected (terminal blood collection) at the following intervals: 0 hours (immediately post-surgery), 24 hours, 48 hours, 72 hours, week-1, and week-2 post-surgery. Blood samples were collected via decapitation.

Haematological Analysis

Blood samples were analysed for white blood cell count, red blood cell count, haemoglobin concentration, and platelet count using an automated haematology analyser (Mindray BC-2800).

Data Analysis

Data were analysed using GraphPad Prism version 10.4.1. Statistical methods included two-way ANOVA for analysing the effects of time and skin excision techniques on the outcomes, row statistics provided the Mean \pm SE, and Tukey's test for multiple comparisons. Data were assessed for normality and homogeneity of variance using Shapiro-Wilk and Brown-Forsythe tests, respectively, prior to parametric analysis. Results were expressed as mean \pm standard error and p-value < 0.05 was considered statistically significant.

RESULTS

Haematology

The results in (Tables 1) revealed that Group B (36.0 ± 2.6) mice exhibited a significant increase ($p < 0.05$) in packed cell volume (PCV) levels at 72 hours post-surgery compared to Group A (52.7 ± 2.3) at 0 and 72 hours. This elevated PCV level in Group B (40.0 ± 2.0) persisted at Week-1 post-surgery. However, at Week 2 the values for PCV in group B (50.7 ± 2.2) significantly decreased ($p < 0.05$) compared to both earlier time points. Interestingly, Group B (51.3 ± 0.9) PCV levels at 0 hours were significantly lower ($p < 0.05$) than at 72 hours (36.0 ± 2.6) when compared to the control group (comparison to a healthy baseline standard). This trend of reduced PCV levels in group B continued for the subsequent 24, 48 hours, and Week-1 (46.7 ± 3.3 , 43.7 ± 4.4 and 40.0 ± 2.0) post-surgery.

Neutrophil counts in Group A (Scalpel) were highest immediately post-surgery (0h) and showed a decreasing trend at 24 and 48 hours before varying at later points, suggesting an initial mobilization (Table 2). At 24 hours, the

Group A (27.0 ± 5.0) neutrophil levels were significantly lower ($p < 0.05$) than Group B (34.3 ± 5.9). However, at Week 2, the group A (49.3 ± 4.1) neutrophil counts significantly increased ($p < 0.05$) compared to both group B (34.3 ± 5.9) at 24 hours and the control group across all time points.

In contrast, the group B (49.3 ± 3.8) neutrophil counts exhibited an initial decrease followed by a significant increase ($p < 0.05$) at 48 hours. At 48 hours, Group B (49.3 ± 3.8) neutrophil levels were significantly higher ($p < 0.05$) than the control group across all time points.

Lymphocyte levels in group A (72.3 ± 4.8) initially decreased at 24 hours but subsequently increased at later time points. At

24 hours, Group A (72.3 ± 4.8) lymphocyte levels were significantly higher ($p < 0.05$) than Group B (65.0 ± 5.7) across all time points and the control group (56.0 ± 3.8) across all time points. However, at two weeks, Group A lymphocyte levels (51.3 ± 0.7) significantly decreased ($p < 0.05$) compared to the control group (comparison to a healthy baseline standard) across all time points (Table 4.4). In group B, the lymphocyte levels gradually increased over time, with significant differences observed between early and late time points. At Week 2, the group B lymphocyte levels were significantly lower ($p < 0.05$) than the control group at 24, 48, and 72 hours.

Table 1: Comparison M \pm SE Haematology Responses Following Scalpel and Electrocautery Incisions with Metronidazole Wound Treatments in Mice

		PCV (%)	HB(g/dl)	WBC $\times 10^9/L$	RBC $\times 10^{12}/L$	NEU (%)	EOS (%)	LYM (%)	MON (%)	BAS (%)
GROUP A: SCALPEL INCISIONS	0 h	52.7 \pm 2.3 ^a	14.1 \pm 0.5	7.4 \pm 0.5	6.9 \pm 0.2	41.3 \pm 1.8 ^a	7.0 \pm 2.6	40.0 \pm 0.0 ^a	1.7 \pm 1.2	0.0 \pm 0.0
	24 h	46.3 \pm 5.8	12.3 \pm 0.6	5.5 \pm 0.2	6.0 \pm 0.1	39.0 \pm 5.0 ^b	0.3 \pm 0.3	72.3 \pm 4.8 ^b	0.3 \pm 0.3	0.0 \pm 0.0
	48 h	43.0 \pm 2.6	11.3 \pm 0.4	7.2 \pm 0.7	6.6 \pm 0.1	^a 36.3 \pm 8.3	4.7 \pm 2.9	65.0 \pm 11.0	0.0 \pm 0.0	0.0 \pm 0.0
	72 h	38.3 \pm 2.8 ^b	13.3 \pm 0.4	9.9 \pm 0.5	7.6 \pm 0.1	^b 36.3 \pm 1.2	6.3 \pm 3.0	^g 68.7 \pm 4.3	0.7 \pm 0.7	0.0 \pm 0.0
	Week 1	41.7 \pm 3.2	11.1 \pm 0.2	8.3 \pm 0.4	8.4 \pm 0.1	34.7 \pm 3.0	3.0 \pm 2.5	57.3 \pm 0.7a	0.0 \pm 0.0	0.0 \pm 0.0
	Week 2	43.7 \pm 4.8	12.8 \pm 0.2	7.0 \pm 0.2	7.8 \pm 0.4	^a 34.0 \pm 2.1	6.7 \pm 3.5	^g 54.3 \pm 6.9	0.7 \pm 0.7	0.0 \pm 0.0
GROUP B: ELECTROCA UTERY	0 h	36.0 \pm 2.6 ^b	13.2 \pm 0.4	6.3 \pm 0.2	6.6 \pm 0.4	40.0 \pm 0.6 ^a	3.3 \pm 1.8	46.7 \pm 1.7a	0.0 \pm 0.0	0.0 \pm 0.0
	24 h	46.7 \pm 3.3	12.1 \pm 0.8	6.0 \pm 0.2	5.5 \pm 0.2	^b 40.1 \pm 5.9	0.3 \pm 0.3	^g 65.0 \pm 5.7b	0.3 \pm 0.3	0.0 \pm 0.0
	48 h	43.7 \pm 4.4	11.8 \pm 0.4	6.9 \pm 0.2	6.5 \pm 0.0	49.3 \pm 3.8	0.3 \pm 0.3	59.7 \pm 4.3a	0.7 \pm 0.7	0.0 \pm 0.0
	72 h	51.3 \pm 0.9	11.7 \pm 0.2	8.8 \pm 0.3	6.9 \pm 0.2	48.0 \pm 4.7	4.7 \pm 1.3	56.0 \pm 3.5a	0.3 \pm 0.3	0.0 \pm 0.0
	Week 1	40.0 \pm 2.0 ^b	11.5 \pm 0.5	7.5 \pm 0.4	8.2 \pm 0.1	54.0 \pm 1.2	6.7 \pm 3.3	^g 65.3 \pm 4.7a	0.7 \pm 0.7	0.0 \pm 0.0
	Week 2	36.7 \pm 2.2 ^a	14.0 \pm 1.2	8.4 \pm 0.7	7.1 \pm 0.1	^(a) 47.7 \pm 1.3 ^a	4.0 \pm 1.5	^g 72.0 \pm 1.2	0.3 \pm 0.3	0.0 \pm 0.0
GROUP C: CONTROL	0 h	^a 49.0 \pm 2.1	13.1 \pm 0.4	8.2 \pm 0.4	7.9 \pm 0.2	^(a) 36.7 \pm 3.5	7.0 \pm 3.6	^g 56.0 \pm 3.8	0.3 \pm 0.3	0.0 \pm 0.0
	24 h	^a 49.0 \pm 2.1	13.1 \pm 0.4	8.2 \pm 0.4	7.9 \pm 0.2	^(a) 36.7 \pm 3.5	7.0 \pm 3.6	^g 56.0 \pm 3.8	0.3 \pm 0.3	0.0 \pm 3.8
	48 h	^a 49.0 \pm 2.1	13.1 \pm 0.4	8.2 \pm 0.4	7.9 \pm 0.2	^(a) 36.7 \pm 3.5	7.0 \pm 3.6	^g 56.0 \pm 3.8	0.3 \pm 0.3	0.0 \pm 0.0
	72 h	^a 49.0 \pm 2.1	13.1 \pm 0.4	8.2 \pm 0.4	7.9 \pm 0.2	^(a) 36.7 \pm 3.5	7.0 \pm 3.6	^g 56.0 \pm 3.8	0.3 \pm 0.3	0.0 \pm 0.0
	Week 1	^a 49.0 \pm 2.1	13.1 \pm 0.4	8.2 \pm 0.4	7.9 \pm 0.2	^(a) 36.7 \pm 3.5	7.0 \pm 3.6	^g 56.0 \pm 3.8	0.3 \pm 0.3	0.0 \pm 0.0
	Week 2	49.0 \pm 2.1	13.1 \pm 0.4	8.2 \pm 0.4	7.9 \pm 0.2	^(a) 36.7 \pm 3.5	7.0 \pm 3.6	^g 56.0 \pm 3.8	0.3 \pm 0.3	0.0 \pm 0.0

Values with different superscript between groups along columns differ ($p < 0.05$) significantly whereas values with asterisk (*) also differ within columns

GROUP A: Group that underwent Scalpel Excision and Treatment with Metronidazole.

GROUP B: Group that underwent Electrocautery Excision and Treatment with Metronidazole.

GROUP C: Group that underwent no surgical Excision and no treatment with Metronidazole.

Table 2: The M \pm SE Haematology Values at Different Post-Surgery Time Following Scalpel Incisions with Metronidazole Wound Treatment in Mice.

Surgical Time	HAEMATOLOGY PARAMETERS								
	PCV%	HB(g/dl)	WBC $\times 10^9/L$	RBC $\times 10^{12}/L$	NEU (%)	EOS (%)	LYM (%)	MON (%)	BAS (%)
GROUP A: SCALPEL INCISIONS	0 h	52.7 \pm 2.3 ^a	14.1 \pm 0.5	7.4 \pm 0.5	6.9 \pm 0.2	41.3 \pm 1.8 ^a	7.0 \pm 2.6	40.0 \pm 0.0 ^a	1.7 \pm 1.2
	24 h	46.3 \pm 5.8	12.3 \pm 0.6	5.5 \pm 0.2	6.0 \pm 0.1	39.0 \pm 5.0	0.3 \pm 0.3	72.3 \pm 4.8 ^b	0.3 \pm 0.3
	48 h	*43.0 \pm 2.6	11.3 \pm 0.4	7.2 \pm 0.7	6.6 \pm 0.1	36.3 \pm 8.3	4.7 \pm 2.9	65.0 \pm 11.0 ^a	0.0 \pm 0.0
	72 h	38.3 \pm 2.8 ^b	13.3 \pm 0.4	9.9 \pm 0.5	7.6 \pm 0.1	36.3 \pm 1.2 ^a	6.3 \pm 3.0	*68.7 \pm 4.3 ^a	0.7 \pm 0.7
	Week 1	41.7 \pm 3.2	11.1 \pm 0.2	8.3 \pm 0.4	8.4 \pm 0.1	34.7 \pm 3.0 ^a	3.0 \pm 2.5	57.3 \pm 0.7 ^a	0.0 \pm 0.0
	Week 2	*43.7 \pm 4.8	12.8 \pm 0.2	7.0 \pm 0.2	7.8 \pm 0.4	34.0 \pm 2.1 ^a	6.7 \pm 3.5	*54.3 \pm 6.9 ^a	0.7 \pm 0.7

Values with different superscript within columns differ (P < 0.05) significantly

GROUP A: Group that underwent Scalpel Excision and Treatment with Metronidazole., GROUP B: Group that underwent Electrocautery Excision and Treatment with Metronidazole., GROUP C: Group that underwent no surgical Excision and no treatment with Metronidazole.

Table 3: The M \pm SE Haematology Values at Different Post-Surgery Time of Electrocautery Incisions and Metronidazole Wound Treatment in Mice.

Surgical Time	HAEMATOLOGY PARAMETERS								
	PCV%	HB(g/dl)	WBC $\times 10^9/L$	RBC $\times 10^{12}/L$	NEU (%)	EOS (%)	LYM (%)	MON (%)	BAS (%)
GROUP B: ELECTRO AUTERY	0 h	36.0 \pm 2.6 ^a	13.2 \pm 0.4	6.3 \pm 0.2	6.6 \pm 0.4	40.0 \pm 0.6 ^a	3.3 \pm 1.8	46.7 \pm 1.7 ^a	0.0 \pm 0.0
	24 h	46.7 \pm 3.3	12.1 \pm 0.8	6.0 \pm 0.2	5.5 \pm 0.2	*40.1 \pm 5.9	0.3 \pm 0.3	65.0 \pm 5.7 ^b	0.3 \pm 0.3
	48 h	43.7 \pm 4.4	11.8 \pm 0.4	6.9 \pm 0.2	6.5 \pm 0.0	49.3 \pm 3.8	0.3 \pm 0.3	59.7 \pm 4.3 ^a	0.7 \pm 0.7
	72 h	51.3 \pm 0.9	11.7 \pm 0.2	8.8 \pm 0.3	6.9 \pm 0.2	48.0 \pm 4.7	4.7 \pm 1.3	*56.0 \pm 3.5	0.3 \pm 0.3
	Week 1	40.0 \pm 2.0 ^b	11.5 \pm 0.5	7.5 \pm 0.4	8.2 \pm 0.1	54.0 \pm 1.2 ^a	6.7 \pm 3.3	65.3 \pm 4.7 ^a	0.7 \pm 0.7
	Week 2	36.7 \pm 2.2 ^a	14.0 \pm 1.2	8.4 \pm 0.7	7.1 \pm 0.1	*47.7 \pm 1.3 ^a	4.0 \pm 1.5	*72.0 \pm 1.2	0.3 \pm 0.3

Values with different superscript within columns differ (p < 0.05) significantly, GROUP A: Group that underwent Scalpel Excision and Treatment with Metronidazole., GROUP B: Group that underwent Electrocautery Excision and Treatment with Metronidazole., GROUP C: Group that underwent no surgical Excision and no treatment with Metronidazole.

Table 4: The M \pm SE Haematology Values of Mice Not Subjected to any forms of Surgery

Surgical Time	HAEMATOLOGY PARAMETERS									
	PCV (%)	HB(g/dl)	WBC $\times 10^9/L$	RBC $10^{12}/L$	NEU (%)	EOS (%)	LYM (%)	MON (%)	BAS (%)	
GROUP C CONTROL	0 h	49.0 \pm 2.1	13.1 \pm 0.4	8.2 \pm 0.4	7.9 \pm 0.2	36.7 \pm 3.5	7.0 \pm 3.6	56.0 \pm 3.8	0.3 \pm 0.3	0.0 \pm 0.0
	24 h	49.0 \pm 2.1	13.1 \pm 0.4	8.2 \pm 0.4	7.9 \pm 0.2	36.7 \pm 3.5	7.0 \pm 3.6	56.0 \pm 3.8	0.3 \pm 0.3	0.0 \pm 0.0
	48 h	49.0 \pm 2.1	13.1 \pm 0.4	8.2 \pm 0.4	7.9 \pm 0.2	36.7 \pm 3.5	7.0 \pm 3.6	56.0 \pm 3.8	0.3 \pm 0.3	0.0 \pm 0.0
	72 h	49.0 \pm 2.1	13.1 \pm 0.4	8.2 \pm 0.4	7.9 \pm 0.2	36.7 \pm 3.5	7.0 \pm 3.6	56.0 \pm 3.8	0.3 \pm 0.3	0.0 \pm 0.0
	Week 1	49.0 \pm 2.1	13.1 \pm 0.4	8.2 \pm 0.4	7.9 \pm 0.2	36.7 \pm 3.5	7.0 \pm 3.6	56.0 \pm 3.8	0.3 \pm 0.3	0.0 \pm 0.0
	Week 2	49.0 \pm 2.1	13.1 \pm 0.4	8.2 \pm 0.4	7.9 \pm 0.2	36.7 \pm 3.5	7.0 \pm 3.6	56.0 \pm 3.8	0.3 \pm 0.3	0.0 \pm 0.0

Values with different superscript within columns differ ($p < 0.05$) significantly

GROUP A: Group that underwent Scalpel Excision and Treatment with Metronidazole.

GROUP B: Group that underwent Electrocautery Excision and Treatment with Metronidazole.

GROUP C: Group that underwent no surgical Excision and no treatment with Metronidazole.

DISCUSSION

The study investigated the haematological effects of different surgical incision techniques, scalpel and electrocautery, in mice, with topical application of metronidazole to all surgical wounds. The findings revealed significant alterations in PCV, neutrophil, and lymphocyte levels over time, highlighting the influence of surgical trauma on the hematopoietic system.

The initial increase in PCV levels observed in Group B at 72 hours post-surgery could be attributed to haemoconcentration due to fluid loss and increased vascular permeability associated with the inflammatory response to surgical trauma. This finding aligns with previous studies demonstrating elevated PCV levels in the early stages of wound healing. However, the subsequent decrease in PCV indicating early haemoconcentration followed by a subsequent decline in PCV by week two, perhaps suggest a dynamic haematological adjustment (Moore *et al.*, 2015). Similarly, the significant early elevation in PCV observed in the electrocautery group at 72 hours is consistent with findings in abdominal surgery, where electrocautery use was correlated with higher postoperative packed cell volume values compared to sharp dissection, attributed to reduced intraoperative fluid loss and haemoconcentration (Miller *et al.*, 2022; Thanarajasingam *et al.*, 2022). Conversely, the trend in the scalpel group aligns with human surgical studies where scalpel incisions, despite greater initial blood loss, typically result in a more rapid normalization of haematocrit values during recovery (Ismail *et al.*, 2017).

The initial decrease in neutrophil counts in Group A at 24 hours may reflect a rapid mobilization of neutrophils to the wound site, leading to a transient reduction in circulating levels. Conversely, the significant increase in neutrophil counts in Group A at two weeks suggests a sustained inflammatory response or delayed healing. This prolonged inflammatory response could be associated with increased tissue damage or infection (Moore *et al.*, 2015). This delayed yet sustained neutrophilia in the electrocautery group mirrors the prolonged inflammatory phase described in histopathological analyses of thermally injured tissues in porcine models (Cheng *et al.*, 2021). Furthermore, the lymphocyte dynamics observed—specifically, the slower recovery in the electrocautery group—echo patterns seen in postoperative immune monitoring in humans, where procedures causing greater tissue necrosis are associated with more prolonged lymphopenia and immunosuppression (Iwata *et al.*,

2016). The more acute but rapidly resolving lymphocyte shift in the scalpel group parallels the 'stress-and-recovery' haematological pattern documented in elective soft tissue surgeries in companion animals (Moore *et al.*, 2015)

The initial decrease in neutrophil counts in group B, followed by a significant increase at 48 hours may indicate a delayed inflammatory response or a less severe initial injury compared to Group A. The subsequent elevation in neutrophil levels might be attributed to the body's attempt to combat potential infection or promote tissue repair (Iwata *et al.*, 2016) The initial decrease in lymphocyte counts in Group A at 24 hours could be attributed to stress-induced lymphopenia, a common response to surgical trauma. The subsequent increase in lymphocyte levels suggests a compensatory response to restore immune function (Moore *et al.*, 2015)

The gradual increase in lymphocyte levels in group B over time, may indicate or suggest a less pronounced initial immune response or a more rapid recovery phase. However, the lower lymphocyte levels at two weeks compared to the control group (comparison to a healthy baseline standard) suggest a potential impairment of immune function or persistent inflammation (Iwata *et al.*, 2016).

Our observation of prolonged neutrophilia in electrocautery wounds aligns with human studies reporting increased local and systemic inflammatory markers after thermal injury (AbdElaal *et al.*, 2019). The lymphocyte response pattern in our scalpel group mirrors the 'stress lymphopenia followed by recovery' documented in postoperative veterinary patients (Moore *et al.*, 2015), suggesting a more acute but resolved immune disruption compared to the sustained dysregulation seen with electrocautery

The topical application of metronidazole, an antimicrobial agent, may have influenced the inflammatory response and subsequent healing process. Metronidazole could potentially modulate the activity of inflammatory cells, such as neutrophils and lymphocytes, thereby affecting haematological parameters (Suárez *et al.*, 2024). However, the specific impact of metronidazole on the observed changes needs to be explored in future studies.

These findings suggest that surgical incision techniques and subsequent healing processes can significantly impact haematological parameters, particularly packed cell volume, neutrophil, and lymphocyte levels. Further research is needed to elucidate the underlying mechanisms and clinical implications of these changes.

The uniform application of topical metronidazole, while introducing a potential confounder due to its known anti-inflammatory properties, was a deliberate design choice to replicate a realistic clinical scenario. In many developing nations and rural veterinary practices, topical antimicrobials are pragmatically employed for wound management despite limited pharmacological evidence for this route. Therefore, our findings reflect the haematological trade-offs between surgical instruments within the context of this common adjunctive care practice. Future studies should compare these techniques both with and without topical antimicrobials to disentangle their specific effects.

In comparison, while limited research has directly compared the effects of scalpel and electrocautery incisions on haematological parameters, studies have shown that surgical trauma can significantly impact various haematological indices. For instance, reported increased white blood cell counts and decreased lymphocyte counts following surgical procedures. These findings are consistent with our observations, highlighting the systemic effects of surgical stress on the immune system.

CONCLUSION

In summary, within the context of standardized postoperative care including topical metronidazole, haematological parameters act as a systemic biosignature for the type of surgical injury. The observed trade-offs, specifically, the scalpel's association with acute blood loss but swift adaptive repair versus electrocautery's effective haemostasis at the expense of a prolonged inflammatory state, were measured under the influence of this adjunctive therapy. This evidence suggests that while electrocautery mitigates intraoperative bleeding, it may concurrently impose a more demanding systemic recovery challenge. For procedures where minimizing the overall inflammatory burden is a priority, the scalpel, despite its perioperative drawbacks, may facilitate a more efficient recovery trajectory.

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