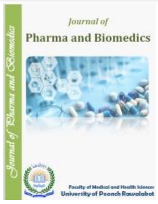

Faculty of Medical and Health Sciences, University of Poonch Rawalakot
Journal of Pharma and Biomedics
ISSN: 3007-1984(online), 3007-1976 (Print)
https://www.jpbsci.com/index.php/jpbs

Comparative Study on Post-Operative Analgesia Produced by Tramadol and Diclofenac after Epidural Lidocaine in Dogs

Muhammad Ramzan[1], Habibullah Janyaro[1], Muhammad Faiz Khand[1], Hidayatullah Soomro[2], Rameez Raja Kaleri[3], Syed Sabir Ali Shah[3], Sahir Odhano[5], Wakash[1], Tamseel Saleem[4], Dilpat Rahi[1]

[1] Department of Veterinary Surgery, Shaheed Benazir Bhutto University of Veterinary and Animal Sciences, Sakrand, Pakistan.
[2] Department of Veterinary Medicine, Shaheed Benazir Bhutto University of Veterinary and Animal Sciences, Sakrand, Pakistan.
[3] Livestock and Fisheries Department Government of Sindh, Pakistan.
[4] Department of Biotechnology, Shaheed Benazir Bhutto University of Veterinary and Animal Sciences, Sakrand, Pakistan.
[5] Department of Fisheries and Aquaculture, Shaheed Benazir Bhutto University of Veterinary and Animal Sciences, Sakrand, Pakistan.

Received: August 30, 2025; Revised: November 15, 2025; Accepted: December 06, 2025

ABSTRACT

Pain is a complex sensory and emotional experience linked to tissue injury that affects physiology. This study was conducted with the aim of comparing the effectiveness of three different epidural analgesic protocols: lidocaine alone (L), lidocaine plus diclofenac (LD), and lidocaine plus tramadol (LT) in managing post-operative pain in dogs undergoing orchiectomy. Twelve healthy adult male dogs were randomly divided into three treatment groups. All animals were administered an epidural injection, with lidocaine and tramadol given at 2 mg/kg body weight each, and diclofenac at a dose of 1 mg/kg. This was performed after premedication and anesthesia induction using propofol. Before and during surgery, key physiological parameters (heart rate, respiratory rate, esophageal temperature, hemoglobin oxygen saturation (SpO2), and blood pressure), time durations (anesthesia time, surgery time, and recovery time), post-operative pain assessment, and wound healing assessment were monitored. The results showed a significant decrease in vital signs across groups during surgery. The time durations showed a significant difference ($p<0.05$) except for recovery time ($p=0.45$). Post-operative pain evaluation revealed that group L provided pain relief for 3 hours, LD for 6 hours, and LT for 8 hours. All groups healed within two weeks, with group LT showing faster recovery comparatively. It is concluded that the combination of epidural lidocaine and tramadol is a better option for post-operative analgesia and faster wound healing. It is suggested to use this combination for orchiectomy in dogs.

Keywords: *Pain, Orchiectomy, Analgesic protocols, Physiological parameters, Wound healing*.

Corresponding Authors: *Rameez Raja Kaleri*
Email: janyaroh@gmail.com

INTRODUCTION

Dogs play vital roles in human society, ranging from companionship to therapeutic and working functions (Gee *et al.*, 2021; Pongracz and Dobos, 2023). However, the rising population of stray dogs poses significant public health and environmental risks, including zoonotic disease transmission, community disturbances and bite injuries (Gill *et al.*, 2022; Gado *et al.*, 2023). Rabies remains the most fatal among these issues, particularly in regions with uncontrolled dog populations. To address this, castration is widely employed, with orchiectomy recognized as the most effective method for population control (Njoga *et al*., 2020; Nazar *et al*., 2024).

Orchiectomy, a surgical removal of testicles, is performed to control uncontrolled breeding and reduce stray populations, thereby lowering shelter intake, euthanasia rates, and management costs (Urfer and Kaeberlein, 2019; Catalkaya *et al*., 2025). Effective pain management is crucial, as nociceptors transmit harmful stimuli to the brain where pain is perceived (Flaherty, 2013; Pedersen *et al*., 2025). Understanding the neurobiology of pain is vital, since untreated postoperative pain may delay healing and prolong recovery (Yam *et al*., 2018; Podder *et al*., 2025).

Post-operative pain after orchiectomy varies with pain tolerance, surgical technique, and health status. Common analgesics include NSAIDs (diclofenac), opioids (tramadol), and local anesthetics (lidocaine) (Hancock *et al*., 2005; Jamison and Mao, 2015; Alorfi, 2023). While IV and IM routes are effective, they often cause systemic side effects. Epidural administration provides targeted, prolonged analgesia with lower doses and fewer complications (Puntillo *et al*., 2021). By blocking nerve transmission, reducing inflammation, and modulating spinal receptors, epidural drugs ensure superior post-operative pain control (Podder *et al*., 2025). Diclofenac, a phenylacetic acid derivative NSAID, exerts anti-inflammatory, analgesic, and antipyretic effects by inhibiting prostaglandin synthesis, thereby reducing pain and inflammation. It is widely applied in veterinary practice for post-operative pain control, facilitating faster recovery and improved patient comfort (Gill *et al*., 2022; Hasan *et al*., 2023). Tramadol, an opioid analgesic, provides central analgesia through µ-opioid receptor activation and inhibition of monoamine reuptake, offering effective pain relief with a comparatively lower risk of respiratory depression. Its favorable safety and tolerability make it a preferred choice in orchiectomy and related procedures (Minami *et al*., 2015; Dominguez-Oliva *et al*., 2021). Lidocaine, commonly used as both a local anesthetic and antiarrhythmic, blocks voltage-gated sodium channels, thereby preventing nerve impulse transmission and producing effective local anesthesia. Additionally, its cardiac membrane-stabilizing effects aid in arrhythmia management (Tikhonov and Zhorov, 2017; Silva *et al*., 2023).

This study was aimed to compare the efficacy and safety of epidural lidocaine, tramadol, and their combination for managing post-operative pain in dogs undergoing orchiectomy. The objectives included evaluating the degree of pain relief, determining the onset and duration of analgesia, and assessing potential side effects, with the ultimate goal of identifying the most effective protocol for canine post-operative pain management.

MATERIALS AND METHODS

Animals

The study was conducted on twelve healthy adult male dogs. They were captured from Sakrand premises and brought at indoor patient ward of Department of veterinary Surgery, Faculty of Veterinary Sciences, Shaheed Benazir Bhutto University of Veterinary and Animal Sciences, Sakrand. The dogs were fed and handled individually for a period of 14 days before the start of the experiment to adapt the environment. During this period all dogs were subjected to clinical and physical examination to rule out diseased ones. Only healthy dogs were selected for this study. The study was approved by departmental board of studies.

Study design

This study was a prospective, randomized, and blinded clinical study.

Procedure

The pre operative health status of each dog was evaluated through physical and clinical examination and laboratory examination. Only healthy, physiologically fit and infection free dogs were included in the study. For each dog, baseline values of heart rate (HR), respiratory rate (RR), esophageal temperature (Te), hemoglobin oxygen saturation (SPO_{2}), systolic arterial blood pressure (SAP), diastolic arterial blood pressure (DAP), mean arterial blood pressure (MAP) were evaluated and recorded before administration of anesthesia.

All the selected dogs were assigned into three groups that differed in the analgesic treatment administered epidurally as group L (Epidural Lidocaine group), group LD (Epidural Lidocaine plus diclofenac) and group LT (Epidural Lidocaine and Tramadol group) comprising of four dogs each group. A manual randomization technique was used to allocate dogs in each group. Four dogs per group were allocated and food, but not water was withheld 12 hours before anesthesia. All dogs were premedicated with atropine sulphate (0.02 mg/kg, Atropine, Venus pharm, Pakistan) to reduce salivary and respiratory secretions and to prevent cardiac arrest, xylazine hydrochloride (1 mg/kg, Xylax, mylabs, Pakistan) acting as sedative and muscle relaxant via I.M route in quadriceps muscles. On the loss of righting reflex, a 20- or 22-gauge catheter (Delta Med, Italy) was aseptically inserted into the cephalic vein, and anesthesia was induced by slowly administering propofol (5mg\kg, Fresofol 1% MCT/LCT, India) to reduce potential cardiac and respiratory depression until a loss of the palpebral reflex and man dibular tone was achieved. All dogs breathed room air. Lactated Ringer's solution (3 mL/kg/hour) (S.A.L.F., Italy) was administered intravenously to all cats throughout the procedure to maintain fluid balance.

With loss of the palpebral reflex after propofol injection, three different epidural treatment were given to each group with diluting inf. normal saline at dose rate of 0.22ml\kg B. W. After clipping and aseptic preparation of lumbosacral area, a 22-gauge epidural needle was injected in lumbosacral junction. To confirm right needle placement in epidural space, hanging drop method was used. Following confirmation of correct needle placement, the animals were administered one of the three epidural treatments: group L received lidocaine (2 mg/kg; Xyloaid, Sehat, India); group LD was given a combination of lidocaine (2 mg/kg) and diclofenac (1 mg/kg; Dicloran, Sami, Pakistan); and group LT received lidocaine (2 mg/kg) along with tramadol (2 mg/kg; Tramal, Dvago, Pakistan). Following epidural administration, the animals were positioned in sternal recumbency with their hindlimbs adducted for 10 minutes. The effectiveness of the EP block was verified by observing relaxation of the anal sphincter, assessed every 2 minutes for 10 minutes by gently applying pressure to the anus or perianal area.

Once the epidural effect was evident in the animals, monitoring of vital parameters started and continued until the completion of surgery. The monitoring protocols included heart rate (HR), non-invasive systolic (SAP), diastolic (DAP), and mean arterial blood pressures (MAP), using a cuff of appropriate size placed on the median artery of the forelimb between the elbow and carpus. Respiratory rate (RR) was assessed by observing thoracic excursions, while hemoglobin oxygen saturation (SpO_2) was measured using a probe attached to the tongue. Esophageal body temperature (Te°) was also monitored. All physiological parameters were recorded at 5-minute intervals throughout the procedure (Figure 1).

The surgical site was aseptically cleaned using povidone-iodine to avoid sepsis. The dog was positioned on lateral recumbency for the surgery. A surgical drape was placed over the area, leaving only the incision site exposed to start orchiectomy procedure. One testicle was grasped and an incision, about 2.5 to 3 cm long, cranial to the scrotum on the midline in the pre-scrotal region was made. The incision was continued through all scrotal layers for easy access to testicle. Gentle pressure was applied to push the first testicle out through the incision. The ligaments holding the testicle were carefully dissected to separate it from the surrounding tissues. The spermatic cord, which includes the vas deferens and testicular vessels, were isolated.

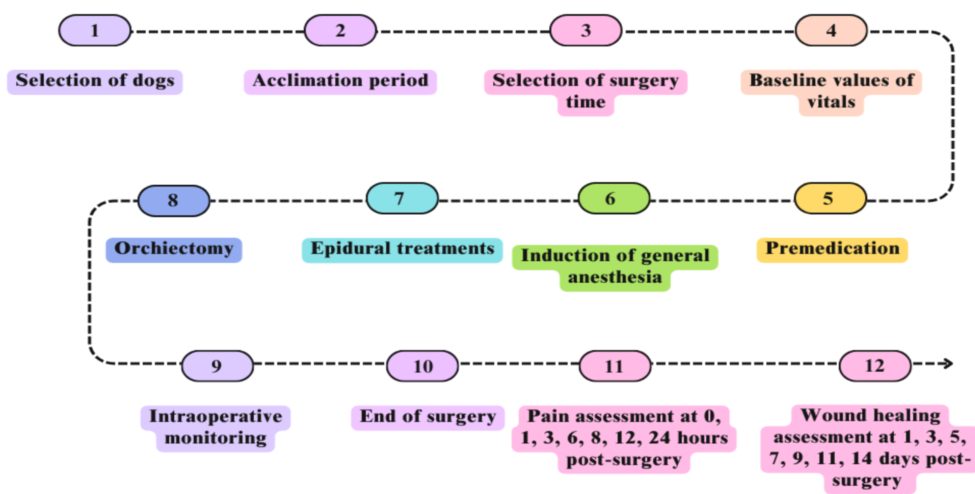

Figure 1: Sequential flow of experimental design and surgical assessments.

Two ligatures were placed on the blood vessels and spermatic cord using vicryl sutures, with one ligature positioned proximally and the other distally. The testicle was then removed by cutting between the distal ligature and the testicle. For the second testicle, the same incision was extended to access it, and the same steps of ligating and removing the testicle were followed. Finally, the wound was closed in two layers system: the inner layers were sutured with vicryl (size 2\0), and the outer skin and subcutaneous tissues were closed using non-absorbable silk sutures (size 2\0).

The duration of anesthesia was recorded from the time of sedation until the animals regained motor function and sensation in their hind limbs (Figure 2). Surgical time was measured from the initial scrotal midline incision to the complete removal of both testicles. Recovery time was defined as the interval between the epidural injection and the point at which the animals could lift their heads and respond to their surroundings. Following surgery, all animals were allowed to recover spontaneously without the use of reversal agents. The return of hind limb sensation (T0) was assessed by applying a mild clamping stimulus to the hind limbs at 5-minute intervals.

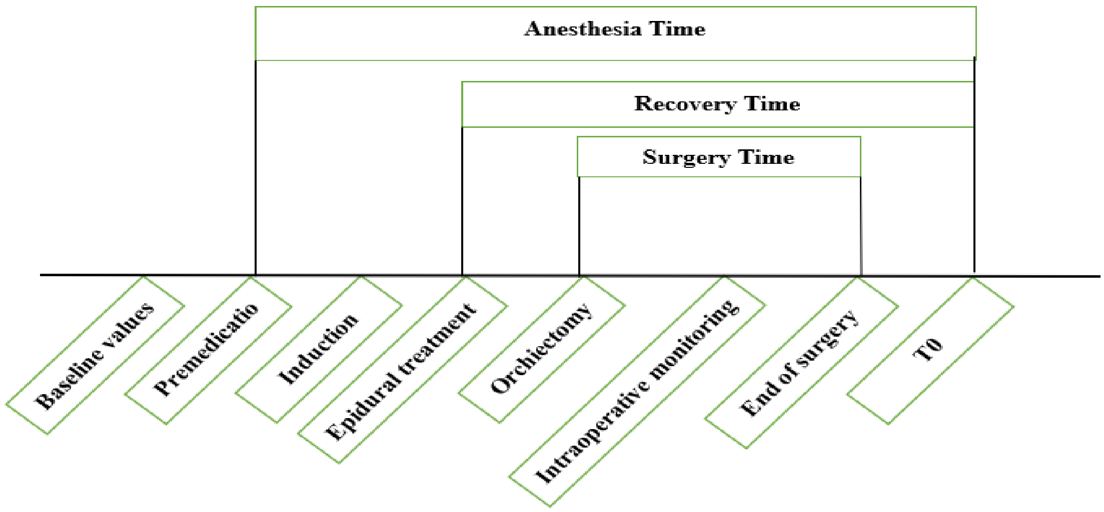

Figure 2: Time durations of various intraoperative events; T0: timepoint when each animal showed a positive response to hind limb stimulation.

Pain assessment: The primary outcome of the study was the assessment of post-operative pain management. Post-operative pain scores were evaluated by an anesthetist who was unaware of the treatment groups. Pain levels were evaluated using the UMPS (University of Melbourne Pain Scale) method, which considers physiological indicators (such as heart and respiratory rates), behavioral signs (including posture and activity), and the animal's response to palpation. Pain scores were measured at several time intervals: 1, 3, 6, 8, 12, and 24 hours (T1, T3, T6, T8, T12, and T24) following T0, which marks the moment when each animal showed a positive response to hind limb stimulation.

Wound healing assessment: The Southampton Wound Assessment Scale (SWAS) was used to evaluate the progress of wound healing, focusing on redness, swelling, discharge, and closure. The assessment was continued upto 14 days post operatively until the removal of sutures.

Statistical analysis

Data was collected and arranged in Microsoft office LTSC professional plus 2021. It was statistically analyzed by one and two way ANOVA through statistics 8.1 to get means, standard errors and p values.

RESULTS

Twelve dogs met the inclusion criteria collected in three months. There was no significant difference between groups in terms of age and body weight (Table 1). The IM administration of atropine sulphate at 0.02 mg/kg B.W and xylazine hydrochloride at 1 mg/kg B.W caused lateral recumbency in all dogs without unconsciousness and allowed the catheter placement in the cephalic vein. The induction of anesthesia with propofol was used to achieve unconsciousness, a lack of palpebral reflex, mild jaw tone, and myorelaxation to enable proper positioning and EP needle placement. No adverse effects related to treatments administered epidurally were observed, such as hypotension, hypothermia, bradycardia, or neurotoxicity. Anal tone was lost in all dogs 5-7 min after EP administration. EP needle positioning, EP drug administration, and surgery were performed without complications in all cases.

Table 1: Age (months) and body weight (kilograms) of animals.

Parameter	Group L	Group LD	Group LT	p values
Age (Month)	18.75 ± 1.49	22.25 ± 1.65	19.75 ± 2.87	0.50
Weight (Kilograms)	20.75 ± 1.11	21.75 ± 0.63	19.75 ± 1.80	0.56

L: Lidocaine; Group LD: Lidocaine+ Diclofenac; Group LT: Lidocaine+ Tramadol; p value: Probability value

During surgery, the depth of anesthesia was monitored, as was unresponsiveness to surgery and jaw tone or myorelaxation. Group L had longest anesthesia duration at 70.0 ± 0.41 minutes, while group LD showed the shortest duration at 68.75 ± 0.48 minutes as shown in Table 2. Significant difference was observed for anesthesia time. In terms of surgery time, group L required the most time at 15.75 ± 0.48 minutes but group LD had lowesr surgery time with 14.50 ± 0.29 minutes. Significant difference was observed. Recovery time showed a minimal variation across the groups. Group LD had the longest recovery time at 45.00 ± 0.41 minutes meanwhile, group L had the shortest recovery time. Non-significant difference was observed.

Table 2: Time recordings (Minutes) of intra operative procedures.

Parameter	Group L	Group LD	Group LT	p values
Anesthesia Time	70.0 ± 0.41	68.75 ± 0.48	69.75 ± 0.25	0.01
Surgery Time	15.75 ± 0.48	14.50 ± 0.29	15.00 ± 0.29	0.03
Recovery Time	44.00 ± 0.41	44.50 ± 0.29	44.25 ± 0.48	0.45

Lidocaine; Group LD: Lidocaine+ Diclofenac; Group LT: Lidocaine+ Tramadol; p value: Probability value

Normal physiological values of all vital signs were taken and shown as baseline values (BV values). As soon as surgery began, all vitals were continuously observed and recorded throughout the process. Heart rate values differed between groups at baseline ($p = 0.05$), though the variation. During anesthesia, HR showed a gradual downward trend across all groups, with significant changes at 15 and 20 minutes ($p = 0.007$) and highly significant within-group reductions ($p < 0.01$). Respiratory rate values were comparable at baseline, with a slight decline at 5 minutes ($p = 0.28$). A progressive reduction followed, reaching significance at 10, 15, and 20 minutes ($p \leq 0.05$), while within-group variation was minimal in group LT and non-significant in groups L and LD.

Esophageal temperature remained similar across groups at baseline ($p = 0.51$). A consistent fall was observed during surgery, with significant changes at 5 and 20 minutes ($p < 0.05$), whereas 10 and 15 minutes remained stable. Within-group comparisons indicated highly significant reductions over time ($p < 0.01$). Hemoglobin Oxygen Saturation values were significantly different at baseline ($p = 0.02$) and remained so at 5 and 10 minutes ($p < 0.05$). At 15 and 20 minutes, intergroup values were not statistically different, although highly significant within-group changes persisted ($p < 0.01$). Systolic arterial pressure values were comparable at baseline but showed significant variation among groups at 5, 10, 15, and 20 minutes ($p < 0.05$), with highly significant within-group differences. Diastolic arterial pressure did not differ at baseline ($p = 0.23$), but significant changes were evident at 5 and 20 minutes, while 10 and 15 minutes remained stable. Mean arterial pressure was also similar at baseline ($p = 0.12$) and at 5 minutes, with significant differences emerging at 10 and 15 minutes ($p < 0.05$) and a highly significant change at 20 minutes ($p = 0.007$).

Table 3: Physiological vital signs values at baseline and during surgery.

Parameter	Time	Group L	Group LD	Group LT	p values
HR Beats per minute	BV	119.0 ± 0.41	120.7 ± 0.48	120.0 ± 0.41	0.05
	5	103.7 ± 0.48	105.0 ± 0.41	104.0 ± 0.41	0.15
	10	102.0 ± 0.41	103.0 ± 0.41	102.0 ± 0.41	0.19
	15	100.0 ± 0.41	101.2 ± 0.25	101.2 ± 0.48	0.07
	20	98.0 ± 0.41	99.2 ± 0.25	99.2 ± 0.48	0.07
	p values within groups	0.0030	0.0030	0.0032	
RR Breath per minute	BV	30.7 ± 0.48	30.0 ± 0.41	30.2 ± 0.63	0.59
	5	24.0 ± 0.41	25.0 ± 0.41	24.25 ± 0.48	0.28
	10	22.5 ± 0.29	23.5 ± 0.29	22.5 ± 0.29	0.05
	15	20.7 ± 0.25	22.0 ± 0.41	20.5 ± 0.29	0.02
	20	19.5 ± 0.29	20.25 ± 0.25	19.0 ± 0.41	0.02

	p values within groups	0.08	0.25	0.009	
ET (°F)	BV	102.2 ± 0.20	102.35± 0.20	102.08± 0.24	0.51
	5	101.1 ± 0.35	101.3 ± 0.22	100.45± 0.22	0.03
	10	100.5 ± 0.22	100.6 ± 0.33	100.0 ± 0.26	0.08
	15	100.0 ± 0.22	100.1 ± 0.33	99.5 ± 0.26	0.07
	20	99.8± 0.11	99.68± 0.31	99.0 ± 0.26	0.02
	p values within groups	0.003	0.002	0.003	
SpO_2 (%)	BV	98.5 ± 0.29	98.0 ± 0.50	99.0 ± 0.29	0.02
	5	96.5 ± 0.29	96.75 ± 0.25	98.0 ± 0.29	0.03
	10	95.7 ± 0.25	96.0 ± 0.50	97.0 ± 0.25	0.04
	15	95.5 ± 0.29	95.25 ± 0.48	96.0 ± 0.29	0.09
	20	94.75 ± 0.25	94.5 ± 0.25	95.2 ± 0.25	0.06
	p values within groups	0.005	0.002	0.003	
SAP (mmHg)	BV	124.0 ± 0.41	125.75 ± 0.48	125.0 ± 0.41	0.16
	5	113.75 ± 0.48	112.0 ± 0.41	111.0 ± 0.41	0.02
	10	112.0 ± 0.41	110.0 ± 0.41	109.0 ± 0.29	0.01
	15	110.0 ± 0.41	108.2 ± 0.25	107.75 ± 0.48	0.007
	20	107.7 ± 0.25	106.2 ± 0.25	106.25 ± 0.25	0.02
	p values within groups	0.003	0.003	0.002	
DAP (mmHg)	BV	81.0 ± 0.41	82.25 ± 0.25	82.0 ± 0.41	0.23
	5	75.25 ± 0.25	76.0 ± 0.29	75.0 ± 0.29	0.05
	10	74.0 ± 0.29	74.0 ± 0.29	73.0 ± 0.41	0.10
	15	72.7 ± 0.25	72.2 ± 0.25	72.2 ± 0.41	0.65
	20	71.75 ± 0.25	70.25 ± 0.41	70.25 ± 0.48	0.03
	p values within groups	0.001	0.003	0.002	
MAP (mmHg)	BV	95.0 ± 0.41	96.75 ± 0.48	96.0 ± 0.41	0.12
	5	88.25 ± 0.25	88.0 ± 0.29	87.0 ± 0.29	0.07
	10	87.0 ± 0.29	86.0 ± 0.29	85.0 ± 0.48	0.03
	15	85.75 ± 0.25	84.25 ± 0.25	84.25 ± 0.41	0.02
	20	84.75 ± 0.25	82.25 ± 0.48	82.25 ± 0.63	0.007
	p values within groups	0.0006	0.001	0.003	

Group L: Lidocaine; Group LD: Lidocaine+ Diclofenac; Group LT: Lidocaine+ Tramadol; BV: Baseline values; 5, 10, 15 and 20 min: intraoperative time point assessments measured in minutes after epidural injection; B\W: Between; HR: Heart rate;RR: Respiratory rate; ET: Esophageal temperature; $SpO_{2:}$ Hemoglobin oxygen saturation; SAP: Systolic arterial blood pressure; DAP: Diastolic arterial blood pressure; MAP: Mean arterial blood pressure; Data are shown as the mean ± standard deviation in groups section; statistics values are p values.

Post-operative pain levels were measured using the University of Melbourne Pain Scale (UMPS) method, in three different treatment groups, group L, group LD and group LT over a 24-hour period after surgery (Figure 3).

Group L, which received only lidocaine showed steady increase in pain after 3 hours, peaking by the 24-hour mark. This suggests that lidocaine alone did not provide sufficient pain relief over time. Group LD, treated with a combination of lidocaine and diclofenac, displayed moderate pain levels that remained lower than those of group L. The reduction in scores up to 6 hours indicates that diclofenac plus lidocaine provide more consistent pain management. Group LT maintained the most effective control of pain and score remained low up to 8 hours indicating effective pain control. Overall, the combination of lidocaine and tramadol was the most effective, followed by lidocaine plus diclofenac, while lidocaine alone was the least effective in managing post-surgical pain.

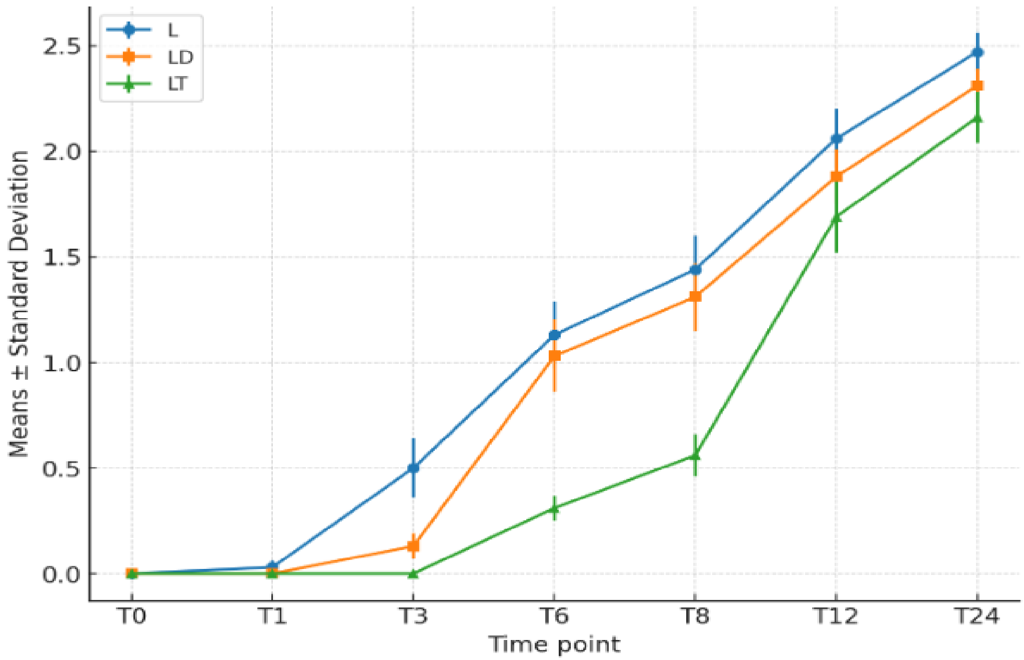

Figure 3: Differences in pain progression and effectiveness of the treatment protocols for each group; Group L: Lidocaine; Group LD: Lidocaine+ Diclofenac; Group LT: Lidocaine+ Tramadol.

The pattern of postoperative wound healing in dogs varied across the three treatment groups, group L (Lidocaine alone), group LD (Lidocaine with Diclofenac), and group LT (Lidocaine with Tramadol) during the 14-day observation period as shown in figure 2. On the first day after surgery, all groups showed minimal wound scores (0.00 ± 0.01), reflecting clean incisions and the absence of any early signs of inflammation. By the third day, wound scores slightly increased in Group L (0.15 ± 0.20) and Group LD (0.25 ± 0.25), whereas Group LT maintained the same minimal score, indicating more favorable early wound healing in the LT group. By Days 5 and 7, wound scores peaked in both Group L and LD (0.50 ± 0.28), suggesting mild to moderate tissue response or inflammation during the mid-healing phase. Group LT, however, showed only a modest rise to 0.25 ± 0.25, which could reflect better control of postoperative tissue reactions.On day 9, wound scores decreased in group L (0.25 ± 0.25) and dropped back to near-baseline in group LT (0.00 ± 0.01), while group LD continued to show higher values (0.50 ± 0.50), possibly indicating delayed wound recovery or persistent inflammation. By Day 11, wound scores in group L and LT returned to the baseline level, whereas group LD still showed mild signs of delayed healing (0.50 ± 0.28). Finally, by day 14, complete or nearly complete wound healing was observed in all groups, as scores stabilized at 0.00 ± 0.01. This outcome suggests that the healing process was effectively completed within two weeks for all treatment regimens. Overall, the combination of group LT appeared to promote more consistent and quicker wound recovery compared to group LD, which showed relatively higher wound scores at multiple intervals.

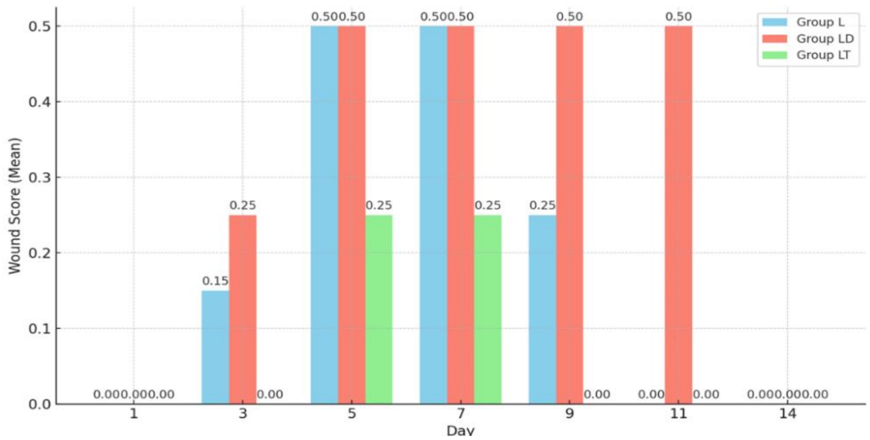

Figure 2: post operative wound assessment by Southampton wound assessment scale across groups.

DISCUSSION

Effective pain management plays important role in canine surgical procedures, significantly enhancing the overall health, recovery, and healing process in dogs (Mwangi *et al*., 2018). The use of multimodal analgesia combining systemic and local or regional drug administration is widely recognized as a highly effective strategy for controlling pain. Among these techniques, the administration of anesthetic and analgesic agents via the lumbosacral epidural route is commonly used in small animals, offering reliable and improved anesthesia and analgesia (Torske and Dyson, 2000; Cicirelli *et al*., 2022).

The present study compared the efficacy and safety of epidural lidocaine, tramadol, and their combination for post-operative pain management in dogs undergoing orchiectomy. Twelve healthy adult males were divided into three groups (L, LD, LT), and standardized anesthetic, surgical, and post-operative protocols were followed. Pain control was assessed behaviorally, with results indicating variation in onset, duration, and intensity of analgesia among groups. No mortality or major complications occurred, and all dogs recovered comfortably, suggesting that these epidural protocols are safe and effective for canine orchiectomy. Heart rate showed a gradual but safe decline across groups, with no significant difference after 5 minutes. Similar findings were reported by Chandanwale *et al*. (2014) and Vullo *et al*. (2023), while Salem *et al*. (2022) also noted reduced heart rate with epidural lidocaine-tramadol, indicating stable cardiovascular response. Respiratory rate also decreased from baseline values to lower but normal ranges in all groups. Comparable results were observed by Habibian *et al*. (2011), Vullo *et al*. (2023), and Salem *et al*. (2022), who attributed this reduction to sedative and analgesic effects, confirming the safety of epidural protocols.

In this study, esophageal temperature showed a gradual decline from baseline values (102.2 ± 0.20, 102.35 ± 0.20, 102.08 ± 0.24) across groups without significant difference, consistent with Vullo *et al*. (2023) and Salem *et al*. (2022), who attributed intraoperative hypothermia to anesthetic-induced vasodilation and reduced metabolism. SpO_2 values (98.5 ± 0.29, 98.0 ± 0.50, 99.0 ± 0.29) declined significantly at baseline, 5, and 10 minutes among groups, in agreement with Vullo *et al*. (2023), while El-Hawari *et al*. (2022) highlighted tramadol and lidocaine's role in maintaining oxygenation and reducing anesthetic needs. SAP values showed significant intergroup variation from the 5-minute interval with mild declines thereafter, comparable to Vullo *et al*. (2023) and Hermeto *et al*. (2015); hypotension observed aligns with tramadol's vasodilatory effect (Itami *et al*., 2011) and lidocaine's sympatholytic action (Nejamkin *et al*., 2020).

The current study showed a safe decline in DAP from baseline values (81.0 ± 0.41, 82.25 ± 0.25, 82.0 ± 0.41) during surgery, consistent with findings of Vullo *et al*. (2023) and Hermeto *et al*. (2015). Tramadol's vasodilatory effect, as reported by Itami *et al*. (2011), may explain the observed reduction in DAP. Similarly, epidural lidocaine was linked to decreased DAP due to sympathetic blockade (Nejamkin *et al*., 2020). MAP also showed a safe reduction from baseline (95.0 ± 0.41, 96.75 ± 0.48, 96.0 ± 0.41), aligning with Natalini *et al*. (2007), Vullo *et al*. (2023), and Hermeto *et al*. (2015). Nejamkin *et al*. (2020) further confirmed lidocaine's sympatholytic effect, supporting the hypotensive influence of lidocaine and its combinations. During the study, significant differences were observed in intraoperative time durations. Group L had the longest anesthesia time (70.0 ± 0.41 min), followed by LT (69.75 ± 0.25 min) and LD (68.75 ± 0.48 min; p = 0.01). Surgery lasted longest in Group L (15.75 ± 0.48 min) and shortest in

LD (14.50 ± 0.29 min; $p = 0.03$), while recovery times did not differ significantly ($p = 0.45$). These findings agree with Vullo *et al*. (2023), who reported similar durations in feline orchiectomy. Singh *et al*. (2012) also emphasized that anesthetic combinations influence anesthesia and recovery, with NSAIDs like diclofenac providing analgesia without prolonging sedation, likely explaining shorter times in the LD group. Postoperative pain was evaluated using UMPS, where all groups initially scored 0.00 ± 0.00 but values rose at different intervals: Group L at 3 h, LD at 6 h, and LT at 6–8 h, indicating analgesic duration of 3, 6, and 8 h, respectively. These findings support Vullo *et al*. (2023) and Almeida *et al*. (2010), who highlighted superior efficacy of lidocaine + tramadol. Wound healing assessed by the Southampton scale showed LT with the mildest and shortest response, LD slightly prolonged, and L moderate but brief. This agrees with Jansen *et al*. (2003), who reported enhanced collagen deposition with epidural analgesics. Huss *et al*. (2019) further noted that appropriate analgesia may facilitate healing by minimizing stress-related delays.

CONCLUSION

This study concluded that epidural lidocaine, alone or with tramadol or diclofenac, is safe and effective for orchiectomy in dogs without major complications such as hypotension, hypothermia, bradycardia, or neurotoxicity. Lidocaine + tramadol produced the longest analgesia (~8 h), better wound healing, and stable vital signs, followed by lidocaine + diclofenac (~6 h) and lidocaine alone (~3 h). Postoperative recovery was smooth in all groups, with SWAS scores favoring the tramadol group. No adverse effects or mortalities were recorded, supporting the clinical applicability of these techniques.

AUTHOR CONTRIBUTION

M. Ramzan designed and conceptualized the study, carried out the experiments, and drafted the manuscript. Dr. Habibullah Janyaro and Dr. Faiz Muhammad Khand provided overall supervision, guidance on study design and oversight of the research process. Dr. Hidayatullah Soomro assisted with data analysis, manuscript preparation, and critical revision. All authors reviewed and approved the final version of the manuscript.

CONFLICT OF INTEREST

All authors declared no conflict of interest.

FUNDING

The study received no external funding.

ETHICAL STATEMENT

All experimental procedures involving dogs were conducted in accordance with institutional ethical guidelines and approved by the Animal care and ethics review committee (ACERC), SBBUVAS, Sakrand under ethical approval No. SBBUVAS/ORIC-ACERC/02/2025.

REFERENCES

Almeida, R.M., Escobar, A. and Maguilnik, S. (2010) ‘Comparison of analgesia provided by lidocaine, lidocaine–morphine or lidocaine–tramadol delivered epidurally in dogs following orchiectomy’, *Veterinary Anaesthesia and Analgesia*, 37(6), pp. 542–549.

Alorfi, N.M. (2023) ‘Pharmacological methods of pain management: Narrative review of medication used’, *International Journal of General Medicine*, 16, pp. 3247–3256.

Çatalkaya, E., Saylak, N., Altan, S., Ersöz-Kanay, B., Yayla, S. and Canli, R. (2025) ‘The effects of different orchiectomy techniques on postoperative pain in cats’, *Bulgarian Journal of Veterinary Medicine*, 28(2).

Chandanwale, A.S., Sundar, S., Latchoumibady, K., Biswas, S., Gabhane, M., Naik, M. and Patel, K. (2014) ‘Efficacy and safety profile of tramadol–diclofenac versus tramadol–paracetamol in acute musculoskeletal conditions, postoperative pain and acute flare of osteoarthritis and rheumatoid arthritis’, *Journal of Pain Research*, 7, pp. 455–463.

Cicirelli, V., Burgio, M., Lacalandra, G.M. and Aiudi, G.G. (2022) ‘Local and regional anaesthetic techniques in canine ovariectomy: A review of the literature and technique description’, *Animals*, 12(15), p. 1920.

Domínguez-Oliva, A., Casas-Alvarado, A., Miranda-Cortés, A.E. and Hernández-Avalos, I. (2021) ‘Clinical pharmacology of tramadol and tapentadol and their therapeutic efficacy in acute and chronic pain models in dogs and cats’, *Journal of Advanced Veterinary and Animal Research*, 8(3), pp. 404–414.

El-Hawari, S.F., Oyama, N., Koyama, Y., Tamura, J., Itami, T., Sano, T. and Yamashita, K. (2022) ‘Sparing effect of tramadol, lidocaine, dexmedetomidine and their combination on the minimum alveolar concentration of sevoflurane in dogs’, *Journal of Veterinary Science*, 23(4), p. 53.

Flaherty, D. (2013) ‘Understanding the mechanisms behind acute pain in dogs and cats', *Veterinary Nursing Journal*, 4(2), pp. 82–87.

Gado, D.A., Ehizibolo, D.O., Meseko, C.A., Anderson, N.E. and Lurz, P.W. (2023) 'Emerging and re-emerging zoonotic pathogens of dogs in Nigeria: A missing link in the One Health approach', *Zoonotic Diseases*, 3(2), pp. 134–161.

Gee, N.R., Rodriguez, K.E., Fine, A.H. and Trammell, J.P. (2021) 'Dogs supporting human health and well-being: A biopsychosocial approach', *Frontiers in Veterinary Science*, 8, p. 630465.

Gill, G.S., Singh, B.B., Dhand, N.K., Aulakh, R.S., Ward, M.P. and Brookes, V.J. (2022) 'Stray dogs and public health: Population estimation in Punjab, India', *Veterinary Sciences*, 9(2), p. 75.

Habibian, S., Bigham, A.S. and Aali, E. (2011) 'Comparison of lidocaine, tramadol and lidocaine–tramadol for epidural analgesia in lambs', *Research in Veterinary Science*, 91(3), pp. 434–438.

Hancock, R.B., Lanz, O.I., Waldron, D.R., Duncan, R.B., Broadstone, R.V. and Hendrix, P.K. (2005) 'Comparison of postoperative pain after ovariohysterectomy by harmonic scalpel-assisted laparoscopy and median celiotomy in dogs', *Veterinary Surgery*, 34(3), pp. 273–282.

Hasan, M.K., Akhter, S., Fatema, K., Hossain, M.R., Sultana, T. and Uzzaman, M. (2023) 'Selective modification of diclofenac to reduce adverse effects: A computer-aided drug design approach', *Informatics in Medicine Unlocked*, 36, p. 101159.

Hermeto, L.C., DeRossi, R., Marques, B.C. and Jardim, P.H. (2015) 'Potentiation of epidural lidocaine by co-administering tramadol via intramuscular or epidural routes in cats', *Canadian Journal of Veterinary Research*, 79(3), pp. 214–220.

Huss, M.K., Felt, S.A. and Pacharinsak, C. (2019) 'Influence of pain and analgesia on orthopedic and wound-healing models in rats and mice', *Comparative Medicine*, 69(6), pp. 535–545.

Itami, T., Tamaru, N., Kawase, K., Ishizuka, T., Tamura, J., Miyoshi, K. and Yamashita, K. (2011) 'Cardiovascular effects of tramadol in dogs anesthetized with sevoflurane', *Journal of Veterinary Medical Science*, 73(12), pp. 1603–1609.

Jamison, R.N. and Mao, J. (2015) 'Opioid analgesics', *Mayo Clinic Proceedings*, 90(7), pp. 957–968.

Jansen, M., Lynen Jansen, P., Junge, K., Anurov, M., Titkova, S., Öttinger, A. and Schumpelick, V. (2003) 'Postoperative peridural analgesia increases colonic contraction strength without impairing anastomotic healing in rats', *International Journal of Colorectal Disease*, 18, pp. 50–54.

Minami, K., Ogata, J. and Uezono, Y. (2015) 'What is the main mechanism of tramadol?', *Naunyn-Schmiedeberg's Archives of Pharmacology*, 388, pp. 999–1007.

Mwangi, W.E., Mogoa, E.M., Mwangi, J.N., Mbuthia, P.G. and Mbugua, S.W. (2018) 'Analgesia practices in dogs undergoing ovariohysterectomy: A systematic review', *Veterinary World*, 11(12), pp. 1725–1732.

Natalini, C.C., da Silva Polydoro, A. and Crosignani, N. (2007) 'Antinociceptive effects of epidural tramadol in dogs undergoing experimental stifle surgery', *Acta Veterinaria Scientiae*, 35(2), pp. 189–195.

Nazar, M., Rehman, F., Asif, H., Hashmi, H., Rehman, A., Arshad, M., Hussain, K., Shahzad, M., Ullah, Z. and Awais, M. (2024) 'Progressive control and management strategies for elimination of rabies among stray dogs in Pakistan', *Biological and Clinical Sciences Research Journal*, 2024(1), p. 819.

Nejamkin, P., Landivar, F., Clausse, M., Lorenzutti, M., Cavilla, V., Gutierrez, V. and Martin-Flores, M. (2020) 'Analgesic, sympathetic and motor effects of 1% and 2% lidocaine administered epidurally in dogs undergoing ovariohysterectomy', *Veterinary Anaesthesia and Analgesia*, 47(6), pp. 797–802.

Njoga, U.J., Ajibo, F.E. and Njoga, E.O. (2020) 'Use of contraceptives for control of stray dog population and rabies spread in Nigeria', *Animal Research International*, 17(3), pp. 3809–3820.

Pedersen, T.R., Berendt, M. and Rusbridge, C. (2025) 'Neuroanatomy of spinal nociception and pain in dogs and cats: A practical review for the veterinary clinician', *Frontiers in Veterinary Science*, 12, p. 1534685.

Podder, D., Stala, O., Hirani, R., Karp, A.M. and Etienne, M. (2025) 'Comprehensive approaches to pain management in postoperative spinal surgery patients', *Neurology International*, 17(6), p. 94.

Pongrácz, P. and Dobos, P. (2023) 'What is a companion animal? An ethological approach based on Tinbergen's four questions', *Applied Animal Behaviour Science*, 267, p. 106055.

Puntillo, F., Giglio, M. and Varrassi, G. (2021) 'Routes of administration for acute postoperative pain medication', *Pain and Therapy*, 10(2), pp. 909–925.

Salem, M., Rizk, A., Mosbah, E., Zaghloul, A., Karrouf, G. and Abass, M. (2022) ‘Antinociceptive effects of lidocaine, tramadol and their combination for lumbosacral epidural analgesia in rabbits’, *BMC Veterinary Research*, 18(1), p. 252.

Silva, A., Mourão, J. and Vale, N. (2023) ‘Lidocaine in the perioperative period: A review’, *Journal of Personalized Medicine*, 13(12), p. 1699.

Singh, T., Malik, V. and Singh, B. (2012) ‘Comparative evaluation of xylazine, midazolam and their combination as preanaesthetics in dogs’, *Indian Journal of Veterinary Surgery*, 33(1), pp. 1–5.

Tikhonov, D.B. and Zhorov, B.S. (2017) ‘Mechanism of sodium channel block by local anesthetics, antiarrhythmics and anticonvulsants’, *Journal of General Physiology*, 149(4), pp. 465–481.

Torske, K.E. and Dyson, D.H. (2000) ‘Epidural analgesia and anesthesia’, *Veterinary Clinics of North America: Small Animal Practice*, 30(4), pp. 859–874.

Urfer, S.R. and Kaeberlein, M. (2019) ‘Desexing dogs: A review of the current literature’, *Animals*, 9(12), p. 1086.

Vullo, C., Falcone, A., Marino, G., Monti, S., Tambella, A.M., Bufalari, A. and Catone, G. (2023) ‘Comparison of epidural lidocaine, tramadol and lidocaine–tramadol on postoperative pain in cats undergoing elective orchiectomy’, *Acta Veterinaria Scandinavica*, 65(1), p. 33.

Yam, M.F., Loh, Y.C., Tan, C.S., Adam, S.K., Manan, N.A. and Basir, R. (2018) ‘General pathways of pain sensation and major neurotransmitters involved in pain regulation’, *International Journal of Molecular Sciences*, 19(8), p. 2164.