RESEARCH ARTICLE

Clinical Studies on Ropivacaine and Lignocaine for Proximal Paravertebral Anaesthesia in Bovines

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Abstract

Paravertebral anaesthesia is one of the most popular, safe and convenient regional anaesthetic technique in ruminants for flank region surgery in standing position. To evaluate anaesthetic effects of ropivacaine and lignocaine hydrochloride, total 18 bovines were randomly divided in three equal groups. In group I and II animals paravertebral anaesthesia was induced using 0.5 % and 0.75 % ropivacaine, respectively, while in group III, 2 % lignocaine was administrated in paravertebral space. The anaesthetic parameters such as onset of analgesia, duration of analgesia, skin temperature of anaesthetized and contralateral non-anaesthetized site, assessment of analgesia and development of scoliosis were recorded in all three groups. Significantly ($p<0.05$) faster onset of analgesia was noted with 2 % lignocaine, whereas significantly ($p<0.05$) longer duration of analgesia was observed in 0.75 % ropivacaine followed by 0.5 % ropivacaine. Thus, it was concluded that ropivacaine (0.5 % and 0.75 %) was at par for onset and duration of analgesia after paravertebral anaesthesia and suitable for longer duration surgical procedures such as enterectomy, entero-anastomosis and Caesarean section which require more than 3 h of intraoperative and post-operative analgesia in standing position without re-administration of anaesthetic agents.

Key words: Bovines, Lignocaine, Paravertebral anaesthesia, Ropivacaine, Skin temperature, Scoliosis.

Ind J Vet Sci and Biotech (2026): 10.48165/ijvsbt.22.4.15

Introduction

General anaesthesia is considered as a risky procedure for large ruminants common problems such as ruminal tympany, regurgitaion of ruminal contents, excessive salivation, radial nerve paralysis in long time lateral recumbency, possibility of pulmonary aspiration pneumonia and hyperthermia (Hall *et al.,* 2001). Therefore, regional anaesthesia has been developed as a substitute for general anaesthesia in bovine. Amongst all regional anaesthesia in ruminants, paravertebral nerve block is the most frequently and widely used anaesthetic technique for surgical opeartions of flank regions. Paravertebral nerve block is commonly utilized for surgical procedures such as rumenotomy, enterotomy, entero-anastomosis, abomasopexy, cystorrhaphy, ovariectomy and Cesarean section by approaching flank in standing position. Paravertebral anaesthesia is classified as proximal paravertebral anaesthesia and distal paravertebral anaesthesia with little difference in site for blocking of the spinal nerves. Proximal paravertebral anaesthesia involves the perineural injection of local anaesthetic in proximity to the spinal nerves as they emerge from the intervertebral canal through the intervertebral foramina. For the sufficient desensitization of the flank region, 13th thoracic spinal nerve, 1st and 2nd lumbar spinal nerves need to be anaesthetized (Valverde and Sinclair, 2015).

Different local anaesthetics are used for regional anaesthesia. Most popular local anaesthetic used is lignocaine hydrochloride. Lignocaine is a first amino amide-type local anaesthetic, first synthesized under the name of xylocaine by Swedish chemist Nils Lofgren in 1943 (Lofgren and Lundqvist, 1943). Lignocaine has fast onset with moderate duration of action. On the other hand, Ropivacaine hydrochloride is a newly discovered local anaesthetic agent, least toxic than lignocaine hydrochloride and bupivacaine hydrochloride, which provides complete analgesia with longer duration of action. It is available as a 0.25 %, 0.5 % and 0.75 % solutions (Egger *et al.,* 2014). There is scarcity of literature on efficacy of various concentrations of ropivacaine hydrochloride using paravertebral anaesthesia in bovines and its comparison with lignocaine. Hence, the present study was designed to evaluate and compare the efficacy of 0.5 % ropivacaine, 0.75 % ropivacaine and 2 % lignocaine in bovine using proximal paravertebral anaesthesia.

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How to cite this article: Barot, H. M., Patel, P. B., Sodagar, B. N., Patel, A. M., Patel, A. M., & Patel, J. B. (2026). Clinical Studies on Ropivacaine and Lignocaine for Proximal Paravertebral Anaesthesia in Bovines. Ind J Vet Sci and Biotech, 22(4), 82-87.

Source of support: Nil

Conflict of interest: None

Submitted 25/03/2026 **Accepted** 28/04/2026 **Published** 10/07/2026

Materials and Methods

Study Design

The study on clinical evaluation of three local anaesthetics, *viz.*, 0.5 % and 0.75 % ropivacaine hydrochloride and 2 % lignocaine hydrochloride using proximal paravertebral anaesthesia was planned and executed on 18 clinical cases (15 Mehsana buffalos, 2 HFx cows and 1 Kankrej bullock) of bovines presented at Department of Veterinary Surgery and Radiology, College of Veterinary Science and Animal Husbandry, Kamdhenu University, Sardarkrushinagar, Gujarat (India) for various surgical for various surgical interventions from a period of **August 2019 to March 2020** (Table 1). The animals were randomly divided into three groups irrespective of age and sex with each group consisting of six animals. All the local anaesthetics used in present study were free from epinephrine or any other preservative.

Technique of Proximal Paravertebral Anaesthesia

The animals were restrained in rumenotomy travis and the lumbar and paralumbar area was aseptically prepared by shaving followed by scrubbing with povidone iodine. The technique of nerve block involved desensitizing the dorsal and ventral branches of last thoracic (T_{13}) and first two lumbar (L_1 and L_2) spinal nerves as they emerge from intervertebral canal and this technique is called as Proximal paravertebral anaesthesia (Fig. 1). It is also termed as Farquharson, Hall, or Cambridge technique (Farquharson, 1940). For the blocking of T_{13} thoracic and first two lumbar (L_1 and L_2) spinal nerves, method adopted for best identification was as per Valverde and Sinclair (2015).

Firstly, with the help of a 3 cm long 20-gauge needle 2 mL of local anaesthetic solution was injected at the desired site to prepare a skin wheal so as to desensitize the area and prevent displacement of needle. For blocking the T_{13} thoracic spinal nerve, a 3.5 or 7.5 cm long 18 gauze needle was inserted 5 cm away from midline, directly downwards through the selected site till the needle strikes the anterior edge of the transverse process of the 1st lumbar vertebra. It was then redirected a little forward and deeper just in front of the transverse process. At this point, required dose rate of local anaesthetic solution was injected. During withdrawal of the needle, further few amounts was infiltrated along the track. During the final withdrawal of the needle, the skin was pressed downwards to prevent separation of the connective tissue and aspiration of the air through the needle.

For blocking the L_1 and L_2 lumbar spinal nerves a transverse line was drawn immediately behind the spinous process of the particular vertebra and the needle was inserted at a point on this line 5 cm away from the midline. As soon as

Table 1: Detail design of study

Groups	No. of animals	Drugs	Dose rate	Surgical approach
I	6	0.5 % Ropivacaine HCl	2.5 mg/kg BW	Left flank laparotomy (n=4) Right flank laparotomy (n=2)
II	6	0.75 % Ropivacaine HCl	1 mg/kg BW	Left flank laparotomy (n=6)
III	6	2 % Lignocaine HCl	0.65 mg/kg BW	Left flank laparotomy (n=5) Right flank laparotomy (n=1)

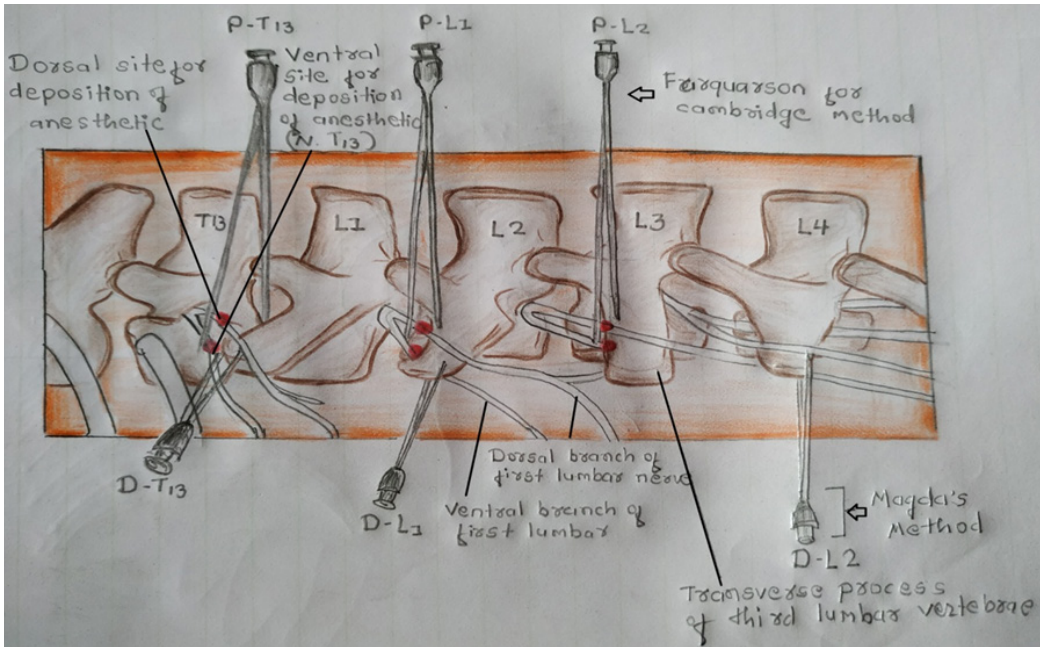

Fig. 1: Anatomical landmarks of proximal paravertebral anaesthesia in bovines

the needle point strikes the anterior edge of the transverse process of the next lumbar vertebra, it was directed little forward and deeper so as to penetrate the intertransverse ligament. At this point, the anaesthetic solution was deposited as described earlier.

Parameters Evaluated

Onset and duration of analgesia of the local anaesthetic drugs were recorded for each case. The cases were observed continuously for 2 h and then every 10 min, until they retain the positive response to the pin prick or haemostat pressure. Skin temperature (°F) of anaesthetized and contralateral non-anaesthetized site was measured before administration of local anaesthetics, 10 min after onset of analgesia and after recovery from analgesia by non-contact infrared thermometer. Analgesia was evaluted during skin, muscle and peritoneum incision and graded as 0 to 2 as under.

Grading	Assesment
Grade 0 (mild analgesia)	Absence of pain evident on surgical incision of skin, however on surgical incision of muscle and peritoneum pain response demonstrated by kicking on belly.
Grade 1 (Moderate Analgesia)	Absence of pain observed during skin and muscle incision, however on surgical incision of peritoneum pain response demonstrated by kicking on belly.
Grade 2 (Complete analgesia)	Absence of pain response evident during surgical incision of skin, muscle and peritoneum.

The development of scoliosis towards blocked site was observed after performing proximal paravertebral anaesthesia and graded as 0 = Absence of scoliosis or 1 = Presence of scoliosis.

Statistical Analysis

All data were presented as mean ±SE for each treatment. A one-way analysis of variance followed by Duncan's multiple range test was used to compare onset and duration of analgesia. Scoring data like assessment of analgesia and scoliosis development score was analyzed by non-parametric Kruskal Wallis test using SPSS software (IBM® SPSS® statistics, version 23.0) and presented as median (range). A value of $p<0.05$ was considered significant.

Results and Discussion

Depth and Distance of Injection

In present study, the distance of injection site from the midline was 5 cm in all 18 animals as described by Hall *et al.* (2001) and produced complete paravertebral anaeasthesia in all animals. Similarly, Hallowell and Potter (2008) desensitized the L_1, L_2 spinal nerves from 5 cm from midline. Depth of injection in present study was 3.5 cm in all animals, except in two cases where animals were heavy, well muscled and obese, where 7.5 cm long 18 gauge spinal needle was used for blocking of T_{13} thoracic, L_1 and L_2 lumbar spinal nerves. Similarly, Hallowell and Potter (2008) anaesthetize the L_1, L_2 spinal nerves with 3.5 cm long 19 gauge needle. However, Hall *et al.* (2001) suggested 7 cm long, 3 mm bore stout needle and Farquharson (1940) suggested 5 cm needle inserted for blocking of spinal nerves in cattle.

Onset and Duration of Analgesia

The onset of analgesia was smooth in all three groups and time to onset of analgesia was 12.16±0.90 min in group I, 11.16±0.47 min in group II, and 7.50±0.81 min in group III (Table 2, Fig. 2). On comparison between groups early loss of pin prick response was observed with 2 % lignocaine (group III) followed by 0.75 % ropivacaine (group II) and 0.5 % ropivacaine (group I) respectively. This was attributed to lipid solubility of local anaesthetics as lipid solubility of a local anaesthetic is the main determinant of its intrinsic potency. Greater lipid solubility permits the anaesthetic to penetrate the nerve membrane more easily and produce rapid onset of action (Malamed, 2013). Garcia (2015) opined that local anaesthetic with a low pKa has a greater proportion of the non-ionized lipid soluble form at physiologic pH and a more rapid onset of action. Hence, lignocaine produced early onset of anaesthesia because lipid solubility of lignocaine (4.0) was greater as compared to lipid solubility ropivacaine (2.9). Lignocaine also has a lower pKa (7.77) as compared ropivacaine (8.16). These findings were in agreement with Chepte *et al.* (2019), who stated that the 2 % lignocaine (9.95±0.24 min) has a faster onset of action as compared to 0.75 % ropivacaine (11.66±0.28 min) when administrated in paravertebral space of cattle. Similar findings were observed by Oliveira *et al.* (2016) after administration of 2 % lignocaine and 0.5 % ropivacaine within distal paravertebral thoracolumber space in ewes and recorded that 2 % lignocaine produced onset of analgesia within 1.5±0.5 min as compared to 0.5 % ropivacaine of 2.1±0.8 min.

Time for onset of analgesia between 0.5 % ropivacaine (group I) and 0.75 % (group II) had no significant difference. However, insignificantly shorter time required for onset in 0.75 % ropivacaine group (11.16±0.47 min) as compared to 0.5 % ropivacine group (12.16±0.90 min). This reduced onset of time of peripheral nerve block could be due to increasing concentration of ropivacaine from 0.5% to 1% (Casati *et al.*, 1999).

Table 2: Onset of analgesia and duration analgesia in bovines (n=18) recieving 0.5 % ropivacaine, 0.75 % ropivacaine and 2 % ligocaine solutions

Parameters	Group I	Group II	Group III	P-value
Onset of analgesia (min)	12.16 ± 0.90^{b}	11.16 ± 0.47^{b}	7.50 ± 0.81^{a}	0.001
Duration of analgesia (min)	281.16 ± 5.00^{b}	296.83 ± 5.78^{b}	119.83 ± 9.86^{a}	0.000

Means bearing different superscript (a,b) differs significantly between group ($p<0.05$).

Duration of analgesia was significantly prolonged in group II animals operated under 0.75 % ropivacaine (296.83 min) as

Fig. 2: Absence of pin prick reflex with needle or pinching reflex with hemostatic forceps suggest complete onset of analgesia

compared to group I and group III animals anesthetized using 0.5 % ropivacaine (281.16 min) and 2 % lignocaine (119.83 min), respectively, however the difference between 0.5 and 0.75 % ropivacaine was statistically insignificant (Table 2). Similar observations were made by Prashant (2016) with different regional anaesthetic technique in buffalo and found that mean duration of anaesthesia for 0.5 % ropivacaine lasted for 299.00±6.19 min and for 2 % lignocaine it was 111.83±4.32 min. These findings were in partial agreement with Chepte *et al.* (2019), who also stated that the 2 % lignocaine produced paravertebral anaesthesia that lasted for 147.51±3.15 min and while that of 0.75% ropicavaine in lasted for 191.15±1.68 min in cattle. Potential reason behind this could be protein binding characteristics of local anaesthetic agents, which primarily influence the duration of action. Hence, agents such as ropivacaine hydrochloride that are highly bound to protein as compared to lignocaine, display longest duration of action (Covino, 1981). Hence, duration of analgesia was prolonged in ropivacaine because of its higher protein binding of 95 % as compared to lignocaine hydrochloride (64 %) and its intrinsic vasoconstriction properties leading to slow absorption and delayed clearance (Garcia, 2015). El-Sharrawy and Yagiela (2006) while performing inferior alveolar nerve block in human, observed 6.0±0.4 h and 5.6±0.4 h mean duration of anaesthesia using 0.5 % and 0.75 % concentration of ropivacaine, respectively.

Skin Temperature of Anaesthetized and Non-anaesthetized Site (°F)

Paravertebral anaesthesia increases skin temperature of the flank region in cattle, which is attributable to vasodilation and increased blood flow resulting from sympathetic blockade (Valverde and Sinclair, 2015). In group I and II, 10 min after injecting 0.5 % and 0.75% ropivacaine, skin temperature of anesthetized site was insignificantly increased (average 0.76 °F, and 2.36 °F, respectively) as compared to that before injecting of local anaesthetic, whereas in group III, injected with 2 % lignocaine, skin temperature of anesthetized site increased significantly (average 2.58 °F). However, no such changes were noted in non-anaesthetized site in any group. In animals of group I, skin temperature did not increase as high as in group II and III (Table 3). Possible reason of this could be ropivacine's biphasic effect on peripheral vasculature, causing vasoconstriction at concentrations below 0.5 % and vasodilation at concentrations above 1 % (Cederholm *et al.,* 1992). The comparison of skin temperature of anaesthetized site within group was significantly different but no such change was observed between groups at any time period.

Assessment of Analgesia and Development of Scoliosis

Four animals each in 0.5 % ropivacine (group I) and 0.75 % ropivacaine (group II), produced complete analgesia in all layers of abdominal wall. However, two animals each in these groups produced complete analgesia in skin layers but mild analgesia was produced in muscles and peritoneum, evident as lifting of limb and occasional kicking on belly during incision of muscle and peritoneum. This observation was evaluated as median analgesic score of 2 (Table 4). In 2 % lignocaine (group III), out of six animals two animals showed reaction during muscle and peritoneum incision and one animal showed reaction during peritoneum incision, thus median analgesic score was 1.5. Similarly, Yadav *et al.* (2019) had observed pain reactions during external

Table 3: Skin temperature (Mean±SE) of anaesthetized site and non-anaesthetized site in different groups

Groups	Time	Anesthetized site	Non-anesthetized site
Group I 0.5 % Ropivacaine hydrochloride	Before injecting of local anaesthetic	92.49±1.87	91.81±2.04
	10 min after onset of analgesia	93.25±2.24	89.62±1.96
	After recovery of anaesthesia	90.42±3.01	90.05±1.17
Group II 0.75 % Ropivacaine hydrochloride	Before injecting of local anaesthetic	90.06±0.64	90.68±1.68
	10 min after onset of analgesia	92.42±1.21	91.65±1.11
	After recovery of anaesthesia	92.17±1.21	92.26±1.87
Group III 2 % Lignocaine hydrochloride	Before injecting local anaesthetic	90.45±1.66^{b}	93.08±1.94
	10 min after onset of analgesia	93.03±1.48^{a}	92.82±1.36
	After recovery of anaesthesia	90.00±1.59^{b}	93.18±0.87
	T (within group)	**0.017**	**0.227**
P value	**G (between group)**	**0.938**	**0.499**
	T*G	**0.214**	**0.536**

Means bearing different superscript (a, b) differ significantly within group ($p<0.05$).

Table 4: Median score of analgesia and scoliosis devlopment in different groups

Parameters	Group I	Group II	Group III	P-value
Assessment of analgesia (0 to 2)	2	2	1.5	0.575
Development of scoliosis (0 to 2)	0	0	0.5	0.492

oblique abdominal muscle incision after 2 % lignocaine administration in distal paravertebral anaesthesia in goats. Moon and Suter (1993) noted that out of 10 horses, degree of pain reaction during incision and closure was none in 6 cases, mild in 2 cases and moderate in 2 cases after paravertebral thoracolumbar anaesthesia with lignocaine and stated that this may due to individual variation in nerve innervation. It was stated that 0.5 % and 0.75 % ropivacaine hydrochloride provides complete analgesia in all four layers of flank and produced least pain during surgery as compared to lignocaine hydrochloride which provides moderate to complete analgesia.

Valverde and Sinclair (2015) stated that development of scoliosis towards anaesthetized site may result in relaxation of the epaxial lumbar muscles due to sensory blockade of motor fibres. In group I and group II, out of six animals in each group only one animal in each group developed scoliosis towards anesthetized site after paravertebral injection and obtained median score of 0 for development of scoliosis. In group III, out of six animals, three animals developed scoliosis towards anesthetized site after performing a proximal paravertebral anaesthesia using 2 % lignocaine, hence median score for development of scoliosis was 0.5. Similar observation was noted by Sloss and Dufty (1977), who observed bowing of back towards left side after paravertebral anaesthesia using 2 % lignocaine in Hereford cattle. However, there was no significant change observed within or between groups.

Conclusion

On the basis of present findings, it was concluded that ropivacaine (0.5% and 0.75%) adequately produced analgesia and was at par with 2% lignocaine for onset and duration of analgesia after paravertebral administration and suitable for longer duration surgical procedures such as enterectomy, enteroanastomosis and Caesarean section which require more than 3 h of intraoperative and postoperative analgesia in standing position without re-administration of anaesthetic agents in bovines.

Acknowledgements

Authors are grateful to the authorities of Kamdhenu University, and Principal, College of Veterinary Science & AH, Sardarkrushinagar, Banaskantha, Gujarat for the facilities provided.

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