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Vijay Kumar
Shankeshwari Nivas, Behind Hero Kailash Service Center, Adarsh Colony (Old), Bidar, Karnataka, India

Dilip Kumar
Dean, Veterinary College, Bidar, Karnataka, India

Usturge SS
Retired Dean and Professor, Department of Surgery, Veterinary College, Bidar, Karnataka, India

BV Shivaprakash
Director of Research, KVAFSU, Bidar, Karnataka, India

Patil NA
Director of Extension, KVAFSU, Bidar, Karnataka, India

MK Tandle
Director of Instructions, PGS, KVAFSU, Bidar, Karnataka, India

Corresponding Author:
Vijay Kumar
Shankeshwari Nivas, Behind Hero Kailash Service Center, Adarsh Colony (Old), Bidar, Karnataka, India

Comparative evaluation of Articaine bupivacaine and Lidocaine for laparotomies using paravertebral anaesthetic technique in ruminants

Vijay Kumar, Dilip Kumar, Usturge SS, BV Shivaprakash, Patil NA and MK Tandle

Abstract
The study was conducted through comparative evaluation of data presented to TVCC, Veterinary College, Bidar. 18cattles were randomly divided into 3 groups with 6 animals in each group Cattles in group I, II and III were operated under Articaine, Bupivacaine and Lidocaine local anaesthesia respectively. The clinical evaluation was done with physiological, haematological and biochemical parameters in cattles. After administering local anaesthetic agent Articaine had quickest and better analgesic effect than Bupivacaine and Lidocaine. The longest duration of analgesia was observed in Bupivacaine followed by Articaine. Physiological parameters showed fluctuations within the normal range. Significant neutrophilia with relative lymphocytopenia was observed in Lidocaine group animals otherwise in Articaine and Bupivacaine group haematological parameters decreased from 0 hours to 48 hours at all the intervals however remained within normal range. Biochemical parameters in all groups were within the normal range however Aspartate Amino-Transferase (AST) showed increase from 0 to 48 hours in all groups. Articaine can be preferred for major surgeries involving efficient regional anesthesia of intermediate duration while Bupivacaine can be preferred for longer duration surgery.

Keywords: Cattles, articaine, bupivacaine, lidocaine regional anesthesia

Introduction
Regional anesthesia is first choice of anaesthesia in ruminants since general anaesthesia has many limitations due to anatomical and physiological peculiarities (Shokry, 1982) [21] and regurgitation (Hossain, 1984, Hashim *et al*., 1989) [6]. In ruminants, flank region, which is innervated by T13, L1 and L2 spinal nerves, is the most frequently used site for laparotomy, caesarian section, rumenotomy, intestinal obstruction, volvulus, ruminal fistula, foreign body syndrome, hernia (Lee, 2006 and Kumar, 2003) [10, 11]. The standing position is optimal for surgeries in ruminants as it reduces the problems associated with bloat, salivation, recumbency related regurgitation and nerve or muscle damage(Trim, 1981) [25]. Paravertebral anaesthesia is one such technique which facilitate regional for flank laparotomies by perineural injection of local anaesthetic solution around spinal nerves as they emerge from the vertebral canal through the intervertebral foramina. The technique was introduced by Farquharson in cattle and it resulted in effective analgesia in all layers of the abdominal wall.
A variety of local anaesthetic drugs penetrate peripheral nerve barriers and provide reversible anaesthesia with acceptable onset time and predictable duration (Skarda, 1986) [19]. Lidocaine Hydrochloride, an amide-type local anaesthetic first synthesized by Swedish chemist Nils Lofgren (1943) [12] has became single agent of choice since its inception due to its intermediate anaesthetic duration and cost restrictions.
Bupivacaine Hydrochloride another amide type local anaesthetic agent produced in 1976 has shown promising stats foe performing longer duration surgeries in ruminants however its efficacy using paravertebral block in ruminants has paucity of data.
Articaine, another local anaesthetic agent prepared in 1969, is reported to diffuse better through soft tissue and bone than other local anaesthetics, claimed to be superior than Lidocaine owing to fast onset of block, excellent quality of anaesthesia in approximately 2 minutes, irrespective of volume injected in contrast to other local anaesthetics which require more dose to produce quicker and denser block. Literatures suggest that patients treated with Articaine will be drug free more quickly than those treated with other local anaesthetics.
Literature on use of local anaesthetics for flank anaesthesia are abundant through use of linear

infiltration or inverted-L block while little information is available on anesthetic efficacy and effect of local anesthetic using paravertebral anesthetic technique, hence the present study was undertaken to facilitate a proper insight of effect and efficacy of local anesthetic using paravertebral block in ruminants with the following objectives

1. To compare the efficacy of articaine, bupivacaine and lidocaine for paravertebral anesthesia for laparotomies in ruminants
2. To evaluate haemato-biochemical changes before, during and after paravertebral block in articaine, bupivacaine, and lidocaine in order to assess their safety.
3. To evaluate physiological and clinical changes induced before, during and after anesthesia in all the three agents.

Materials and Methods

The study on anaesthetic comparison of three Local Anaesthetic *viz*. Articaine1, Bupivacaine 2 and Lidocaine3 was conducted on 18 clinical cases of cattles with various disorders requiring laparotomies. The animals were randomly divided into 3 groups with 6 animals each. All the cattles were subjected to laparotomies using paravertebral
block as described by Farquharson (1940) [4]. The dose of articaine hydrochloride was standardized after pilot studies. The dose rate of 8 mg/kg body weight was found to be effective.

Table 1: Design of technical programme of clinical study

Group number	No. of animals	Anaesthetic agent	Dose of the Agent	Surgery performed
I	6	Articaine HCl 4%	8 mg/kg	Enterectomy (1) Caesarian (1) Rumenotomy (4)
II	6	Bupivacaine HCl 0.5%	4 mg/kg	Ventral Hernia (2) Caesarian (1) Rumenotomy (3)
III	6	Lidocaine HCl 2%	4 mg/kg	Typhlectomy (2) Caesarian (2) Rumenotomy (2)

Preanesthetic preparation of the animal

All the animals were made to stand for administering Local anaesthetic agent through dorsal paravertebral technique. Heart rate, respiratory rate and rectal temperature were recorded prior to anesthesia. Hematological and biochemical constituents were estimated before anesthesia and major surgery.

Anesthetic Technique

In this technique the dorsal and ventral branches of the last thoracic (T13) and first and second lumbar (LI and L2) spinal nerves were desensitized as they emerge from the intervertebral Foramina. The technique is called the Farquharson, Hall, or Cambridge technique. In addition, the third and fourth (L3 and L4) lumbar spinal nerves can be desensitized if analgesia of the caudal most part of the paralumbar fossa for cesarean section or ipsilateral for teat and mammary gland was desired. However, weakness of the pelvic limb may be caused by desensitizing the L3 and L4 nerves, which carry motor fibers to the femoraland ischial nerves. The skin overlying the spinal column on the side to be desensitized was clipped, surgically scrubbed, and disinfected. The skin at the most obvious parts of the transverse processes of LI, L2, and L3 at a point 2.5 to 5.0 cm from the dorsal midline was identified and desensitized by injecting 2 to 3 mL of local anesthetic solution, using a short and comparatively fine needle (2.5-cm, 20-gauge). An 18-gauge spinal needle was inserted into the desensitized skin. The needle was passed ventrally until its point encountered the transverse process of L2 or the intertransverse (L1-L2) ligament. Small amount (2 to 3 mL) of the anesthetic was injected as the needle advanced to counteract the spasm of the longissimus dorsi muscle and prevent bending of the long needle. When contact was made with bone, the needle was walked off the cranial edge of the transverse process of L2 and advanced approximately 1 cm to pass through the intertransverse fascia. The penetration of the intertransverse fascia could be usually felt. Approximately 10 to 15 mL of anesthetic agent is injected with little resistance to desensitize the ventral branch of L 1. The needle was withdrawn 1 to 2.5 cm to above the fascia and dorsal surface of the transverse process. An additional 5 mL of the anesthetic was injected with slight resistance to desensitize the dorsal branch of L1. To desensitize T13 and L2, the needle was inserted cranial to the transverse processes of L I and L3, its tip walked off the cranial edges of the transverse processes to a depth comparable to the previous injection site, and the nerves were desensitized similarly to L1.

Assessment of anesthesia

The anesthetic effect was evaluated based on clinical, physiological, haematological and biochemical changes.

Clinical observation

The onset of analgesia and duration of analgesia were recorded in all the three groups.
The changes in physiological, hematological and biochemical parameters were recorded.

Assessment of pain

Pain was assessed using noxious stimulus like pin-prick method over the paralumbar
fossa.

Table 2: Pain score to judge the quality of post-operative analgesia was prepared as follows

Category	Description	Score
Response to pin-prick	No Response at the operated site	0
	Slight response	1
	Moderate response	2
	High response	3

Physiological parameters

1. **Heart Rate (Beats/minute):** The heart rate was measured by ascultation using a stethoscope at 0-hour, 1 hour, 24 hours and 48 hours of anesthesia.
2. **Respiratory Rate (Breaths/minute):** The respiratory rate was measured by observing the movement of thoracic and abdominal wall during inspiration and expiration at 0 hour, 1hour, 24 hours and 48 hours of anesthesia.
3. **Rectal temperature (0F):** The rectal temperature was recorded by placing clinical thermometer into the rectum of the animal at 0 hour, 1hour, 24 hours and 48 hours of anesthesia.

Haematological studies

The blood samples were collected in EDTA tubes at 0-hour, 1

hour, 24 hours and 48 hours of anesthesia and the haematological parameters that were evaluated are:

1. **Haemoglobin (g/dl):** Haemoglobin was estimated by Sahli's haemoglobinometer as per the standard method recommended by Schalm *et al*. (1975) [17] and values were expressed in g/dl.
2. **Packed cell volume (%):** Packed cell volume was estimated by microhaematocrit method as described by Benjamin (1985) and the values were expressed in percentage.
3. **Total Erythrocyte count (million cells/µl):** Total Erythrocyte count was estimated by procedure described by Schalm *et al. (*1975) [17] and values were expressed in millions cells per microlitre of blood.
4. **Total leucocyte count (thousand cells/µl):** Total leucocyte count was estimated as per the procedure described by Jain (2000) and the values were expressed as thousand cells per microlitre of blood.
5. **Differential leucocyte count:** Differential leucocyte count done was by staining the blood smear with Giemsa stain and leucocyte counted as per method described by Jain (2000).

Biochemical studies

Serum samples obtained from blood samples collected at 0 hour (prior to anesthesia), 1 hour, 24 hours and 48 hours were subjected to estimation of.

1. **Serum creatinine:** Serum creatinine was estimated and values were expressed in mg/dl for all animals.
2. **Alanine amino-transaminase (ALT)/ Serum glutamic pyruvic transaminase (SGPT):** ALT level was estimated by Reitman and Frankel (1957) and the values were expressed as IU/L
3. **Aspartate Amin-Otransferase (AST)/ Serum glutamic oxaloacetic transaminase:** AST level was estimated by Reitman and Frankel (1957) and the values were expressed as IU/L

Statistical analysis

The data generated before and at different intervals of anesthesia within and between the groups were analyzed by statistical methods described by Snedecor and Cochran (1989) [23]. Student 't' test was used for comparison of means within the group from 0 hour and between the group I, II and III at different intervals of anesthetic study.

Results

The present study was conducted on 18 clinical cases requiring laparotomies in ruminants brought for treatment at Veterinary College Hospital, Bidar. Three local anesthetic agents were compared following paravertebral anesthetic technique as described by Farquharson. The results of the study are presented as follows.

Onset of Analgesia (minutes)

The Mean ± SE values of onset of analgesia for Group I, II and III were found to be 4.67± 0.92, 20.16± 1.04 and 11.33±0.49 respectively. The onset of analgesia was quicker ($P\leq 0.01$) in articaine hydrochloride when compared with bupivacaine hydrochloride and lidocaine hydrochloride.

Table 3: Mean ± SE of onset of analgesia in different groups of local anaesthetic

Parameter	Group I	Group II	Group III
Onset of Analgesia (min)	4.67± 0.92x	20.16± 1.04y	11.33±0.49y

x, y means bearing superscript x, y differ significantly from each other at $P\leq 0.01$ level

Duration of Analgesia (minutes)

The Mean ± SE values of duration of analgesia for Group I, II and III were recorded as 204.17±12.99, 295.83±45.73 and 153.33±19.21 respectively. The duration of analgesia was highest in group II animals followed by group I and III animals. Statistically ($P\leq 0.05$) higher duration of analgesia was observed in group I and group II animals when compared to group III animals. The duration of analgesia did not vary statistically between group I and II animals.

Table 4: Mean ± SE of duration of analgesia in different groups of local anaesthetic

Parameter	Group 1	Group II	Group III
Duration of Analgesia (min)	204.17±12.99	295.83±45.73a	153.33±19.21b

Pain Score

The Mean ± SE of pain score for the Group I, II, and III was 1.33 ± 0.21, 2.16 ± 0.17 and 2.00 ± 0.25 respectively. The pain score was least in articaine hydrochloride anesthesia when compared to bupivacaine hydrochloride and lidocaine hydrochloride, which was statistically significant at the level of $P\leq 0.05$. The results of the present study indicated that articaine hydrochloride was powerful local analgesic compared to bupivacaine hydrochloride and lidocaine hydrochloride. The high pain score of bupivacaine hydrochloride in the present study show that it was less effective than lidocaine hydrochloride.

Table 5: Mean ± SE of pain score in different groups of local anesthetics

Parameter	Group i	Group ii	Group III
Pain Score	1.33 ± 0.21a	2.16 ± 0.17b	2.00 ± 0.258

a, b means bearing superscript a, b differ significantly from each other at $P\leq 0.05$ level

Physiological Parameters

Rectal Temperature (0F)

The Mean ± SE values of rectal temperature at 0 hour before anesthesia were 100.17 ± 0.35, 100.73±0.24, and 99.81±0.76 in Groups I, II and III, respectively. 1 hour after anesthesia the mean ± SE values in Groups I, II and III were 99.70±0.48, 100.17±0.69 and 99.55±1.07 respectively. After 24 hours of anesthesia the mean ± SE values in Groups I, II and III were 99.93±0.44, 100.13±0.42, and 100.30±0.36 respectively. The values were 100.03±0.24, 100.18±0.36 and 100.03±0.46 in Groups I, II and III respectively after 48 hours of anesthesia. The comparison within the group and between the groups at different intervals of the present study revealed that there was no statistically significant (P>0.05) difference in the rectal temperature. The rectal temperature fluctuated within normal physiological limits at all the intervals of the study and in all the groups of animals.

Heart rate (beats/min)
The Mean ± SE values of heart rate at 0 hour before anesthesia were 71.17±5.32, 64.47±6.12 and 73.33±3.28 in Groups I, II and III, respectively. 1 hour after anesthesia the mean ± SE values in Groups I, II and III were 64.33±9.22, 64.00±10.64 and 70.16±3.49 respectively. After 24 hours of anesthesia the mean ± SE values in Groups I, II and III were 66.83±6.87, 65.67±6.23 and 74.50±4.90 respectively. The values were 68.00±5.08, 67.50±4.63 and 79.33±6.46 in Groups I, II and III respectively after 48 hours of anesthesia. The comparison within the group and between the groups at different intervals of the present study revealed that there was no statistically significant (P>0.05) difference in the heart rate. The heart rate fluctuated within normal physiological limits at all the intervals of the study and in all the groups of animals.

Respiratory rate (breaths/min)
The Mean ± SE values of heart rate at 0 hour before anesthesia were 22.00±3.33, 25.00 ±3.53 and 24.67±2.24 in Groups I, II and III, respectively. 1 hour after anesthesia the mean ± SE values in Groups I, II and III were 20.50±3.04, 19.67±3.71 and 22.67±2.49 respectively. After 24 hours of anesthesia the mean ± SE values in Groups I, II and III were 21.00±2.61, 20.16±3.07 and 21.50±3.19 respectively. The values were 22.16±2.65, 19.83±3.53 and 23.00±4.21 in Groups I,II and III respectively after 48 hours of anesthesia. The comparison within the group and between the groups at different intervals of the present study revealed that there was no statistically significant (P>0.05) difference in the respiratory rate. The respiratory rate fluctuated within normal physiological limits at all the intervals of the study and in all the groups of animals.

Haematological study
Haemoglobin (g/dl) Before giving anesthesia (0 hour) the Mean ± SE values in Group I, II and III were 11.64±1.42, 12.88±0.79 and 11.76±1.21 respectively. In Group I, II and III after 1 hour of anesthesia the Mean ± SE values were 9.88±0.86, 11.37±0.80 and 10.56±1.15 respectively. The Mean ± SE values 24 hours after the anesthesia were 10.45±1.04, 10.90±0.76 and 9.97±1.29 respectively in Group I, II and III. After 48 hours the Mean ± SE values in Group I, II and III were 9.86±0.75, 10.57±0.73 and 9.66±1.28 respectively. The comparison within the group and between the groups at different intervals of the present study did not revealed any statistically significant (P>0.05) difference in the Haemoglobin levels. The levels of Haemoglobin fluctuation was within the normal physiological limits at the intervals of the study and in all the groups of animals.

Packed cell volume (%)
Before giving anesthesia (0 hour) the Mean ± SE values in Group I, II and III for PCV (%) were35.40±4.28, 39.21±2.78 and 36.28±2.89 respectively. In Group I, II and III after 1 hour of anesthesia the Mean ± SE values were 31.58±1.92, 34.27±2.47 and 32.17±3.19 respectively. The Mean ± SE values 24 hours after the anesthesia were 32.13±2.27, 32.22±1.96
and 31.00 ± 3.04 respectively in Group I, II and III. After 48 hours the Mean ± SE values in Group I, II and III were 30.23±1.71, 32.03±2.14 and 29.57±3.56 respectively. The comparison within the group and between the groups at different intervals of the present study revealed that there was no statistically significant (P>0.05) difference in the PCV values. The PCV values fluctuated within normal physiological limits at all the intervals of the study and in all the groups of animals.

Total erythrocyte count (×106/µl)
Before giving anesthesia (0 hour) the Mean ± SE values in Group I, II and III were 6.68±0.53, 6.61±0.41 and 6.04±0.48 respectively. In Group I, II and III after 1 hour of anesthesia the Mean ± SE values were 5.67±0.35, 6.02±0.41 and 5.64±0.44 respectively. The Mean ± SE values 24 hours after the anesthesia were 6.10±0.30, 5.58±0.45 and 5.37±0.44
respectively in Group I, II and III. After 48 hours the Mean ± SE values in Group I, II and III were 5.79±0.25, 5.47±0.42 and 5.16±0.48 respectively. The comparison within the group and between the groups at different intervals of the present study revealed that there was no statistically significant (P>0.05) difference in the TEC values. The TEC values fluctuated within normal physiological limits at all the intervals of the study and in all the groups of animals.

Total leukocyte count (×103 /µl)
Before giving anesthesia (0 hour) the Mean ± SE values in Group I, II and III were 10.25±0.82, 17.48±3.18 and 12.35±2.06 respectively. In Group I, II and III after 1 hour of anesthesia the Mean ± SE values were 9.52±0.95, 15.81±2.89 and 12.43±1.85 respectively. The Mean ± SE values 24 hours after the anesthesia were 10.50±2.03, 15.10±2.52 and10.41±1.30 respectively in Group I, II and III. After 48 hours the Mean ± SE values in Group I, II and III were 9.16±1.17, 14.83±2.55 and 10.35±1.36 respectively. The comparison within the group and between the groups at different intervals of the present study revealed that there was no statistically significant (P>0.05) difference in the TLC values. The TLC values fluctuated within normal physiological limits at all the intervals of the study and in all the groups of animals.

Neutrophils (%)
Before giving anesthesia (0 hour) the Mean ± SE values in Group I, II and III were 67.33±3.48, 64.33±3.25 and 65.16±1.96 respectively. In Group I, II and III after 1 hour of anesthesia the Mean ± SE values were 63.17±1.66, 65.50±2.17 and 71.00±0.45 respectively. The Mean ± SE values 24 hours after the anesthesia were 59.50±0.76, 65.67±2.01 and 69.83±0.79 respectively in Group I, II and III. After 48 hours the Mean ± SE values in Group I, II and III were 61.33±1.17, 59.33±5.10 and 67.33±0.80 respectively. The comparison within the groups showed that in Group I animals there was decrease in neutrophil count between 1to 48 hours when compared to pre-anesthetic level, however this decrease was not statistically significant (P>0.05). Group II and III animals showed 1hour to 24 hours and 1 hour to 48 hours neutrophilia respectively when compared to pre-anesthetic level. The neutrophilia was statistically significant ($P \leq 0.05$) only at 1 hour in group III animals. The comparison between groups at different intervals showed that the Group III animals had statistically higher ($P \leq 0.01$) neutrophil count when compared to Groups I and II animals. At 24 hours the comparison between groups revealed that highest neutrophilia was observed in Group III animals followed by Group II animals. Eutrophilia in Group III was statistically significant at the level of $P \leq 0.01$ when compared to Group I animals. Neutrophilia in Group II when compared to Group I animals

was statistically significant at the level of $P \leq 0.05$. At 48 hours significant neutrophilia was observed in Group III animals compared to Groups I and II animals.
These results suggests that under Lidocaine Hydrochloride anesthesia stress response was more when compared to Articaine Hydrochloride and Bupivacaine Hydrochloride.

Lymphocytes (%)
The Mean ± SE values of Lymphocytes at 0 hour before anesthesia were 27.83±2.17, 32.17±2.89 and 29.83±2.24 in Groups I, II and III, respectively. 1 hour after anesthesia the mean ± SE values in Groups I, II and III were 31.50±1.76, 30.16±2.13 and 25.67±0.56 respectively. After 24 hours of anesthesia the mean ± SE values in Groups I, II and III were 35.00±0.58, 30.00±1.80 and 26.67±0.67 respectively. The values were 33.67±0.95, 31.50±1.86, 29.83±1.02 in Groups I, II and III respectively after 48 hours of anesthesia. The comparison within the groups revealed that there was lymphocytosis ($P \leq 0.01$) at 24 hours when compared with 0 hour in Group I animals, whereas Group II and III animals did not show any difference in lymphocyte count at 0 hours and between 1 to 48 hours. The comparison between the groups showed that at 1 hour the lymphocyte count was more ($P \leq 0.05$) in Group I and II animals when compared with Group III animals. At 24 hours lymphocyte count was higher in Group I and II animals when compared to Group III animals. The difference was statistically significant at the level of $P \leq 0.01$. Similar trend was observed at 48 hours however the difference was statistically significant only at the level of $P \leq 0.05$. Neutrophilia with relative lymphocytopenia was observed in Lidocaine anesthesia (Group III) suggesting that Lidocaine was not effective in abolishing pain.

Monocytes (%)
The Mean ± SE values of Monocytes at 0 hour before anesthesia were 3.16±0.48, 2.16±0.40 and 3.00±0.45 in Groups I, II and III, respectively. 1 hour after anesthesia the mean ± SE values in Groups I, II and III were 3.67±0.61, 2.83±0.16 and 2.33±0.42 respectively. After 24 hours of anesthesia the mean ± SE values in Groups I, II and III were 3.50±0.56, 2.50±0.42 and 2.16±0.40 respectively. The values were 3.00±0.51, 2.16±0.16 and2.00±0.25 in Groups I,II and III respectively after 48 hours of anesthesia. Monocyte level fluctuated within normal physiological limits in all the groups of animals and at all the intervals of study.

Eosinophils (%)
The Mean ± SE values of Monocytes at 0 hour before anesthesia were 1.66±0.21, 1.33±0.21 and 2.00±0.25 in Groups I, II and III, respectively. 1 hour after anesthesia the mean ± SE values in Groups I, II and III were 1.66±0.21, 1.33±0.21 and 1.33±0.21 respectively. After 24 hours of anesthesia the mean ± SE values in Groups I, II and III were 2.00±00, 1.83±0.16 and 1.33±0.21 respectively. The values were 2.00±00, 1.50±0.22 and 1.33±0.21 in Groups I, II and III respectively after 48 hours of anesthesia. Eosinophils level fluctuated within normal physiological limits in all the groups of animals and at all the intervals of study.

Biochemical observations
Serum Creatinine (mg/dl)
Before giving anesthesia (0 hour) the Mean±SE values in Group I, II and III for Creatinine(mg/dl) were 1.74±0.15, 1.80±0.11 and 1.59±0.11 respectively. In Group I, II and III after 1 hour of anesthesia the Mean±SE values were 1.87±0.32, 1.68±0.14 and 1.52±0.08 respectively. The Mean±SE values 24 hours after the anesthesia were 1.72±0.21, 1.85±0.14 and 1.59±0.10 respectively in Group I, II and III. After 48 hours the Mean±SE values in Group I, II and III were 1.74±0.28, 1.70±0.06 and 1.61±0.11 respectively. The comparison within the group and between the groups at different intervals of the present study revealed that there was no statistically significant (P>0.05) difference in the serum Creatinine values.

Alanine amino-transaminase (IU/L)
Before giving anesthesia (0 hour) the Mean ± SE values in Group I, II and III for ALT were 42.48±2.32, 35.00±3.23 and 49.32±5.91 respectively. In Group I, II and III after 1 hour of anesthesia the Mean ± SE values were 39.18±1.76, 39.00±2.54 and 42.87±5.79 respectively. The Mean ± SE values 24 hours after the anesthesia were 42.34±2.92, 40.00±3.71 and 43.59±6.03 respectively in Group I, II and III. After 48 hours the Mean ± SE values in Group I, II and III were44.53±3.17, 41.33±1.41, and 44.00±5.40 respectively. The comparison within the group and between the groups at different intervals of the present study revealed that there was no statistically significant(P>0.05) difference in the ALT values. The ALT values fluctuated within normal physiological limits at all the intervals of the study and in all the groups of animals.

Aspartate amino- transferase (IU/L)
Before giving anesthesia (0 hour) the Mean ± SE values in Group I, II and III for AST (IU/L) were 133.17±25.14, 90.00±10.49 and 87.62±14.04 respectively. In Group I, II and III after 1 hour of anesthesia the Mean ± SE values were 130.83±16.57, 105.00±11.38 and 84.31±14.17 respectively. The Mean ± SE values 24 hours after the anesthesia were 148.17±22.64, 112.67±8.07 and 113.67±10.49 respectively in Group I, II and III. After 48 hours the Mean ± SE values in Group I, II and III were 158.33±26.91, 124.33±7.36 and 102.66±14.78 respectively. The comparison within the group and between the groups at different intervals of the present study revealed that there was no statistically significant (P>0.05) difference in the AST values. The AST values fluctuated within normal physiological limits at all the intervals of the study and in all the groups of animals.

Discussion
The present study on comparing anesthetic efficacy of 3 local anesthetic agent was conducted on 18 clinical cases of large ruminants requiring flank laparotomy using paravertebral anesthetic technique as described by Farquharson (1940) [4]. The newer agent Articaine hydrochloride has gained immense popularity in dental surgeries and is replacing lidocaine hydrochloride in complicated dental surgeries. Articaine hydrochloride for the first time in ruminant surgery was used in this study for paravertebral block. The results of this study are discussed under the following headings.

Onset of Analgesia
The onset of analgesia was quicker ($P \leq 0.01$) in articaine hydrochloride when compared with bupivacaine hydrochloride and Lidocaine hydrochloride. This could be attributed to thiophene ring that Articaine molecule carries and which increases its lipid solubility and is absent in both bupivacaine and lidocaine. Onset of analgesia was slowest

with bupivacaine which may be due to concentration of the agent. Similar findings were reported by Kaukinen *et al*. (1978), Sukhminder *et al*. (2012), Bachmann *et al*. (2012) and documented by Skarda *et al*. (2007) [9, 24, 1, 20].

Duration of analgesia

The duration of action of local anesthetics was highest with bupivacaine followed by articaine and then by lidocaine. Bupivacaine rapidly enters the sodium channel of myocardium during the action potential (systole) however it exits from sodium channel slowly during recovery (diastole), with the potential for accumulation. This mechanism of fast-in, slow-out Kinectics makes bupivacaine long acting local anesthetic (Cox *et al*., 2003) [2]. The present study's results are in accordance with Cox *et al.* (2003), Shahid *et al*. (2011) and De Rossi *et al.* (2010) [2, 18, 3]. In the present study articaine showed longer duration of action than lidocaine which could be due to epinephrine in ratio of 1:100000 with articaine. There was a significant difference between bupivacaine and lidocaine and similar findings were reported by Maryam *et al.* (2011) [13] in sheep after paravertebral anesthesia.

Pain score

The pain score showed a significant difference between articaine and bupivacaine, however there was less significant difference between articaine and lidocaine. The fact could be difference in concentration of the agents affecting the potency of the agent. Animals operated under articaine anesthesia exhibited least pain than lidocaine and bupivacaine. Rekha *et al*. (2012) [16] have also found that bupivacaine produced mild to moderate analgesia in buffaloes after spinal administration.

Physiological parameters

Physiological parameters like rectal temperature, heart rate and respiratory rate showed fluctuations within the normal physiological limits, similar reports had been reported by Maryam *et al*. (2011) [13] when lidocaine and bupivacaine were used for paravertebral block in conscious sheep. The heart rate in Group I showed non-significant decrease at 1 hour after anesthesia whereas in other group animals such decrease was not noted. It was anticipated that lidocaine and bupivacaine may induce cardio-toxicity but correct dose of the agents used in the present study did not cause any toxic effects. Similar findings were earlier reported by Hadi *et al.* (2008), Rekha *et al.* (2008), Maryam *et al.* (2011) [5, 16, 13].

Haematological parameters

All the haematological parameters showed non-significant fluctuations within the group and between the groups. Bupivacaine hydrochloride and lidocaine hydrochloride showed non-significant decrease in haemoglobin, PCV and total erythrocyte count values from preanesthetic levels. The decrease might be attributed to pooling of circulating blood cells in the spleen or other reservoirs secondary to decreased sympathetic activity. These results are in agreement with findings reported by Rekha *et al.* (2012) [16] in buffaloes. Olaifa *et al.* (2009) [14] have also reported that with 2% lidocaine hydrochloride, haematological values remained within the normal range after paravertebral anesthesia. Similar results were also found by Singh *et al.* (2005) [22]. Total erythrocyte count values showed decrease in all the animals from 0 hour. In group II and III there was non-significant (P>0.05) decrease in TEC values at all intervals from 0 hour however in group I there was increase from 1 hour to 24 hours and again decrease from 24 to 48 hours. The total leucocyte values were within the normal limits in all the groups of agents. Bupivacaine and lidocaine showed decrease in values from 0 hour to 48 hours however the decrease was non-significant (P>0.05). In group I there was 0 to 1 hour non-significant decrease in TLC value and again from 1 to 24 hours there was non-significant increase in TLC values and then decrease from 24 to 48 hours.

Neutrophilia was observed in group II and III from 1 hour to 24 hours and 1 hour to 48 hours respectively when compared with pre-anesthetic levels. Highest neutrophilia was observed in group III animals at 24 and 48 hours when compared with group I and II which were significant at $P \leq 0.01$ and at $P \leq 0.05$ levels respectively. Neutrophilia in group II and III could be due to adrenocortical stimulation and subsequent effect of glucocorticoids on circulating neutrophils. Low neutrophilia in articaine group could be attributed to less immunogenicity of articaine which was in accordance with Sukhminder *et al.* (2012) [24]. Increase in lymphocytes ($P \leq 0.05$) was observed in group I at 24 hours of anesthesia when within the group comparison was made while group II and III did not show any such difference. Significant decrease ($P \leq 0.05$) was observed in lymphocytes in group III when compared with group I and II at different intervals which could be attributed to relative neutrophilia in group III. Similar observation was made by Olaifa *et al.* (2009) [14] where lymphocytes showed decrease from 0 hour to 24 hours in animals treated with lidocaine. Monocytes and Eosinophils values fluctuated within the normal physiological limits in all the groups of animals and at all the intervals.

Biochemical parameters

Biochemical parameters like serum creatinine, ALT and AST were estimated in the present study. Articaine hydrochloride undergoes 90-95% metabolism by serum esterases and excretion by kidneys therefore pre-anesthetic and after administering local anesthetic serum creatinine levels were estimated. In all the groups and at all the intervals creatinine values fluctuated within normal physiological limits which were in accordance with Jadon *et al.* (1996). ALT is more liver specific enzyme and lidocaine, bupivacaine and part of (5-10%) articaine undergoes metabolism in liver and was anticipated to increase ALT values however none of the agent did increase the ALT significantly. Similar findings were reported by Hadi *et al.* (2008) [5] with bupivacaine in Chall sheep and are in partial accordance with Singh *et al.* (2005) [22] where they found rise in ALT level after giving lidocaine in buffaloes calves however ALT levels returned to normal range at 24 hours. AST values increased from pre-anesthetic (0 hour) to 48 hours in all the animals of 3 groups however the increase was not significant (P>0.05). This rise in values could be attributed to muscle damage resulting from laparotomy.

Conclusion

The present study was undertaken on 18 clinical cases of large ruminants in which flank laparotomies were performed like rumenotomy, enterotomies, caesarian section and so on. Three local anesthetics *viz*. articaine, bupivacaine and lidocaine were assessed and compared for analgesic potency in regional anesthesia using paravertebral anesthetic technique as described by Farquharson (1940) [4]. Paravertebral anesthesia has many advantages over local tissue infiltration like lesser requirement of agent, uniform anesthetic blocking of surgical

site, abdominal pressure decreases facilitating easy suturing and absence of anesthetic solution from surgical wound margins. In the present study the animals were randomly divided into 3 groups with 6 animals in each group. In group I, the animals were subjected to articaine hydrochloride wherein operations namely enterotomy, caesarian and rumenotomies were performed. In group II, animals were subjected to bupivacaine hydrochloride and repair of ventral hernias, caesarian and rumenotomies were done while in group III, typhlectomies, caesarian and rumenotomy under lidocaine hydrochloride anesthesia. In all the groups onset of analgesia was recorded and the data revealed that articaine was quicker followed by lidocaine and then by bupivacaine. The duration of action was longest for bupivacaine followed by articaine and lidocaine. Bupivacaine enters sodium channels and exits slowly during diastole making it longer acting agent. Articaine proved to be excellent agent in alleviating pain during surgery with animal experiencing lesser pain than lidocaine and bupivacaine. The physiological parameters like rectal temperature, heart rate and respiratory rate showed fluctuation within normal limits. The parameters showed decrease from 0 hour to 1 hour in all the groups and then increased from 1 hour to 48 hours. The parameters remained in normal range throughout the period of observation. The haematological parameters like haemoglobin, PCV and total erythrocyte count were within the normal range. The parameters in groups II and III decreased from 0 hour to 48 hours. In group I, all the values decreased at 1 hour while increased at 24 hours and again decreased at 48 hours. The TLC values also decreased in all the groups but were non-significant. Pooling of circulating blood cells in the spleen or other reservoirs secondary to decreased sympathetic activity could be reason for decrease in values. Neutrophilia was observed in group II and III which could be due to adrenocortical stimulation and subsequent effect of glucocorticoids on circulating neutrophils. Lymphocytopenia was observed in group III which could be due to relative neutrophilia making lidocaine hydrochloride not so effective in abolishing pain. Monocytes and eosinophils in all three groups and at all intervals showed non-significant fluctuations within the normal range. The biochemical parameters, creatinine, ALT did not show any significant difference from normal values in any of the groups and at any of the intervals. AST values however increased from 0 hour to 48 hours in all the groups may be due muscle damage during laparotomy.

Based on the above findings following conclusions were made

1. Articaine hydrochloride has quicker onset of analgesia followed by lidocaine hydrochloride and then by bupivacaine hydrochloride
2. Bupivacaine hydrochloride is the longest acting local anesthetic of the three.
3. Bupivacaine hydrochloride can be used for longer surgeries.
4. Articaine hydrochloride is the best local anesthetic in abolishing pain for performing flank surgery under regional anesthesia while bupivacaine hydrochloride produces mild to moderate analgesia.
5. Paravertebral block offers many advantages over local tissue infiltration or inverted L block or T-block like decrease of abdominal pressure, lesser anesthetic solution required and more complete block is achieved with visceral sensation is also abolished.
6. None of the 3 agents used in the present study produced adverse effect on the physiological parameters when used in correct dose.
7. All the 3 agents have do not alter haematological parameters significantly and articaine hydrochloride has lesser effect on neutrophils than bupivacaine hydrochloride and lidocaine hydrochloride.
8. All the 3 agents do not affect biochemical parameters significantly.
9. Articaine hydrochloride is better local anesthetic agent than the other 2 agents however
   cost is the limiting factor.

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