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Research Article

Clinical Assessment of Articaine and Ropivacaine Hydrochloride for Caudal Epidural Anesthesia in Cattle

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Abstract

The present research work was undertaken to compare the clinical efficacy of 4% articaine hydrochloride with 0.75% ropivacaine hydrochloride for epidural analgesia in cattle. Total twelve clinical cases of cattle referred to Veterinary Clinical Complex for tail amputation were included in the study. These clinical cases were randomly divided into two equal groups (n = 6) irrespective of age, sex, and breed. On clinical evaluation, articaine produced significantly ($p \leq 0.01$) rapid analgesia as compared to the ropivacaine. However, a significantly ($p \leq 0.01$) longer duration of action was recorded in the ropivacaine treated group. The clinico-physiological and haemato-biochemical parameters showed non-significant fluctuation in both groups. Articaine 4% percent and 0.75% percent of ropivacaine can be used for caudal epidural analgesia in given doses without any untoward effects. Moreover, articaine hydrochloride has a faster onset of action and could manage intense painful conditions. Similarly, ropivacaine could be successfully used in prolonged surgical interventions.

Keywords: Caudal; Epidural; Articaine; Ropivacaine; Cattle; Nerve Block

Introduction

Ruminants are more prone to respiratory embarrassment, ruminal tympany, regurgitation, salivation and associated problems during general anaesthesia [1]; therefore, local and regional anaesthesia is an integral part of the ruminant practice. The advantages of regional anaesthesia include easy field applicability, safety and no need to have complex and expensive equipment. Most surgical interventions can be performed with safety and no pain in ruminants using sedation, regional nerve block, and physical restraint [2]. Cattle suffer from various surgical conditions of the posterior region involving the tail, perineum, scrotum and hind limb. The epidural nerve block was most commonly used to prevent or control pain during surgeries involving the tail, anus, vulva, perineum, caudal udder, scrotum, and upper hind limbs [3]. The caudal epidural nerve block provides a safer alternative to general anaesthesia in ruminants [4]. Local anaesthetics are widely used for analgesia in cattle, and researchers consistently engaged in discovering more potent and safe local anaesthetic agents. Ropivacaine and articaine are two newly introduced amide local anaesthetics. In a study conducted on 18 cattle it was revealed that mean time required for onset of analgesia in 4% articaine hydrochloride (4.67 ± 0.92 minutes) treated group was significantly ($p \leq 0.01$) shorter as compared to the 0.5% bupivacaine hydrochloride (20.16 ± 1.04 minutes) and lidocaine (11.33 ± 0.49 minutes). The slowest onset of action was recorded in 0.5% bupivacaine hydrochloride among the drugs compared. The longer duration of anaesthesia was recorded in 0.5% bupivacaine hydrochloride, followed by 4% articaine hydrochloride and 2% lidocaine hydrochloride [5]. The ropivacaine hydrochloride required a significantly ($p \leq 0.01$) longer induction time whereas the duration of anaesthesia was sustained for a significantly longer period in 0.5% ropivacaine hydrochloride treated group than 2% lidocaine, 0.5% levobupivacaine hydrochloride [6]. On a comparative assessment of ropivacaine, articaine and lignocaine hydrochloride for paravertebral analgesia in cattle, it was observed that ropivacaine has the slowest ($p \leq 0.01$) onset of action as compared to articaine and lignocaine. On the contrary longest ($p \leq 0.01$) duration of action was recorded in ropivacaine, followed by articaine and ropivacaine [7]. Many researchers studied the effects and safety of various local anaesthetics drugs in ruminants. However, significantly less literature was available on articaine and

ropivacaine on epidural analgesia in cattle. The present study evaluated the clinical efficacy and safety of 4 % articaine and 0·75 per cent ropivacaine for caudal epidural analgesia in cattle.

Materials and Methods

All the cattle were randomly divided into two equal (n = 6) groups irrespective of their age, sex and breed. The cases in group 1 were treated with 4% articaine hydrochloride (Septodont, Saint-Maur-des-Fosses Cedex -France) @ 1 mg/kg b. wt. whereas, in group 2 treated with 0.75% ropivacaine hydrochloride (Neon Laboratories Ltd. Caves Road, Andheri (East) Mumbai- 400 093, Maharashtra India) @ 0.15 mg/kg b.wt epidurally. The sacrococcygeal and inter-coccygeal sites were clipped and prepared aseptically for nerve block.

After standing alongside of standing animal, the tail was moved in an up and down direction to locate the fossa between the last sacral vertebra and the first coccygeal vertebra or between the first and second coccygeal vertebrae. An 18-gauge 3.8 cm needle (with no syringe attached) was directed to the skin surface. Once the skin was penetrated, place a drop of local anaesthetic solution in the hub of the needle (hanging drop technique). Then the needle was advanced slowly until the anaesthetic solution was drawn into the epidural space by negative pressure, which confirmed the proper placement of the needle. Then the syringe was attached to the needle and the anaesthetic solution was slowly injected with no resistance [4].

The analgesia was assessed by the onset of action, duration of action and area of desensitization. The time after the injection to observe diminished avoidance response was recorded as the onset of action. This was recorded by the response of cattle to needle pricks (20-gauge 2.5 cm long hypodermic needle). A strong avoidance response manifested in kicking, rapidly moving tail and turning of the head towards the needle pricks site was considered the normal response of the animal to the painful stimulus [8]. The time interval from the onset of action to the complete return of sensation at the site was considered as the duration of action. The area of desensitization was judged with cattle response to needle pricks (20 gauge 2.5 cm long hypodermic needle) at the perineal region (both sides of the midline), tail (dorsal aspect) and upper parts of the hind limbs (lateral and medial aspect of the thigh) at 5, 10, 15, 20, 30, 45 and 60 minute intervals after epidural nerve block [8]. Area of desensitization was scored based on a 0 to 3 grading scale as per Pathak., *et al*. 2012 and described below in table 1. Clinico-physiological parameters were also evaluated in all cases recorded before (0 minutes) and at 20-40 and 60-minutes intervals after drug administration in both groups.

Statistical analysis was performed using a statistical package for social science (SPSS21.0 software) one way analysis of Variance (ANOVA) was used to compare the differences of means between intervals. Whereas the difference between two groups was compared using two sample independent t-test Kruskal - Wallis H test (one-way ANOVA), a scored - based test was used to determine if there were statistically significant differences between the groups for non- parametric groups data (desensitization score).

Grading	Depth analgesia	Response
0	No analgesia	Strong avoidance response to the needle pricks
1	Mild analgesia	Weak avoidance response to the needle pricks
2	Moderate analgesia	Occasional avoidance response to the needle pricks
3	Complete analgesia	No avoidance response to the needle pricks

Table 1: Grading of response to the painful stimuli.

Result and Discussion

Assessment of analgesia

Onset of action (Minutes)

The mean values recorded for the onset of action during the study in both groups are presented below in table 2. The mean values for the onset of action in group 1 and group 2 were 4.08 ± 0.22 and 7.01 ± 0.54 minutes, respectively, with pooled mean of 5.55 ± 0.47. In comparison to mean values in both groups, the onset of action was significantly ($p \leq 0.01$) quicker in group 1 than in the animals of group 2. The significantly rapid onset of action in articaine treated group might be attributed to the thiophene ring. The presence of a thiophene ring in its structure increases lipid solubility and favours quicker action [9]. However, the absence of thiophene ring, low lipid solubility, lower concentration of drugs and the inherent vasoconstriction ability of ropivacaine might be responsible for significantly delayed onset in group 2. Similar findings were also recorded by [7,10], who studied the efficacy of articaine and ropivacaine hydrochloride. Rapid onset of action was also recorded in articaine treated group as compared to bupivacaine and lidocaine hydrochloride for laparotomies using paravertebral nerve block in ruminants by [5].

Parameters	Group 1	Group 2	Pooled mean	t-statistics	d. f	Sign.
Onset of action (minutes)	4.08 ± 0.22[a]	7.01 ± 0.54[b]	5.55 ± 0.47	8.44	10	.000

Table 2: Mean ± SE values for the onset of action in both groups expressed in minutes.

Means bearing different superscripts differ significantly (p ≤ 0.01).

Duration of action (Minutes)

The mean values of duration of action in both groups are depicted below in table 3. The duration of action in group 1 was 256.00 ± 8.43 minutes, whereas in group 2 it was 330.00 ± 11.54 minutes with a pooled mean of 293.33 ± 12.98. Based on data, it was evident that anaesthetic blockade was sustained for a significantly (p ≤ 0.01) longer period in the cases treated with ropivacaine compared to the articaine treated group. The ability of local anaesthetic to sustain for a longer duration depended on its affinity towards the plasma protein [9]. The ropivacaine had a greater (94%) affinity to the plasma protein [11], which might be accountable for longer duration of action than the articaine treated group. Additionally, the inherent ability of vasoconstriction in ropivacaine might be attributed to the slower absorption and delayed clearance than articaine. These findings are corroborated with [6,7].

Parameters	Group 1	Group 2	Pooled mean	t-statistics	d. f	Sign.
Duration action (minutes)	256.00 ± 8.43[a]	330.00 ± 11.54[b]	293.33 ± 12.98	22.0 ± 0.02	10	.000

Table 3: Mean ± SE values for the duration of action in both groups expressed in minutes.

Means bearing different superscripts differ significantly (p ≤ 0.01).

Area of desensitization (Minutes)

The mean score recorded for the area of desensitization at the dorsal aspect of the tail, perineum, and hind limbs during the study in groups 1 and 2 at different intervals are tabulated in table 4. The mean score for an area of desensitization at the dorsal aspect of the tail up to 60 minutes at various intervals after epidural administration of the drug in group 1 increased from 4.25 to 27.50. Whereas, in group 2 it was 3.25 to 26.00. At the perineum region in group 1 and group 2 analgesia score was ranged from 4.83 to 32.00 and 3.50 to 29.00 respectively. The mean score for area of desensitization at medial aspect of the thigh in group 1 varied from 6.50 to 34.00, while in group 2 it was 4.50 to 31.50. In the lateral aspect of thigh in group 1 the score ranged from 7.50 to 35.50, whereas, in group 2, it was gone from 5.50 to 33.50.

Time Intervals (minutes)	Dorsal aspect of tail		Perineum		Hind limb			
					Medial aspect of thigh		Lateral aspect of thigh	
	Group 1	Group 2	Group 1	Group 2	Group 1	Group 2	Group 1	Group 2
5	4.25	3.25	4.83	3.50	6.50	4.50	7.50	5.50
10	16.25	9.50	10.00	8.67	9.50	6.50	8.33	7.50
15	27.50	26.00	21.00	16.25	15.50	15.00	15.17	14.83
20	27.50	26.00	29.00	24.75	27.00	22.00	21.00	20.83
30	27.50	26.00	32.00	29.00	32.00	31.50	33.50	28.33
45	27.50	26.00	32.00	29.00	34.00	31.50	35.50	33.50
60	27.50	26.00	32.00	29.00	34.00	31.50	35.50	33.50
Chi^2 test	41.00	33.20	38.20	36.66	40.11	38.07	39.98	38.39
d. f	6	6	6	6	6	6	6	6
significance	.000	.000	.000	.000	.000	.000	.000	.000

Table 4: Mean values for the area of desensitization in both groups expressed in minutes.

On comparison between the groups at 5, 10, 15, 20, 30, 45 and 60-minute intervals, it was observed that the mean score of analgesia at the dorsal aspect of tail, perineum, and hind limbs were significantly ($p \leq 0.01$) higher in cattle treated with articaine in group 1 as compared to cattle treated with ropivacaine in group 2. The higher analgesic score in group 1 indicated rapid analgesia over a larger but limited portion of the posterior part of the body than group 2. However, in group 2 the onset of analgesia was slower and required more time for diffusion than in group 1.

The potency of the local anaesthetic drugs relied on the pKa, and lipid solubility. The local anaesthetic agents having lower pKa required less time for onset than those with higher pKa values. Similarly, more excellent lipid solubility enables the rapid spread of drugs [12].

The presence of a thiophene ring in the articaine structure increases the lipid solubility and favours the quicker onset of action which was absent in ropivacaine. Similarly, the pKa value of articaine hydrochloride was 7.8, whereas, in ropivacaine hydrochloride, it was 8.05 [9-12]. These factors might be attributed to the higher analgesic score and rapid spread of analgesia in group 1 compared to group 2. Similarly, the lower concentration of ropivacaine than articaine might be responsible for the delayed onset and slow spread.

Conclusion

In the light of the present study, it can be concluded that articaine and ropivacaine produced optimum analgesia at given doses in cattle. Moreover, articaine hydrochloride has a faster onset of action and could manage intense painful conditions; however, the cost is a limiting factor. Similarly, ropivacaine could be successfully used in prolonged surgical interventions.

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