Original Article

Buffalo Bulletin (October-December 2025) Vol.44 No.4
https://doi.org/10.56825/bufbu.2025.4444279

CLINICO-PHYSIOLOGICAL RESPONSE OF BUPIVACAINE ALONE AND IN COMBINATION WITH XYLAZINE AND PENTAZOCINE FOR LUMBAR EPIDURAL ANAESTHESIA IN BUFFALO CALVES

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Received: 19 April 2021
Accepted: 12 December 2025

ABSTRACT

The present study was conducted during March 2014 to August 2014 on eighteen non descriptive buffalo calves ranging from 6 to 8 months to evaluate the clinico-physiological response of bupivacaine alone and in combination with xylazine and pentazocine for lumbar epidural anaesthesia. All the animals were subjected clinical examination before the start of anaesthetic study and the base values (0 minutes) for physiological parameters and ruminal movement were recorded as reference. The animals were randomly divided into three groups with six animals in each group *viz*. A, B and C on the basis of anaesthetic drugs used. In Group A- Bupivacaine alone 0.15 mg/kg, in Group B - Bupivacaine 0.15 mg/kg and Xylazine 0.05 mg/kg and in Group C-Bupivacaine 0.15 mg/kg and Pentazocine 0.5 mg/kg respectively, were administered at lumbar epidural space. The animals were observed by various clinical and physiological parameters. The clinical observation revealed an early onset of analgesia was in Group B followed by Group C and Group A. The depth of analgesia and areas of desensitization was deeper and better in Group B followed by Group C and then Group A. Motor incoordination showed earlier in Group B and C as compared to Group A. The score for onset of sedation was earlier in Group B animals as compared to Group A and C. Maximum duration of analgesia was recorded in animals of Group B followed by animals of Group C and Group A. Group B showed a significantly ($P<0.01$) late recovery as compared to Group C and Group A. A significant ($P<0.05$) decrease in heart rate and respiration rate in all the groups. Rectal temperature and ruminal movements showed decrease in Group A and C whereas significant ($P<0.05$) decrease in Group B. The transient changes in physiological parameters were compensated within 24 h. It is concluded that bupivacaine alone and in combination with xylazine and pentazocine can be used safely for lumbar epidural anaesthesia in buffalo calves.

Keywords: *Bubalus bubalis*, buffaloes, bupivacaine, buffalo calves, lumbar epidural, pentazocine, xylazine

INTRODUCTION

Regional anaesthesia is generally preferred in ruminants as they are prone to regurgitation, ruminal tympany, respiratory embarrassment and

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associated problems during general anaesthesia (Hall and Clarke, 1991). Segmental epidural block is routinely used to block the thoracic, lumbar and sacral nerves to desensitize the abdominal region, flank, and perineum for performing surgery of these regions in ruminants (Tyagi and Singh, 1996). For segmental lumbar epidural anaesthesia very less, volume is needed to desensitize same spinal nerves (Hiraoka *et al*., 2007). Epidural administration of either local anaesthetic or narcotic analgesia ensures rapid onset, uniform anaesthesia which can be of longer duration (Lumb and Jones, 1984). The amount of local anaesthetic or narcotic analgesics required to induce maximum and satisfactory anaesthesia is lower with epidural route. There is no postural hypotension, potentially allows easy ambulation of patients and prevents cardiovascular collapse or convulsions. Bupivacaine has been extensively used in human medicine, but only limited literature is available regarding its clinical application in veterinary practice.

Bupivacaine hydrochloride is a potent amino-amine local anaesthetic. This analgesic drug is widely used for epidural anaesthesia as it blocks sensory fibres preferentially to relative sparing of motor fibers. Bupivacaine has been used spinally for pre-emptive and post -traumatic analgesia in buffalo calves (Pathak *et al*., 2012 a). Alpha2 adrenergic agonist drug i.e. xylazine is said to induce tranquilization and sedation along with good muscle relaxation and analgesia during surgery procedure in buffalo calves but it carries the risk of suppressing the cardiovascular system. When xylazine is given epidurally, it produces greater perineal analgesia than when given intramuscularly (Pathak *et al*., 2012 a). The analgesic effect of xylazine is produced through activation of alpha-2 adrenoceptors present in spinal cord as reported by Branson *et al.* (1993). According to Jones *et al.* (1977), pentazocine lactate is a novel and powerful non-narcotic analgesic that is a modification of the benzomorphane nucleus. In addition to producing analgesia, it is an agonist at K receptors. Unlike other opioids, bradycardia is not a side effect of pentazocine. A high dose of pentazocine raises blood pressure and heart rate. It is about half as effective as morphine as an analgesic, but five times as effective as meperidine. Nearly 5 to 25 % of pentazocine lactate is excreted unchanged through the kidney and 2% in the faeces, the remainder appears in the urine as metabolites (Jones *et al*., 1977).

Review reveals scanty literature regarding epidural use of bupivacaine in combination with pentazocine and xylazine in buffalo calves. Therefore, objective of the present study was to evaluate the clinico-physiological response of bupivacaine alone and in combination with xylazine and pentazocine for lumbar epidural anaesthesia in buffalo calves.

MATERIALS AND METHODS

The present study was conducted during March 2014 to August 2014 at Department of Veterinary Surgery and Radiology, College of Veterinary Science and Animal Husbandry, Anjora, Durg (Chhattisgarh) on eighteen non descriptive buffalo calves ranging from 68 months of age weighing 55 to 75 kg. All the animals were dewormed with albendazole 7.5 mg/kg body weight orally one month before the start of anaesthetic study. All the animals were stall-fed, provided with clean drinking water and maintained under uniform managemental conditions throughout the study period. The animals were kept off feed for 24 h and water was withheld for 12 h prior to the

start of epidural anaesthesia. All the animals were subjected clinical examination before the start of anaesthetic study and the base values (0 minute) for physiological parameters and ruminal movement were recorded as reference.

Anaesthetic protocols

All the animals were randomly divided into three groups *viz*. A, B and C with six animals in each group. The doses of different anaesthetics were selected after conducting pilot trials in a few buffalo calves before the conduction of anaesthetic trials. Following restraining of animal in a standing position with cotton rope halters in a cattle travis. The lumbosacral region was aspectically prepared by clipping, shaving and painting with povidone iodine for lumbar epidural injection. The local anaesthetic 2% lignocaine HCl was used to obtain insensitive wheal using fine needle at the centre of lumbar region and then an 18-gauge, 7.5 cm spinal needle was used for aseptic lumbar epidural injection. The needle was directed at angle of 90^{o} angle to the spinal cord along the median plane and was slowly advanced to a depth of 2 to 3 cm until the lumbar epidural space was reached after penetrating the interarcuate ligament when the resistance to injection of drug was abolished drug was injected. The correct position of the needle was ascertained by free outflow of CSF from the needle hub. The animals in Group A received Bupivacaine alone at the dose rate of 0.15 mg/kg and kept as Control group. The animals of group B and C received Bupivacaine 0.15 mg/kg and Xylazine 0.05mg/kg and Bupivacaine 0.15 mg/kg and Pentazocine 0.5 mg/kg respectively at lumbar epidural space. The volume of the drug injected was 6 ml in all the groups after reconstructing with distilled water. The animals were observed for various clinical and physiological parameters

ObservationsClinical observations

Clinical observations included recording of onset of analgesia, depth of analgesia, area of desensitization, motor in coordination, sedation and salivation at 0, 10, 20, 30, 45, 60, 75, 90, 120, 180 and 240 minutes after injection. Onset of analgesia was determined after epidural injection of drugs by recording the response to pinprick was recorded at every 15 seconds at abdominal and inguinal region till the loss of sensation. Depth of analgesia and area of desensitization was recorded at flank, inguinal region, hind limbs, perineum and tail by observing response to pinpricks at a particular region. Depth of analgesia was graded on a 0 to 3 score scale using a score system where 0 = No analgesia/ Strong reaction to pin prick, 1 = Mild analgesia/ Weak response to pin prick, 2 = Moderate analgesia/Occasional response to pin prick, 3 = Complete analgesia / No response to pin prick (Singh *et al*., 2007). Sedation and motor incoordination was graded on a 0 to 4 score scale as walking without staggering-0, able to stand but walks with little incoordination-1, able to stand but walks with extreme incoordination-2, animal attained sternal recumbency but able to flex and extend the limbs if disturbed-3 and animal attained lateral recumbency but unable to flex and extend its limb-4. Time from loss of sensation to return of sensation in the perineal region was recorded as duration of analgesia. Recovery time was recorded at the time elapsed from administration of drug to time taken for attaining standing position and started walking without support. During the period of analgesia, the animals were also observed for the extents of salivation include onset, persistency and cessation of salivation in all the animals.

Physiological observations

The physiological parameters include

rectal temperature(ºF), heart rate (beats/minute) and respiratory rate (breath/minute) which were recorded before anaesthetic study at 0 min. and at 10, 20, 30, 45, 60, 75, 90, 120, 180 and 240 minutes after injection of drugs. Ruminal movements were recorded at every 30 minutes from paralumbar fossa after the injection of drugs till complete recovery and 12 h after the injection.

Statistical analysis

The mean and standard error of the recorded were calculated and data analyzed using Analysis of variance (ANOVA) and Duncan's multiple range test (DMRT) were used to compare the data of parametric observations at different intervals between the groups as described by Snedecor and Cochran (1994). Kruskal-Wallis's test was used to compare the means among the groups of nonparametric observations. The values were considered significant at $P<0.05$ and $P<0.01$.

RESULTS AND DISCUSSIONS

Clinical observations

The onset of analgesia in Group B (5.83±0.60 minutes) was significantly ($P<0.05$) shorter as compared to animals of Group A (10.33±0.76 minutes) and Group C (9.00±2.41 minutes). Group A showed a delayed onset of analgesia as bupivacaine alone was used. An early onset of analgesia was recorded with xylazine in combination with bupivacaine (Group B), followed by bupivacaine in combination pentazocine (Group C) and bupivacaine alone (Group A). The results are in accordance with the findings of Grubb *et al.* (1993); Aithal *et al.* (1996). This has been attributed to the fact that the analgesia induced by xylazine is mediated through the alpha-2-adrenoceptors in spinal cord. The primary site of antinociceptive action of alpha-2 agonists after intrathecal administration at alpha-2 adrenoreceptors is substantia gelatinosa of dorsal horn neurons (Yaksh, 1985).

Depth of analgesia and area of desensitization was recorded at thorax, flank, inguinal region, hind limbs, perineum and tail by observing response to pin pricks at a particular region and were graded on a 0 to 3 score scale which are shown in Figure 1. In Group A, bupivacaine produced mild analgesia at thorax, inguinal, hind limbs, perineum and tail while mild to moderate analgesia was recorded at thorax. The less analgesia produced by bupivacaine could be attributed to lower dose rate used in the present study. The results of the present study are in conformity with the observations of Singh *et al.* (2010) who also reported mild to moderate analgesia of tail, perineum, inguinal, hind quarters after epidural bupivacaine (0.125 to 0.128 mg/kg) in buffalo calves. Bupivacaine with xylazine in Group B induced complete analgesia of thorax and perineum region while mild to moderate analgesia of flank, inguinal, hind limbs, and tail as xylazine induced deeper and prolonged analgesia. Since analgesia produced by alpha-2 adrenoceptor agonists in the present study was not generalized, it might have been resulted from inhibition of release of neurotransmitters (Kuraishi *et al*., 1985), decreased neuronal activity (Vainio, 1983) and inhibition of release of substance P (Grubb *et al*., 1993) at the level of substantia gelatinosa of dorsal horn of spinal cord. The alpha-2 agonists have induced regional anaesthesia after epidural administration in cattle (Lin *et al*., 1998) and in buffaloes (Pratap *et al*., 2000). Bupivacaine in combination with pentazocine (Group C) showed moderate anaglesia of thorax while mild to moderate

analgesia of flank, inguinal, hind limbs, perineum, tail but did not attain complete analgesia was at any time interval throughout the observation. The depth of analgesia and areas of desensitization was deeper and better in combination of bupivacaine with xylazine (Group B) followed by Group C (bupivacaine with pentazocine) and then Group A (bupivacaine alone). This could be attributed to additive or synergisteric effects of bupivacaine and xylazine. Pathak *et al.* (2012 a) concluded that bupivacaine 0.25 mg/kg and xylazine 0.05 mg/kg have almost similar analgesic potency on spinal administration in buffaloes, however they could produce only moderated analgesia.

All the animals of Group A (bupivacaine alone), showed moderate incoordination while walking only at 45 minutes interval. Thereafter, animals were able to walk with little incoordination. This might be due to blocks of sensory and motor fiber observed following lumbar injection of bupivacaine. Similar findings were reported by Freise *et al.* (2008). Animals of Group B showed extreme incoordination at 10 minutes post injection and thereafter, attained sternal recumbency. After 120 minutes animals could be able to stand but showed extreme incoordination up to 180 min. Thereafter, animals were able to walk but showed extreme incoordination while walking. The higher score of motor incoordination and sternal recumbancy in Group B might be due to the additive or possibly synergistic effect of xylazine with bupivacaine at the spinal level, leading to more intense spinal effect. Xylazine has local anaesthetic properties (LeBlanc *et al*., 1988), probably due to structural similarity with bupivacaine (Antonaccio *et al*., 1973). Similar findings were reported by Singh *et al.* (2010) in buffalo calves. In Group C, animals showed extreme incoordination while walking from 45 to 60 minutes thereafter, animals were able to walk with little incoordination of hind limb up to 180 minutes post injection. This might be due to opiates which have been reported to have local anaesthetic properties (Harah *et al*., 2002). In the present study, motor incoordination was recorded earlier in Group B and C as compared to Group A. However, bupivacaine in combination with xylazine (Group B) showed higher score for motor incoordination during the 20 to 75 minutes interval as compared to Group A and C.

Salivation was mild in Group B after bupivacaine-xylazine administration followed by very mild salivation in Group C where combination of bupivacaine and pentazocine was given and animals of Group A did not show any signs of salivation till the end of observation where bupivacaine alone was given epidurally (Figure 2). Alpha-2 agonists like xylazine have been reported to cause salivation in ruminants due to decreased swallowing (Knight, 1980). Delayed salivations were observed with epidural administration of α-2 agonists which might be due to delayed absorption of drug from the epidural space as also reported by Tiwari *et al*. (1999) in buffaloes.

The score for onset of sedation was earlier in Group B animals as compared to Group A and C (Figure 3). All the animals of Group A (bupivacaine alone) did not show any signs of sedation during first 10 minutes post injection period. However, a very mild sedation was observed between 20 to 60 minutes interval and animals remained alert and standing during entire period of observation. Bupivacaine in combination with xylazine (Group B) produced mild sedation from 10 to 20 minutes interval. Thereafter, moderate sedation was observed up to 90 minutes interval which became mild at the end of observation. Whereas bupivacaine with pentazocine (Group C) produced a very mild sedation at 20 to 30 minutes interval

which remained mild up to the end of observation. Combination of bupivacaine with xylazine (Group B) showed significantly (P<0.01) higher score for sedation throughout the period of observation except 20 minutes intervals in comparison to other groups. This might be due to additive or synergisteric effect of bupivacaine and xylazine in Group B. The effects of alpha2 agonist are associated with activation central alpha adrenoceptors, which causes decrease in the release and turn of nor-epinephrine in the CNS. This indicates that drug after absorption from subarachnoid space was distributed to brain (Skarda and Muir, 1992).

Animals of Group B showed significantly (P<0.01) longer duration of analgesia (204.17±3.00 minutes) as compared to animals of Group A (108±2.08 minutes) and Group C (129.67±2.64 minutes). Duration of analgesia in animals of Group C was significantly (P<0.01) longer than Group A. Longer duration of analgesia was recorded in animals of Group B followed by animals of Group C and Group A. Short duration of analgesia in Group A could be correlated to its rapid absorption and metabolism after the injection. In the present study, Group B produced significantly (P<0.01) longer duration analgesia probably due to synergistic effect of xylazine with bupivacaine as compared to that of Group C and Group A. Similar findings were observed after epidural xylazine-lidocaine in cattle (Grubb *et al*., 2002) and goats (Aithal *et al*., 1996; Kinjavdekar, 1998). The justification for longer duration of analgesia in Group B as compared to other group might be due to alpha-2 mediated inhibition of local anaesthetic vasodilatory effects and a direct local vasoconstriction by which alpha-2 agonist prolongs analgesia achieved by local anaesthetics as the combination acts for a longer duration than either agents alone (Grubb *et al*., 1993). Bupivacaine combined with pentazocine in Group C animals also showed longer duration of analgesia as compared to that of Group A. Similar findings were also observed by Rajappa (2012) who reported that prolongation of bupivacaine induced analgesia with simultaneous use of pentazocine in human patients.

Animals of Group A, B and C showed complete recovery at 144.67±3.93 minutes, 245.83±4.08 minutes. and 185.17±4.64 minutes, post injection period respectively. Group B showed a significantly (P<0.01) late recovery as compared to Group C and Group A. Group B showed prolonged recovery from bupivacaine and xylazine which could be related to the fact that alpha-2 agonists (xylazine) after their absorption from epidural space are released slowly from local depot of the drug in nervous tissue over longer period of time (Hall *et al*., 2001).

Animals of Group A and Group C showed non-significant decrease in ruminal movements which returned to near normal value by 24 h (Figure 4.) The animals of Group B (bupivacaine with xylazine) showed significant (P<0.05) decrease in ruminal movements from 30 to 240 minutes post injection. However, the value returned to near preadministration level by 24 h. The decreased ruminal movements might be due to the phenomenon that alpha-2 agonists, after quick absorption, gets bound to alpha-2 adrenergic receptors in the CNS and fore stomach muscles, thereby inhibiting reticulo-ruminal contractions as observed by Ruckebusch and Allan (1987) after administration of alpha-2 agonist in cattle. Comparison among all the three groups revealed that they did not differ significantly at any time intervals but the xylazine and bupivacaine combination (Group B) showed significant (P<0.01) difference in ruminal movements at 120 minutes from Group A and C.

Physiological observations

In animals of Group A (bupivacaine) a significant (P<0.05) decrease in heart rate was recorded between 45 to 75 minutes interval after lumbar epidural injection, however thereafter heart rate showed an increasing trend and returned to near proadministration level by end of observation. In animals of Group B (bupivacaine with xylazine) a significant (P<0.05) decrease in heart rate was recorded after 10 minutes of lumbar epidural injection which was highly significant (P<0.01) between 20 to 120 minutes interval. However, the values returned to near normal by 240 minutes. In animals of Group C (bupivacaine combination with pentazocine) heart rate was decreased significantly (P<0.01) from 20 to 90 minutes time intervals which was returned to near normal values at the end of observation (Table 1). Decrease in heart rate by bupivacaine alone might be due to paralysis of cardiac sympathetic fibers or a generalized decrease in the sympathetic activity (Lumb and Jones, 1984). Similar findings have been reported by Hussain and Kumar (1988); Singh *et al*. (2010) in buffaloes after epidural/spinal administration of bupivacaine. In the present study, the decrease in heart rate after lumbar epidural injection of was more pronounced in Group B (bupivacaine with xylazine) in comparison to Group A (bupivacaine) and C (bupivacaine and pentazocine). This might be attributed to additive effect of both drugs along with action xylazine on central nervous system after its systemic absorption from the venous sinuses in the epidural space. A significant decrease in heart rate has been considered to be classical response following administration of alpha2 agonist in all the ruminants tested so far (Kinjavdekar *et al*., 1999).

In animals of Group A (bupivacaine alone) a significant decrease (P<0.01) in respiration rate (RR) was observed at 45 minutes and in Group C (bupivacaine and pentazocine combination), RR decreased significantly (P<0.01) from 30 to 90 minutes which returned to normal at the end of the observation. Animals of Group B (bupivacaine and xylazine combination) showed a significant (P<0.01) decrease from 10 minutes up to 120 minutes interval. Thereafter, it improved slightly but remained below the base value (Table 2). In the present study, respiration rate (RR) decreased in all the three groups, after lumbar epidural administration of drugs but the depression was more pronounced when xylazine was used in combination with bupivacaine (Group B) in comparison to Group A and C suggesting additive depressant effect of both the group of drugs on the respiratory centers and confirms the finding of Kinjavdekar (1998). Decreased respiration rate might result from their depressing action on respiratory center in central nervous system (Hall *et al*., 2001). In the present study, the decrease in respiration rate in all the three group might be due to bupivacaine through the blockade of nerves innervating the muscles of respiration (Rayees *et al*., 2011). Similar observations were also reported by Pathak *et al*. (2012b) in buffaloes. The analgesic and respiratory depressant activity of the pentazocine is mainly due to the "l" isomer (Wood-smith *et al*., 1968). In the present study, respiration rate was significantly decreased from 30 to 90 minutes intervals in Group C and the similar finding was also observed by Raina *et al*. (2008) in buffalo calves. Comparison among different groups revealed that values of Group A and C did not differ significantly at any stage of observation, but decrease in respiration rate was more pronounced in Group B and it differed significantly (P<0.01) from 75 to 90 minutes intervals in comparison to Group A and Group C. The decrease in respiration

Table 1. Effect on heart rate (Beats/ minute) after lumbar epidural administration of bupivacaine alone and in combination with xylazine and pentazocine in buffalo calves.

Group	Time interval(min)										
	0	**10**	**20**	**30**	**45**	**60**	**75**	**90**	**120**	**180**	**240**
A	47.33±1.36	46.67±1.33	45.50±1.23	44.67±1.20	43.50*±0.96	43.67*±0.71	43.83*±0.60	44.67±0.88	46.00±1.46	46.83±1.33	47.17±1.30
B	48.00±1.84	42.00*±1.69	39.67**±1.86	38.00**±1.61	37.17**±1.58	35.30**±1.78	34.20**±1.64	36.30**±1.42	39.50**±1.34	43.33*±1.26	46.67±1.82
C	50.00±1.77	46.83±1.05	44.00**±1.06	43.67**±0.95	42.50**±1.06	42.33**±1.05	43.67**±1.12	44.50**±1.34	46.33*±1.41	47.67±1.05	49.67±1.43

*Significantly different from the base value within group at 5% level (P<0.05).

**Significantly different from the base value within group at 1% level (P<0.01).

Table 2. Effect on respiration rate (breaths per minute) after lumbar epidural administration of bupivacaine alone and in combination with xylazine and pentazocine in buffalo calves.

Group	Time interval(min)										
	0	**10**	**20**	**30**	**45**	**60**	**75**	**90**	**120**	**180**	**240**
A	16.50±1.69	16.00±1.69	14.00±1.03	12.83*±0.83	12.17**±0.91	12.50*±0.96	13.00*±0.73	13.50±0.85	14.17±0.60	15.17±0.70	16.00±1.21
B	17.00±1.13	14.33**±0.84	12.50**±0.76	11.50**±0.34	10.17**±0.31	9.63**±0.17	9.00**±0.52	10.33**±0.42	12.33**±0.71	14.50*±0.72	15.67±0.84
C	16.00±0.58	14.67±0.61	13.50*±0.50	12.00**±0.52	10.50**±0.76	10.67**±0.42	11.83**±0.31	12.67**±0.49	13.83*±0.48	14.83±0.31	15.33±0.33

*Significantly different from the base value within group at 5% level (P<0.05).

**Significantly different from the base value within group at 1% level (P<0.01).

Table 3. Effect on rectal temperature (°F) after lumbar epidural administration of bupivacaine alone and in combination with xylazine and pentazocine in buffalo calves.

Group	Time interval (minute)										
	0	**10**	**20**	**30**	**45**	**60**	**75**	**90**	**120**	**180**	**240**
A	100.43±0.16	100.33±0.20	100.00±0.25	99.82±0.23	99.55±0.21	99.57±0.17	99.77±0.20	99.83±0.13	100.00±0.16	100.22±0.14	100.38±0.15
B	100.92±0.30	99.87*±0.32	99.43*±0.23	99.25*±0.19	99.00**±0.19	98.95**±0.27	99.02**±0.41	99.30**±0.29	99.33*±0.28	99.92*±0.31	100.54±0.29
C	100.37±0.26	100.07±0.26	99.63±0.20	99.37±0.17	99.30±0.11	99.30±0.18	99.38±0.17	99.62±0.16	99.80±0.17	99.95±0.25	100.13±0.15

*Significantly different from the base value within group at 5% level ($P<0.05$).

**Significantly different from the base value within group at 1% level ($P<0.01$).

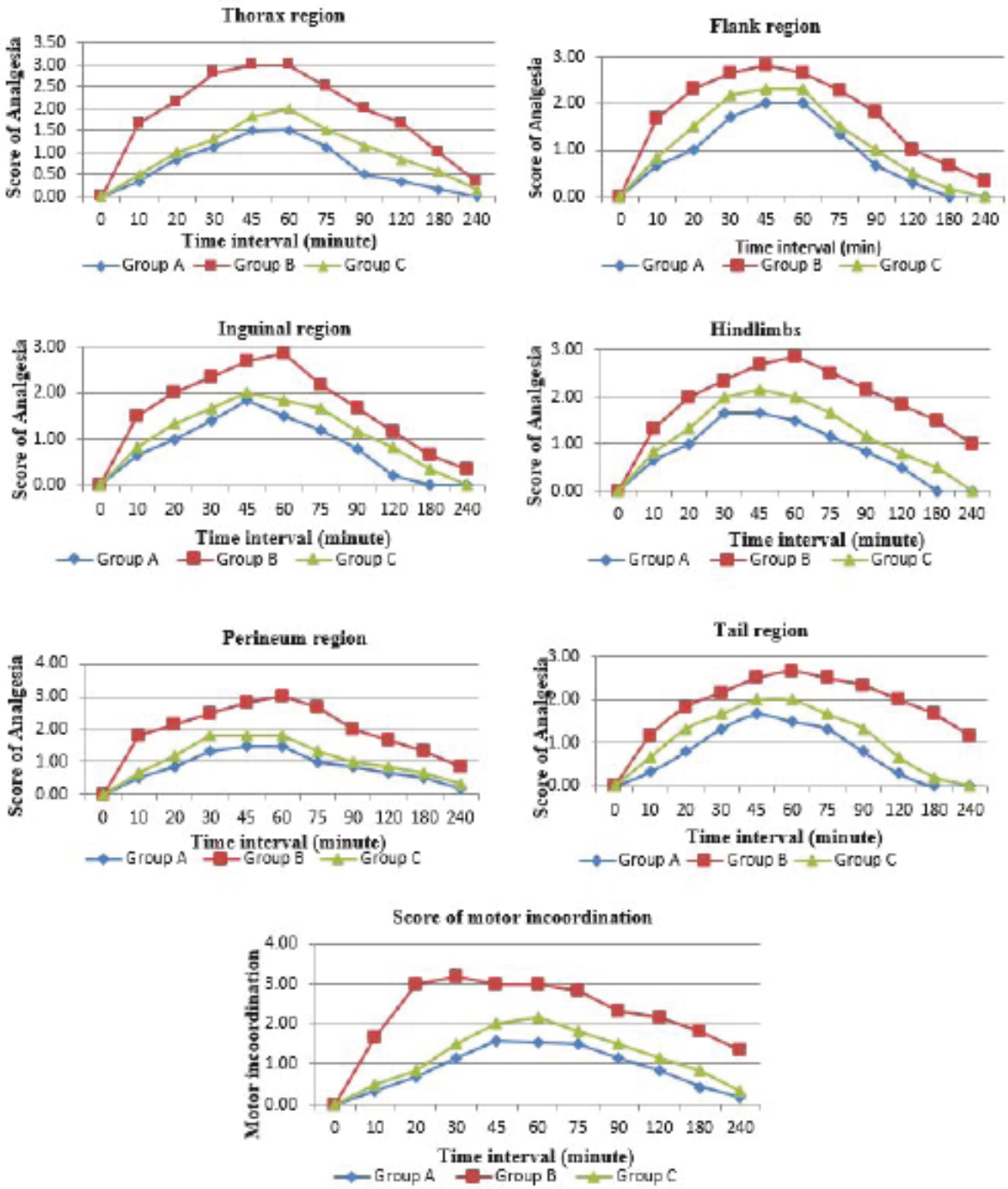

Figure 1. Scores of analgesia at different region after lumbar epidural administration of bupivacaine alone and in combination with xylazine and pentazocine in buffalo calves.

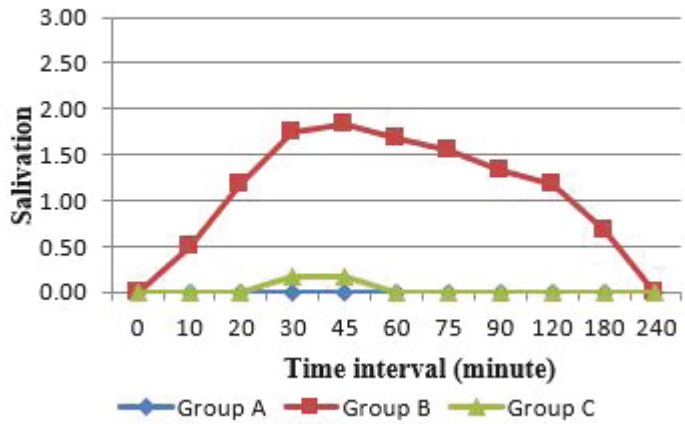

Figure 2. Score of salivation.

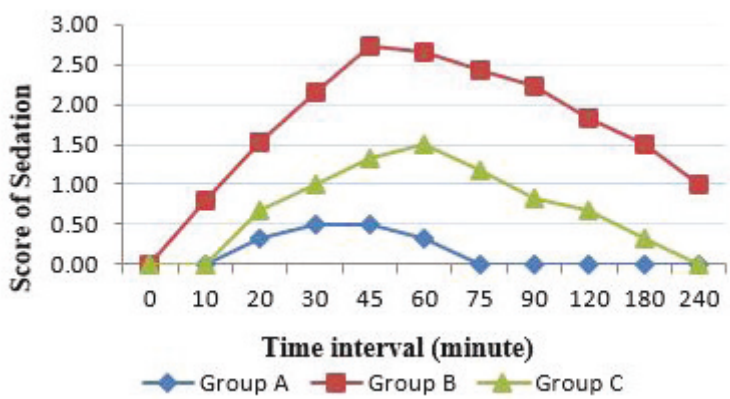

Figure 3. Score of sedation.

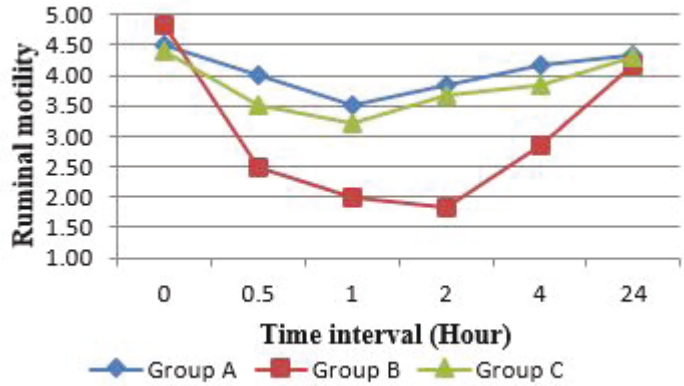

Figure 4. Effect on ruminal motility.

rate in Group B could be due to alpha2 agonists cause some degree of respiratory depression through stimulation of supraspinal adrenoreceptors following systemic absorption of the drugs as also reported by Lin *et al*. (1998); Prado *et al*. (1999).

A gradual and non-significant decrease in rectal temperature was observed in Group A and C up to 45 and 60 minutes respectively and then the value returned to near base value by 240 minutes (Table 3). The decrease in rectal temperature in animals administered with bupivacaine alone might probably be due to the peripheral vasodilatation in area of block. This finding corroborates with the findings of Ozaydin and Kilick (2003) in cattle calves. Decrease in rectal temperature had also observed after the administration of pentazocine diazepam in canine surgical patients by Pandey and Sharma (1986). In animals of Group B (bupivacaine with xylazine) significant ($P<0.05$) decrease in rectal temperature was recorded between 10 to 30 minutes post injection which became highly significant ($P<0.01$) between 45 to 90 minutes. Thereafter, the value returned to near normal by 240 minutes. In the present study, decreased in rectal temperature might be due to additive depressant effect of bupivacine and xylazine in central nervous system. The decrease in rectal temperature might be due to generalized sedation, decrease in metabolic rate, muscle relaxation and CNS depression produced by sedative and analgesic effect. Depression of thermoregulation by alpha 2 agonists might have resulted in hypothermia in Group B animals. Moreover, xylazine potentiates the effect of epidural anaesthetic (bupivacaine) and accelerates the heat loss through peripheral vasodilatation. Similar observations of hypothermia have been observed following epidural use of xylazine in calves Amarpal *et al*. (1997) and in goats (Singh *et al*., 2007). Comparison among different groups revealed that xylazine and bupivacaine combination (group B) showed significant ($P<0.01$) decrease in rectal temperature within a group but there were non-significant changes between all the three groups throughout the period of observation.

CONCLUSION

On the basis of this study, it was concluded that bupivacaine alone and in combination with xylazine and pentazocine can be used safely and effectively for lumbar epidural anaesthesia in buffalo calves. However, combination of bupivacaine with xylazine produced better lumbar epidural anaesthesia with quicker onset, deeper and of longer duration analgesia. All the drugs produced only transient alternation in physiological parameters and compensated within 24 h.

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