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Dorsolumbar Epidural Analgesia in Water Buffalo: Anaesthetic Assessment and Anatomical Studies

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ABSTRACT:

Anesthesia of the flank region of ten native buffaloes was accomplished through the dorsolumber epidural technique by using two different doses (4ml and 5ml) from anesthetic mixture containing xylazine hydrochloride (2%) and lidocaine hydrochloride (2%). Computed tomography and gross dissection were done for the thoraco-lumber region to show the special structures in this area. The results showed that, the anaesthetized area and the duration of analgesia in both sides of the flank region were wider and more prolonged at dose 5 ml than at 4 ml from the mixture. The CT showed that the epidural space at the lumbar region is enlarged and the widest part found at the third and fourth lumbar vertebrae. There is no inter-arcuate space between the last two thoracic vertebrae while the space was found between the last thoracic and the first lumbar vertebrae and continues between all lumbar vertebrae. Grossly, the last thoracic and first lumbar spinal nerve rootlets are nearly centered on the intervertebral discs between the last thoracic and the first lumbar vertebrae and between the first and the second lumbar vertebrae respectively. The second, the third, the fourth and the fifth lumbar spinal nerve rootlets are displaced cranially to extent, which the rootlets of the second and third lumbar spinal nerves are nearly located in the caudal portion of the canal of the second and third lumbar vertebrae respectively. Furthermore, the fourth lumbar spinal nerve rootlets are nearly located in the central part of the canal of the fourth lumbar vertebra, while the fifth lumbar spinal nerve rootlets appeared in the cranial portion of the canal of the fifth lumbar vertebra. The study illustrated that dorsolumber epidural anesthesia was easy to perform in buffaloes and consume low dose from anesthetic drug which save cost, time and effort. Moreover, adding of xylazine hydrochloride to the local anesthetic will promote its anesthetic properties in addition to the sedative effect needed in such conditions.

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1. INTRODUCTION

Domestic buffalo was introduced to Egypt since long time ago. It was introduced from India via Mesopotamia (present-day Iran and Iraq) during the ninth century. Buffalos constitute an important part of the array of domestic animal resources in Egypt and many other African countries (Bhatt, 1999; Wilson, 2012). The buffalos were descended from two distinct types, swamp buffalos and riverine buffalos. The riverine buffalos found mainly at the Mediterranean aria from which the Egyptian buffalos are descended and they were hold for milk and meat production (Shalash, 1988; Soliman, 2009). Although the aforementioned economic importance of the buffalos; the available data about anesthetic techniques and surgical affections considered scarce. While in cattle, several methods of anesthesia for flank laparotomy have been described. In addition, each of them has some advantages and disadvantages for clinical use (Roberts, 1986, karda, 1996; Hall, et al., 2001)

Epidural analgesia using local anesthetics is produced by the inhibition of conduction of impulses of sensory nerves found at the epidural space (Levy, 1974). The action of local anesthetics is nonselective and depression of autonomic and motor nerves accompanies desensitization. This nonselective depression of motor nerves may result in recumbency. On the other hand, it was found that opioids and alpha-adrenergic agents produce selective caudal epidural analgesia, by activating specific spinal receptors. Stimulation of these spinal receptors results in the inhibition of rostral transmission of pain impulses; therefore, a potential advantage of such agents is the production of selective sensory blockade, without the unfavorable depression of motor or autonomic neurons (Ang, 1977; Cousins and Mather, 1984; Yaksh, 1985).

Xylazine hydrochloride, an alpha2-adrenergic agonist, was investigated for epidural analgesia in different species of animals including horse, cattle, buffalo calves and goat (Leblanc et al., 1988; Caron and LeBlanc, 1989; Pathak, 1999; Pathak et al., 2002). It resulted in safe and effective analgesia produced much less depression of motor function, as well as it produced longer duration of analgesia than produced by lidocaine (Ko et al., 1989; Kinjavdekar et al., 2000; Pathak et al., 2009). In addition, epidural administration of xylazine hydrochloride produces less pronounced cardiopulmonary effect compared to intramuscular and intravenous injection (Rehage et al., 1994; Junhold and Schneider, 2002). After epidural administration of xylazine in animals, the injected animals showed signs of sedation, which, attributed to the systemic effect of xylazine after its absorption to the systemic circulation through the epidural vein and lymphatic (Danghee and Chunsik, 2001; Pathak et al., 2012).

Due to the side effects of general anesthesia and recumbency, It is preferred that most abdominal surgeries in cattle be performed in the standing position (Lumb and Jones, 1984; Wagner et al., 1990). Sufficient analgesia during flank surgery of cattle is needed for the welfare of the cattle through painless surgery and the prevention of injury to the veterinarian from kicking or struggling (Lee et al., 2006). Segmental dorsolumbar epidural anesthesia, one of the anesthetic techniques used for flank surgery of standing cattle, it is performed to desensitize a number of nerve roots by a single injection. This produces a belt of anesthesia around the animal's trunk (both flanks) while maintaining the motor control of the hind limbs (Skarda, 1996). Injection of a fixed volume of Xylazine in combination with lidocaine in the epidural space of cattle through the space between the L_1 and L_2 was used by Lee et al. (2004a and 2005) and Hiraoka et al. (2007) it possess several advantages including analgesia of both flanks by a single injection of a small volume of anesthetic with minimal desensitization of the hind limbs, which, in turn saving time and effort, lowering the cost of each surgery while, securing the welfare of the animal.

The present study aimed to throw the light on the special structure of the lumber region of buffalos grossly and by CT imaging. Moreover, examine the application of standing flank anesthesia in buffalos under the effect of dorsolumber epidural anesthesia using a combination of lidocaine hydrochloride and xylazine hydrochloride with special reference to the onset and distribution of the analgesia.

2. Materials and methods

This study was done at the faculty of veterinary medicine, University of Sadat City, Egypt. The study involved ten healthy adult female buffalos (450- 550 kg) aged 7-9 years. CT scan and gross dissection were done on 4 specimens from vertebral column at the thoracolumbar region. These specimens were obtained from slaughtered healthy buffalo aged over 2 years in abattoirs of El Shohadaa city, Menofia.

Two specimens were scanned using a Toshiba CT unit and the normal dissection and paramedian section were made to all specimens to view the contents of vertebral canal.

The studied animals were divided into two groups (5 animals each). The animals restrained in stanchion and the skin between the last thoracic and the first lumbar vertebrae was shaved and aseptically prepared. About 1-2 ml of lidocaine 2% was injected subcutaneously in order to perform insensitive skin area then a spinal needle (A 15 G, 142 mm) was inserted in the dorsal midline between the last thoracic and the first lumber vertebrae and advanced slowly into the epidural space. The entrance of the epidural space was detected by hanging drop technique using saline (Skarda and Tranquilli 2007). The air allowed to freely enter the space for about 1 min to decrease the effect of negative epidural pressure (Lee et al, 2004a) then the needle inserted for about 1 cm deeper penetrating the epidural fat (Lee et al, 2004b). The anesthetic mixture was injected after confirming that there was no blood or cerebrospinal fluid present in the aspirate. The first group was received 4 ml mixed anesthetic solution containing 1 ml of 2% xylazine hydrochloride and 3 ml of 2% lidocaine hydrochloride according to the method described by Lee and Yamada (2005) while the second group received 5 ml mixed anesthetic solution containing 1 ml of 2%

xylazine hydrochloride and 4 ml of 2% lidocaine hydrochloride. The solution was administered at a rate of 0.5 ml/s with the needle bevel directed cranially and the needle removed after administration.

The following items were recorded:

1. The distance from the skin to the epidural space and the appropriate depth of injection.
2. The existence of sedation (drooping of the upper eyelids, position of the head relative to the shoulders and the reduction in awareness to the surroundings).
3. The analgesic effect; which assessed by the animal's response to noxious stimulus consisting of skin pin prick with needle and hemostat pressure (closed to the first ratchet). The stimulus applied to the upper flank, lower flank, last rib and ileum region. The responses were measured each minute after administration of the drug till loss of sensation and then each 5 minutes interval until return of sensation.

3. RESULTS

Our observations showed that the mean distance from the skin to the epidural space in the dorsolumber space was 9.51 cm. Advancement of the needle into the spinal canal was easy and successful in 8 of 10 buffalos from the first trial (80 %) and in the rest 2 buffalos (20 %) from the second trial.

The analgesic effect:

The analgesic effect of the mixture appeared in all animals. In the first group, it was started about 20-25 mints from injection and lasts for 55- 105 min while in the second group it was started 14-19 min and lasts for 100-120 min.

The sedative effect:

All animals in both groups showed signs of sedation in terms of lowering of the head and the upper eyelids and perfuse salivation. Sedation started from 6- 9 min after epidural injection and lasted for 50-52 min in the first group while in the second group, signs of sedation started about 6- 7.5 min post injection and lasted for 60- 70 min. In the first group, one animal showed sever degree of ataxia in term of sternal recumbency at about 26 min after injection then stand up without assistance (at about 3 min) and another one showed mild degree of ataxia and still standing while the rest of the animals (3 animals) in this group showed no ataxia. In the second group, two animals showed sever degree of ataxia in terms of sternal recumbency then stand up without assistance (at about 3 min) and one animal showed mild degree of ataxia and still standing while the rest of animals (2 in number) showed no signs of ataxia.

Anatomical findings:

The movable vertebrae are joined together by ligaments uniting the arches and processes; some of these are short, i. e., confined to a single joint, while others are long, i. e., extend along considerable part of the vertebral column:

Short ligaments:

- ***Interspinous ligaments (ligamenta interspinalia):*** extend between the spinous processes of the lumbar vertebrae. They consist of white fibers directed obliquely downward and forward (Fig. 1).
- ***Interarcuate ligaments (ligamenta flava):*** are elastic sheets filling the interarcuate space (Fig. 1).

Long ligaments:

- ***Supraspinous ligament:*** a strong cord of fibrous tissue attached to the summits of the lumbar vertebral spines and also called lumbo-dorsal ligament (Fig. 1).
- ***Dorsal longitudinal ligament (Ligamentum longitudinale dorsale):*** lies on the floor of the lumbar vertebral canal (Fig. 1).
- ***Ventral longitudinal ligament (Ligamentum longitudinale ventrale):*** lies on the ventral surface of the bodies of the lumbar vertebrae (Fig. 1).

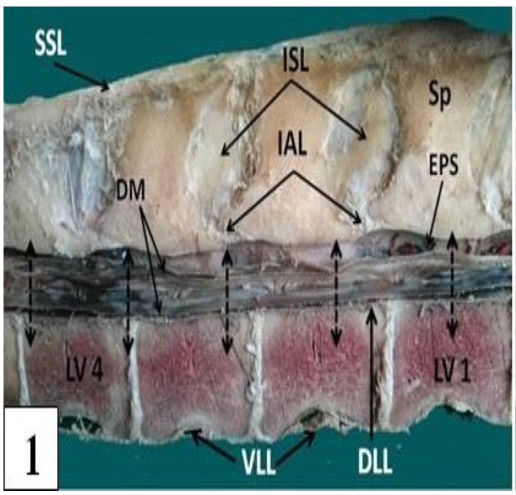
The last thoracic and first lumbar spinal nerve rootlets are nearly centered on the intervertebral discs between the last thoracic and the first lumbar vertebrae and between the first and the second lumbar vertebrae respectively (Fig. 2).

The second, the third, the fourth and the fifth lumbar spinal nerve rootlets are displaced cranially to extent, which the rootlets of the second and third lumbar spinal nerves are nearly located in the caudal portion of the canal of the second and third lumbar vertebrae respectively (Fig. 2). Furthermore, the fourth lumbar spinal nerve rootlets are nearly located in the central part of the canal of the fourth lumbar vertebra, while the fifth lumbar spinal nerve rootlets appeared in the cranial portion of the canal of the fifth lumbar vertebra (Fig. 2).

The gross anatomy and CT showed that the epidural space at the lumbar region is enlarged with the widest part is found at the third and fourth lumbar vertebrae (Fig. 2, 3).

There is no inter-arcuate space between the last two thoracic vertebrae while the space is found between the last thoracic and the first lumbar vertebrae and continued between all lumbar vertebrae (Fig. 3).

The intervertebral foramina are often modified, forming a complete lateral vertebral foramen and a relatively shallow intervertebral foramen in the first and second lumbar vertebrae (Fig. 4). In the caudal series of the lumbar vertebrae, the two openings are joined together forming large intervertebral foramina (Fig. 4).



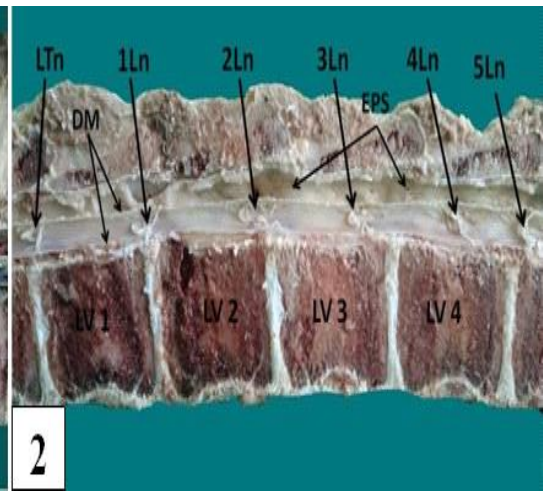
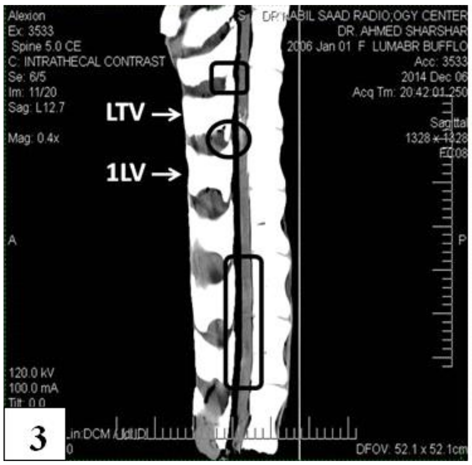


Figure (1): Paramedian section at the region of the lumbar vertebrae (after removal of the spinal cord) showing: LV1=body of the first lumbar vertebra, LV4=body of the fourth lumbar vertebra, SP=spinous process of the lumbar vertebrae, SSL=supraspinous ligament, ISL=interspinous ligament, IAL=interarcuate ligament, DLL=dorsal longitudinal ligament, VLL=ventral longitudinal ligament, DM= dura mater, EPS=epidural space. The distances between the dotted black arrows represent the lumbar spinal cord segments that replaced cranially.

Figure (2): Paramedian section at the region of the thoracolumbar vertebrae (after removal of the spinal cord) showing: LTn=last thoracic nerve rootlet, 1Ln=first lumbar nerve rootlet, 2Ln=second lumbar nerve rootlet, 3Ln=third lumbar nerve rootlet, 4Ln=fourth lumbar nerve rootlet, 5Ln=fifth lumbar nerve rootlet, LV1=1st lumbar vertebra, LV2=2nd lumbar vertebra, LV3=3rd lumbar vertebra, LV4=4th lumbar vertebra. DM= dura mater. The widest part of the epidural space (EPS) found at the 3rd and 4th lumbar vertebrae.



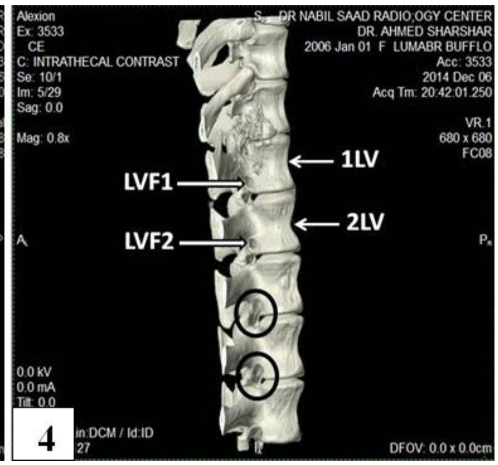


Figure (3): Midsagital section at the region of thoracolumbar vertebrae by CT showing that there is no inter-arcuate space between the last two thoracic vertebrae (black square), while the space is found between the last thoracic vertebra (LTV) and the first lumbar vertebrae (1LV) (black circle) and continues between all lumbar vertebrae. The black oblong indicates the widest part of the epidural space at the 3rd and 4th lumbar vertebrae.

Figure (4): lateral view of 3D construction at the region of thoracolumbar vertebrae by CT showing: LVF1=lateral vertebral foramen of 1st lumber vertebra (1LV), LVF2=lateral vertebral foramen of 2nd lumbar vertebra (2LV). Te black circles indicate that the lateral vertebral and intervertebral openings are joined forming large intervertebral foramina.

4. DISCUSSION

In our locality, the buffalos constitute a main part of the line of animal production, in terms of milk and meat production. Buffalos subjected to several problems that required surgical interference in the flank region during standing position to overcome the side effect of recumbency. The commonly used anesthetic regimen for flank anesthesia such as; linear infiltration, field block and paravertebral analgesia have many disadvantages (Roberts, 1986, karda, 1996; Hall, et al., 2001). Therefore, dorsolumber epidural analgesia was tried to avoid these disadvantages. According to our knowledge dorsolumber epidural analgesia not previously used in buffalos, although, it is widely used for flank laparotomy in cattle (Lee, et al, 2004, 2005, and 2006, Hiraoka, et al, 2007). However, epidural administration of xylazine with other local anesthetics was evaluated in buffaloes calves (Pathak, et al, 2012).

Insertion of the epidural needle into the epidural space between the last thoracic and first lumber vertebrae was successful in 8 of 10 buffalos (80 %) from the first trial, while the rest 20 % was successful from the second trial. The primary cause of this may be attributed to the individual variation between the animals regarding to that the injection in all animal was done by one person and with the same protocol.

The difference between the distance from the skin to the epidural space in the current study and other studies (Lee et al, 2006) may be attributed to the anatomical variation between cattle and buffalos. Lee and Yamada (2005) recommended the use of 1ml xylazine in healthy adult cattle. Another study (Hiraoka et al 2007) recommended the reduction of this dose from 1ml to 0.5 ml in weak animals to prevent sever sedation and recumbency. The current study followed the recommendation of Lee and Yamada (2005) and used 1ml xylazine in healthy adult buffaloes; however, ataxic signs were more apparent in our studied buffaloes than in cattle (Lee and Yamada, 2005). These observations come in contrast with that of Eesa (2007) who proved that cattle appeared to be more sensitive to xylazine than buffaloes. Therefore, the exact sensitivity of buffaloes to xylazine may need more researches to determine the accurate dosages and degree of sensitivity.

Lee and Yamada (2005), Lee et al. (2006) and Hiraoka et al. (2007) recommended the use of 3 ml of lidocaine Hcl in combination with xylazine (1 ml) for flank analgesia and they found that this dose produces satisfactory degree of flank analgesia in cattle. In group one of our experiments the same dose produced poor degree of flank analgesia that extended only to the level of the second lumber vertebrae (limited backward distribution). In the second group (1ml xylazine and 4 ml lidocaine) the backward distribution was greater and produced greater degree of analgesia. The differences in the onset and the duration of analgesia between the two groups were attributed to the dose of the anesthetic mixture, which inversely proportionate with the rate of distribution.

The present anatomical dissection revealed that the caudal border of the arch of the 12th thoracic vertebra is overlapping up on the cranial border of the arch of the 13th thoracic vertebra. Therefore, there is no interarcuate space between the last two thoracic vertebrae.

There is agreement with Hillmann (1975) who stated that the interarcuate space is started from the thoracolumbar space, were narrow in the cranial part of the lumbar region, and increased in the width in the caudal series among the lumbar vertebrae.

The enlarged epidural space in this region is due to widening of the vertebral canal to accommodate the swelling of the spinal cord in the lumbar region and this result is not differ from that mentioned by König and Liebich (2004) at the same region in other domestic animals.

As increasing of the animal age, the vertebral column increase more in length than the spinal cord leading to cranial displacement of the caudal part of the spinal cord segments especially at the lumbar part within the vertebral canal and it is similar to the foundation of König and Liebich (2004) and Hillmann (1975) in the ruminant and other domestic animals.

The current study illustrated the easiness and effectiveness of the dorsolumbar epidural anesthetic technique for flank analgesia in buffaloes. It gave bilateral flank analgesia by a single injection of a small volume of anesthetic. The study proofed that the use of mixture of 4ml lidocaine and 1 ml xylazine was superior to mixture of 3 ml lidocaine and 1 ml xylazine for dorsolumber flank analgesia in buffaloes, but further studies may be needed to overcome the ataxic effect accompanied the application of such mixture in spite of the superiority of dorsolumber technique over other techniques for flank anesthesia. Therefore, and apart from the accompanied ataxic signs, we recommend this technique for the veterinarians to save their time and effort and cost of surgery.

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