J. Vet. Sci. (2006), **7**(1), 69–72

JOURNAL OF
Veterinary
Science

Practical tips for modified dorsolumbar epidural anesthesia in cattle

Inhyung Lee[1,*], Norio Yamagishi[2], Kenji Oboshi[2], Naoki Sasaki[1], Haruo Yamada[1]

[1]*Department of Clinical Veterinary Science and* [2]*Research Center for Animal Hygiene and Food Safety, Obihiro University of Agriculture and Veterinary Medicine, Hokkaido 080-8555, Japan*

Segmental dorsolumbar epidural anesthesia has been considered difficult to perform. The purpose of this study was to determine whether or not it is difficult for beginners to learn how to do modified dorsolumbar epidural anesthesia of cattle. Thirty cattle were divided into two groups, young (n = 8) and adult (n = 22), according to their age and body weight, and 0.12% new methylene blue (NMB) was injected into the first interlumbar (L1–L2) epidural space by four fifth-year veterinary school students who had never performed this method. After a 1 hour lecture on the modified dorsolumbar epidural anesthesia procedure which included basic anatomy and skills, each student successfully performed the procedure. In the young group, the NMB solution was distributed between the periosteum and the epidural fat (BPF) in one half and between the epidural fat and the dura mater (BFD) in the other half of the cattle. In about 60% (13/22) of the adult group, the NMB solution distributed as BFD type. This study showed that the modified dorsolumbar epidural anesthesia procedure is easy for beginners to perform if they overcome their fear about the deeper insertion of the epidural needle with basic anatomical knowledge and a little experience.

Keywords: dorsolumbar, epidural, anesthesia, cattle

Introduction

It is preferred that most abdominal surgeries in cattle be performed in the standing position because of the side effects from general anesthesia and recumbency. In several anesthetic techniques for flank surgery of standing cattle, segmental dorsolumbar epidural anesthesia is performed to desensitize a number of nerve roots by a single injection. This produces a belt of anesthesia around the animal's trunk while maintaining control of the limbs [9].

However, the technique induces a wide individual variation in analgesia, which may be the result of differences in the distribution of the solution injected into the epidural space [4]. This variation may be caused by many influencing factors when using this technique for flank analgesia of cattle. The epidural fat and the negative epidural pressure, especially, may influence the spread of solution and affect the pharmacokinetics of drugs injected into the dorsolumbar epidural space [4,6,7,8]. Therefore, the method was modified to minimize the effects of epidural pressure and epidural fat and is now considered a useful anesthetic technique for flank laparotomy in standing cattle [5].

Dorsolumbar epidural anesthesia has been considered to be the most technically challenging spinal nerve block to perform, although in expert hands it can be the most effective [2,3]. In the authors' opinion, the fact that the needle needs to be inserted about 8 cm in order to enter into the epidural space, which is above the spinal cord, may make one fearful and hesitant to use this anesthetic method as a first choice for flank surgery of cattle. So, in this study, we examined whether or not it is difficult for beginners to learn and use the modified dorsolumbar epidural anesthesia of cattle in the veterinary medical teaching hospital.

Materials and Methods

Thirty Holstein cattle (between one to 9 years of age) that were scheduled for euthanasia from March 2002 to August 2003 were used in this study. Study protocol and experimental design were approved by the Obihiro University of Agriculture and Veterinary Medicine Laboratory Animal Care and Use Committee.

The animal's body weight (BW) was measured and its body condition score (BCS) was determined on a five-point scale (1, Emaciated; 2, Thin; 3, Average; 4, Fat and 5, Obese) with increments of 0.25 for scores between 2.25 and 4.00 [1]. Animals ≥2 years old and with BW >400 kg, were assigned to the adult group (age, 4.4 ± 2.0 years; BW, 562 ± 88 kg; BCS, 2.75 ± 0.39). In each adult animal, 5 ml of

Present address: Department of Neuroscience and Cell Biology, University of Texas Medical Branch, 301 University Boulevard, Galveston, TX 77555-1069, USA

*Corresponding author
Tel: +1-409-772-6707, Fax: +1-409-772-4687
E-mail: inlee@utmb.edu

0.12% new methylene blue (NMB) in 0.9% saline was injected into the first interlumbar (L1–L2) epidural space. Cattle <2 years old and with a BW <400 kg were assigned to the young group (age 1.2 ± 0.3 years; BW 275 ± 86 kg; BCS, 2.88 ± 0.44), and in this group 1 ml NMB/100 kg of BW was administered. The NMB solutions were prepared as reported previously [4].

As beginners, four fifth-year students of the School of Veterinary Medicine participated in this study. They listened to a one hour lecture given by one author (IL) on the modified dorsolumbar epidural anesthesia procedure, including basic anatomy and skills. Then, they randomly administered NMB solution under the supervision of the authors.

After skin preparation and local anesthesia, a 16 G, 120 mm Hakko disposable epidural needle (Tuohy needle; Hakko Medical, Japan) was inserted into the first interlumbar space using a dorsal midline approach. When the needle tip reached the ligamentum flavum, the stylet was removed and saline was added to the hub of the needle. The needle was then slowly inserted into the epidural space. The entrance into the epidural space was identified by the hanging drop technique, and air was then allowed to enter freely for about one minute to decrease the effect of the negative epidural pressure, and then the epidural needle was slowly inserted about 1 cm deeper to penetrate the epidural fat. The insertion of the needle was stopped if the cattle showed any sign of discomfort, such as a sudden movement or 'dipping' of the back [5]. After confirming that there was no blood or cerebrospinal fluid (CSF) present in the aspirate, NMB solution was administered at a rate of 0.5 ml/second with the needle bevel directed cranially, and the needle was then removed. The distance from the skin to the epidural space and the depth of the injection were determined as described [8]. Between thirty to sixty minutes after the injection, the cattle were euthanatized with intravenous pentobarbital sodium (25 mg/kg) and exsanguination.

The vertebral column, from the level of the middle thoracic to the lumbar vertebrae, was removed, and the dorsal arch of each vertebra was dissected. The site of penetration of the ligamentum flavum was confirmed, and any deviation from the midline was recorded. The extent of cranial and caudal migration of the dye within the epidural space from the injection site was measured by examining stained epidural fat and the dura mater on the left and right sides. The dura mater was bisected longitudinally to determine whether the dura mater had been penetrated. The number of stained vertebrae was counted as in a previous study [4].

Descriptive statistics (mean ± SD) was applied to the two groups. A Mann-Whitney test was used to compare the extent of migration between cranial and caudal direction and/or two types within the same group and between the two groups. A value of $p < 0.05$ was considered significant.

Results

Each student had at least seven chances to inject the NMB solution. After the first experience of epidural injection, each student performed the procedure without additional support. The epidural injection was successfully performed at all 30 cattle without problems.

The distance from the skin to the epidural space and the depth of the injection of the adult group [82 ± 5 (range: 70~91) and 91 ± 6 (80~103) mm] were significantly greater than those of the young group [57 ± 8 (50~73) and 65 ± 9 (57~83) mm] ($p < 0.001$), respectively. The penetration sites of the ligamentum flavum were within 5 mm of the midline. There was no difference between the left and right deviation of the young group [4 ± 1 (n = 4) and 3 ± 1 mm (n = 4)] and/or those of the adult group [3 ± 1 (n = 14) and 2 ± 1 mm (n = 8)].

Table 1. Distribution of new methylene blue after administration at the first interlumbar epidural space in cattle

Group	Type	Cranial		Caudal		Total	
		Left (Range)	Right (Range)	Left (Range)	Right (Range)	Left (Range)	Right (Range)
Young (n=8)	BPF (n=4)	1.5 ± 1.3 (T12-0)	1.5 ± 1.0 (T13-0)	1.5 ± 1.7 (0-L5)	1.0 ± 0.8 (0-L3)	3.0 ± 2.2 (T12-L5)	2.5 ± 1.7 (T12-L3)
	BFD (n=4)	1.5 ± 0.6 (T13-L1)	1.0 ± 0.8 (T13-0)	1.8 ± 0.5 (L2-L3)	1.3 ± 0.5 (L2-L3)	3.3 ± 1.0 (T13-L3)	2.3 ± 1.3 (T13-L3)
Adult (n=22)	BPF (n=9)	2.7 ± 0.9* (T11-T13)	2.1 ± 0.6 (T12-L1)	1.2 ± 0.4 (L2-L3)	1.1 ± 0.3 (L2-L3)	3.9 ± 1.1 (T11-L3)	3.2 ± 0.7 (T12-L3)
	BFD (n=13)	1.3 ± 0.6 (T12-L1)	1.3 ± 1.0 (T12-0)	1.8 ± 0.6 (L2-L4)	1.8 ± 0.6 (L2-L4)	3.0 ± 0.6 (T12-L4)	3.0 ± 0.9 (T12-L4)

Data expressed as mean ± SD.
T11, T12 and T13: the eleventh, twelveth and thirteenth thoracic vertebra; L2, L3, L4 and L5: the second, third, forth and fifth lumbar vertebra, respectively.
BPF: between the periosteum and the epidural fat; BFD: between the epidural fat and the dura mater.
*$p < 0.05$ versus BFD type.

There were two types of distribution; the first one was distribution between the periosteum and the epidural fat (BPF), the other one was between the epidural fat and the dura mater (BFD) (Table 1). In the young group, the NMB solution distributed as BPF type in one half (n = 4) and BFD type in the other half (n = 4) of the cattle. There was no significant difference between the left and right side and/or between the cranial and caudal migration. In the BPF type in the young group, one cow showed only left-sided, and another, only right-sided distribution. In about 60% (13/22) of the adult group, the NMB solution distributed as BFD type. Although there was no one-sided distribution in the BPF type of the adult group, the NMB solution migrated more left cranially than that of the BFD type ($p < 0.05$). The NMB solution was totally distributed to about three vertebral segments in the both groups, and there was no penetration of the dura mater in the both groups.

Discussion

This study shows that the modified dorsolumbar epidural anesthesia procedure is easy for beginners to learn and perform if they have basic anatomical knowledge and a little experience.

Information on the feeling during penetration of the supraspinous and interspinous ligaments and ligamentum flavum, and on the depth to the epidural space, helped them to perform the insertion procedure into the epidural space with more confidence.

The distance from the skin to the epidural space of adult cattle is about 80 mm with variation from 70 to 91 mm, which is relatively shorter than that (8~12 cm) in text [9]. This shorter distance might be caused by the technique of the midline needle insertion, and size or breed of cattle [8]. This length is a very important index with regard to the feeling of the resistance of the three ligaments during epidural insertion of the epidural needle. The supraspinous ligament and ligamentum flavum are very resistant to penetration of the needle, but the interspinous ligament has little resistance. Also, midline insertion may make for smaller a deviation than the paramedian approach because the interlumbar space between the first and second lumbar spinous process can be palpated easily and deviation from the vertical line can be checked during the procedure.

However, to beginners, it seemed that deeper insertion of the epidural needle to penetrate the epidural fat after penetration of ligamentum flavum in addition to insertion of the needle into the epidural space was a fearful thing. Every student hesitated to insert the needle at first because they had no experience. In order for beginners to determine the place to stop the needle during deeper insertion, it was important to inform them how to distinguish signs such as a sudden movement or 'dipping' of the back from the normal defensive behaviors. These signs were taken as an indication that the dura mater had contacted the spinal cord [7]. The absence of being able to discriminate the signs from the normal behaviors of cattle and the fear about inserting the needle into the spinal cord by mistake might cause the beginners to stop too soon, before complete penetration of the epidural fat. The total penetration rate of the epidural fat in the adult group was about 60%. Therefore, the lower rate of success (50%) in the young cattle was considered to be an effect of their being smaller than adult cattle. Although the deviation of the penetration site from the midline is similar to that of the adult, relatively smaller anatomical structures in the vertebra than those of the adult will make a greater difference the distribution of the NMB solution. Two cases of one-sided distribution in the BPF type of the young group could be an example and this distribution may be a cause of unilateral or contralateral analgesia.

The area of segmental anesthesia is a function of total mass (volume × concentration) of drugs injected [9]. If we know the effect of a volume, it will be possible to evaluate the effect of a concentration of the anesthetic. Total distribution of NMB solution in the epidural space was similar to that found in previous studies [4,7]. This distribution means actual distribution of solution after injection into the epidural space. The stained spinal segments in this study were greater than the analgesic area after administration of lidocaine, but smaller than that after xylazine, an α_2-adrenergic agonist [5,6]. This could be a reflection of different pharmacokinetics of lidocaine and xylazine after epidural administration with the same volume in the epidural space, which is a very hydrophobic condition because the dura mater is surrounded by the epidural fat [4,6].

The object of the modified dorsolumbar epidural anesthesia method is to inject anesthetic solution under the epidural fat and to induce a more reliable and similar analgesia because the epidural fat affects distribution of injected solution and pharmacokinetics and/or pharmacodynamics of anesthetic drug [6]. 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 cattle. Beginners in this study successfully performed the epidural insertion without problems and the success rate of administration under the epidural fat was 60%. This rate will increase if they master the technique by repeated practice including the ability to discriminate some signs from the normal behaviors of cattle. Therefore, if beginners have the experience of performing deeper epidural insertion without fear, they will gain a most effective anesthesia tool for flank surgery in standing cattle.

Acknowledgments

Authors thank Yugo Itoh, DVM; Ayako Ohya, DVM; Takehide Komiyama DVM and Miho Hiraoka DVM for

injection of NMB to the experimental animals during their undergraduate period. Authors also thank Miss Victoria Cochran and Mrs. Denise Broker for help during preparation of this manuscript.

References

1. **Ferguson JD, Galligan DT, Thomsen N.** Principal descriptors of body condition score in Holstein cows. J Dairy Sci 1994, **77**, 2695-2703.
2. **Hall LW, Clarke KW, Trim CM.** Veterinary Anaesthesia. 10th ed. pp. 315-339, Saunders, London, 2001.
3. **Ivany JM, Muir WW.** Farm animal anesthesia. In: Fubini SL, Ducharme NG. (eds.). Farm Animal Surgery. pp. 97-112, Saunders, Philadelphia, 2004.
4. **Lee I, Soehartono RH, Yamagishi N, Taguchi K, Yamada H**. Distribution of new methylene blue injected into the dorsolumbar epidural space in cows. Vet Anaesth Analg 2001, **28**, 140-145.
5. **Lee I, Yamagishi N, Oboshi K, Ayukawa Y, Sasaki N, Yamada H.** A comparison of xylazine, lidocaine and the two drugs combined for modified dorsolumbar epidural anaesthesia in cattle. Vet Rec 2004, **155**, 797-799.
6. **Lee I, Yamagishi N, Oboshi K, Yamada H.** Effect of epidural fat on xylazine-induced dorsolumbar epidural analgesia in cattle. Vet J 2003, **165**, 330-332.
7. **Lee I, Yamagishi N, Oboshi K, Yamada H.** Eliminating the effect of epidural fat during dorsolumbar epidural analgesia in cattle. Vet Anaesth Analg 2004, **31**, 86-89.
8. **Lee I, Yamagishi N, Oboshi K, Yamada H, Ohtani M.** Multivariate regression analysis of epidural pressure in cattle. Am J Vet Res 2002, **63**, 954-957.
9. **Skarda RT**. Local and regional anesthetic techniques: ruminants and swine. In: Thurmon JC, Tranquilli WJ, Benson GJ (eds.). Lumb & Jones' Veterinary Anesthesia. 3rd ed. pp. 479-514, Williams & Wilkins, Baltimore, 1996.