Epidural administration of fixed volumes of xylazine and lidocaine for anesthesia of dairy cattle undergoing flank surgery

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Several techniques for providing anesthesia in standing cattle undergoing flank surgery have been described. Each of these techniques has various advantages and disadvantages, but the ideal technique would be one that provides complete anesthesia of the flank following injection of a small volume of anesthetic and is not associated with any adverse effects. The epidural anesthetic technique results in desensitization of a number of nerve roots following a single injection of anesthetic, producing a band of anesthesia encircling the trunk but allowing the animal to maintain control of its limbs. However, this technique is associated with wide individual variations in degree of analgesia, which may be a result of differences in the distribution of the anesthetic solution injected into the epidural space. The epidural fat affects the spread of anesthetic solutions and alters the pharmacokinetics of xylazine following injection into the epidural space. Also, pressure in the epidural space is typically negative, which may affect the distribution of anesthetic solutions.

A modification of the standard epidural anesthetic technique developed to minimize the effects of epidural pressure and epidural fat has been described. With this modification, a 16-gauge, 120-mm Tuohy needle is inserted into the L1-2 intervertebral space from a dorsal midline approach and positioning of the needle tip in the epidural space is confirmed by use of the hanging drop technique. After air has been allowed to enter freely for approximately 1 minute, the needle is slowly advanced 7 to 10 mm to penetrate the epidural fat and the anesthetic solution is then administered. Administration of a combination of xylazine hydrochloride (0.025 mg/kg [0.011 mg/lb]) and lidocaine hydrochloride (0.1 mg/kg [0.045 mg/lb]) with this technique has been shown to induce anesthesia suitable for performing a laparotomy in standing cattle. However, in clinical practice, it may be impossible to obtain an exact body weight prior to surgery in cattle. The purpose of the present report, therefore, was to describe results of the use of this modified epidural approach to inject fixed volumes of xylazine and lidocaine in standing cattle undergoing flank surgery.

Procedure
Skin caudal to the first lumbar spinous process was aseptically prepared, and 5 mL of 2% lidocaine was injected in the subcutaneous tissues dorsal to the ligamentum flavum. A 16-gauge, 120-mm Tuohy needle was then inserted in the L1-2 intervertebral space through a dorsal midline approach. When the needle tip reached the ligamentum flavum, the stylet was removed and saline (0.9% NaCl) solution was added to the hub of the needle. The needle was then slowly inserted into the epidural space. Entrance into the epidural space was identified by means of the hanging drop technique, and air was allowed to freely enter the epidural space for approximately 1 minute to decrease any effects of negative epidural pressure. The needle was then slowly advanced approximately 1 cm to penetrate the epidural fat (Figure 1). Insertion of the needle was stopped if the cow showed any signs of discomfort, such as a sudden movement or dipping of the back. After aspiration of the needle to confirm that there was no blood or CSF present, a fixed volume of anesthetic solution was administered. For the initial cattle, the anesthetic solution consisted of 1 mL of 2% xylazine and 4 mL of 2% lidocaine. In subsequent cattle, the anesthetic solution consisted of 1 mL of 2% xylazine and 3 mL of 2% lidocaine. The needle bevel was directed cranially, and anesthetic solution was administered at a rate of 0.5 mL/s. Following administration of the anesthetic solution, the needle was removed.

Figure 1—Illustrations of standard and modified methods for epidural anesthesia in cattle. With the standard method, anesthetic is injected after penetration of the ligamentum flavum (LF, A), which results in distribution of the anesthetic solution between the periosteum and epidural fat (EF). With the modified technique, the needle is advanced through the EF (B) before anesthetic injection so that the anesthetic solution is distributed between the EF and the dura mater (DM). D = Intervertebral disk. VB = Vertebral body.
The distance from the skin to the epidural space and the depth of needle insertion were determined as described. The degree of sedation, extent of anesthesia of the flank, and degree of ataxia were assessed before administration of the drugs (baseline) and then at 5-minute intervals for 30 minutes and at 15-minute intervals until surgery was completed. Degree of sedation was defined in terms of drooping of the animal's upper eyelids, the position of its head relative to its shoulder, and any apparent reduction in its awareness of its surroundings. Time until the onset of anesthesia and areas affected in the left and right flanks were assessed on the basis of the animal's response to superficial and deep pinpricks. After the start of surgery, the extent of anesthesia was assessed on the side that was unaffected by surgery. The cranial and caudal extents of the area of anesthesia were assessed in terms of the number of spinal nerve segments involved. The degree of ataxia was assessed by observing the position of the animal's hind limbs, how much the animal swayed and leaned against the chute, and the extent of knuckling of the metatarsophalangeal joints. If the animal made purposeful movements, such as repeated kicking or struggling, during the skin and muscle incision, additional anesthesia was obtained by means of infiltration of lidocaine in a line block or inverted L-block pattern, but if the animal made only nonpurposeful movements, the surgery was performed without additional anesthesia. After surgery, if deemed necessary by the attending anesthesiologist, cattle received atipamezole hydrochloride IV (dose equal to 0.1 times the dose of xylazine) to reverse any sedation. A student t test was used to compare various groups of cattle. A value of P ≤ 0.05 was considered significant.

Results

The modified epidural anesthetic technique with fixed volumes of xylazine and lidocaine was performed in 18 female Holstein cattle scheduled to undergo flank surgery. Cattle ranged from 2 to 9 years old (mean ± SD, 4.6 ± 2.1 years) and weighed between 450 and 800 kg (990 and 1,760 lb; mean ± SD, 623 ± 86 kg [1,370 ± 189 lb]). Body condition score (BCS) determined on a 5-point scale (1 = emaciated, 2 = thin, 3 = average, 4 = fat, and 5 = obese, with increments of 0.25) ranged from 2.25 to 4.00. The study protocol and experimental design were approved by the Obihiro University of Agriculture and Veterinary Medicine Laboratory Animal Care and Use Committee.

For the first 8 cattle (age [mean ± SD], 4.3 ± 1.0 years; body weight, 624 ± 96 kg [1,373 ± 211 lb]; BCS, 2.91 ± 0.27), the anesthetic solution consisted of 1 mL of 2% xylazine and 4 mL of 2% lidocaine. However, after epidural administration of this dose, the eighth cow became recumbent prior to surgery. Therefore, for the remaining 10 cattle (age, 4.8 ± 2.7 years; body weight, 623 ± 83 kg [1,370 ± 183 lb]; BCS, 3.35 ± 0.63), the anesthetic solution consisted of 1 mL of 2% xylazine and 3 mL of 2% lidocaine.

There were no significant differences in age, body weight, or BCS between groups. Mean distance from the skin to the epidural space and mean depth of needle insertion for the first 8 cows (84 ± 2 mm and 93 ± 3 mm, respectively) were not significantly different from values for the subsequent 10 cows (85 ± 4 mm and 95 ± 4 mm, respectively). Also, the dose of xylazine for the first 8 cows (0.033 ± 0.006 mg/kg [0.015 ± 0.003 mg/lb]) was not significantly different from the dose of xylazine for the subsequent 10 cows (0.033 ± 0.004 mg/kg [0.015 ± 0.002 mg/lb]), but the dose of lidocaine for the first 8 cows (0.131 ± 0.023 mg/kg [0.06 ± 0.01 mg/lb]) was significantly (P < 0.001) higher than the dose of lidocaine for the subsequent 10 cows (0.098 ± 0.013 mg/kg [0.045 ± 0.006 mg/lb]).

Mean times to the onset of sedation (10.8 ± 3.8 minutes vs 15.0 ± 7.1 minutes) and to the onset of flank anesthesia (12.5 ± 5.2 minutes vs 13.0 ± 5.5 minutes) were similar for the 2 groups. Extent of anesthesia, calculated as number of spinal nerve segments, for the initial 8 cows (6.3 ± 1.5 segments [range, T10 to L3]) was similar to extent of anesthesia for the subsequent 10 cows (6.3 ± 1.4 segments [range, T9 to L3]). All 8 cows given the higher dose of lidocaine developed ataxia, and the eighth cow (body weight, 650 kg [1,430 lb]) suddenly became recumbent 25 minutes after administration of xylazine (0.031 mg/kg [0.014 mg/lb]) and lidocaine (0.123 mg/kg [0.056 mg/lb]). After 20 minutes, the animal stood without assistance. Omentopexy for correction of left displacement of the abomasum was performed the following day.

Seven of the 10 cows given the lower dose of lidocaine developed ataxia. One cow became recumbent during suturing of the incision; serum biochemical analyses indicated that this cow was hypocalcemic (total serum calcium, 6.6 mg/dL).

Ten of the 17 cows underwent omentopexy, 3 underwent rumenotomy, 3 underwent fistulation, and 1 underwent cesarean section. For both groups of cattle, surgery was begun approximately 30 minutes after epidural administration of xylazine and lidocaine (29.2 ± 4.4 minutes and 31.3 ± 12.4 minutes) and duration of surgery ranged from 27 to 276 minutes (129.5 ± 110.1 minutes and 68.6 ± 64.4 minutes). Infiltration of additional anesthetic was required before surgery in only 1 cow; this cow had received the lower dose of lidocaine. Rumenotomies in the 3 cattle were performed by students, and infiltration of additional anesthetic was required prior to suturing of the incision, approximately 4 hours after epidural administration of xylazine and lidocaine.

Two cattle given the lower dose of lidocaine were given atipamezole to reverse the sedation before transportation.

Discussion

Epidural anesthesia has been considered an unreliable technique in cattle, in part because so many factors affect the outcome, so that different degrees of anesthesia may be obtained in different cattle, despite the use of the same drug doses and the same technique. In addition, the needle must be inserted approximately 8 cm to reach the epidural space, which may cause practitioners to be hesitant to use the technique. However, adoption of the modified epidural anesthesia technique appears to have standardized some of these factors so that satisfactory anesthesia can be obtained with less individual variation.
lidocaine at a dose of 0.1 mg/kg was found to result in sufficient sedation and anesthesia for flank surgery in standing cattle. For practical use in the field, however, a simpler method that does not require measuring body weight and calculation of the anesthetic dose may be useful. On the basis of distribution of the anesthetic solution following injection into the epidural space and clinical results obtained with various anesthetic doses, we initially elected to test the effects of administering 1 mL of xylazine and 4 mL of lidocaine. Sedative and analgesic effects were satisfactory, and surgeries were performed successfully in 7 of the 8 cattle in which this combination was used. However, 1 animal became recumbent before surgery started. Thus, the combination dose was reevaluated. Recumbency in this cow was considered to be an effect of the lidocaine because the cow was only lightly sedated and stood 20 minutes later without assistance. Although the 5-mL combination dose does not distribute to the sixth lumbar and first and second sacral spinal nerves, which constitute the sciatic nerve, there may be a possibility of diffusion through the CSF after injection of the solution in the epidural space. For this reason, the volume of lidocaine was decreased to 3 mL for subsequent cattle.

Sedative and analgesic effects after administration of the 4-mL anesthetic combination were similar to those obtained with the 5-mL combination. One cow did become recumbent toward the end of surgery, but this cow was hypocalcemic, and recumbency may have been a result of severe sedation and suppression of the cardiopulmonary system. Thus, although we recommend use of 1 mL of xylazine in healthy adult animals, we also recommend that the dose of xylazine be reduced to prevent severe sedation and recumbency in animals that are weak and in animals that have various diseases and disorders.

Use of the modified epidural anesthetic technique to inject fixed volumes of xylazine and lidocaine at the L1-2 intervertebral space resulted in sufficient anesthesia of the flank in the present study. Mean distance from the skin to the epidural space and mean depth of needle insertion were higher than values reported in previous studies, probably because of the larger size and higher BCS of cattle in the present study. For cattle in the present study, scrubbing, disinfecting, and draping of the surgical site were performed 5 minutes after epidural administration of xylazine and lidocaine. Thus, surgery was begun approximately 30 minutes after epidural injection. In a field situation, this may represent too long of a delay. Thus, the method may be further modified to shorten preparation time. After epidural administration of the anesthetic solution, light sedation will be apparent in about 10 minutes and anesthesia of both flanks should be apparent within about 15 minutes.

Following epidural administration of xylazine and lidocaine, anesthesia of the flanks can only be performed with a Tuohy-type epidural needle. Because the Tuohy needle tip is relatively blunt, compared with the spinal needle tip, the Tuohy needle permits easier identification of contact with the ligamentum flavum and is less likely to puncture the dura mater. Also, this method is performed through a midline approach, which results in a shorter distance from the skin to the epidural space than is associated with a lateral approach. Lastly, the epidural needle is advanced about 1 cm (7 to 10 mm) to penetrate epidural fat after entry into the epidural space. However, there may be individual variations in this depth because of individual variations among cows and because of differences among anesthesiologists in regard to how quickly needle advancement is stopped once the epidural space is initially entered. Therefore, signs from the cow should be considered the main indicator of needle depth rather than any absolute measurement. Signs of discomfort, such as a sudden movement or dipping of the back, indicate that the dura mater is in contact with the spinal cord.

During flank surgery of cattle, kicking and violent movement have been considered natural or common. In the authors’ opinion, such actions may be caused by the cattle experiencing pain and fear. Therefore, proper sedation and anesthesia should be obtained prior to surgery. Veterinarians have a moral obligation to attempt to control pain and suffering in their animal patients.3 The modified epidural anesthesia technique with injection of fixed volumes of xylazine and lidocaine appears to be an acceptable method for providing anesthesia in standing cattle undergoing flank surgery.

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a. Hakko disposable epidural needle, Hakko Medical Inc, Tokyo, Japan.
References


Selected abstract for JAVMA readers from the American Journal of Veterinary Research

Evaluation of well-being, productivity, and longevity of pregnant sows housed in groups in pens with an electronic sow feeder or separately in gestation stalls
Leena Anil et al

Objective—To compare well-being, performance, and longevity of gestating sows housed in stalls or in pens with an electronic sow feeder (ESF).

Animals—382 pregnant sows of parities 1 through 6.

Procedure—Sows were housed in separate stalls (n = 176) or group pens (206) with an ESF. Well-being of sows was assessed at various time points in terms of injuries, salivary cortisol concentration, and behavior in a novel arena or to a novel object. Farrowing performance and longevity of sows were also assessed.

Results—Total injury scores (TIS) of sows in pens were significantly higher at initial introduction and mixing. In stall-housed sows, TIS was significantly higher during late gestation. The TIS and cortisol concentration were significantly lower in stall-housed sows, compared with values for sows in pens. As parity increased, the likelihood of higher median TIS decreased significantly in pen-housed sows and increased significantly in stall-housed sows. The TIS of sows in pens was negatively correlated with body weight and backfat thickness, whereas these correlations were positive in stall-housed sows. Farrowing performance and results for novel arena or objects did not differ. Proportion of sows removed was significantly higher for pens than for stalls; lameness was the major reason for removal for both systems.

Conclusions and Clinical Relevance—Stalls impose space restrictions for larger sows, resulting in injuries during late gestation. Interventions are needed to minimize aggression during initial introduction and mixing and at the ESF in pens to reduce severe injuries or lameness of gestating sows. (Am J Vet Res 2005;66:1630–1638)