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RESEARCH PAPER

The volume effect of lidocaine on thoracic epidural anesthesia in conscious Beagle dogs

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Abstract

Objective To evaluate the volume effect of local anesthetic solution on thoracic epidural analgesia in dogs.

Study design Prospective, experimental trial.

Animals Five healthy adult Beagle dogs weighing 9.7 ± 1.3 kg.

Methods A catheter was inserted into the seventh thoracic epidural space using a lumbosacral approach, and secured with suture under total intravenous (IV) anesthesia with propofol. Each dog was administered four volume treatments (0.05, 0.10, 0.15 and 0.20 mL kg^{-1}) of 2% lidocaine via the catheter at 12 hour intervals. In every treatment, dogs were re-anesthetized with propofol (6 mg kg^{-1}, IV) and isoflurane, and received iohexol at each volume to visualize the epidural distribution (ED) through computed tomography. Three hours after epidurography, when dogs had recovered from anesthesia, the appropriate volume of lidocaine was injected through the catheter, and sensory blockade (SB) in dermatomes was evaluated by pinching with a mosquito forceps. Results were presented as median (range), and the volume effect on ED and SB was analyzed with one-way Kruskal–Wallis ANOVA.

Results In proportion to volumes (0.05, 0.10, 0.15 and 0.20 mL kg^{-1}), there were significant increases in the extent of ED from 7.4 (5.5–9.0) to 10.4 (8.0–12.0), 13.2 (12.5–13.0), and 15.2 (13.0–18.0) vertebrae, respectively, $p < 0.001$, and in SB from 2.7 (1.0–5.0) to 6.8 (4.5–10.5), 9.9 (6.5–13.0), and 13.1 (11.0–15.0) dermatomes, respectively, $p < 0.001$. Unilateral ED and SB were observed in all treatments with various grades, and this distribution was more frequent in the low volume treatments. In the high volume treatments, temporary complications including Horner's syndrome, ataxia, paraplegia, depression, stupor, and intermittent cough occurred often.

Conclusions and clinical relevance The increase in volume of local anesthetic solution improved SB by resulting in more consistent bilateral dermatome blockade as well as an extended blockade. However, caution should be exerted, as higher volume injections of lidocaine caused side effects in all dogs.

Keywords dog, lidocaine, neurologic effects, thoracic epidural, volume.

Introduction

Thoracic epidural analgesia (TEA) is a regional anesthesia-based technique used to relieve thoracic pain after surgery or during critical care in small animals and humans (Wetmore & Glowaski 2000; Hansen 2001; Manion & Brennan 2011). Concern that TEA may induce side effects potentially unsafe for the patient has delayed acceptance of the technique into routine use. In humans, further studies of TEA have supported its' use to reduce the incidence of respiratory complications following various types of surgery (Ballantyne et al. 1998).

In small animals, use of an epidural catheter to induce TEA has been reported (Wetmore & Glowaski 2000; Hansen 2001), but there is little published research focusing on TEA in veterinary compared to human medicine.

Thoracic epidural injection of local anesthetic agents is commonly performed via an epidural catheter. Insertion of an epidural catheter facilitates management of continuous pain by easy administration of repetitive bolus injections or constant infusion (McLeod & Cumming 2004). In humans, intermittent bolus injection is preferred compared to constant infusion, because a bolus injection results in more extensive epidural distribution (ED) and less regression of sensory blockade (SB) (Wong et al. 2006). However, the risks of respiratory depression (Etches et al. 1989) and hemodynamic instability (Shuman & Peters 1976) have been documented and associated with the use of bolus epidural injections. Therefore, choice of a bolus dose that achieves adequate analgesia with minimal complications is important.

Epidural drugs are typically administered to small animals in a volume of 0.10–0.22 mL kg^{-1} (Wetmore & Glowaski 2000; Hansen 2001). However, the relationship between volume and the effect of local anesthetics administered at the thoracic level has not been characterized in dogs. Therefore, this study was performed to determine the effect of injectate volume on TEA using the lumbosacral approach in dogs.

Materials and methods

All experimental procedures were approved by the Institutional Animal Care and Use Committee of Seoul National University (SNU-130306-1). Data were obtained from five male Beagles that were clinically healthy based on physical examination, radiographic imaging (chest and spine views) and blood tests (complete blood cell count and serum chemistries). Body condition score (BCS) was assessed on a 9-point scale based on methods described previously (Mawby et al. 2004). The mean $\pm$ SD body weight was 9.7 $\pm$ 1.3 kg, and the median BCS was 5 (ranges, 5–6). Food was withheld for 6 hours with free access to water before anesthesia. Before the experimental procedure, hair was clipped over the cephalic vein, lumbosacral area and bilaterally over the thorax for intravenous (IV) catheterization, epidural puncture, and assessment of blocked dermatomes, respectively.

A 22 gauge 25 mm over-the-needle catheter (Sewoon Medical, Korea) was inserted into the cephalic vein. Propofol (Provive 1%; Claris, India) was administered IV up to 6 mg kg^{-1} until endotracheal intubation was possible, and then supplemented by repeated incremental IV boluses at 2 mg kg^{-1} as required. The dog was allowed to breathe spontaneously, and Hartmann's solution (H/S; Daihan Pharm., Korea) was administered at a rate of 10 mL kg^{-1} $hour^{-1}$ IV during the procedure. Electrocardiogram (ECG), hemoglobin oxygen saturation (SpO_2) by pulse oximetry, respiratory rate (f_R) by capnometry, end-tidal carbon dioxide tension ($P_{E'}CO_2$), and oscillometric arterial blood pressure (sAP) were continuously monitored (Datex-Ohmeda S/5; GE Healthcare, Finland). The dogs were positioned in sternal recumbency with the pelvic limbs extended cranially along the abdomen and thorax. Skin over the lumbosacral area was prepared for aseptic puncture. A Tuohy needle (17 gauge 9.84 cm; Arrow International Inc., PA, USA) with the bevel directed cranially was inserted between the seventh lumbar (L7) and first sacral vertebra (S1). Placement of the tip of the needle in the epidural space was assessed by a pop sensation and no resistance to injection of 0.9% saline (1 mL, N/S; Daihan Pharm.). The epidural catheter (REF EC-05000 TheraCath; Arrow International Inc.) was equipped with an imbedded coiled spring and a stylet wire to prevent collapse and kinking during advancement along the epidural canal. The catheter was inserted into the epidural space via the Tuohy needle using aseptic technique, then the dog was repositioned in lateral recumbency, and the catheter was advanced cranially up to the level of the seventh thoracic vertebra (T7). Correct placement of the catheter tip was confirmed by lateral radiograph after removing the stylet from the catheter. Furthermore, inadvertent insertion of the catheter into a venous sinus or intrathecal space was verified by negative withdraw of blood or cerebrospinal fluid (CSF), respectively. After completing the installation, the catheter was fixed on the dorsal skin with sutures and a sterile drape (Ioban 2; 3M Health Care, MN, USA), and fully filled with 0.5 mL 0.9% saline that corresponded to a previously measured catheter volume. At the end of the procedure, animals were allowed to recover from anesthesia and observed for 24 hours for catheter dislodgement or any acute neurologic signs resultant from catheter placement, such as epidural hematoma or nerve damage (Giebler et al. 1997;

