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RESEARCH PAPER

Ultrasound-guided femoral nerve block using a ventral suprainguinal approach in healthy dogs

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Abstract

Objective To determine whether an ultrasound (US)-guided femoral nerve block using a ventral suprainguinal approach could be successfully achieved in sedated dogs; to measure the time to execute the nerve block, onset time, duration, and complete block rate in sensory and motor nerves; and to examine any differences between two volumes for injection.

Study design Blinded crossover experimental study.

Animals A total of 10 clinically healthy adult Beagle dogs.

Methods The femoral nerve of the right pelvic limb was infiltrated with 0.5% bupivacaine at 0.4 (treatment 0.4B) or 0.2 mL kg^{-1} (treatment 0.2B), or saline at 0.4 mL kg^{-1} (control) in sedated dogs. The sensory and motor nerve functions were scored on a scale of 0 (complete blockade) to 2 (normal). The onset time and duration of the sensory and motor nerve blockade were compared between treatments 0.4B and 0.2B using a Wilcoxon signed rank test. Sensory and motor nerve function scores for each of the three treatments were compared at multiple time points using a nonparametric multiple comparisons test.

Results The time to execute the nerve block was 2.5 ± 0.9 minutes (n = 30). For both 0.4B and 0.2B treatments, the onset times of both the sensory and motor nerve blockades were 15 minutes. The durations of the sensory nerve blockade for 0.4B and 0.2B were 9.9 ± 1.4 and 10.0 ± 1.2 hours, respectively, and those of the motor nerve blockades were 10.5 ± 1.3 and 10.2 ± 1.3 hours, respectively. No adverse effects were noted. No significant difference was observed between 0.4B and 0.2B.

Conclusions and clinical relevance A US-guided femoral nerve block using a ventral suprainguinal approach demonstrated a short onset and long duration with 0.5% bupivacaine 0.2 mL kg^{-1} and can be performed under sedation in dogs.

Keywords analgesia, bupivacaine, canine, local anesthetic, pelvic limb.

Introduction

Peripheral nerve blocks, combined with general anesthesia and a multimodal analgesic approach, have been performed in animals for preemptive analgesia (Gurney & Leece 2014). The accurate localization of nerves has been improved by electrical nerve location (Futema et al. 2002; Mahler & Adogwa 2008; Portela et al. 2010) and ultrasound (US) guidance (Campoy et al. 2010; Echeverry et al. 2010, 2012a, b; Shilo et al. 2010; Mogicato et al. 2015). A US-guided peripheral nerve block technique offers several advantages, such as visualization of the target nerves and needle, and spread of local anesthetic solution during injection, compared with a nerve stimulation technique without visualization (Marhofer et al. 2005; Graff et al. 2015; Akasaka & Shimizu 2017).

The combined blockade of the femoral and sciatic nerves has been employed for surgical procedures performed on the pelvic limb (Rasmussen et al. 2006; Campoy et al. 2010; Echeverry et al. 2010). When these nerves were imaged using a US-guided technique, the sciatic nerve could be identified clearly and successfully stained (Echeverry et al. 2010).

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However, the femoral nerve (Echeverry et al. 2010) and saphenous nerve (Shilo et al. 2010) were not easily identified at the femoral triangle (inguinal approach), and the staining success rate of the femoral nerve was only 62.5% (Echeverry et al. 2010). The femoral nerve, originating from the fourth lumbar (L4) to the sixth lumbar (L6) spinal nerves, lies within the iliopsoas muscle before passing into the proximal pelvic limb. Before leaving the iliopsoas muscle, the saphenous nerve arises from the cranial side of the femoral nerve (O'Connor & Woodbury 1982) and supplies the skin on the medial aspect of the thigh, stifle, tarsus and paw (Gurney & Leece 2014). The saphenous nerve is the only component of the femoral nerve that derives sensory cutaneous information (Gurney & Leece 2014). The femoral nerve runs alongside the femoral artery and vein at the femoral triangle. A new US-guided approach to block the femoral nerve within the iliopsoas muscle using a ventral suprainguinal approach was subsequently reported (Echeverry et al. 2012a, b; Mahler 2012; Mogicato et al. 2015). The femoral nerve was located easily using this approach and motor nerve function was blocked in all dogs ($n = 5$) (Echeverry et al. 2012b). However, the time to perform this technique, evaluation of the sensory nerve blockade and onset time and duration of the blockade were not reported.

This study was designed to determine whether a US-guided femoral nerve block using a ventral suprainguinal approach could be achieved in sedated dogs, to demonstrate the efficacy of such a blockade and to examine any differences between two volumes for injection (0.4 and 0.2 mL kg^{-1}). We hypothesized that this approach could be achieved under sedation, that the efficacy of the nerve blockade would be high and that no difference in effect would occur between the two volumes.

Materials and methods

Animals

This research protocol was approved by the Institute of Experimental Animal Sciences of the Tokyo University of Agriculture and Technology University (no. 28−14). The study animals were 10 healthy female Beagle dogs aged (mean ± standard deviation) 2.3 ± 0.5 years, weighing 9.9 ± 1.7 kg and with body condition scores of 3/5. The dogs were free from hematologic, neurologic and orthopedic abnormalities based on hematologic, physical, orthopedic, neurologic and radiographic examinations. The animals were maintained in strict accordance with the recommendations in the Guide for the Care and Use of Laboratory Animals of the National Institutes of Health.

Study design

This study was conducted as a blinded crossover experimental trial randomized using the RANDBETWEEN function in Excel. The right femoral nerves of the 10 dogs were blocked on three occasions, with an interval of 10 days between procedures. Bupivacaine (MARCAINE injection 0.5%; AstraZeneca KK, Japan) at 0.4 mL kg^{-1} (2 mg kg^{-1}, treatment 0.4B, $n = 10$) or 0.2 mL kg^{-1} (1 mg kg^{-1}; treatment 0.2B, $n = 10$) or normal saline at 0.4 mL kg^{-1} (Otsuka Pharmaceutical Co. Ltd, Japan; treatment 0.4S, $n = 10$) was injected under US guidance. All nerve blocks were performed by the same anesthetist (SS), and the assessment of the nerve blocks was performed by another researcher (MA) who was unaware of which treatment had been administered.

US-guided femoral nerve block

A US-guided femoral nerve block using a ventral suprainguinal approach was performed in sedated dogs. The dog was administered medetomidine (20 μg kg^{-1}; Domitor; Nippon Zenyaku Kogyo Co. Ltd, Japan) intramuscularly. Echolocation was performed using a high-frequency 13 MHz UST-5543 linear array transducer (Hitachi Aloka Medical Ltd, Japan) and a ProSound α10 ultrasound system (Hitachi Aloka Medical Ltd). The dogs were positioned in dorsal recumbency with the pelvic limbs naturally extended. The hair of the caudolateral abdomen was clipped, and the skin at the site of needle insertion was cleaned with 70% alcohol. The transducer was oriented perpendicular to the midline and slightly cranial to the inguinal nipple, and the orientation marker of the transducer was positioned laterally. The transducer was then glided from cranial to the inguinal nipple to the midpoint between the nipples to obtain an optimal short-axis view of the femoral nerve. The femoral nerve was located within the iliopsoas muscle and lateral to the external iliac artery, which was observed distant from the femoral nerve (Echeverry et al. 2012b; Mogicato et al. 2015; Fig. 1). The iliopsoas muscle was observed as a triangular hypoechoic structure with an internal pattern of scattering echoes. The short axis of the

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