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RESEARCH PAPER

Comparison of lidocaine and lidocaine–epinephrine for the paravertebral brachial plexus block in dogs

Amélie Choquette, Jérôme RE del Castillo, Maxim Moreau, Martin Guillot, Kate Alexander, Jean-Jacques Kona-Boun, Dominique Gauvin & Eric Troncy
Animal Pharmacology Research Group of Quebec (GREPAQ), Faculty of Veterinary Medicine, University of Montreal, Saint-Hyacinthe, QC, Canada

Correspondence: Eric Troncy, Department of Veterinary Biomedical Sciences, Faculty of Veterinary Medicine, Université de Montréal, P.O. Box 5000, Saint-Hyacinthe, QC, Canada J2S 7C6 Email: eric.troncy@umontreal.ca

Abstract

Objective To compare the motor and sensory block efficacy and duration of a modified paravertebral brachial plexus block (PBPB) after administration of lidocaine alone (LI) or combined with epinephrine (LE).

Study design Prospective, randomized, blinded, crossover study.

Animals A total of eight healthy female Beagle dogs.

Methods Under general anesthesia, modified PBPB was performed on the left thoracic limb using neurostimulation and/or ultrasound guidance to administer lidocaine (2 mg kg^{-1}; 0.2 mL kg^{-1}) either alone (treatment LI, $n = 10$) or with epinephrine (1:100,000; treatment LE, $n = 9$). Sensory block was evaluated through reaction to a painful mechanical stimulus applied at five sites on the limb. Motor block effect was evaluated according to visual gait assessments and thoracic limb vertical force measurements under dynamic and static conditions. Data were analyzed using repeated-measures generalized estimating equations. All statistical tests were performed two-sided at the $\alpha = 0.05$ significance threshold.

Results The duration of sensory block did not differ significantly between treatments. Visible gait impairment was more persistent in LE than in LI (118 ± 63 minutes for LI and 163 ± 23 minutes for LE; mean ± standard deviation) ($p = 0.027$). At nadir value, dynamic peak vertical force was lower in LE than in LI ($p = 0.007$). For both dynamic and static evaluations, the nadir and the return to baseline force were delayed in LE (return to normal at 180–200 minutes) when compared with LI (130–140 minutes) ($p < 0.005$).

Conclusions and clinical relevance The addition of epinephrine to lidocaine prolonged the duration and increased the intensity of the regional block, as verified by visual gait assessment and kinetic analysis. No significant difference was noted between treatments regarding sensory blockade. Kinetic analysis could be useful to evaluate regional anesthetic effect in dogs.

Keywords force platform gait analysis, lidocaine, neurostimulation, paravertebral brachial plexus block, ultrasound-guided nerve block.

Introduction

Regional nerve desensitization using local anesthetics is well established in small animal practice (Skarda & Tranquilli 2007a). A variety of dosages, drug combinations and block techniques are being studied to improve medical or surgical pain management (Mosing et al. 2010; Trumpatori et al. 2010). Until recently, there were fewer options for blocking the thoracic limb than the pelvic limb in dogs. The subscapular brachial plexus block effectively desensitizes the limb from elbow to digits, but analgesia proximal to the elbow is unpredictable (Bailey & Kitchell 1987; Duke 2000). By targeting the nerves at the vertebral foramina, the paravertebral brachial plexus approaches are interesting options for providing analgesia and muscle relaxation of the shoulder and brachium (Lemke & Dawson 2000; Lemke & Creighton 2008).

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The first published mapping of the paravertebral brachial plexus block (PBPB) injection sites reported partial nerve staining rates in canine cadavers (Hofmeister et al. 2007). Ultrasound (US) and neurostimulation (NS) guidance techniques allow more accurate needle tip placement and have improved the performance of appendicular nerve blocks in humans (Chan et al. 2007; Sites et al. 2007; Marhofer et al. 2010). The US and NS guidance techniques have been described and validated for pelvic limb nerve blocks in dogs (Campoy et al. 2008; Echeverry et al. 2010; Shilo et al. 2010). The success rate and incidence of complications for US and/or NS guided PBPB using colorimetric evaluations have been reported (Bagshaw et al. 2009; Rioja et al. 2012).

The addition of epinephrine to a local anesthetic is known to provide a stronger and longer duration of nerve block by causing vasoconstriction, which slows the diffusion of the anesthetic away from the nerve (Skarda & Tranquilli 2007b). The effect of epinephrine on regional blocks with local anesthetics has been described in humans (Sakura et al. 1999; Pressman et al. 2005), rats (Fink et al. 1978; Sinnott et al. 2003) and sheep (Rostami & Vesal 2011), but similar published studies in dogs are lacking.

The visual assessment of a dog's ability to stand and walk describes a regional block effect (Costa-Farré et al. 2009; Shilo et al. 2010; Trumpatori et al. 2010). These variables are measured on an ordinal scale that, as all subjective assessments, may lack reliability and accuracy (Streiner et al. 2015). The vertically oriented ground reaction force acquired with a force platform instrument is commonly used to measure limb function in dogs (Budsberg et al. 1987; Moreau et al. 2004, 2014; Beraud et al. 2010), and may prove useful for measuring the effect of limb regional anesthesia in dogs.

With the goal of realization of the US- and NS-guided PBPB in dogs, we hypothesized that: 1) the addition of epinephrine to lidocaine (treatment LE) would provide a stronger and longer duration of nerve block than lidocaine alone (treatment LI); and 2) the clinical effects of nerve block with LI and LE could be differentiated by three tests: cutaneous sensory evaluation, visible gait impairment of the dog and force platform kinetic measurements. Our objectives were: 1) to compare the efficacy and duration of PBPB after administration of LI or LE; and 2) to compare the time courses of PBPB assessments with the subjective cutaneous sensory testing, visible gait impairment scoring and force platform kinetic analysis.

Materials and methods

All study protocols described herein were approved by the Université de Montréal, Faculté de Médecine Vétérinaire Institutional Animal Care and Use Committee (no. RECH-1574).

Pilot study

The modified PBPB technique of Lemke & Creighton (2008) with US (M-Turbo Vet; FUJIFILM SonoSite Inc., WA, USA) guidance was simulated on six canine cadavers. After serial dye injections, the brachial plexus was dissected to localize the stained zones. Four anesthetized Beagle dogs were subjected to US color-flow Doppler to identify the regional vascularization, followed by NS (Stimuplex Dig RC; B. Braun Medical Inc., PA, USA) to evaluate the muscular responses elicited by the targeted nerve roots. In addition, the effective LI injection volume was determined by varying dose amounts and concentration.

Main study design and procedures

Animals

A total of 8 healthy female Beagle dogs aged 2–5 years and [mean ± standard deviation (SD)] weighing 11 ± 1.3 kg were selected from the same research colony as the dogs in the pilot study. All dogs had undergone radiography within the past year to confirm healthy joints and were subjected to physical and orthopedic examinations, and laboratory blood testing (hematocrit, total proteins and blood urea nitrogen). Animals were trained for leash walking on a force platform for 4 weeks before beginning the study. Prior to each anesthesia, dogs were reexamined, weighed and fasted for 12 hours with free access to water.

Treatment allocation

Dogs were assigned to one of two treatments using a block balanced randomized (www.graphpad.com/quickcalcs) crossover design, controlled for age, sex and body weight. Lidocaine (Lurocaïne, 20 mg mL^{-1}; Vétoquinol N.-A. Inc., QC, Canada) or lidocaine with epinephrine (lidocaine HCl 2% and epinephrine 1:200,000, USP; Hospira, Inc., IL, USA) were diluted at a 1:1 volume ratio with sterile physiological saline (0.9% sodium chloride inj., USP; Baxter Healthcare,

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