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RESEARCH PAPER

Anatomical characterization of the brachial plexus in dog cadavers and comparison of three blind techniques for blockade

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Abstract

Objectives To describe the ventral spinal nerve rami contribution to the formation of the brachial plexus (BP), and to compare ease of performing and nerve staining between three blind techniques for BP blockade in dogs.

Study design Prospective, randomized, blind study.

Animals A total of 18 dog cadavers weighing 28.2 ± 9.7 kg (mean ± standard deviation).

Methods Dogs were randomly assigned to two of three BP treatments: traditional approach (TA), perpendicular approach (PA), and axillary approach (AA). Dye (0.2 mL kg^{-1}) was injected in the left BP using a spinal needle; another BP treatment was used in the right BP. Landmarks (L) included: L1, midpoint between point of the shoulder and sixth cervical (C_6) transverse process; L2, scapulohumeral joint; and L3, first rib. For TA, the needle was introduced craniocaudally through L1, medial to the limb and cranial to L3. For PA, the needle was directed perpendicular and caudal to L2, aligned with L1, until cranial to L3. For AA, the needle was directed ventrodorsally, parallel and cranial to L3 until at L1. All BPs were scored for dyeing quality [0 (poor) to 5 (excellent)]. The left BP was dissected for nerve origins. Durbin test was used to compare scores ($p < 0.05$).

Results In all dogs, the musculocutaneous nerve originated from C_7 and C_8; the radial nerve from C_8, the first thoracic vertebra (T_1) (16/18 dogs) and C_7 (2/18); and the median and ulnar nerves from C_8, T_1 (17/18) and C_7 (1/18). Respective raw scores and adjusted scores for the incomplete block design were not significantly different ($p = 0.72$; ranks TA 16.5, PA 19.0, AA 18.5).

Conclusions and clinical relevance The musculocutaneous, median, ulnar and radial nerves originate from C_7, C_8 and T_1. Regardless of the technique, knowledge of anatomy and precise landmarks are relevant for correct dye dispersion.

Keywords anatomy, brachial plexus block, dog.

Introduction

The brachial plexus is a network of nerves that provides innervation to all structures of the thoracic limb. The canine brachial plexus has been documented to receive contributions from the ventral spinal nerve rami of the fifth cervical (C_5) to the second thoracic (T_2) vertebrae (Allam et al. 1952; Mahler & Adogwa 2008; Dyce et al. 2010). However, contributions from C_5 and T_2 are usually minor, if present at all (Allam et al. 1952).

Blockade of the brachial plexus is commonly performed in canine patients undergoing surgical procedures of the thoracic limb to provide local analgesia and to improve patient comfort. In people and cats undergoing general inhalation anesthesia, successful block of the brachial plexus provides an inhalant sparing effect, allowing a reduction in the requirements of anesthetic drugs needed to maintain a surgical plane of anesthesia (Mosing et al. 2010; Yuan et al. 2014).

Innervation to the thoracic limb can be blocked at its origin from the spinal cord (cervical paravertebral block), at the brachial plexus or once the specific nerves travel from the plexus to the limb. The cervical paravertebral block provides regional anesthesia of the distal thoracic limb as well as the proximal humerus and shoulder (Lemke & Dawson 2000). Alternatively, individual blockade of the radial, ulnar, median and musculocutaneous nerves can be performed below their origin from the brachial plexus to provide specific local analgesia of the distal thoracic limb (Trumpatori et al. 2010).

A number of techniques have been described in dogs for performing the block at the level of the brachial plexus. A blind technique has thoroughly been described, which uses specific anatomic landmarks (Campoy & Read 2013; Campoy et al. 2015); however, block failure is still relatively common despite following the descriptions of this block (Nutt 1962; Futema et al. 2002; Campoy et al. 2008; Ricco et al. 2013). Alternatively, the location of the plexus to perform the brachial plexus block can be more accurately determined using electrical stimulation or ultrasonography (Futema et al. 2002; Mahler & Reece 2007; Mahler & Adogwa 2008; Campoy et al. 2010, 2015; Campoy & Read 2013). The use of sophisticated equipment to identify anatomical structures and precise location of the brachial plexus at the cervical or plexus level may be cost or skill limited by most veterinary practitioners, and it did not substantially improve success rates when the block was performed at the cervical paravertebral level (Rioja et al. 2012). Therefore, a review and better description of the current blind technique could provide more concise instructions for improved performance and success rate of the block.

This study had two objectives. The first objective was to dissect and describe the ventral spinal nerve rami that contribute to the formation of the canine brachial plexus and each of its nerves. The second objective was to compare, in dogs, the dye distribution and nerve staining between the currently described traditional blind technique for brachial plexus blockade (Campoy & Read 2013; Campoy et al. 2015) and two alternative blind approaches that use different accesses to the plexus, axillary and perpendicular. It was hypothesized that the alternative approaches would provide easier approaches and better dye distribution than the traditional approach (TA) for brachial plexus blockade in dogs.

Materials and methods

Animals

A total of 18 dog cadavers (six mixed breed dogs, four Labrador Retrievers, two Siberian Huskies, one Bassett Hound, one Border Collie, one German Shepherd, one Golden Retriever, one Rottweiler and one Alaskan Malamute), mean ± standard deviation (SD) weight of 28.2 ± 9.7 kg (range, 14–44 kg) were obtained from a private source, and used for evaluation of three techniques for blockade of the brachial plexus and dissection of the brachial plexus. All cadavers were collected and kept frozen until the start of the study, then thawed completely prior to use and completion of the study over a 3 week period. A proposal was submitted to the University of Guelph Institutional Animal Care Committee, but no approval was necessary for the use of cadavers.

Brachial plexus block techniques

Dogs were equally assigned to one of three techniques – TA, perpendicular approach (PA) or axillary approach (AA) – by a randomization scheme (http://www.randomization.com) with six dogs for each approach. Each dog was first injected in the region of the left brachial plexus with yellow tissue marking dye (0.2 mL kg^{-1}; Cancer Diagnostics Inc., NC, USA). Then the plexus was dissected to identify the location of the dye and each nerve associated with the brachial plexus, including their origins from the spinal cord. Following this phase, the dog was injected in the right brachial plexus with the same volume of dye using one of the alternative techniques, also randomly assigned. Consequently, each dog was treated with two of the three approaches, and the study design resulted in 12 injections for each approach, six injections on the left and six on the right.

The TA was performed with the dog in lateral recumbency with the upper thoracic limb in a relaxed position and extended away from the body, perpendicular to the long axis of the torso (standing angle). The point of the shoulder, the transverse process of C_6, the caudal aspect of the scapulohumeral joint and the first rib were palpated. A 20 gauge, 8.9 cm spinal needle (BD Medical, NJ, USA) was introduced at the midpoint between the transverse process of C_6 and the point of the shoulder (landmark L1), medial to the limb and between the scapula and caudal section of the jugular groove, and advanced in a cranial to

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