The Veterinary Journal 241 (2018) 8–19

Contents lists available at ScienceDirect

The Veterinary Journal

journal homepage: www.elsevier.com/locate/tvjl

Review

Regional anesthetic techniques for the thoracic limb and thorax in small animals: A review of the literature and technique description

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ARTICLE INFO

Keywords:
Brachial plexus
Cats
Dogs
Regional anesthesia
Thoracic paravertebral

ABSTRACT

Veterinary regional anesthesia (RA) has been rapidly increasing in popularity over the last 10 years, as evidenced by the increasing amount of literature available and the continuous development of new techniques in small animals. The introduction of new technologies such as nerve stimulation and ultrasound (which increased the objectivity and precision of the procedure) and the promising beneficial perioperative effects conferred by RA are encouraging clinicians to incorporate these techniques in their daily perioperative anesthetic and analgesic animal care. However, there is a lack of consensus regarding outcomes when RA is used, as well as outcome comparisons between regional anesthetic techniques. Further large-scale clinical studies are still necessary. This article is the first part of a two-part review of RA in small animals, and its aim is to discuss the most relevant studies in the veterinary literature, where objective methods of nerve location have been used, and to illustrate in pictures the currently used techniques for providing RA to the thoracic limb and the thorax in small animals.

Introduction

For the last 20 years, regional anesthesia (RA) has been one of the primary interests of many research groups in veterinary medicine. In the last five years, more than 100 studies have been published on the subject in the most important veterinary journals, and a handful of textbooks dedicated to small animal RA in various languages and with different degrees of detail have been incorporated in the veterinary literature (Campoy and Read, 2013; Lerche et al., 2016; Otero and Portela, 2017). Neuraxial and peripheral RA are widespread in today's clinical veterinary practice, and they are indicated in many surgical and pain management procedures (Wenger, 2004; Mosing et al., 2010; Campoy et al., 2012; Vettorato et al., 2012; Portela et al., 2014).

The use of objective methods to locate the target nerves, such as nerve stimulation (NS) and ultrasound (US), has reduced the failure rates associated with many of the techniques previously performed blindly (Lewis et al., 2015; Munirama and McLeod, 2015) and has led to a resurgence of interest in this area through the development of a new generation of regional anesthetic techniques. NS allows the inference of nerve location based on the electrical current required to elicit an effector muscle response, while US allows real-time visualization of the nerve, the needle-to-nerve relationship, and the injectate distribution, which overcome the limitations of NS (Portela et al., 2013a).

The aim of this review is to discuss the most relevant studies in the veterinary literature where objective methods of nerve location have been used and to use pictures to illustrate currently used techniques for administering peripheral nerve blocks in small animals. This literature review will focus on the RA techniques involving the thoracic limb and the thorax, while a second part will focus on techniques involving the abdominal wall and the pelvic limb.

Regional anesthesia of the thoracic limb

Desensitization of the entire thoracic limb or selected areas can be obtained by approaching the nerves at different locations from their emergence from the intervertebral foramina to a more distal location in the brachial region. An overview of the various approaches to the thoracic limb guided by NS and US is presented in Fig. 1 and summarized in Table 1.

Relevant anatomy of the thoracic limb

The brachial plexus (BP) provides sensory, motor and autonomic innervation to the thoracic limb. It is formed by the ventral

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https://doi.org/10.1016/j.tvjl.2018.09.006
1090-0233/

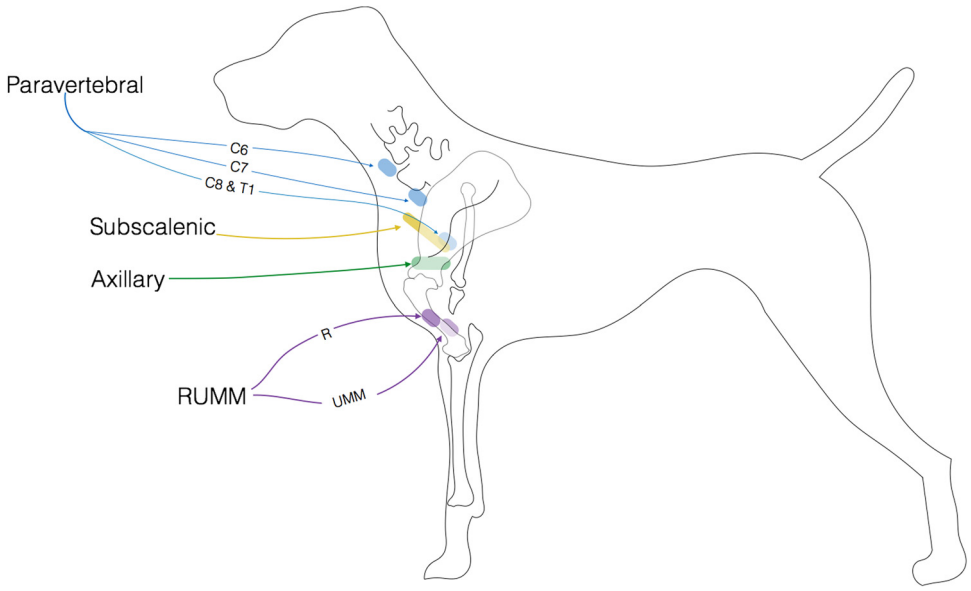

Fig. 1. Approaches described for thoracic limb nerve blocks. Modified from Otero and Portela 2017. Used with permission. RUMM, radial, ulnar, median and musculocutaneous nerves.

branches of the 6th, 7th and 8th cervical spinal nerves and the 1st thoracic spinal nerve, which are interconnected at the axillary space to form the suprascapular (C6), subscapular (C6 and C7), musculocutaneous (C7), axillary (C7 and C8), radial (C7, T8 and T1), median (C8 and T1) and ulnar (C8 and T1) nerves (Allam et al., 1952).

Paravertebral brachial plexus (PVBP) block

This technique aims to block the ventral branches of the spinal nerves forming the BP close to their respective intervertebral foramina (Lemke and Dawson, 2000). It provides analgesia to almost the entire thoracic limb, including the shoulder joint, thereby effectively blocking structures proximal to the elbow (Choquette et al., 2017).

A study performed in dog cadavers showed that only 33% of the cases had a successful staining of all the targeted spinal nerves (C6, C7, C8, and T1) when a blind technique was used (Hofmeister et al., 2007). Due to the difficulty in reaching the nerves located beneath the scapula, Lemke and Creighton (2008) proposed to block C8 and T1 by a single injection, cranial to the first rib, above the costochondral junction and guiding the needle by NS. However,

Table 1
Nerves blocked, indications and relevant comments of the peripheral nerve blocks of the thoracic limb and thorax.

Technique	Nerves blocked	Indications	Notes
Thoracic limb			
Paravertebral BP block (US or NS)[a]	C6, C7 and C8-T1	• Thoracic limb amputations	No evidence of effect on dorsal branches of the spinal nerves, therefore it could not provide complete analgesia for amputation.
		• Surgical procedures proximal to the elbow	
Subscalenic BP block (US)[a]	C6, C7 and C8-T1	• Thoracic limb amputations	It does not block dorsal branches of the spinal nerves and therefore it does not provide complete analgesia in amputations.
		• Humeral surgery • Elbow surgery • Radial/ulnar surgery	
Axillary BP block (US or NS)	Musculocutaneous, radial, ulnar, and median	• Distal humeral surgery	An increase in the recommended volume might increase the success rate of this blockade. Dilution of local anesthetic might be necessary to avoid injecting toxic doses.
		• Elbow surgery • Radial/ulnar surgery	
RUMM block (US or NS)	Musculocutaneous, radial, ulnar and median	• Radial/ulnar surgery	
		• Carpal surgery • Metacarpal surgery	
Thorax			
Thoracic Paravertebral block (NS or US)[a]	Thoracic spinal nerves	• Lateral thoracotomies	It is recommended to block at least five spinal nerves if NS is used.
		• Rib cage surgery	It is recommended to block three to five spinal nerves if US is used.

BP, brachial plexus; RUMM, radial, ulnar, median and musculocutaneous nerves.
[a] No clinical studies published; therefore, recommendations are based on the authors' experience.