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RESEARCH PAPER

Sonographic evaluation of epidural and intrathecal injections in cats

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Abstract

Objectives To describe the ultrasonographic anatomy of the caudal lumbar spine in cats and to detect ultrasound (US) signs associated with epidural or intrathecal injection.

Study design Prospective, clinical study.

Animals Twenty-six client-owned cats.

Methods Transverse (position 1) and parasagittal (position 2) two-dimensional US scanning was performed over the caudal lumbar spine in all cats. Midline distances between the identified structures were measured. Cats assigned to epidural injection (group E, $n = 16$) were administered a bupivacaine–morphine combination confirmed by electrical stimulation. Cats assigned to intrathecal injection (group I, $n = 10$) were administered a morphine–iohexol combination injected at the lumbosacral level and confirmed by lateral radiography. The total volume injected (0.3 mL kg^{-1}) was divided into two equal aliquots that were injected without needle repositioning, with the US probe in positions 1 and 2, respectively. The presence or absence of a burst of color [color flow Doppler test (CFDT)], dural sac collapse and epidural space enlargement were registered during and after both injections.

Results US scanning allowed measurement of the distances between the highly visible structures inside the spinal canal. CFDT was positive for all animals in group E. In group I, intrathecal injection was confirmed in only two animals, for which the CFDT was negative; seven cats inadvertently and simultaneously were administered an epidural injection and showed a positive CFDT during the second aliquot injection, and the remaining animal was administered epidural anesthesia and was excluded from the CFDT data analysis. Dural sac collapse and epidural space enlargement were present in all animals in which an epidural injection was confirmed.

Conclusions and clinical relevance US examination allowed an anatomical description of the caudal lumbar spine and real-time confirmation of epidural injection by observation of a positive CFDT, dural sac collapse and epidural space enlargement.

Keywords cats, doppler, epidural, intrathecal, ultrasound.

Introduction

The techniques of epidural and intrathecal anesthesia are traditionally performed in veterinary medicine to control nociception and postoperative pain (Otero & Campoy 2013). In cats, the epidural space is traditionally accessed at the lumbosacral level,

and needle placement is commonly confirmed with the perception of a 'pop' or a distinct loss of resistance as soon as the needle pierces the interarcuate ligament (Jones 2001; Skarda & Tranquilli 2007; Valverde 2008). However, performing epidural injection using this blind and subjective technique in the presence of a large dural sac (Fletcher & Malkmus 1999) increases the risk for accidental dural puncture and intrathecal injection of anesthetics (Maierl & Liebich 1998; Otero et al. 2014), which may result in profound hypotension, cardiovascular collapse and death (Casoni et al. 2014).

In humans, ultrasonography facilitates the central neuraxial blockade by providing pre-procedure scanning of the spine (Karmakar et al. 2009; Chin et al. 2011), real-time assessment of needle placement and spread of injection (Raghunathan et al. 2008; Lundblad et al. 2012; Triffterer et al. 2012), and an unambiguous identification of epidural or intrathecal injection with the presence or absence of a color flow Doppler signal (Tsui et al. 2013), dural sac collapse and enlargement of the epidural space (Roberts et al. 2005). According to Tsui et al. (2013), detection of a burst of color would represent the injection of fluid into a narrow area such as the epidural space, whereas a minimal or absent color signal indicates the injection of fluid into an already fluid-filled space, such as the intrathecal space filled with cerebrospinal fluid (CSF). Additionally, it has been reported that ultrasound (US) examination before epidural and intrathecal injections in dogs can increase the rate of success and accelerate the learning curve for the performance of epidural anesthesia (Etienne et al. 2010; Gregori et al. 2014; Liotta et al. 2014).

No report describing the sonoanatomy of the caudal lumbar region in cats, or the use of US to aid neuraxial blockades in this species, was found in a literature search. The aim of this study was to describe the US anatomy of the caudal lumbar region and to detect US signs associated with neuraxial injection. The study was designed to test the hypothesis that a positive color flow Doppler test (CFDT), as well as dural sac collapse and epidural space enlargement, would be present during epidural but not intrathecal drug administration in cats.

Materials and methods

With the approval of the Institutional Animal Care and Use Committee, Faculty of Veterinary Sciences, University of Buenos Aires (project no. 2012/31) and after obtaining owners' written consent, 26 domestic short-haired adult cats were enrolled in this prospective clinical study. All animals were admitted to the Veterinary Teaching Hospital, Faculty of Veterinary Sciences, University of Buenos Aires to undergo surgical procedures in which epidural or intrathecal anesthesia was planned as part of the analgesic protocol.

Exclusion criteria were an American Society of Anesthesiologists (ASA) physical status of class IV or higher, pelvic trauma, congenital alterations of the spine, coagulation disorders and skin infection at the puncture site.

Cats were assigned to either epidural injection (group E, $n = 16$) or intrathecal injection (group I, $n = 10$).

Anesthetic management

At 15 minutes after premedication with dexmedetomidine (10 μg kg^{-1}; Dexdomitor; Pfizer Animal Health, Argentina) intramuscularly, general anesthesia was induced with propofol intravenously to effect (2–4 mg kg^{-1}; Propovet; Laboratorios Richmond, Argentina), followed by tracheal intubation or laryngeal mask placement. Anesthesia was maintained with isoflurane in oxygen delivered through a pediatric circle system, allowing spontaneous ventilation. Heart rate (HR), respiratory rate, pulse oximetry, noninvasive arterial blood pressure and rectal temperature were measured throughout the procedure using a multi-parameter monitor (Goldway VET 420A; Goldway US, Inc., NY, USA).

Ultrasound investigation of the lumbar region

The US study was performed by an anesthesiologist (PEO) experienced in US-guided regional anesthesia, with a portable Sonosite M-Turbo with Version 3.4.1 software (Sonosite, Inc., WA, USA) and a 45 mm wide linear array probe set to a frequency of 11–13 MHz (HLF 38; Sonosite, Inc.). A scanning depth of 2.7 cm was selected and gain was manually adjusted to obtain the best possible image. Cats were positioned in sternal recumbency with a 10 cm diameter roll cushion beneath the lower abdomen. The dorsal region from the mid-lumbar area to the proximal third of the tail was clipped. The lumbosacral junction was identified by palpation and the lumbar vertebrae (L) spinous processes counted cranially from L7 to L5. The skin overlying these spinous processes was then marked using a skin-

