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RESEARCH PAPER

# Thermography as an early predictive measurement for evaluating epidural and femoral–sciatic block success in dogs

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## Abstract

**Objective** To evaluate skin temperature increase as an early predictive measure for evaluating epidural and femoral-sciatic block success in dogs.

**Study design** Prospective clinical trial.

**Animals** A total of 29 dogs undergoing orthopaedic surgery on one hindlimb.

**Methods** Dogs were anaesthetized and placed into lateral recumbency with the affected limb uppermost and the coat was clipped. Baseline infrared thermographic images (T0) of the affected limb, of the paw pad of the affected leg and of the ipsilateral paw pad were taken. Subsequently, dogs received either an epidural (EPI; $n = 11$) or a femoral–sciatic block (FS; $n = 18$) using bupivacaine 1 mg kg$^{-1}$. Then, 2 minutes after placement of the block, thermographic images were obtained every 3 minutes for a total of four measurements (T1–T4) and surgery was commenced. Rescue analgesia consisting of fentanyl 1 µg kg$^{-1}$ was administered if needed. A regional block was considered successful if the dose of fentanyl administered was less than the lower 95% confidence interval of the geometric mean of the total fentanyl used in each group. A $\geq 1$ °C increase of skin temperature was considered as the minimum increase required for detection of a successful block.

**Results** A total of 12 out of 18 blocks in the FS and eight of 11 in the EPI group were considered successful based on fentanyl consumption. Out of these, only four of 12 in the FS and one of eight in the EPI group developed an increase in temperature of $\geq 1$ °C. Contrarily, four of six of the non-successful cases in the FS and three of three in the EPI group developed an increase in temperature of $\geq 1$ °C.

**Conclusions and clinical relevance** Contrary to reports in people, thermography did not indicate regional block success prior to surgery in dogs. However further studies under more controlled conditions are needed to determine whether thermography can be used to indicate failure of regional blockade.

## Introduction

Providing optimum perioperative analgesia during orthopaedic surgeries can be challenging. Local anaesthesia is commonly used to interrupt the generation and propagation of action potentials in neural tissue to block sensory and possibly motor function. Used as part of a multimodal approach to enhance intraoperative analgesia, local anaesthetic techniques are considered superior to a standard analgesic protocol consisting of repeated injections of nonsteroidal anti-inflammatory agents and hydromorphone for treating pain in the postoperative period (Troncy et al. 2002); however, they are not always successful.

In dogs, the success for lumbar–plexus–sciatic block has been reported to be 76% (Vettorato et al. 2012) and for extradural injection 88.0–93.6% (Heath et al. 1985; Troncy et al. 2002). Block failure



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can occur due to incorrect needle placement or patient positioning, incorrect puncture site, equipment failure and insufficient choice of local anaesthetic dose and/or volume (Hermanides et al. 2012).

In an anaesthetized animal, it can be difficult to assess whether action potentials have been successfully blocked or not. This may affect postoperative analgesia as a result of awareness of pain on emergence as has been demonstrated in humans (Asghar et al. 2014). In human medicine, surrogate measures such as pin prick testing or cold/warm stimulation have traditionally been used to test the efficacy or *success* of local anaesthetic blockade prior to surgery. However, these tests are subjective, require a cooperative patient (Asghar et al. 2014) and cannot be used in patients in whom the block was attempted under deep sedation or general anaesthesia (Cheema et al. 1994). The same difficulties also apply to veterinary subjects in which regional anaesthetic blocks are usually undertaken in anaesthetized animals prior to invasive surgery.

As successful regional blockade leads to vasodilation and subsequent increases in skin temperature due to blockade of sympathetic nerve fibres, Galvin et al. (2006) suggested that this increase in skin temperature could be used to evaluate block effectiveness with higher sensitivity and specificity than observations of changes in sensation to pinprick and cold stimuli and may offer advantages in evaluating the success of regional anaesthetic blocks in anaesthetized or heavily sedated subjects.

Thermography is a noninvasive and reliable method of detecting and visualizing changes in surface temperatures. Surface heat measured from the skin is directly related to the local dermal microcirculation, which is directly controlled by the autonomic nervous system. Blockade of sympathetic nerve fibres by local anaesthetic agents leads to vasodilation and increased blood flow, resulting in an increase in skin temperature, specifically in the toes or fingertips of the blocked limb (Werdehausen et al. 2007). Studies in human medicine have found an increase in mean skin temperature to be an early and reliable indicator of a successful epidural, femoral and sciatic nerve block (Galvin et al. 2006; Stevens et al. 2006; Werdehausen et al. 2007; van Haren et al. 2013). The temperature increase observed after successful block is due to the blockade of the postganglionic sympathetic fibres, which travel alongside all major nerves and are responsible for control of the vasomotor tone of the vessels in the innervated area. These fibres are blocked first, followed by sensory and finally motor nerves (Fischer & Pinnock 2004), thereby accounting for the faster results obtained by thermography compared to sensory or motor tests.

In veterinary medicine, thermography has been used for detecting and visualizing changes in superficial temperature in animals for a variety of reasons (von Schweinitz 1999; Turner 2001; Knizkova & Kunc 2007; Levet et al. 2009; Redaelli et al. 2014). In dogs, thermography has been used to identify normal thermographic patterns in the limbs of healthy dogs (Loughin & Marino 2007), to evaluate heat loss via the skin after premedication (Vainionpää et al. 2013) and for diagnostic purposes (Um et al. 2005; Grossbard et al. 2014; Biondi et al. 2015). However, to the author's knowledge there have been no studies evaluating thermography as a predictive measure for the success of local anaesthetic blocks in animals.

The aim of this study was to assess the feasibility of thermography to predict the success of extradural (EPI) and femoral–sciatic (FB)local anaesthetic blocks in dogs prior to orthopaedic surgery within a time frame applicable for a clinical setting. We hypothesized that an increase in skin temperature of $\geq$ 1 °C in the paw pads after regional anaesthesia would correlate positively with regional block success.

## Materials and methods

The study was approved by the Royal (Dick) School of Veterinary Studies Veterinary Ethical Review Committee (VERC ref 34/14) and informed owner consent was obtained.

Inclusion criteria for enrolment in the study were dogs requiring anaesthesia for orthopaedic procedures of a pelvic limb. The dogs were required to have an American Society of Anesthesiologists score of I or II without the presence of coagulopathies, disruption of blood vessels in the area of interest or contraindications for the use of local anaesthetics or regional block techniques.

A sample size calculation assuming 80% power based on a similar study in humans (Stevens et al. 2006) was conducted prior to the start of the study using a two-sample *t* test (Minitab Statistical software). The calculation was based on the mean temperature change observed within the groups of that study: $1.8 \pm 0.9$ °C for those administered a femoral–sciatic nerve block and $5.7 \pm 2.3$ °C for those administered an epidural. According to the calculation, a total of six dogs and four dogs were required for the FS group and EPI group, respectively. Data

  

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