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RESEARCH PAPER

Do heat and moisture exchangers in the anaesthesia breathing circuit preserve body temperature in dogs undergoing anaesthesia for magnetic resonance imaging?

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Abstract

Objective To investigate whether the use of a heat and moisture exchanger (HME) preserves body temperature in dogs weighing <10 kg anaesthetised for magnetic resonance imaging (MRI).

Study design Prospective, randomised, clinical trial.

Animals Thirty-one client-owned dogs.

Methods Dogs were randomly assigned to a treatment group [HME (n = 16) or no HME (n = 15)]. Dogs were pseudorandomised according to the premedication they were administered, either dexmedetomidine or no dexmedetomidine. Induction agents were not standardised. General anaesthesia was maintained with isoflurane vaporised in 100% oxygen delivered using a T-piece and a fresh gas flow of 600 mL kg^{-1} minute^{-1}. Rectal temperature was measured before premedication (T1), after induction (T2), before moving to the MRI unit (T3) and at the end of the MRI scan (T4). Ambient temperatures were measured in the induction room, outside and inside the MRI unit. Data were analysed using a general linear model with T4 as the outcome variable. Linear correlations were performed between T1, T2, T3 and T4, and variables that predicted T4 were investigated.

Results Sex, age and body mass were not significantly different between groups. There were no significant differences in rectal temperature between groups at any time point (group with HME at the end of MRI = 36.26 ± 1.05 °C; group with no HME at the end of MRI = 36.24 ± 1.41 °C) but at the end of the MRI, dogs administered dexmedetomidine (36.6 ± 0.7 °C) had a higher rectal temperature compared with dogs not administered dexmedetomidine (35.9 ± 1.6 °C) for premedication. Rectal temperature varied directly with ambient temperature in MRI scanning room and inversely with anaesthetic duration.

Conclusions and clinical relevance Using an HME did not alter body temperature in dogs weighing <10 kg undergoing an MRI, but including dexmedetomidine in the premedication regimen seemed to preserve the body temperature during anaesthesia.

Keywords dexmedetomidine, dogs, heat and moisture exchanger, hypothermia, magnetic resonance imaging.

Introduction

Postanaesthetic hypothermia is very common in small animals (Redondo et al. 2012a, b). Recent retrospective studies estimate the frequency of hypothermia to be 97.4% and 83.6%, respectively, for cats and dogs when hypothermia is defined as $T°$ < 38.5 °C (Redondo et al. 2012a, b). However, normothermia for dogs and cats has also been previously described as 37.8–39.2 °C (Armstrong et al. 2005), so this prevalence of hypothermia might be an overestimation. However, there appears to be no

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overall agreement in the literature about the definition of hypothermia in small animals.

Hypothermia has a myriad of effects on body systems. For example, it can affect the cardiovascular system to cause bradycardia, arrhythmias and hypotension; the respiratory system to cause hypoventilation, apnoea and hypoxaemia; the metabolic and endocrine systems to decrease metabolic rate and reduce the efficacy of the coagulation cascade; and the immune system to increase the risk of wound infection (Armstrong et al. 2005). Many studies in small animals (Cabell et al. 1997; Machon et al. 1999; Kibanda & Gurney 2012; Clark-Price et al. 2013) have shown that active warming techniques such as heat mats and forced warm-air blankets are effective at preventing or treating perioperative hypothermia. However, preservation of body temperature during anaesthesia in patients undergoing magnetic resonance imaging (MRI) is problematic. MRI scanners use magnetic fields and radio waves to form images of the body. Therefore, all electrical devices used in MRI scanners have to be nonmagnetic and electrically nonconductive. Another feature of MRI rooms is their low temperature, which is mandatory to keep the magnet cool. To the authors' knowledge, none of the currently available active warming devices are MRI compatible. Maintenance of normothermia is one of the key goals of supportive practices during anaesthesia. The only option to support body temperature when animals are undergoing an MRI scan is to use passive warming devices that are compatible with MRI technology.

Heat and moisture exchangers (HMEs) are disposable devices placed between the patient and the breathing system. The exchanging medium is composed of foam, paper or a substance that acts as a condensation and absorption surface. This medium is enclosed in plastic housing. There is also commonly a port built into the plastic housing to allow a gas sampling line for a respiratory gas monitor to be attached. The aim of the device is to conserve exhaled water and heat and return it to the patient in the inspired gas (Dorsch & Dorsch 2014). There are no clinical data in the literature regarding the efficacy of HMEs in preservation of body temperature when used alone (i.e., without external warming devices such as heat mats) in small animals weighing <10 kg.

The primary aim of this study was to investigate the efficacy of HMEs to maintain normothermia in dogs <10 kg body mass undergoing anaesthesia for MRI. We hypothesised that dogs receiving an HME would maintain a higher rectal body temperature than dogs that did not receive an HME in the anaesthetic breathing system.

A secondary aim was to test the hypothesis that anaesthetised dogs administered dexmedetomidine for premedication would have a smaller decrease in rectal temperature than dogs not administered dexmedetomidine as part of their premedication protocol.

Materials and methods

Dogs

A prospective, pseudorandomised, clinical trial on 31 client-owned dogs weighing <10 kg and requiring general anaesthesia for an MRI scan was conducted. The American Society of Anesthesiologists (ASA) physical status grade was also recorded but was not part of the inclusion criteria. This study was approved by the University of Bristol ethical committee (VIN/13/028). Study-specific owner consent was not considered necessary by the institution's ethics committee because anaesthetists were free to choose between routinely used sedative and anaesthetic medications and the consent to participate in the study was covered by the clinic's general client consent form. The inclusion criteria for the study were that animals weighed between 2.5 and 10 kg, had intravenous access established with an intravenous catheter before premedication, and tolerated rectal measurement of body temperature. Dogs with hypothermia (<37.8 °C) or hyperthermia (>39.2 °C) before premedication were excluded from the study.

Procedures

Because of the clinical nature of the study, it was problematic to standardise the anaesthesia protocol for all dogs that entered the study, therefore the anaesthesia protocol was matched between cases receiving an HME (HME group) and the control group (no HME; Fig. 1). Thus, two randomisation charts were used, one for dogs premedicated with dexmedetomidine and the other for dogs not premedicated with dexmedetomidine to assure that the same number of cases was administered dexmedetomidine in each group.

Following a complete physical examination by a clinical anaesthetist, dogs were allocated to a group (HME or no HME). Dose and choice of the premedication and induction agent were at the discretion of the clinician in charge of the case. All dogs were administered an opioid, which was most commonly butorphanol. Dexmedetomidine dose, in those

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