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RESEARCH PAPER

Comparison of the effects of propofol and emulsified isoflurane alone or combined with dexmedetomidine on induction of anesthesia in dogs

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Abstract

Objective To compare the respective effects of propofol and emulsified isoflurane administered alone and in combination with dexmedetomidine on the quality of induction of anesthesia, physiological variables and recovery in dogs.

Study design Prospective, randomized, experimental trial.

Animals Thirty-six adult mixed-breed dogs.

Methods Animals were randomly assigned to one of four induction protocols: propofol alone (group P); emulsified isoflurane alone (group EI); both propofol and dexmedetomidine (group PD), or both emulsified isoflurane and dexmedetomidine (group EID). Pulse rate (PR), respiratory rate (f_R), non-invasive arterial blood pressure and arterial blood gases were measured at baseline, before induction, immediately after intubation (time 0), and at 5 minute intervals until the dog began to swallow and the trachea was extubated. The quality of induction and recovery, and degree of ataxia were scored by a single investigator unaware of group assignment. The durations of anesthesia and recovery, and the incidence of adverse events were recorded.

Results There were no clinically significant differences among the groups in induction quality. Systolic arterial pressure was lower in EID compared with P at 5 minutes. PR and f_R were lower in PD and EID compared with P after induction. The $PaCO_2$ at 5 minutes was higher than at baseline in group P. Ataxia score was lower in EID than in P. Time from induction to extubation and time from extubation to sternal recumbency were lower in EID compared with PD.

Conclusions and clinical relevance There were no clinically significant differences among the groups in induction quality. In PD and EID, but not in P, PR and f_R were decreased after induction. The EID combination resulted in smooth and rapid induction and recovery and thus may be useful clinically for induction of anesthesia.

Keywords dexmedetomidine, dog, emulsified isoflurane, intravenous anesthesia, propofol.

Introduction

Dexmedetomidine is a highly selective α_2-adrenoreceptor agonist (α_2-agonist) that is widely used in clinical veterinary medicine for anxiolysis, analgesia and sedation (Chen et al. 2012). It is also reported to decrease central sympathetic outflow and to modify intraoperative cardiovascular responses to noxious stimuli during laparoscopy (Maze & Tranquilli 1991; Aho et al. 1992). Minimal respiratory depression has been reported (Gerlach et al. 2009). In one study of vascular surgery in humans, use of dexmedetomidine weakened the stress response and release of norepinephrine by modulating sympathetic activity (Talke et al. 2000). In another study in humans, premedication with dexmedetomidine (25 μg kg^{-1}) administered intramuscularly

(IM) reduced oxygen consumption, carbon dioxide production and energy consumption in comparison with placebo (0.9% NaCl) (Taittonen et al. 1997). Disadvantages to its use include hypotension, hypertension, nausea, bradycardia and dry mouth (Bhana et al. 2000).

Propofol (2,6-diisopropylphenol) is administered by intravenous (IV) injection to provide induction of anesthesia before the administration of an inhalation agent (Taboada & Murison 2010) or as a continuous administration for total IV anesthesia (Ambros et al. 2008). The advantages of propofol include rapid and smooth induction of anesthesia, short duration of action, smooth recovery and few cumulative effects when it is administered repeatedly (Muir & Gadawski 1998). However, a decrease in systemic arterial pressure following IV administration of propofol has been documented in humans and animals (Shafer et al. 1988; Park & Lynch 1992). Recovery from propofol anesthesia in dogs has been found to be superior to recovery from thiopental (Ko et al. 1999) or etomidate (Sams et al. 2008) in terms of quality and recovery time.

The IV administration of liquid volatile anesthetic agents is usually lethal (Stemp 1990), although several studies in various species suggest that use of lipid emulsions of isoflurane or halothane IV may be effective for induction of anesthesia (Biber et al. 1984; Eger & MacLeod 1995; Musser et al. 1999). Use of emulsified isoflurane (EI) has generated interest as it does not require specific ventilatory circuits, provides quick induction of anesthesia and recovery, is associated with hemodynamic stability (Mathias et al. 2004), and incurs less environmental pollution than inhalation anesthesia. IV administration of 8% EI was reported to be effective without adverse effects in rats (Zhou et al. 2006) and dogs (Yang et al. 2006). Furthermore, EI was demonstrated to have protective effects on the lungs in rats (Zhang et al. 2011).

The aims of this study were: 1) to compare the effects of propofol and EI for induction of anesthesia; and 2) to characterize the effects of dexmedetomidine on anesthetic induction and dose requirements of propofol and EI.

Materials and methods

Animals

With the approval of the Animal Care and Use Committee of Northeast Agricultural University, Harbin, China, 36 adult mixed-breed dogs were included in the study. Dogs weighed 3.7–5.8 kg and were aged 1.0–2.8 years. Exclusion criteria included overweight condition, cardiovascular disease, administration of additional sedative agents, and sedation or anesthesia within 48 hours of the procedure. All dogs underwent a routine physical examination, complete blood count, biochemical profile and electrocardiography before the experiment. All animals appeared to be healthy and exhibited no clinical signs of disease.

Materials

Emulsified isoflurane was prepared as described previously (Yang et al. 2006) by putting 0.8 mL liquid isoflurane (Heilongjiang Key Laboratory of Anesthesiology and Intensive Care Research, Heilongjiang, China) and 9.2 mL 30% Intralipid (Second Affiliated Hospital of Harbin Medical University, Heilongjiang, China) into a 10 mL glass ampoule, which was then sealed using an alcohol blowtorch. The ampoule was vigorously shaken by a vortex mixer (Naze Co. Ltd, Shanghai, China) for 15 minutes to dissolve the isoflurane into the lipid emulsion. This preparation procedure was reported in a previous study which found that the isoflurane concentration remained unchanged for 6 months when the ampoules were stored at room temperature (Yang et al. 2006).

Study protocol

All animals were fasted for at least 8 hours before the experiment and were provided with water at all times until the time of premedication. The weight and body condition score (BCS) of each dog were obtained by the same person according to the published literature (Lund et al. 1999). Using a computer-generated list of random numbers, each of the 36 dogs was allocated to one of four equally sized groups: group P, propofol (6 mg kg^{-1}; Xi'an Libang Pharmaceutical Co. Ltd, Shaanxi, China); group PD, propofol (4 mg kg^{-1}) and dexmedetomidine (3 μg kg^{-1}; Pfizer Pharmaceutical Co. Ltd, NY, USA); group EI, EI (0.5 mL kg^{-1}); and group EID, EI (0.4 mL kg^{-1}) and dexmedetomidine (3 μg kg^{-1}). In groups PD and EID, dexmedetomidine was administered IV at least 5 minutes prior to induction of anesthesia.

A 24 gauge catheter (Pu Yi Medical Devices Co. Ltd, Shanghai, China) was inserted into a cephalic

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