Veterinary
Anaesthesia and Analgesia
Formerly the Journal of Veterinary Anaesthesia

Veterinary Anaesthesia and Analgesia, 2015, **42**, 133–141 doi:10.1111/vaa.12190

RESEARCH PAPER

Cardiovascular function during maintenance of anaesthesia with isoflurane or alfaxalone infusion in greyhounds experiencing blood loss

Anthea L Raisis, Lisa Smart, Eleanor Drynan & Giselle Hosgood
College Of Veterinary Medicine, Murdoch University, Perth, WA, Australia

Correspondence: Anthea L Raisis, Veterinary Anaesthesia and Analgesia Section, College of Veterinary Medicine, Murdoch University, Murdoch drive, Murdoch, Perth, WA 6150, Australia. E-mail: A.Raisis@murdoch.edu.au

Abstract

Objective To compare adequacy of oxygen delivery and severity of shock during maintenance of anaesthesia with isoflurane or alfaxalone infusion in greyhounds experiencing blood loss.

Study design Prospective, randomised study.

Animals Twenty-four greyhounds (ASA I).

Methods All greyhounds were premedicated with methadone (0.2 mg kg^{-1}) intramuscularly. Anaesthesia was induced with alfaxalone 2.5 mg kg^{-1}intravenously. Following endotracheal intubation, the dogs were connected to an anaesthetic circle circuit delivering oxygen. Dogs were allocated to receive inhaled isoflurane or an intravenous infusion of alfaxalone for maintenance of anaesthesia. Isoflurane was initially administered to achieve an end-tidal concentration of 1.4% and alfaxalone was initially administered at 0.13 mg kg^{-1} $minute^{-1}$. The dose of isoflurane or alfaxalone was adjusted during instrumentation to produce a clinically equivalent depth of anaesthesia. All dogs were mechanically ventilated to normocapnia (P_aCO_2 35–40 mmHg; 4.67–5.33 kPa). Passive warming maintained core body temperature between 37 and 38 °C. Measured and calculated indices of cardiovascular function, including mean arterial blood pressure (MAP), cardiac index (CI), systemic vascular resistance index (SVRI), oxygen delivery index ($\dot{D}O_2I$), oxygen consumption index ($\dot{V}O_2I$) and oxygen extraction ratio (OER), were determined at baseline (60 minutes after start of anaesthesia) and after removal of 32 mL $kg^{-1}$and 48 mL $kg^{-1}$of blood.

Results In all dogs, blood loss resulted in a significant decrease in MAP, CI, $\dot{D}O_2$, and a significant increase in SVRI, $\dot{V}O_2I$, and OER. The changes in each of the indices did not differ significantly between dogs receiving isoflurane and dogs receiving alfaxalone.

Conclusion and clinical relevance No difference in oxygen delivery or severity of shock was observed when either inhaled isoflurane or intravenous alfaxalone infusion was used for maintenance of anaesthesia in greyhounds experiencing blood loss. There appears to be no clinical advantage to choosing one anaesthetic agent for maintenance of anaesthesia over the other in a dog experiencing blood loss.

Keywords alfaxalone, anaesthesia, blood loss, haemorrhage, isoflurane.

Introduction

Intra-operative blood loss and hypovolaemia-related hypotension is a problem associated with surgery that can contribute to morbidity and mortality in people and animals (Gaynor et al. 1999; Morris

et al. 2005; Redondo et al. 2007). Treatment of hypovolaemia during surgery is based on blood volume expansion with intravenous (IV) fluid therapy and, if necessary, administration of blood products. Many anaesthetic agents cause a dose-dependent decrease in blood pressure by depressing myocardial contractility, and/or decreasing systemic vascular resistance. In addition, the baroreceptor reflex response to hypotension is suppressed in a dose-dependent manner. Identification of agents that preserve baroreceptor reflex activity may help limit the severity of shock that can occur with intraoperative blood loss.

A recent study compared the effects of different inhalational anaesthetic agents on cardiovascular function following blood loss (Teixeira Neto et al. 2007). During isoflurane anaesthesia, blood loss was associated with a significantly smaller decrease in cardiac index (CI) and mean arterial pressure (MAP) when compared to halothane anaesthesia and a significantly smaller decrease in MAP when compared to sevoflurane anaesthesia. The smaller decrease in MAP during isoflurane anaesthesia was associated with a significant increase in systemic vascular resistance index (SVRI) which suggested that there was less interference with arterial vasoconstriction, a component of the baroreceptor reflex response to hypotension. Based on these results, isoflurane is considered to be the preferred inhalational anaesthetic agent for anaesthesia of dogs expected to suffer intra-operative blood loss.

Recently, alfaxalone, a neurosteroid anaesthetic agent, has been re-introduced into the veterinary market. Since its re-introduction, there has been extensive investigation of the use of alfaxalone for induction and maintenance of anaesthesia in healthy dogs (Amengual et al. 2013; Herbert et al. 2013). Administration of alfaxalone is associated with an increase in heart rate (HR) and CI despite a decrease in MAP and systemic vascular resistance (Muir et al. 2008; Rodriguez et al. 2012), suggesting that some baroreceptor reflex activity may be present after administration of this agent. If baroreceptor reflex activity persists during alfaxalone infusion, use of this agent for maintenance of anaesthesia of dogs may help preserve cardiovascular function in dogs that suffer intra-operative blood loss. If superior to isoflurane, this agent could provide an alternative for maintenance of anaesthesia in these animals.

The aim of this study was to compare the cardiovascular function before and after blood loss in dogs anaesthetized with inhaled isoflurane or IV alfaxalone. It was hypothesised that when alfaxalone and isoflurane are used to maintain a similar depth of anaesthesia, the decrease in CI, oxygen delivery index ($\dot{D}O_2I$) following blood loss would be less and the severity of shock and thus oxygen extraction ratio (OER) would be lower for dogs receiving alfaxalone compared to dogs receiving isoflurane.

Materials and methods

Animals

Twenty-four donated healthy adult greyhounds (15 males, nine females), scheduled to be used as blood donors were included. Dogs were deemed healthy based on physical examination and a complete blood count within reference intervals. This study was approved by the Animals Ethics Committee of Murdoch University (permit number R2398/11).

Anaesthesia

Each dog received one of two anaesthesia maintenance regimes, either inhaled isoflurane or IV infusion of alfaxalone, according to a randomly generated sequence. All dogs were premedicated with methadone (0.2 mg kg^{-1} intramuscularly (IM) (Methone; Parnell Australia Pty Ltd, Australia) and, 30 minutes later, anaesthesia was induced using 2.5 mg kg^{-1} of alfaxalone IV (Alfaxan; Jurox Pty Ltd, Australia), which achieved adequate depth of anaesthesia for orotracheal intubation.

After endotracheal intubation, the greyhounds were positioned in left lateral recumbency and connected to a small animal rebreathing (circle) system, which delivered up to 100% oxygen. Isoflurane (I.S.O. Veterinary Companies of Australia) was initially administered to achieve an end-tidal concentration ($F_E'ISO$) of 1.4%, which is equivalent to 1.2 × minimum alveolar concentration (MAC) reported in unpremedicated normovolaemic dogs where anaesthesia was induced and maintained with isoflurane (Mattson et al. 2006; Credie et al. 2010). An agent monitor (Capnomac Ultima, Datex-Ohmeda Medical Supplies Australia) was used to measure $F_E'ISO$. Alfaxalone initially was administered at a rate of 0.13 mg kg^{-1} $minute^{-1}$ IV. The administered dose of each agent was adjusted during the instrumentation period, if required, to achieve an equivalent depth of anaesthesia in all dogs characterised by the following clinical signs: ventral eye