Veterinary
Anaesthesia and Analgesia

Formerly the Journal of Veterinary Anaesthesia

Veterinary Anaesthesia and Analgesia, 2010, **37**, 440–450 doi:10.1111/j.1467-2995.2010.00558.x

RESEARCH PAPER

Evaluation of cardiovascular, respiratory and biochemical effects, and anesthetic induction and recovery behavior in horses anesthetized with a 5% micellar microemulsion propofol formulation

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Abstract

Objective To characterize cardiovascular, respiratory and biochemical effects and recovery behavior associated with a 3-hour continuous infusion of a micellar microemulsion propofol formulation in horses.

Study design Prospective experimental trial.

Animals Six healthy adult horses, 9 ± 2 years old and weighing 557 ± 14 kg.

Methods All horses received xylazine (1 mg kg^{-1}, IV) 5 minutes prior to anesthetic induction. Each horse was anesthetized on two occasions with a 5% micellar microemulsion propofol formulation (2 mg kg^{-1}, IV); first as a single bolus (phase I) and then as a 3-hour continuous infusion (phase II). Propofol pharmacokinetics were obtained from phase I and used to determine the starting infusion rates in phase II. Anesthetic induction and recovery characteristics were quantitatively and qualitatively assessed. Cardiovascular, respiratory and biochemical parameters were monitored during anesthesia and recovery.

Results Induction quality varied, ranging from good to poor. Standing and overall recovery quality scores were consistently excellent in phase I but more variability was observed among horses in phase II. Heart rate (HR) and mean arterial pressure (MAP) were adequately maintained but marked hypoventilation developed. There were only minimal changes in blood biochemical analytes following anesthesia.

Conclusions and clinical relevance The micellar microemulsion propofol formulation, administered as a 3-hour continuous infusion, showed similar results compared to those previously described with a commercially available propofol preparation. However, based on present findings, use of propofol as a primary anesthetic in horses for prolonged periods of anesthesia requires further study to determine the limits of safety and clinical applicability.

Keywords equine, propofol, recovery, total intravenous anesthesia.

Introduction

Propofol is an intravenous anesthetic that has a rapid onset, short duration of action, rapid metabolism and does not result in biologically active metabolites. It has been and continues to be used extensively in humans and small companion

animals (Short & Bufalari 1999; Wagner & Hellyer 2000) as an induction agent and for maintenance of general anesthesia. Propofol use in the horse was first described in 1985 (Nolan & Hall 1985) and since then various studies have looked at its anesthetic effects in this species, either as a sole agent (Mama et al. 1995, 1996; Frias et al. 2003; Oku et al. 2005, 2006) or in combination with other drugs (Nolan et al. 1996; Flaherty et al. 1997; Mama et al. 1998; Matthews et al. 1999; Bettschart-Wolfensberger et al. 2001, 2003; Oku et al. 2003; Ohta et al. 2004; Umar et al. 2006, 2007), and good anesthesia recovery quality has been commonly reported. Despite its favorable characteristics for total intravenous anesthesia and potential benefits regarding anesthetic recovery, the use of the commercially available propofol formulation in equine anesthesia has remained limited, due to its high cost of purchase, low concentration (large volume injections) and short shelf life (increased contamination potential). However, a new formulation of propofol (MEDDS, Inc, CA, USA) has been developed. This micellar microemulsion formulation is inexpensive to produce, potentially available in more concentrated forms and less prone to microbial growth. Initial studies comparing high and low concentrations of the micellar microemulsion propofol with the currently available lipid emulsion in horses showed promising results (Boscan et al. 2006) supporting further study.

The purpose of this study was to characterize cardiovascular, respiratory and biochemical effects and recovery behavior during and following prolonged continuous infusion of a 5% micellar microemulsion propofol formulation in horses.

Materials and methods

Horses

Six healthy horses (five Thoroughbreds and one Standardbred) were studied. They included four geldings and two females, 9 ± 2 years old (range, 6–12 years), that weighed 557 ± 14 kg. The study protocol was approved by the Animal Use and Care Committee.

Study conditions

Each of the six horses was anesthetized twice, with at least a 2-month interval between events. All horses were fasted for 12 hours before anesthetic induction, but water was available at all times. At least 1 hour prior to induction, rectal temperature (T), heart rate (HR), respiratory rate (f_R), packed cell volume (PCV) and plasma protein concentration (TP) were determined. A 14-gauge 13-cm catheter was inserted percutaneously in each jugular vein. The catheter placed in the left external jugular vein was used for drug administration and the one placed in the right jugular for blood sampling. After catheter placement, the horses were walked into a padded recovery stall for sedation and induction of anesthesia.

Phase I (first anesthesia – single induction dose)

Horses were sedated with 10% xylazine (Anased; Akorn Inc, IL, USA) (1 mg kg^{-1} of body weight, IV) 5 minutes prior to anesthetic induction with a 5% micellar microemulsion propofol (2 mg kg^{-1} of body weight, IV, administered by continuous hand injection over 1 minute). For induction, the horse's head was supported by an experienced person using a long rope that was attached to the horse's halter at one end and then passed through a ring embedded in the wall of the recovery stall above the level of the horse's head. Following propofol injection, the horses were allowed to move from standing to sternal and then to left lateral recumbency with minimal or no assistance beyond the restraint provided by the head rope. The rope and the halter were then removed, and the horses were observed, but not assisted, until standing. Anesthetic induction and recovery were evaluated directly by two investigators (EPS and MLR) using a 5-point scoring scale (1, poor; 2, marginal; 3, fair; 4, good; 5, excellent). The scoring system has been previously described in greater detail elsewhere (Mama et al. 1995, 1996).

For each horse, the time to first anesthetic effect (generally characterized by raising of the head and transient stiffening of the neck muscles), time to relaxing the hind limbs (sitting), time to sternal recumbency, and observations regarding the quality of induction were recorded. During recovery from anesthesia, the time to first movement (movement of an ear, head or limb), head lift, first attempt to move to a sternal posture and to stand, successfully attaining and remaining in sternal recumbency and standing were recorded. The number of attempts to gain sternal recumbency and to stand was also recorded. The quality of the stand and the overall quality of recovery were assessed separately using the 5-point scoring scale described above.

