Veterinary
Anaesthesia and Analgesia
Formerly the Journal of Veterinary Anaesthesia

Veterinary Anaesthesia and Analgesia, 2012, **39,** 245–255 doi:10.1111/j.1467-2995.2011.00701.x

RESEARCH PAPER

Medetomidine continuous rate intravenous infusion in horses in which surgical anaesthesia is maintained with isoflurane and intravenous infusions of lidocaine and ketamine

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Abstract

Objective To evaluate medetomidine as a continuous rate infusion (CRI) in horses in which anaesthesia is maintained with isoflurane and CRIs of ketamine and lidocaine.

Study design Prospective, randomized, blinded clinical trial.

Animals Forty horses undergoing elective surgery.

Methods After sedation and induction, anaesthesia was maintained with isoflurane. Mechanical ventilation was employed. All horses received lidocaine (1.5 mg kg^{-1} initially, then 2 mg kg^{-1} $hour^{-1}$) and ketamine (2 mg kg^{-1} $hour^{-1}$), both CRIs reducing to 1.5 mg kg^{-1} $hour^{-1}$ after 50 minutes. Horses in group MILK received a medetomidine CRI of 3.6 μg kg^{-1} $hour^{-1}$, reducing after 50 minutes to 2.75 μg kg^{-1} $hour^{-1}$, and horses in group ILK an equal volume of saline. Mean arterial pressure (MAP) was maintained above 70 mmHg using dobutamine. End-tidal concentration of isoflurane ($F_E'ISO$) was adjusted as necessary to maintain surgical anaesthesia. Group ILK received medetomidine (3 μg kg^{-1}) at the end of the procedure. Recovery was evaluated. Differences between groups were analysed using Mann-Whitney, Chi-Square and ANOVA tests as relevant. Significance was taken as $p < 0.05$.

Results $F_E'ISO$ required to maintain surgical anaesthesia in group MILK decreased with time, becoming significantly less than that in group ILK by 45 minutes. After 60 minutes, median (IQR) $F_E'ISO$ in MILK was 0.65 (0.4–1.0) %, and in ILK was 1 (0.62–1.2) %. Physiological parameters did not differ between groups, but group MILK required less dobutamine to support MAP. Total recovery times were similar and recovery quality good in both groups.

Conclusion and clinical relevance A CRI of medetomidine given to horses which were also receiving CRIs of lidocaine and ketamine reduced the concentration of isoflurane necessary to maintain satisfactory anaesthesia for surgery, and reduced the dobutamine required to maintain MAP. No further sedation was required to provide a calm recovery.

Keywords horse, isoflurane, ketamine, lidocaine, medetomidine.

Introduction

For prolonged surgery, horses are anaesthetised commonly with inhalation anaesthetic agents.

However, these agents cause dose-related cardiopulmonary depression and provide poor antinociception (Steffey & Howland 1978). Thus anaesthetic depth can be unsteady and affected by the intensity of surgical stimulation (Haga & Dolvik 2005). Consequently, additional systemic analgesics are administered and reduce the requirement of inhalation agents. The quality of the recovery phase is also of particular importance in equine anaesthesia and the use of sedatives such as alpha-2 agonists has been recommended to produce a calm and uncomplicated return to the standing position. (Santos et al. 2003).

As an alternative to inhalational anaesthesia, total intravenous anaesthesia (TIVA) reduces the endocrine stress response (Luna et al. 1996) and some combinations preserve the blood pressure (McMurphy et al. 2002). Agents with cardiovascular and analgesic properties such as ketamine (Wright 1982) minimize the autonomic response to noxious stimuli. However, ketamine-based TIVA is limited to short anaesthetic procedures due to its potential for drug accumulation in the body. By combining inhalation and injectable agents (partial intravenous anaesthesia, PIVA), the positive effects of both may be obtained. Lower doses of each agent will be used and therefore undesirable effects, such as prolonged recovery due to drug accumulation, reduced, and an adequate state of surgical anaesthesia maintained over a longer period of time (Spadavecchia et al. 2002). Ketamine induces analgesia (Sadove et al. 1971), amnesia, and immobility. It decreases the minimum alveolar concentration (MAC) value for halothane (Muir & Sams 1992) and also improves cardiovascular parameters, mainly by enhancing sympathetic tone. Since recovery quality from anaesthetic doses of ketamine is poor, it is not used as a sole intravenous (IV) agent in horses, (Muir et al. 1977), nor as a constant infusion rate (CRI) at high doses during inhalation anaesthesia (Muir & Sams 1992). However, it is used frequently at lower doses both with a variety of sedative agents for TIVA, and as intermittent boluses or CRI during inhalation anaesthesia.

Systemic lidocaine has shown analgesic effects in several human experimental studies (Koppert et al. 2004) and in experimental pain models in horses (Robertson et al. 2005). Lidocaine IV infusion also decreases requirements for inhalation anaesthetics in horses during experimental (Doherty & Frazier 1998) and clinical trials (Dzikiti et al. 2003). The depression of EEG changes by lidocaine intravenous administration in ponies receiving halothane provides further evidence for its antinociceptive activity (Murrell et al. 2005). The combination of ketamine and lidocaine for PIVA during isoflurane anaesthesia has been described as being advantageous as compared to sole inhalant anaesthesia but recovery phases were slightly inferior despite the use of sedatives (Enderle et al. 2008).

Alpha2-adrenoceptor agonists are effective analgesics (Kamerling et al. 1991). In some studies their use either as single injection or as a CRI has resulted in a dose dependent reduction of inhalation agents (Steffey et al. 2000; Neges et al. 2003; Ringer et al. 2007). However, other studies have failed to confirm this (Devisscher et al. 2010; Schauvliege et al. 2011). Medetomidine has a high clearance rate and short half-life in horses, making it potentially an ideal agent to be given as a CRI (Bettschart-Wolfensberger et al. 1999). Medetomidine CRI has been used to supplement isoflurane anaesthesia in clinical cases, and cardiopulmonary parameters demonstrated to be well maintained (Kalchofner et al. 2009). Medetomidine and lidocaine also have been used in combination during isoflurane anaesthesia in horses (Kruger & Stegmann 2009; Valverde et al. 2010).

The objective of this current study was to evaluate, in horses undergoing elective surgery, if the addition of medetomidine to the combination of lidocaine and ketamine would influence the amount of isoflurane required to maintain anaesthesia, the clinically measured cardiopulmonary parameters and the recovery properties. The hypothesis tested was that horses receiving lidocaine and ketamine alone would require more isoflurane and dobutamine than horses receiving additional medetomidine as a CRI in order to maintain a comparable anaesthetic plane. It also was hypothesized that horses treated peri-operatively with medetomidine as a CRI would recover from general anaesthesia at least as well as the other group without the need for additional sedation during the early recovery phase.

Materials and methods

Animals

Animals included in the study consisted of 40 adult horses, physical status ASA (American Society of Anesthesiologists classification) I–III which were referred to the veterinary clinic for elective surgery.