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SHORT COMMUNICATION

Total intravenous anaesthesia (TIVA) with propofol-fentanyl and propofol-midazolam combinations in spontaneously-breathing goats

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Abstract

Objective To compare the efficacy and cardiopulmonary effects of propofol and fentanyl, with propofol and midazolam for total intravenous anaesthesia.

Study design Prospective, randomized, crossover experimental study.

Animals Six goats; three does and three wethers.

Methods Goats received either fentanyl 0.02 mg kg^{-1} (treatment FP) or midazolam 0.3 mg kg^{-1} (treatment MP) intravenously. One minute later anaesthesia was induced with propofol, then maintained by constant rate infusion of propofol 12.0 mg kg^{-1} $hour^{-1}$ and fentanyl 0.02 mg kg^{-1} $hour^{-1}$ (treatment FP) or propofol 12.0 mg kg^{-1} $hour^{-1}$ and midazolam 0.3 mg kg^{-1} $hour^{-1}$ (treatment MP) for 90 minutes. Response to noxious stimulus was tested every 10 minutes and propofol dose adjusted to prevent purposeful movement. Cardiopulmonary parameters were measured continuously, and arterial blood-gas analysis performed intermittently. Recovery was timed and quality scored. Results are presented as median (IQR).

Results Differences in the propofol induction dose [4.00 (3.96–4.01) and 3.97 (3.91–4.00) mg kg^{-1} for treatments FP and MP, respectively] were not significant. Quality of induction in both groups was smooth. The median propofol dose for maintenance was less ($p = 0.004$) with treatment FP (12.0 mg kg^{-1} $hour^{-1}$) than MP (18.0 mg kg^{-1} $hour^{-1}$). Cardiopulmonary function was well maintained with both treatments. Recovery times in minutes from the end of anaesthetic infusion for treatments FP and MP respectively were; to extubation 3.0 (3.0–3.0) and 4.5 (3.3–5.0); to sternal position, 4.5 (3.3–5.0) and 5.0 (5.0–6.5) and to standing 13.0 (10.3–15.0) and 15.0 (11.3–17.3). Quality of recovery was acceptable in both groups, but abnormal behavioural signs were observed after treatment FP.

Conclusions and clinical relevance Total intravenous anaesthesia with propofol and fentanyl or propofol and midazolam, at the doses studied, in spontaneously-breathing, oxygen-supplemented goats is practicable. Recovery from the fentanyl-propofol combination is not always smooth.

Keywords anaesthesia, constant rate infusion, fentanyl, goat, midazolam, propofol.

Introduction

Propofol is the most suitable agent for total intravenous anaesthesia (TIVA), as it has a short context-sensitive half-time (Bettschart-Wolfensberger et al. 2000). However its poor analgesic properties make it unsatisfactory as a sole agent since the

dosages required to eliminate responses to surgery cause significant cardiopulmonary depression (Smith et al. 1994). In goats, its use as a constant rate infusion (CRI) in combination with ketamine causes immobility and cardiopulmonary effects comparable to those associated with sevoflurane anaesthesia (Larenza et al. 2005), but there is little information on its combination with other agents in this species.

Fentanyl, a mu (MOP) opioid agonist, is used in many species to provide analgesia during propofol anaesthesia (Smith et al. 1994). In goats, it has a short half-life following intravenous (IV) injection, and is therefore suitable for CRI (Carroll et al. 1999). Midazolam, a water-soluble benzodiazepine, is used as a sedative, muscle relaxant and an anticonvulsant in human patients (Cao et al. 2002). In goats, its intramuscular (IM) use causes dose dependent sedation (Stegmann & Bester 2001). Midazolam administered at 0.3 mg kg^{-1} IV resulted in a 40% reduction in the dose of propofol required for induction of anaesthesia (Dzikiti et al. 2009).

In the present study, we assessed in goats the anaesthetic efficacy and cardiopulmonary effects of TIVA from propofol co-administered with either fentanyl or midazolam, and tested the hypothesis that either regimen would produce similar anaesthestic and cardiopulmonary effects.

Materials and methods

This study was approved by the Faculty's Animal Use and Care Committee (Protocol Number: V045/06). Subjects of the study were six adult mixed-breed goats (three does and three wethers). The goats were healthy, based on physical examination, complete blood count and serum biochemical analysis. Their age ranged from 20.0–21.0 months and weight from 39.6–46.5 kg. Every goat received each of the two treatments, with a 4-week washout period between experiments. Allocation as to order of treatment was random. Food and water were withheld for 18–24 hours before anaesthesia.

Study protocol

Baseline measurements were taken of rectal temperature (digital thermometer), and of heart (HR) and respiratory (f_R) rates (by thoracic auscultation over 1 minute). Goats then were placed on a custom-made sling-cum-table for ease of restraint. A 24 gauge catheter was inserted into an auricular artery. Arterial blood pressures [systolic (SAP), diastolic (DAP) and mean (MAP)] were measured and an arterial sample was taken. An 18 gauge catheter was inserted into each cephalic vein for administration of drugs and IV fluids, respectively.

Fentanyl, 0.02 mg kg^{-1}, or midazolam, 0.3 mg kg^{-1}, were administered IV over a 1-minute period. One minute later and immediately before the administration of propofol, the degree of sedation was assessed using a 0–2 scale whereby 0 = no sedation; 1 = moderate sedation – the goat assumed sternal recumbency, and 2 = heavy sedation – the goat failed to maintain sternal recumbency and was unable to hold up its head. Propofol then was administered, initially as a bolus at 2.0 mg kg^{-1} over 15 seconds, followed by incremental doses at 0.5 mg kg^{-1} every 15 seconds until the goats were judged to be anaesthetized sufficiently to allow endotracheal intubation, as determined by presence of a weak palpebral reflex and relaxation of the jaws. Immediately after tracheal intubation the goats were placed in left lateral recumbency. Quality of anaesthetic induction was scored using a 0–2 scale whereby 0 = excitement, jumps or attempts to stand after becoming recumbent, unable to place orotracheal tube; 1 = slightly prolonged (>2 minutes) induction or mild excitement; 2 = smooth induction, no excitement, orotracheal intubation easy. The goats then were connected both to a circle breathing system (Anaesthesia System, Clinicare, Crest Health Technology, UK) with a fresh gas oxygen flow rate of 2 L $minute^{-1}$, and to the monitoring systems. The goats breathed spontaneously but if the end-tidal carbon dioxide ($P_{E'}CO_2$) increased to 55 mmHg or if the peripheral oxygen saturation (SpO_2), decreased below 90%, then mechanical ventilation was commenced. A CRI, of propofol (12.0 mg kg^{-1} $hour^{-1}$) together with either with fentanyl (0.02 mg kg^{-1} $hour^{-1}$) (treatment FP) or midazolam (0.3 mg kg^{-1} $hour^{-1}$) (treatment MP) was started immediately after induction of anaesthesia. Propofol for CRI was drawn up to fill a 60 mL syringe; while fentanyl or midazolam were mixed with normal saline to 60 mL in a separate syringe. The propofol and the fentanyl or the midazolam were infused through the same vein using accurate and alarmed syringe-driving pumps (Perfusor Compact; BBraun, Germany). Ringer's lactate was infused at 4 mL kg^{-1} $hour^{-1}$ by a volumetric pump (Infusomat; BBraun) into the other cephalic vein.

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