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Short Communication

Effects of Medetomidine Constant Rate Infusion on Sevoflurane Requirement, Cardiopulmonary Function, and Recovery Quality in Thoroughbred Racehorses Undergoing Arthroscopic Surgery

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ABSTRACT

To evaluate the clinical efficacy of medetomidine constant rate infusion (CRI) in sevoflurane-anesthetized Thoroughbred racehorses undergoing arthroscopic surgery. Sevoflurane requirement and cardiopulmonary function were compared between horses maintained with sevoflurane alone (group S; n = 25) and those maintained with sevoflurane in combination with medetomidine CRI at a rate of 0.05 μg/kg/min (group SM; n = 25). Recovery quality was also compared between the two groups. A single IV bolus of 1.0 μg/kg medetomidine was administered to the horses in group S at the end of anesthesia, whereas no additional sedatives were administered in group SM. Mean end-tidal sevoflurane concentrations were significantly lower in group SM (2.5 ± 0.1%) than in group S (2.8 ± 0.1%). Mean arterial blood pressure (MAP) values were significantly higher in group SM than in group S. On the other hand, mean dobutamine infusion rate required for maintaining MAP within the target values (60–80 mm Hg) was significantly lower in group SM than in group S. The number of attempt to stand was significantly fewer, and recovery score was significantly better in group SM compared with group S. In conclusion, medetomidine CRI reduced sevoflurane requirement by approximately 10% with good maintenance of cardiopulmonary function and better recovery quality.

1. Introduction

Among volatile anesthetic agents, sevoflurane has the advantages of rapid induction, easy control of anesthetic depth, and rapid recovery because of its low blood solubility [1–3]. However, sevoflurane is known to induce dose-dependent cardiopulmonary depression, which increases the risk of perianesthetic mortality and death [4–6]. Therefore, balanced anesthetic techniques are often used to reduce the amount of volatile anesthetics requirement and to minimize their cardiopulmonary depressant effect in equine practice [7].

Most balanced anesthetic techniques include the use of an α_2-adrenoceptor agonist because of its potent sedative and analgesic effect [7]. Medetomidine is a more specific α_2-agonist compared with detomidine and xylazine [8–11]. The short half-life of medetomidine and its selectivity and potency are suitable to be used as a constant rate infusion (CRI) for balanced anesthesia in horses [12–15].

It was reported that medetomidine CRI reduced the minimum alveolar concentration (MAC) of desflurane by

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28% in experimental ponies [16]. Others reported that isoflurane anesthesia in combination with medetomidine CRI resulted in improved cardiopulmonary function, analgesia, and muscle relaxation [13,15]. However, sevoflurane sparing effect of medetomidine CRI under surgical procedure has not been investigated in clinical cases. Thus, in this study, sevoflurane requirement and cardiopulmonary function during anesthesia were compared between horses maintained with sevoflurane alone (group S) and those maintained with sevoflurane in combination with medetomidine CRI (group SM).

The recovery period is an especially important part of general anesthesia in horses. Therefore, sedatives, mostly α_2-agonists, are commonly administered before recovery for the improvement of recovery quality [17,18]. In this study, recovery quality was also compared between horses administered a single IV bolus of medetomidine at the end of anesthesia (group S) and those given no additional sedatives before recovery (group SM).

The purpose of this study was to evaluate clinical efficacy of medetomidine CRI in sevoflurane-anesthetized Thoroughbred racehorses undergoing arthroscopic surgery.

2. Materials and Methods

2.1. Animals

Fifty Thoroughbred racehorses with chip fractures of the carpal bones undergoing arthroscopic surgery were included. The surgery was performed to a single leg or both legs by random experienced surgeons. These horses were assigned randomly to group S and group SM. Twenty-five horses assigned to group S were maintained with sevoflurane alone, and twenty-five horses assigned to group SM were maintained with sevoflurane in combination with medetomidine CRI. The mean ± standard deviation (SD) age and body weight were 3.7 ± 1.0 years old and 456 ± 34 kg in group S and 3.5 ± 1.2 years old and 454 ± 27 kg in group SM, respectively. All horses were presented preanesthetic blood examination and electrocardiographic reading. Food, but not water, was withheld for 12 hours before anesthesia.

2.2. Anesthesia and Instrumentation

All horses were premedicated with medetomidine (5.0 μg/kg IV) and induced anesthesia by a rapid injection of 5% guaifenesin (1,000 mL per head IV) with thiopental sodium 2.0 g per head. After induction of anesthesia, the horses were intubated endotracheally and positioned in dorsal recumbency. Anesthesia was maintained with sevoflurane and oxygen (approximately 5 L/min) using intermittent positive pressure ventilation at a rate of 8–12 breaths/min.

A base-apex lead electrocardiogram was used to monitor heart rate (HR) and rhythm. Arterial blood pressures were measured directly through the catheter by a transducer system. Respiratory gas was collected continuously, and end-tidal sevoflurane concentration (ET_{SEVO}) was determined by infrared absorption. The ET_{SEVO} was recorded throughout anesthesia, and HR, systolic arterial blood pressure (SAP), diastolic arterial blood pressure (DAP), and mean arterial blood pressure (MAP) were recorded every 5 minutes by an anesthesia monitoring system. Arterial blood samples were collected every 15 minutes and arterial carbon dioxide partial pressure ($PaCO_2$), arterial oxygen partial pressure (PaO_2), and pH were immediately analyzed by a blood-gas analyzer.

2.3. Experimental Protocol

Horses in group SM received medetomidine CRI at a constant rate of 0.05 μg/kg/min throughout the maintenance period. The depth of anesthesia was assessed subjectively by two experienced anesthetists based on the traditional vital signs. The chief anesthetist was blinded throughout the experiments. Anesthetic depth was adjusted by altering inspired sevoflurane concentration to be maintained at the adequate level for the surgical procedure. Anesthetic depth was judged to be light, if movement, brisk palpebral response, spontaneous nystagmus, or sudden change of cardiovascular parameters were observed. Lactated Ringer's solution was administered at a rate of approximately 10 mL/kg/hr throughout anesthesia. Dobutamine was infused to maintain MAP between 60 and 80 mm Hg.

Horses were allowed to recover without assistance. Horses in group S were administered a single IV bolus of 1.0 μg/kg medetomidine at the end of anesthesia, whereas those in group SM were given no additional sedatives. Oxygen was supplied until adequate spontaneous respiration appeared, and then the endotracheal tube was removed. Recovery quality was scored from G5 (excellent) to G1 (poor) according to a modified scoring system from Gozalo-Marcilla et al [19]. The number of attempt to stand and times taken from the end of anesthesia to appearance of spontaneous respiration, extubation, first movement, sternal recumbency, first attempt to stand, and standing were recorded. After surgery but before recovery, flunixin meglumine (1.0 mg/kg IV) was administrated.

2.4. Statistical Analysis

Two-way repeated-measures analysis of variance tests were applied to compare cardiovascular data between two groups. Tukey–Kramer test for multiple comparisons were applied, when significant differences were identified. Age, body weight, mean ET_{SEVO}, mean dobutamine infusion rate, blood gas data, duration of anesthesia, recovery times, the number of attempt to stand and recovery score was compared between the two groups using Mann–Whitney U test. Values are given as mean ± SD, and statistical significance was set at $P < .05$.

3. Results

No abnormality was found in all horses on the results of preanesthetic blood examination and electrocardiography. There were no significant differences in age and body weight between the two groups. Mean ET_{SEVO} values during the maintenance period are shown in Fig. 1. Mean ET_{SEVO} values were significantly lower ($P < .001$) in group SM (2.5 ± 0.1%) than in group S (2.8 ± 0.1%). Sevoflurane