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RESEARCH PAPER

Cardiorespiratory parameters in the awake pigeon and during anaesthesia with isoflurane

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Abstract

Objective To determine baseline cardiovascular and respiratory variables in the awake pigeon, and to assess those variables during anaesthesia at the individual minimal anaesthetic concentration (MAC) of isoflurane during spontaneous breathing.

Study design Prospective, experimental trial.

Animals Seven healthy adult pigeons weighing a mean ± standard deviation (SD) of 438 ± 38 g.

Methods Heart rate (HR), heart rhythm, respiratory rate (f_R), end-expired carbon dioxide tension ($P_E'CO_2$), indirect systolic arterial pressure (SAP) and cloacal temperature (T) were measured in birds in the awake state (after acclimatization to handling). Two weeks later, the pigeons were anaesthetized with isoflurane in order to determine their MAC and evaluate the same cardiovascular and respiratory variables during a further 40 minutes of isoflurane anaesthesia.

Results In the awake pigeon, mean ± SD HR, SAP, f_R, $P_E'CO_2$ and T were, respectively, 155 ± 28 beats minute^{-1}, 155 ± 21 mmHg, 34 ± 6 breaths minute^{-1}, 38 ± 8 mmHg (5.1 ± 1.1 kPa) and 41.8 ± 0.5 °C. Mean isoflurane MAC was 1.8 ± 0.4%. During maintenance of anaesthesia at MAC, although no significant decreases between values obtained in the awake and anaesthetized states emerged in HR or respiratory rate, significant decreases in SAP and cloacal temperature and an increase in $P_E'CO_2$ were observed. No arrhythmia was identified in awake pigeons, whereas second- and third-degree atrioventricular blocks occurred under isoflurane.

Conclusions and clinical relevance Isoflurane MAC in pigeons appeared to be higher than in other avian species. Isoflurane anaesthesia in pigeons resulted in hypercapnia, hypotension, mild hypothermia and second- and third-degree atrioventricular blocks.

Keywords anaesthesia, bird, blood pressure, cardiorespiratory, heart rate, isoflurane, pigeon.

Introduction

In birds, anaesthesia can be provided either by injectable agents or by inhalation agents. Inhalation anaesthesia is the preferred technique (Naganobu & Hagio 2000; Gunkel & Lafortune 2005) and isoflurane has been traditionally used for avian anaesthesia (Escobar et al. 2011). Isoflurane anaesthesia is characterized by minimal cardiovascular adverse effects, rapid induction and short recovery times, although short periods of excitement during induction and recovery, and apnoea or cardiac arrhythmias during maintenance, have been reported in bald eagles (Aguilar et al. 1995; Joyner et al. 2008).

In the pigeon, anaesthesia protocols for isoflurane in which the delivered concentrations (according to vaporizer dial setting) were 3.0–5.0% for induction and 1.5–3.0% for maintenance have been described (Korbel 1998; Touzot-Jourde et al. 2005). An isoflurane minimal anaesthetic concentration (MAC), defined as the end-expired concentration of anaesthetic agent at which 50% of anaesthetized individuals will not move in response to a supramaximal noxious stimulus (Eger et al. 1965), of a mean ± standard deviation (SD) of 1.51 ± 0.15% has been reported in pigeons (Fitzgerald & Blais 1991).

Heart rate (HR), respiratory rate (f_R), arterial blood pressure [systolic (SAP), mean (MAP)], end-expired carbon dioxide tension ($P_E'CO_2$) and blood gas analysis have been documented in a study assessing the effects of intermittent positive pressure ventilation in pigeons undergoing coelioscopy anaesthetized with isoflurane (Touzot-Jourde et al. 2005). Temperature, reflexes and peripheral haemoglobin oxygen saturation (SpO_2) have been described in a study comparing the uses of isoflurane and sevoflurane in healthy pigeons (Korbel 1998). The normal electrocardiogram (ECG) of the unanaesthetized competition pigeon has been described (Murcia et al. 2005). However, there is a lack of information on cardiovascular (HR, heart rhythm, SAP, MAP) and respiratory (f_R, $P_E'CO_2$) parameters when pigeons are anaesthetized with isoflurane outwith the context of surgical or diagnostic procedures and during spontaneous breathing. In addition, respiratory parameters and blood pressure have not been documented in the awake pigeon.

This study aimed to assess cardiovascular and respiratory variables in the awake pigeon and during anaesthesia at the individual's MAC of isoflurane during spontaneous breathing.

Materials and methods

Birds

Seven adult pigeons were used in this study. They were selected for good health based on a physical examination, and treated with fenbendazole (Panacur; MSD Animal Health Belgium NV, Belgium) and ronidazole (Trichocure; Oropharma NV, Belgium) against parasites (worms, coccidia and trichomonas) 2 months prior to the experiment. They were housed in an aviary measuring 3 × 2 × 2 m). All seven pigeons were acclimatized to handling during a 2 month period before the study commenced. All animals entered and completed all phases of the study. The experiment protocol (14/209) was approved by the Ethical Committee for Animal Welfare of the University of Namur. Based on a power calculation, this sample size was sufficient to demonstrate, should it occur, a 20% difference in HR, blood pressure and respiratory rate between awake and anaesthetized pigeons, and the occurrence of arrhythmias. The bracketing method (Escobar et al. 2012) used in this study in the determination of MAC can be performed in small samples.

Baseline monitoring parameters in awake animals

Several physiological variables were measured in each pigeon in the awake state without tranquillization. Measurements were performed in a quiet environment. The bird was covered with a light towel to reduce stress. After the measuring instrument (e.g. ECG) had been placed, the pigeon was gently restrained for 15 minutes before measurements were obtained. Birds were restrained in an upright position for ECG and gas measurements to reduce the effects of stress (Murcia et al. 2005). For technical reasons, indirect SAP and cloacal temperature (T) were measured in dorsal recumbency. Each measure was obtained separately. ECGs were recorded for periods of 10 minutes.

An ECG (Cardiocap; Datex-Ohmeda Oy, Finland) was used to assess HR and rhythm. Blunted alligator clip electrodes were connected directly to the skin at the patagium of each wing and at the skin fold proximal to the left stifle joint. Topical alcohol was used sparingly to increase conductivity at the electrode sites, but efforts were made to avoid an evaporative cooling effect. A Doppler blood flow probe and occlusive cuff with sphygmomanometer (Doppler Vet BP; Mano Médical, France) was used to monitor indirect SAP. A blood pressure cuff (size: 2.5 cm) (Pedisphyg; CAS Medical Systems, Inc., CT, USA) was positioned between the tibiotarsal–tarsometatarsal joint and the stifle joint. The width of the blood pressure cuff was equivalent to 40–50% of the limb circumference. The Doppler probe was placed, using ultrasound coupling gel to ensure adequate contact, distal to the blood pressure cuff, over the metatarsal artery. For gas analysis (inspired CO_2, $P_E'CO_2$, inspired isoflurane and end-expired isoflurane), the sectioned blind end of a latex glove finger (size: small) was fixed around the beak of the pigeon