

RESEARCH PAPER

Effects of pneumoperitoneum and of an alveolar recruitment maneuver followed by positive end-expiratory pressure on cardiopulmonary function in sheep anesthetized with isoflurane–fentanyl

Jéssica C Rodrigues^a, Francisco J Teixeira-Neto^{a,b}, Sofia A Cerejo^a,
 Nathalia Celeita-Rodríguez^b, Natache A Garofalo^b, Juliany G Quitzan^b &
 Thalita LA Rocha^a

^aFaculdade de Medicina, Univ Estadual Paulista (UNESP), Botucatu, Brazil

^bFaculdade de Medicina Veterinária e Zootecnia, Univ Estadual Paulista (UNESP), Botucatu, Brazil

Correspondence: Francisco J Teixeira-Neto, Faculdade de Medicina Veterinária e Zootecnia, Universidade Estadual Paulista (UNESP),

Distrito de Rubião Jr S/N, Botucatu, CEP 18618-970, SP, Brazil. E-mail: fteixeira@fmvz.unesp.br

Abstract

Objective To investigate the effects of pneumoperitoneum alone or combined with an alveolar recruitment maneuver (ARM) followed by positive end-expiratory pressure (PEEP) on cardiopulmonary function in sheep.

Study design Prospective, randomized, crossover study.

Animals A total of nine adult sheep (36–52 kg).

Methods Sheep were administered three treatments (≥ 10 -day intervals) during isoflurane–fentanyl anesthesia and volume-controlled ventilation (tidal volume: 12 mL kg⁻¹) with oxygen: CONTROL (no intervention); PNEUMO (120 minutes of CO₂ pneumoperitoneum); PNEUMO_{ARM/PEEP} (PNEUMO protocol with an ARM instituted after 60 minutes of pneumoperitoneum). The ARM (5 cmH₂O increases in PEEP of 1 minute duration until 20 cmH₂O of PEEP) followed by 10 cmH₂O of PEEP until the end of anesthesia. Cardiopulmonary data were recorded until 30 minutes after abdominal deflation.

Results PaO₂ was decreased from 435–462 mmHg (58.0–61.6 kPa) (range of mean values in CONTROL) to 377–397 mmHg (50.3–52.9 kPa) in PNEUMO ($p < 0.05$). Quasistatic compliance (C_{qst}, mL cmH₂O⁻¹ kg⁻¹) was decreased from 0.85–0.92 in CONTROL to 0.52–0.58 in

PNEUMO. PaO₂ increased from 383–385 mmHg (51.1–51.3 kPa) in PNEUMO to 429–444 mmHg (57.2–59.2 kPa) in PNEUMO_{ARM/PEEP} ($p < 0.05$) and C_{qst} increased from 0.52–0.53 in PNEUMO to 0.70–0.74 in PNEUMO_{ARM/PEEP}. Abdominal deflation in PNEUMO did not restore PaO₂ and C_{qst} to control values. Cardiac index (L minute⁻¹ m²) decreased from 4.80–4.70 in CONTROL to 3.45–3.74 in PNEUMO and 3.63–3.76 in PNEUMO_{ARM/PEEP}. Compared with controls, ARM/PEEP with pneumoperitoneum decreased mean arterial pressure from 81 to 68 mmHg and increased mean pulmonary artery pressure from 10 to 16 mmHg.

Conclusions and clinical relevance Abdominal deflation did not reverse the pulmonary function impairment associated with pneumoperitoneum. The ARM/PEEP improved respiratory compliance and reversed the oxygenation impairment induced by pneumoperitoneum with acceptable hemodynamic changes in healthy sheep.

Keywords alveolar recruitment maneuver, pneumoperitoneum, sheep.

Introduction

Anesthetized sheep may develop oxygenation impairment and increased alveolar-to-arterial oxygen gradient [P(A-a)O₂] owing to the presence of large areas of atelectasis in dependent lung regions

(Hedenstierna et al. 1989). Changes in lung function in anesthetized sheep are similar with those observed in anesthetized humans because the development of atelectatic areas on computed tomography show a strong linear correlation with the degree of oxygenation impairment and intrapulmonary shunt fraction (\dot{Q}_s/\dot{Q}_t) in both species (Wolf et al. 2015).

Pneumoperitoneum for laparoscopic surgery is commonly used in humans and in dogs. Inflation of the abdomen in humans with carbon dioxide (CO_2) for laparoscopic procedures results in decreased total respiratory compliance owing to a cranial displacement of the diaphragm, although arterial oxygenation may not be significantly impaired (Andersson et al. 2002; Sprung et al. 2002; Nguyen et al. 2004). However, lung function in anesthetized sheep and other ruminants may be more severely affected by pneumoperitoneum because progressive gas trapping within the rumen may further displace the diaphragm cranially and result in oxygenation impairment because of atelectasis (Fujimoto & Leneham 1985; Hedenstierna et al. 1989).

An alveolar recruitment maneuver (ARM) is used during mechanical ventilation to open collapsed alveoli by temporary administration of a high inspiratory pressure (Lachmann 1992; Tusman et al. 1999). This procedure is followed by long-term application of positive end-expiratory pressure (PEEP) that is adjusted to maintain these alveoli open throughout the entire respiratory cycle. This strategy may increase arterial oxygen partial pressure (PaO_2) and respiratory system compliance during pneumoperitoneum for laparoscopic gastric banding in obese human patients (Almarakbi et al. 2009).

The hypothesis for the present study was that CO_2 pneumoperitoneum up to an intra-abdominal pressure of 15 mmHg would cause a negative effect on respiratory system compliance [decreased quasistatic compliance (C_{qst})] and decrease PaO_2 by increasing \dot{Q}_s/\dot{Q}_t . In this scenario, an ARM consisting of step-wise increases in PEEP until 20 cmH_2O followed by 10 cmH_2O of PEEP during volume-controlled ventilation would reverse the oxygenation impairment and decreased C_{qst} without causing excessive cardiovascular depression.

Materials and methods

Animals and study design

This study was approved by the Animal Care Committee of the São Paulo State University (No. 171/2015). A total of nine Santa Inês sheep (four females

and five males), 14–18 months old and weighing 36–52 kg were selected for the study. Animals were healthy determined by physical examination, complete blood cell count and fecal egg count within normal ranges before each experiment.

The animals were administered three treatments at intervals of 10 days in a prospective, randomized (www.randomizer.org) crossover design: 1) CONTROL treatment, anesthesia maintained with conventional volume-controlled ventilation [tidal volume (V_T) 12 mL kg^{-1}] and zero end-expiratory pressure (ZEEP) with no intervention; 2) PNEUMO treatment, CO_2 pneumoperitoneum with a 15 mmHg intra-abdominal pressure for 120 minutes, with the same ventilation protocol used in CONTROL; and 3) PNEUMO_{ARM/PEEP} treatment, CO_2 pneumoperitoneum with a 15 mmHg intra-abdominal pressure, ventilation protocol used in CONTROL for 60 minutes, followed by an ARM and 10 cmH_2O PEEP for another 60 minutes.

Supplementary data related to this article can be found online at <http://dx.doi.org/10.1016/j.vaa.2016.05.017>.

Instrumentation and variables monitored

Food and water were withheld for 24 and 12 hours before anesthesia, respectively. A 20 gauge catheter was inserted into a cephalic vein for drug administration and infusion of lactated Ringer's solution (2 $\text{mL kg}^{-1} \text{ hour}^{-1}$; JP Indústria Farmacêutica, SP, Brazil) during anesthesia. Ceftiofur (1.1 mg kg^{-1} ; Minoxel Plus; Elanco, SP, Brazil) was administered intramuscularly (IM) before anesthesia and at 24 and 48 hours after anesthesia. Animals were administered flunixin meglumine (1.1 mg kg^{-1} ; Banamine, MSD, SP, Brazil) intravenously (IV) and fentanyl (5 $\mu\text{g kg}^{-1}$; Fentanest; Cristália Produtos Químicos e Farmacêuticos Ltda, SP, Brazil) IV followed 15 minutes later by induction of anesthesia with IV propofol ($5.6 \pm 0.9 \text{ mg kg}^{-1}$; Propovan; Cristália Produtos Químicos e Farmacêuticos Ltda) titrated until orotracheal intubation could be performed. Animals were positioned in dorsal recumbency and anesthesia was maintained with isoflurane (Isoforine; Cristália Produtos Químicos e Farmacêuticos Ltda) in oxygen and an infusion of fentanyl (5 $\mu\text{g kg}^{-1} \text{ hour}^{-1}$) IV using a syringe pump (Pump 11 Elite; Harvard Apparatus, MA, USA). Inspired O_2 fraction (FIO_2) was monitored by a paramagnetic cell, whereas end-expired isoflurane fraction (F_eIso) and end-expired CO_2 partial pressure (P_eCO_2) were

Download English Version:

<https://daneshyari.com/en/article/8919893>

Download Persian Version:

<https://daneshyari.com/article/8919893>

[Daneshyari.com](https://daneshyari.com)