Rev Bras Anestesiol. 2014;64(2):79–83

REVISTA BRASILEIRA DE ANESTESIOLOGIA
Official Publication of the Brazilian Society of Anesthesiology
www.sba.com.br

SCIENTIFIC ARTICLE

Comparison of the effect of sevoflurane and propofol on oxygenation during gradual transition to one-lung ventilation

Ayşe Karci[a,*], **Seden Duru**[a], **Hasan Hepağuşlar**[a], **Lügen Çiftçi**[b], **Osman Yilmaz**[c]

[a] *Department of Anesthesiology and Reanimation, Medical School, Dokuz Eylul University, İzmir, Turkey*
[b] *Department of Anesthesiology, State Hospital, Denizli, Turkey*
[c] *Department of Laboratory Animal Science, Medical School, Dokuz Eylul University, Inciralti, İzmir, Turkey*

Received 16 January 2013; accepted 22 March 2013
Available online 11 October 2013

KEYWORDS
One-lung ventilation;
Gradual transition;
Sevoflurane propofol

Abstract
Background: It is known that hypoxic pulmonary vasoconstriction increases as a result of intermittent regional hypoxic challenges. The aim of this study was to compare the effects of sevoflurane and propofol on oxygenation and shunt fraction during one-lung ventilation in a novel model of hypoxic preconditioning before one-lung ventilation.
Methods: Sixteen Wistar-albino rats were anesthetized intra-peritoneally before venous and arterial cannulations and tracheotomized. The animals were randomly allocated to receive either sevoflurane 2% or 10 mg/kg/h propofol infusion and ventilated with 100% oxygen at an inspiratory rate of 80 breaths/min for 30 min. Three cycles of one-lung ventilation and two-lung ventilation were performed and one-lung ventilation was continued for 15 min. Arterial blood gas samples were obtained as follows: after cannulation and tracheotomy, following 30 min of treatment with sevoflurane or propofol, and at the 5th and 15th min of one-lung ventilation.
Results: The PaO_2 levels were higher and shunt fractions were lower in rats receiving propofol compared to rats treated with sevoflurane but the difference was not significant; the two groups were comparable in terms of $PaCO_2$.
Conclusions: The similar effects of sevoflurane and propofol on PaO_2 during one-lung ventilation following hypoxic preconditioning may be due to other causes beside the inhibition of hypoxic pulmonary vasoconstriction. Gradual transition to one-lung ventilation is a novel technique for preconditioning experiments for one-lung ventilation.

Introduction

During one-lung ventilation (OLV), the operated lung not only remains atelectatic, but also hypoperfused because of

* Corresponding author.
E-mail: ayse.karci@deu.edu.tr (A. Karci).

0104-0014
http://dx.doi.org/10.1016/j.bjane.2013.03.003

hypoxic pulmonary vasoconstriction (HPV), which is a protective mechanism that diverts pulmonary blood flow away from the lung regions with low alveolar oxygen tensions to better ventilated areas of the lung, and reduces the intrapulmonary shunt and systemic hypoxia.[1–3] In order to maximize HPV in the non-ventilated lung, repeated intermittent cycles of deflation–inflation to the lung (hypoxic preconditioning (HP)) are recommended during the initiation of one lung ventilation.[4–6]

Although it is generally accepted that volatile anesthetics inhibit HPV and may promote hypoxemia in a dose-dependent manner during OLV,[2,7,8] IV anesthetics including propofol, inhibit HPV to a small degree.[8,9]

The overall objective of the present study was to determine the efficacy of HP using a new model of 'gradual transition' to OLV as defined in a previous study,[7] before the initiation of OLV and to compare the effects of sevoflurane and propofol during the procedure.

Materials and methods

The animals were handled in accordance with the principles of laboratory animal care and all the experimental procedures were approved by the Research Commission for the Care and Use of Laboratory Animals of School of Medicine, Dokuz Eylul University.

Sixteen Wistar-albino rats (weighing 312–382 g) were anesthetized by intraperitoneal injection of ketamine (40 mg/kg) and xylazine (5 mg/kg) prior to venous and arterial cannulations.

The femoral vein was then cannulated with a polyethylene tube for infusion of the agents; the same cannula was also used to infuse saline continuously at a rate of 3 mL kg^{-1} h^{-1}. The femoral artery on the other side was similarly cannulated to measure the blood pressure and monitor the arterial blood gases. Following tracheotomy, a 16-gauge cannula was inserted into the trachea and connected immediately to the mechanical ventilator (*Kent Scientific Pressure-controlled Ventilator*) and the animals were allowed to ventilate in a pressure-controlled mode with an inspired oxygen fraction (FIO_2) of 100%, and a respiratory rate of 60 breaths/min. To eliminate artifacts from spontaneous breathing movements, paralysis was induced with 0.1 mg/kg rocuronium bromide.

Following a 15-min stabilization period, blood was withdrawn for measurement of arterial blood gasses. The animals were randomly allocated to receive either 2% sevoflurane through a calibrated vaporizer (Group S; $n = 8$) or 10 mg/kg/h propofol infusion (Group P; $n = 8$) for 30 min after the stabilization period. At the end of 30 min, the tracheal cannula was pushed forward and it was confirmed that the tip was in the bronchus, the lung was ventilated for 1 min and that the cannula was pulled back for two-lung ventilation (TLV). The animals were ventilated with an inspired oxygen fraction (FIO_2) of 100%, and a respiratory rate of 80 breaths/min during this period. The rats were subjected to OLV following three cycles of 1-min OLV and 1-min TLV. This procedure was performed in all the animals before the investigations commenced. Arterial blood gases were collected at the 5th and 15th minutes of OLV and the shunt fraction was calculated.

The shunt fraction was calculated using the formula:

$$\frac{Q_s}{Q_t}(\text{shunt fraction}) = (5.8 \times \text{RI}) + 6.7, \text{ where RI was the respiratory index.}$$

$$\text{(a) RI} = \frac{PAO_2 - PaO_2}{PaO_2}$$

$$\text{(b) } PAO_2 = ([PB - PH_2O] \times FIO_2) - PaCO_2$$

PB = barometric pressure (760 mmHg at sea level); PH_2O = partial pressure of water (47 mmHg); PAO_2 = alveolar partial pressure of oxygen, PaO_2 = arterial partial pressure of oxygen, $PaCO_2$ = arterial partial pressure of carbon dioxide, FIO_2 = inspiratory oxygen fraction.

We used the method suggested by Koessler et al. and Peyton et al.[10,11] The calculation was done with the formula where RI (Respiratory Index) = $\{[(PB - PH_2O) \times FIO_2] - PaCO_2 - PaO_2\}/PaO_2$.

Statistical analyses

All the results were expressed as means ± standard deviation. The scattered parameters were expressed by the SE values. The SPSS 11.0 for Windows was used for the statistical analyses. The Kolmogorov–Smirnov test was used to evaluate the intergroup differences.

The statistical tests were carried out with the significance level set at $p < 0.05$.

Results

The intermittent cycles of deflation–inflation before OLV were studied in 16 rats allocated randomly to treatment with sevoflurane inhalation or propofol infusion.

There were no significant differences in the blood gas analysis and shunt fraction among the protocol groups, either at the end of stabilization period, or after treatment with sevoflurane or propofol.

Following 30 min of anesthesia, marked decreases in arterial oxygen tensions (mean ± SE) were observed in the propofol and sevoflurane groups 5 min after the onset of OLV (101.48 ± 12.37 and 77.08 ± 6.17, respectively). The decrease was 29% and 38% in the propofol and the sevoflurane groups, respectively, and this decrease was not significant between the groups ($p = 0.074$). After 15 min, the decrease in oxygenation was more pronounced (mean 71.65 ± 5.39 [57.90–103.10] and 66.01 ± 4.19 [56.50–100.08]). Consistently, the PaO_2 values were higher in the propofol group for the duration of OLV (Fig. 1).

Similarly, arterial carbon dioxide levels showed an increase with initiation of OLV in rats treated with propofol and those treated with sevoflurane at 5 min (35.44 ± 2.9;