

Inhalation induction with sevoflurane in adult cardiac surgery patients. A case series

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ABSTRACT

Introduction: Anesthesia induction through volatile agents is a well-established technique in several fields but not in adult patients undergoing cardiac surgery. Successful inhalation induction requires a poorly soluble, reasonably potent and minimally irritant agent, and the benefits associated to this technique include reduced incidence of hypothermia and hypotension and lower costs when compared to some intravenous anesthetics agents.

Methods: Fifty-six patients undergoing coronary artery bypass grafting were observed at the induction of general anesthesia with sevoflurane in oxygen by facial mask. All patients received 2% sevoflurane in 100% oxygen initially for 30 seconds. The inspired concentration of sevoflurane was increased to 7% until loss of consciousness and then reduced back to 2%. Next, intravenous 0.5 µg/kg sufentanil and 0.1 mg/kg pancuronium were administered. Volume-controlled ventilation was started before tracheal intubation.

Results: All 56 patients tolerated the inhalational induction. No patient presented signs of airway irritation. Hypotension occurred in 30 patients and was managed with low dose phenylephrine.

Conclusions: This case series showed that inhalation induction is feasible and safe even in adult patients undergoing cardiac surgery.

Keywords: *volatile anesthetics, sevoflurane, anesthetics technique, induction, cardiac surgery.*

INTRODUCTION

Inhalation induction in adult cardiac surgery patients is not an established procedure as there is fear of hypotension. Volatile agents have cardioprotective properties that might result in a reduction of postoperative mortality in cardiac surgery (1-5). This effect seems to be associated with the duration of their administration (6).

Successful inhalation induction for adults

(7) in non-cardiac surgery is well established and requires poorly soluble, reasonably potent and minimally irritant agent (8,9). Because sevoflurane has the combination of all these properties, it makes inhalation induction in adults practical and safe (7,10). The objective of this study was to describe the technique of inhalation induction with sevoflurane in a case series of patients undergoing coronary artery bypass grafting surgery (CABG) with cardiopulmonary bypass (CPB).

METHODS

After approval by the local institutional ethics committee and after obtaining writ-

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ten informed consent, 56 patients scheduled to undergo coronary artery bypass graft (CABG) were observed at the induction of general anesthesia with sevoflurane in oxygen. All patients received 7.5 mg of midazolam intramuscularly 30 minutes before surgery. Initial monitoring included continuous DII and modified V5 electrocardiography, analysis of the ST segment in DII, DI and modified V5 derivations, pulse oximetry, invasive mean blood pressure (MAP) positioned in the radial artery and analysis of the bispectral index (BIS).

All patients underwent inhalation induction with the use of a facial mask with a delivered concentration of 2% sevoflurane in 100% oxygen and fresh gas flow of 6 L/min for 30 seconds.

The delivered concentration of sevoflurane was then increased to 7% until loss of consciousness, (guided by bispectral index scale values <65) and then reduced to 2%. Next, intravenous sufentanil at a dose of 0.5 µg/kg and 0.1 mg/kg pancuronium were administered.

Before intubation, volume-controlled ventilation was started with fresh gas flow of 2 liters with 60% oxygen in air, tidal volume of 8 to 10 mL/kg and respiratory rate adequate to maintain end tidal CO₂ between 30 and 35 mmHg. During induction we specifically recorded the incidence of hypotension and clinical signs of airway irritation (cough, wheezing and/or laryngospasm).

The maintenance of anesthesia in the period before and after CPB was performed with sevoflurane 0.5% to 2% end-tidal to maintain the BIS values between 40 and 60. Sufentanil boluses of 0.5 µg/kg were administered whenever necessary to keep mean arterial pressure between 60 and 80 mmHg.

A bolus of 0.02 mg/kg pancuronium was administered when the third response to train of four appeared. Increments in sevoflurane concentration were used when BIS

values exceeded 60. In this case, the delivered concentration was increased to 4% and the fresh gas flow to 6 L/min for one minute, and then returned to basal parameters (fresh gas flow 2 L/min and delivered sevoflurane 2%). If BIS did not return to pre-established values, the procedure was repeated one more time. In case of absence of response, a dose of 0.05 mg/kg midazolam was administered.

During CPB, anesthesia was maintained with sevoflurane 0.5% to 2% administered together with a FiO₂ of 50% in the oxygenator circuit through calibrated vaporizer to maintain BIS values between 40 and 60. Sufentanil 0.5 µg/kg was used to keep the mean arterial pressure between 45 and 70 mmHg.

During the maintenance of anesthesia in the period before and after CPB, in situations of hypotension (defined as mean arterial pressure - MAP - of less than 60 mmHg for more than 30 seconds), the use of inotropes and vasoactive agents observed the following protocol:

- Phenylephrine 0.1 mg bolus administered before and after CPB, for each minute, when anesthetic agents were at minimum levels, repeated every minute to keep filling pressures adequate.
- Dopamine was administered when anesthetic agents were at minimum levels; filling pressures were high and cardiac index (CI) was less than 2.4 L/m²/min. It was started at a dose of 5 µg/kg/min with increments of 1 µg/kg/min until the desired MAP level was reached.
- Norepinephrine was administered when the CI remained below 2.4 L/m²/min at dopamine doses of 10 µg/kg/min. Started at a dose of 0.1 µg/kg/min, with increments of 0.1 µg/kg/min until the desired MAP level was reached.

Descriptive statistics were used and data expressed as mean ± standard deviation, or as number and percentage.

RESULTS

Data of all 56 patients were analyzed. All the patients accepted to have anesthesia induction by facemask and well tolerated the inhalational induction.

Preoperative and intraoperative data are described on *Table 1*. The overall incidences of complications related to induction of anesthesia are shown on *Table 2*. Before induction, all patients were normotensive and, during induction, no patient presented signs of airway irritation. Hypotension occurred in 30 patients, promptly reverted with phenylephrine only.

Table 1 - *Demographics.*

	Patients (n = 56)
Preoperative data	
Gender	
female	18 (32%)
male	38 (68%)
Age (years)	58 ± 7.0
ASA III	56 (100%)
Body mass index (kg/m ²)	27 ± 3.7
Smokers	33 (59%)
Obesity	14 (25%)
Hypertension	34 (60%)
Diabetes mellitus	44 (79%)
Dyslipidemia	28 (50%)
Continuous data are expressed as mean (M) and SD. Count data are shown as number (n) and percentage. SD = standard deviation.	

Table 2 - *Adverse events and use of vasoactive agents.*

	Patients (n = 56)
Adverse events	
Airway irritation	0
Hypotension	30 (54%)
Vasoactive agents	27 ± 3.7
Phenylephrine	30 (54%)
Dopamine	0
Norepinephrine	0
Count data are shown as number (n) and percentage.	

DISCUSSION

In this case series we described the safety of anesthesia induction with sevoflurane in adults undergoing cardiac surgery. Assuming an inhaled anesthetic is to be used for maintenance, inhalation induction offers the additional advantage of minimizing the lack of good anesthesia planning during transition from intravenous to inhaled agents, eliminating what is, in effect, a second induction. This can also reduce the amount of vapor that is used during the maintenance period (11). On top of that, use of inhalational induction allows to benefit the volatile agent's cardiac protection by volatile agents even during induction. According to De Hert et al. (6) the cardioprotective effects of an anesthetic regimen with sevoflurane were clinically most apparent when the volatile anesthetic was administered throughout the surgical procedure. Other theoretical advantages of inhalational induction include a reduction in the costs. In one study, Thwaites et al. (10) described that sevoflurane induction was substantially cheaper than propofol, in non-cardiac surgery, both on the basis of the exact amount of propofol required and on the basis of one ampoule per patient.

According to Ikeda et al. (12), core temperatures in patients who received IV propofol for anesthetic induction were consistently lower than those in patients who received inhaled sevoflurane for anesthetic induction. This suggests that even a brief period of propofol induced vasodilatation during anesthetic induction causes substantial redistribution hypothermia that persists throughout surgery.

Although low flows are desirable during maintenance, higher flows are necessary during induction, because the higher the flow, the faster the induction as the less is the constant of time to generate higher uptake of anesthetics at the lungs. So, hi-

gher fresh gas flows may wash anesthetic into the breathing circuit and alveoli faster, speeding induction, while lower flows should delay induction. This concept can also be used to explain “inhalation bolus” of sevoflurane during surgery to avoid awareness and hypertension during surgery. Inhalation bolus may be defined as the dynamic use of the vaporizer and fresh gas flow to control the hemodynamic responses to surgical intense stimulus. There is usually a delay between a change in the vaporizer setting and the onset/offset of the desired clinical effect (13).

Two different techniques of inhalation induction have been described. The use of vital capacity breathe technique, which requires the saturation of the breathing system with the inhalational anesthetics prior to induction, and tidal breathing techniques, that don't require this (14, 15). Despite the fact that some authors consider vital capacity breath technique more efficient (15), we did not consider the use this technique because higher concentrations of volatile agents in just one breath uptake in a cardiac patient could be less safe, even though tidal breathing technique could increase the time of the induction. Even though some patient might experience a choking sensation or discomfort because of the face mask during induction, in our study no patient reported subjective dissatisfaction because of the induction technique.

Another potential benefit of the inhalational induction is the fact that this could cause less hypotension during induction when we compare with some intravenous agents. In a double blind randomized study Walpole et al. (14) concluded that sevoflurane decreases arterial blood pressure less than propofol during inhalation induction even in elderly patients, suggesting that for these patients inhalation induction could be a better choice compared with some intravenous agents. If we assume the fact that

inhalation induction has fewer effects on blood pressure compared with some intravenous agents, we could consider this technique even safer for cardiac patients.

In 1999, Gravel NR et al. (16) compared the hemodynamic effects of sevoflurane when used for induction and maintenance of anesthesia with those of a total intravenous technique in a randomized study including 30 patients undergoing CABG surgery. The results showed that induction of anesthesia with sevoflurane supplemented by sufentanil provided hemodynamic responses comparable with those of total intravenous anaesthesia (TIVA) although bradycardia was observed more often with sevoflurane and intraoperative control of systemic blood pressure was achieved with fewer interventions with a sevoflurane/sufentanil maintenance than with a propofol/sufentanil technique.

In another randomized study, Vidal MA et al. (17) evaluated the efficacy, side effects, and hemodynamic alterations during anesthetic induction with sevoflurane in 30 patients scheduled for CABG, comparing the techniques of administration with tidal volume breathing and with vital capacity breaths. The results indicated that hemodynamic stability seems to be similar with both techniques to provide inhaled anesthetic induction with sevoflurane and that mean arterial pressure decreased in both groups with no significant differences. The authors concluded that hemodynamic stability seems to be similar with both techniques to provide inhaled anesthetic induction with sevoflurane in cardiac patients.

The results of our study are in accordance with these papers, showing that the inhalation induction technique is possible and safe for adult cardiac patients. Moreover, the availability of a nonpungent and rapidly acting inhalational agent like sevoflurane has renewed our interest in the use of volatile anesthetics in cardiac surgery because

of their well-documented cardioprotective properties (1-5).

Limitations of the study. This study only describes an induction technique in cardiac surgery patients (inhalation induction); it is not randomized and doesn't compare inhalation induction with any other technique.

CONCLUSION

This case series showed that inhalation induction with sevoflurane is feasible and safe in adult patients undergoing cardiac surgery.

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