Single breath vital capacity induction of anesthesia with 8% sevoflurane versus intravenous propofol for laryngeal tube insertion in adults

Khaled M. El-Radaideh, PhD, Facharzt, *Mohammed A. Al-Ghazo,* MD, FRCS.

ABSTRACT

Objective: To compare the conditions for laryngeal tube airway insertion obtained by the inhalation of 8% sevoflurane using a vital capacity breath (VCB) technique with propofol intravenous induction.

Methods: We carried out a prospective, randomized, single blind study at King Abdullah University Hospital, Irbid, Jordan from September 2005 to April 2006. Involved in this study were 80 adult (ASA physical status I and II) patients aged 26–70 years undergoing elective surgery under general anesthesia. The patients were randomized into 2 groups. An independent observer noted the time to loss of consciousness, the presence of adverse events, time to successful laryngeal tube placement and the number of attempts needed until a successful laryngeal tube insertion.

Results: With the single VCB method, sevoflurane produced a loss of consciousness faster than propofol did (51.6 ± 4.4 versus 59.7 ± 4.9 seconds, $p<0.001$). The insertion of laryngeal tube was faster in the propofol group (77.2 ± 20.2 versus 122.2 ± 33.3 seconds, $p<0.001$) and required fewer attempts (1.2 ± 0.4 versus 1.6 ± 0.7, $p<0.02$). The overall incidence of complications during the induction of anesthesia as well as during the laryngeal tube insertion, especially apnea (42% versus 0%; $p<0.001$), was more frequent in the propofol group (82.5% versus 27.5%; $p<0.001$).

Conclusion: We conclude that vital capacity breath induction with sevoflurane produces a faster loss of consciousness and fewer side effects than propofol and efficient for laryngeal tube insertion, but takes slightly longer than propofol due to the prolonged jaw tightness.

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From the Department of General Surgery (Al-Ghazo) and Anesthesia (El-Radaideh), King Abdullah University Hospital, Faculty of Medicine, Jordan University of Science and Technology, Irbid, Jordan.

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Address correspondence and reprint request to: Dr. Khaled M. El-Radaideh, Assistant Professor of Anesthesia, Faculty of Medicine, Jordan University of Science and Technology, PO Box 953, Irbid 21110, Jordan. Tel. +962 (79) 6380779. Fax. +962 (2) 7200621. E-mail: elradk01@yahoo.com

A laryngeal tube (VBM Medizintechnik, Sulz, Germany) is a multi-usable, single-lumen, transparent silicon tube with an oropharyngeal and an esophageal low-pressure silicon cuff and with a ventilatory orifice located between these 2 cuffs.[1,2] This device have been developed to secure a patient airway during either spontaneous breathing or controlled ventilation and to protect the airway preventing regurgitation and aspiration of stomach contents by inflating the esophageal cuff.[2-4]

Satisfactory insertion of the laryngeal tube after induction of anesthesia requires sufficient depth of anesthesia for suppression of airway reflexes. A popular method of providing anesthesia for laryngeal tube insertion is the use of intravenous propofol.[5,6] It has the advantages of inducing anesthesia rapidly and depressing upper airway reflexes,[6] but it is associated with several disadvantages such as pain on injection, apnea and hypotension.[7-9]

Recently, single-breath vital capacity (VCB) inhalation induction of anesthesia with 8% sevoflurane has been used as an alternative to intravenous induction. This method allows a rapid and well-tolerated induction of anesthesia and is associated with hemodynamic stability when compared with intravenous propofol.[10,11] We designed a randomized, prospective, single blind study in adults aged 26-70 years to compare the conditions for the insertion of laryngeal tube provided by the induction of anesthesia using a single-breath vital capacity inhalation induction with 8% sevoflurane with the conditions provided by intravenous propofol.

Methods. After obtaining Local Research Ethics Committee approval and written informed consent from the patients, we studied over a period of approximately 8 months from September 2005 to April 2006 at King Abdullah University Hospital, Irbid, Jordan, 80 fasted unpremeditated adult

patients, aged 26-70 years. All patients were classified as American Society of Anesthesiology (ASA) physical status I or II and scheduled for herniorrhaphy, short gynecological and short urological procedures under general anesthesia (**Table 1**).

Patients were not included in the study if they were unable to cooperate, had a history of drug or alcohol abuse, had an allergy or sensitivity to volatile anesthetics or to propofol, and known or suspected to have genetic susceptibility to malignant hyperthermia. According to a randomization based on computer generated codes the patients were randomized into 2 groups: Sevoflurane group (n=40) and propofol group (n=40). The vital capacity technique was explained to patients in the anesthetic induction room.

All patients were monitored with an electro-cardiograph (ECG), capnography, pulse oximetry and an automatic non-invasive blood pressure monitor. The patients of both groups were preoxygenated prior to anesthesia induction. The traditional preoxygenation technique consisted of 3 minutes of tidal volume breathing, using an oxygen flow of 5 L/min with a good face mask seal. After preoxygenation, each patient of the sevoflurane group was instructed to inhale as deeply as possible and then to exhale to residual volume. Their anesthesia circuit was primed with 8% sevoflurane and 66% nitrous oxide in oxygen at 9 L/min (6:3) for 1 min. At end-expiration, the oxygen mask was removed, and the mask connected to the primed circuit was placed firmly over the patient's face. Patients were encouraged to perform the VCB and to hold their breath as long as they could. If they exhaled again before losing consciousness, patients were encouraged to take additional deep breaths until they were asleep. While holding their breath, the patients were asked to open their eyes every 10 seconds. Loss of response to open the eyes was taken as loss of consciousness (LOC). This was confirmed by testing for the loss of eyelash reflex. Thirty seconds after the LOC, the ease of mouth opening was assessed for the laryngeal tube insertion. If this attempt was unsuccessful, another attempt was made every 30 seconds, up to a maximum of 4 tries. During the interval between each attempt, patients in the sevoflurane group were allowed to continue spontaneous, assisted ventilation of sevoflurane 8% in nitrous oxide 66% and oxygen.

After preoxygenation the anesthesia of the patients in the propofol group was induced with 2.5 mg × kg^{-1} propofol intravenously over 30 seconds. Time to LOC was determined as it had been for the sevoflurane group (loss of response to open the eyes and loss of eyelash reflex). Thirty seconds after the LOC following injection of propofol, laryngeal tube placement was attempted. If unsuccessful, another attempt was made every 30 seconds, up to a maximum of 4 tries. Each time preceded by propofol boluses of 1 mg × kg^{-1} intravenously and spontaneous, assisted ventilation of nitrous oxide 66% and oxygen (9 L/min.). Once the laryngeal tube insertion was successful, all patients were given sevoflurane 4% in nitrous oxide 66% and oxygen. After 5 minutes, the concentration of sevoflurane was decreased to 2%.

An independent blinded observer noted the response of the patients to laryngeal tube insertion including the presence or absence of adverse event such as severe coughing, gagging, laryngospasm, inadequate jaw relaxation for passage of the laryngeal tube, and involuntary limb and head movements. In addition, the observer recorded the following: Time from the start of induction to loss of eyelash reflex, time to apnea and its duration, time to successful laryngeal tube placement and the number of attempts needed until a successful laryngeal tube insertion.

Table 1 - Demographic data.

Variable	Sevoflurane group (n=40)	Propofol group (n=40)
Age; years	47 ± 14	48 ± 13
Gender; M: F	25: 15	28: 12
ASA I/II	28/12	31/9
Weight; kg	68 ± 8	70 ± 8
Height; cm	171 ± 5	173 ± 4
Herniorrhaphy	15	12
Gynecologic procedures	12	16
Urological procedures	13	12

ASA - American Society of Anesthesiology, Values are mean ± standard deviation or number

Statistical analysis. A power analysis with a pilot study revealed that a group size of 33 would be required for detecting a 20% difference in time needed to the successful insertion of the laryngeal tube between groups (p=0.5; power=0.8). All results are expressed as mean ± SD or range. Between group comparisons were conducted using Student's t-test to identify differences in parametric, normally distributed data with the Bonferroni correction for multiple comparisons. The chi-squared test and the Kruskal-Wallis test were used for nonparametric data. A p-value less than 0.05 was taken as statistically significant. Statistical calculations were performed using Statistical Package for Social Sciences for windows version 11.0.

Results. Eighty patients were enrolled in this study. The 40 patients who underwent VC inhalation induction and the 40 who underwent intravenous induction were comparable with respect to demographic data (**Table 1**).

The mean time to loss of consciousness was 51.6 ± 4.4 seconds in patients receiving sevoflurane compared with 59.7 ± 4.9 seconds in propofol group (p<0.001). The insertion of the laryngeal tube was faster in propofol group (77 ± 20 versus 122 ± 33 seconds, p<0.001) and required fewer attempts (1.2 ± 0.4 versus 1.6 ± 0.7, p<0.02) (**Table 2**). The adverse events occurring during the induction and during the attempted insertion of the laryngeal tube are summarized in **Table 3**. The overall incidence of complications during the induction of anesthesia as well as during the laryngeal tube insertion, especially apnea (42.5% versus 0%; p<0.001), was more frequent in the propofol group (82.5% versus 27.5%; p<0.001) (**Table 3**). One patient in the sevoflurane group developed laryngospasm immediately after the insertion of the laryngeal tube. This was terminated easily and rapidly by removing the laryngeal tube. We increased FiO_2 to 100% and attempted the re-insertion first after 60 seconds instead of 30 seconds.

Discussion. This study demonstrated that sevoflurane single VCB induction compares well with propofol for the insertion of laryngeal tube in adults, but required a longer induction time to achieve that. Rapidity of induction and insertion of the laryngeal tube is required, but the quality of these processes is also important. The overall incidence of complications during the induction as well as during the laryngeal

Table 2 - Attempts and time to successful insertion of laryngeal tube.

Variable	Sevoflurane (n=40)	Propofol (n=40)
Time to loss of consciousness (seconds)	51.6 ± 4.4 [40-60]*	59.7 ± 4.9 [50-70]
Attempts at insertion of the laryngeal tube	1.6 ± 0.7 [1-3]	1.2 ± 0.4 [1-2]**
Time to the successful insertion of the laryngeal tube (seconds)	122.2 ± 33.3 [90-180]	77.2 ± 20.2** [60-120]

Values are mean ±SD [range] or number.
*significantly different from propofol (p<0.001)
**significantly different from sevoflurane (p<0.001)

Table 3 - Adverse events during induction of anesthesia and during the insertion of the laryngeal tube.

Variable	Sevoflurane n=40 (%)	Propofol n=40 (%)	P-value
During induction of anesthesia			
Involuntary movements	6	3	<0.437
Cough	1	1	<0.241
Apnea	0	17 (42.5%)*	<0.001
During the insertion of the laryngeal tube.			
Involuntary movements	2	8	
Gagging and coughing	1	4	
Laryngospasm	1	0	<0.32
Total	**11 (27.5%)***	**33 (82.5%)**	<0.001

values are expressed as number
*Significant difference from propofol (p<0.001)

tube insertion was less frequent in the sevoflurane group (27.5% versus 82.5%, $p<0.001$), while earlier studies reported a higher incidence of airway side effects with sevoflurane induction when using lower initial concentrations, slower induction techniques, or non primed circuits.[10,12,13] Apnea (defined as failure to start spontaneous breathing within 30 seconds of laryngeal tube insertion) occurred in 42% of the patients in the propofol group but did not occur in the sevoflurane group. More attempts at laryngeal tube insertion were required in the sevoflurane group, and the time to successful insertion was 45 seconds longer.

Vital capacity breath of sevoflurane provides good conditions for laryngeal tube insertion, especially when used with nitrous oxide 50% in oxygen. It was reported that the addition of nitrous oxide enhances the safety and speed of sevoflurane induction.[12] Asai et al[3] has shown that when nitrous oxide was used the intra-cuff pressure of the laryngeal tube progressively increased over time but unexpected incidence of postoperative sore throat was higher where nitrous oxide was not used.

The time to loss of response to command in those patients who held a single breath was 51.6 ± 4.4 seconds, using a primed circuit with 8% sevoflurane and 66% nitrous oxide. This result compares well with the 41 ± 16 seconds reported by others.[10,14] It was shown that the time to jaw relaxation with sevoflurane was longer compared with propofol,[14] while laryngeal reflexes attenuation was excellent with both sevoflurane and propofol. In this series, the main difficulty regarding the quality of laryngeal insertion when using sevoflurane was in the mouth opening. The jaw tightness could be due to lag time during which the alveolar concentration of sevoflurane equilibrates with the brain, which results in inadequate anesthesia during the initial attempts at laryngeal tube insertion.[5] Turan et al[4] reported that the number of attempts needed for a successful laryngeal tube insertion was less than that needed for laryngeal mask insertion. This may be due to the used muscle relaxant. Relaxation of the jaw muscles sufficient for a jaw thrust may be a reflection of adequate depth of anesthesia.[15] However, some authors argue that the lag time is unlikely to be important with sevoflurane due to its low blood-gas partition coefficient.[16] Another possible explanation is related to the anesthetics themselves. Propofol is known to have a relaxant effect on jaw muscles,[17] whereas inhaled anesthetics may cause increased muscle tone and plasticity.[18] So, the similar depth of anesthesia may cause a greater jaw relaxation with propofol. However, it is difficult to compare the depth of anesthesia between inhaled and intravenous anesthesia. Although adequate depth of anesthesia may be correlated to plasma concentration for propofol,[19] the correlation between minimum alveolar anesthetic concentration (MAC) values and depth of anesthesia for sevoflurane is not clearly defined. This is because MAC refers to a state of equilibrium, which is not achieved during single VCB induction. In this series, the mean arterial pressure in patients receiving propofol was lower than that in patients receiving sevoflurane (data not shown), which is consistent with the previously reported results in other series.[12]

The safety and reliability of sevoflurane single VCB induction of anesthesia makes it an alternative to intravenous propofol for the laryngeal tube insertion. Sevoflurane VCB induction resulted in a lower complication rates and stable homodynamic profile during induction of anesthesia and laryngeal tube insertion. However, it may result in a longer time laryngeal tube insertion due to prolonged jaw tightness.

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