

## Comparison of Induction and Recovery Characteristics of Sevoflurane, Halothane and Propofol in Pediatric Outpatients

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### ABSTRACT

**Objective:** This study was done to compare and select the suitable anesthetic agent with smooth rapid induction, smooth rapid recovery, early readiness for discharge and with few intraoperative and emergence complications in pediatric outpatients.

**Material & methods:** We studied 60 children undergoing bone marrow or C.S.F. aspiration for the diagnosis or follow up of leukemia or Hodgkin's disease. They were randomly allocated to receive either sevoflurane or halothane as inhalation anesthetics or propofol as an intravenous one, for both induction and maintenance of anesthesia. Induction times, recovery times and intraoperative and emergence complications were recorded and statistical analysis of data was done to compare the differences between the three agents.

**Results:** The three agents were found to provide satisfactory anesthetic conditions with few perioperative complications. However the use of propofol mandates insertion of an intravenous cannula, that was very difficult in small children under treatment with chemotherapy and also had prolonged recovery times. While the use of halothane was limited by its potential liver damaging effect with repeated anesthetic exposures.

**Conclusion:** Sevoflurane was found to be the most suitable agent in this study. It had a smooth rapid induction time, the shortest recovery time, rapid hospital discharge, with very few intraoperative and postoperative complications and with no risk of anesthesia repetition in short time interval.

**Key Words:** Sevoflurane - Halothane - Propofol - Pediatric - Outpatients.

### INTRODUCTION

Inhalation induction remains a widely used technique in pediatric outpatient anesthesia, particularly for small children under treatment with chemotherapy in whom intravenous cannulation is difficult.

It is becoming increasingly apparent that

sevoflurane has the potential to be the inhalation induction agent of choice in children. It has several properties that make it an attractive alternative to the currently available anesthetics; its relatively low blood-gas solubility, the non-pungent odour and lack of irritation to airway passages makes it a very useful anesthetic for rapid induction in pediatric outpatients. Its low solubility should also allow for a more predictable emergence from anesthesia, thereby facilitating patients' turnover in a busy ambulatory surgical center [11,12,14].

Halothane is still widely used in pediatric outpatient anesthesia as it has a relatively non-pungent odour; it lacks airway irritation and has smooth and relatively rapid induction qualities [9,13]. It is of limited use in pediatric oncology wards because of its potential hepatic damage with repeated exposures especially with compromised liver functions after treatment with chemotherapy.

Propofol is still the intravenous agent of choice for induction in outpatient anesthesia because of its favorable recovery profile and its low incidence of side effects. However, the use of propofol is associated with pain on injection, cardiovascular and respiratory depression and requires an intravenous line, which is very difficult to be found in pediatric patients under treatment with chemotherapy [7,17].

In this study, we compared the induction and recovery criteria of sevoflurane with those of the other inhalation anesthetics, halothane and the intravenous anesthetic propofol in the outpatient pediatrics undergoing very short procedures in the oncology clinics.

## MATERIAL AND METHODS

We studied 60 patients, ASAI-II, aged 2-10 years in the outpatient pediatric clinic undergoing diagnosis or follow up of leukemia or lymphoma by doing bone marrow aspiration, intrathecal aspiration of C.S.F., or usually both procedures together under general anesthesia.

All patients were unpremedicated and were randomly allocated to receive either sevoflurane (S group) or halothane (H group) by a face mask, or propofol intravenously (P group) for both induction and maintenance of anesthesia.

For inhalation induction, the anesthetic was delivered by the use of a Mapleson F breathing system or a Bain-system according to the age of the child. Sevoflurane was administered at a vaporizer setting of 8% and halothane at 5% in O<sub>2</sub>. The time taken to loss of eye lash reflex as a sign of loss of consciousness and the time to complete induction (small pupils, no gross bodily movements, regular respiration) were recorded for all patients. When induction was complete, the patient was maintained with 2% of the agent used till the end of the time of the biopsy.

A 20-gauge intravenous cannula was inserted in the patients allocated for intravenous induction with propofol. Lignocaine 10 mg was injected intravenously as prophylaxis against pain produced by injection of propofol and induction was performed with 2.5-3 mg/kg of propofol injected slowly till loss of consciousness, then other maintenance doses were injected on need.

Induction and intraoperative complications (struggling, cough, excessive secretions, laryngeal spasm, bronchospasm, vomiting, movements and O<sub>2</sub> desaturation) were recorded.

Emergence times were also recorded. Those were the time taken from stoppage of anesthesia to that when the patient could localize a painful stimulus, time to eye opening to command and the time the patient was awake and able to speak and could be discharged to the waiting area with his parents. Emergence complications (agitation, somnolence and vomiting) were recorded.

Pulse oximeter saturations and heart rate were monitored from the start in all patients till the end of the procedure. Patients were transferred to the recovery room when they had a patent airway, acceptable respiratory pattern,

normal oxygen saturations and with no need for mandibular support. The child was observed and an oxygen mask was applied and the times were recorded.

## RESULTS

Demographic data were comparable in the three study groups (Table 1).

The distribution of age, sex, ASA physical status and time of operation were similar in the three groups with no significant statistical difference, except for the time of anesthesia, which was significantly shorter in group (P) due to the short induction time by the intravenous propofol administration.

We compared the induction times and the intraoperative complications in the three study groups (Table 2). The time to loss of eye lash reflex was significantly more rapid with sevoflurane ( $38.8 \pm 6.9$  sec) than with the other inhalation agent halothane, but the difference between the time to complete induction of anesthesia with sevoflurane and halothane was small and not statistically significant reflecting nearly similar rapid induction times of the two agents.

With the use of the intravenous anesthetic propofol, the time to loss of eye lash reflex and the time to complete induction were more rapid with statistically significant differences compared to the two other inhalation anesthetics.

The overall incidence of complications during induction was slight and similar in all three groups, except for struggling, which was high in the two inhalation groups due to refusal of face mask application. The incidence of patient movements after induction of anesthesia with surgical stimulation or any painful stimulus was statistically significantly higher with propofol (60%) than with sevoflurane (20%) and halothane (15%) requiring other maintenance doses.

Recovery criteria were studied in the three groups (Table 3). The time from stoppage of anesthesia to that when the patient localized painful stimulation was recorded. The shortest time was for the sevoflurane group ( $94.5 \pm 44.9$  sec), which was significantly shorter than both the halothane and the propofol groups. In the recovery area, where the time taken to responding to command and eye opening was recorded, the shortest recorded time was that of sevoflurane

group (268.8±86.8 sec), but the difference was not statistically significant from that of halothane. The intravenous propofol group had a more prolonged time, which was highly significant than the two other inhalation groups.

The time at which the patient could be transferred to his parents to the waiting area was also recorded and the shortest time was for sevoflurane. The most prolonged time was for propofol group (668.5±155.4 sec), which was significantly longer than the two other groups.

As regards emergence complications, no child vomited in the three groups. Agitation and restlessness during recovery were more frequent with the sevoflurane group, 9 patients (45%) were crying or doing abnormal excitatory movements on emergence for a short time followed by a good recovery without dizziness or somnolence. In the halothane group, emergence somnolence was a prominent feature that occurred in 17 patients who recovered well yet spoke with a desire to sleep.

Table (1): Patient characteristics and clinical data.

	S Group	H Group	P Group
Number	20	20	20
Age (years)	5.6±2.4	5.4±2.5	5.0±1.8
Sex (M/F)	12/8	13/7	11/9
ASA (I/II)	13/7	15/5	14/6
Time of operation (sec)	104.3±62.1	100.3±54.2	142.5±81.2
Time of anesthesia (sec)	237.5±75.9	242.3±65.5	185.4±80.1*

\*  $p < 0.05$

Table (2): Induction criteria.

	S Group	H Group	P Group
Loss of lash reflex (sec)	38.8±6.9*	44.5±9.3	20.2±3.2*
Induction time (sec)	133.3±25.8	137.5±23.2	42.9±5.1*
<i>Intraoperative complications:</i>			
Struggling (n)	12 (60%)	11 (55%)	6 (30%)
Cough (n)	3 (15%)	2 (10%)	3 (15%)
Excessive secretion (n)	–	–	–
Laryngospasm (n)	1 (5%)	1 (5%)	–
Bronchospasm (n)	–	–	–
Movement (n)	4 (20%)	5 (25%)	12 (60%)*
Vomiting (n)	–	–	–
Oxygen desaturation (n)	–	–	–

n = Number \*  $p < 0.05$

Table (3): Recovery criteria.

	S Group	H Group	P Group
Localization of pain (sec)	94.55±44.9*	152.5±50.8	109.0±72.4
Eye opening to command (sec)	268.8±86.8	320.5±85.6	484.0±132.1
Fit for discharge (sec)	377.0±79.9*	462.5±84.3	668.5±155.4
<i>Emergence complications:</i>			
Agitation (n)	9 (45%)*	1 (5%)	– (0%)
Somnolence (n)	3 (15%)	17 (85%)	8 (40%)
Vomiting (n)	– (0%)	– (0%)	– (0%)

n = Number

\*  $p < 0.05$

## DISCUSSION

Inhalation induction remains a widely used technique in pediatric outpatient anesthesia. Ambulatory anesthesia with sevoflurane offers a good alternative to the currently available anesthetics. When administered in pediatric outpatients undergoing very short procedures, sevoflurane produced highly satisfactory anesthetic and surgical conditions with few perioperative complications.

In this study, the loss of eyelash reflex with loss of consciousness was significantly more rapid with sevoflurane than with halothane, but the difference in induction times was not significant.

Black and coworkers and Ariffin and his colleagues, compared the induction times between sevoflurane and halothane in pediatric outpatients, and had similar results, that sevoflurane had a shorter induction time than halothane [2,1]. Also, Sarner et al., compared times to intubations during sevoflurane and halothane anesthesia and showed the two to be almost identical [12].

Paris et al., [11] compared sevoflurane and halothane in outpatient dental anesthesia and found that the time to loss of eyelash reflex was shorter with sevoflurane, as in our study and other previous studies [2,7,13], but the time of complete induction was significantly longer with sevoflurane than with halothane [11]. They explained why sevoflurane induction times were not so rapid despite of its low solubility. The maximum concentration of the agents that could be delivered by the available vaporizers was

halothane 5% and sevoflurane 8%. These correspond to approximately 5 MAC and 4 MAC, respectively; this suggests that part of the limitation of induction time for sevoflurane may be a function of the vaporizer. In addition, sevoflurane is a more respiratory depressant than halothane at concentrations > 1.4 MAC, so that at deeper planes of anesthesia uptake of the vapor may be slower than halothane which may make induction relatively slower [4].

Recovery from sevoflurane anesthesia was more rapid, than halothane, as would be expected from its lower blood gas solubility. This is in agreement with the study of Smith et al., and Sury et al., which showed more rapid emergence with sevoflurane than isoflurane and halothane, respectively [14,15]. Other studies also reported that sevoflurane had shorter induction and emergence times than halothane with no major complications [3,5]. Sevoflurane was not found to be associated with an increased incidence of coughing, laryngospasm, bronchospasm, excessive secretions, vomiting, or oxygen desaturation to less than 90%; analogous to other studies evaluating the use of sevoflurane for induction of anesthesia [6,14].

We found that sevoflurane and halothane were similar in the smoothness of induction and recovery and the quality of anesthesia overall. There were little complications and side effects, which were nearly similar between the two groups. However, the recovery of patients was different between the two groups. Agitation and restlessness were prominent features of group (S) appearing in large number of patients, but for a short time followed by a fully awake child and this was noted by other investigators [10,11,15]. Uezono et al., had recorded that 38% of their pediatric patients developed agitation [18]. Somnolence was apparent in most of the halothane group. Villani et al., 1998 reported that children receiving sevoflurane had shorter times of showing purposeful movements, emergence from anesthesia and achieving readiness to discharge [19].

Although induction times with sevoflurane were slower compared with propofol, this difference was not of great clinical significance as it was compensated by the rapid recovery characteristics of sevoflurane.

Joo and his colleagues, performed a meta-

analysis of twelve previous studies to compare the characteristics of sevoflurane and propofol for induction of anesthesia [7]. They found no statistical difference in the time of induction or the complications occurring with induction between the two drugs, with similar efficacy for anesthesia induction.

The transition from induction to maintenance with sevoflurane was significantly smoother compared with propofol. This difference could be explained by the fact that when anesthesia has been induced by inhalation, the inspired concentrations were almost equilibrated, so that subsequent small changes in the depth of anesthesia were readily achieved. In contrast, after induction of anesthesia with propofol, the drug rapidly redistributed leading to a decrease in the depth of anesthesia. During this period, it was necessary to introduce the maintenance agent rapidly in order to reestablish an adequate depth of anesthesia. At the same time, stimulating events such as patient positioning, skin cleaning and insertion of the large bore cutting needle usually results in patient movement requiring a greater depth of anesthesia and repeated maintenance doses. These intraoperative patient movements during propofol anesthesia were observed and reported by Thwaites et al., 1997 and Nathan et al., 1998 [17,8].

Both sevoflurane and propofol had favorable recovery profiles. Propofol anesthesia provided slower emergence and less agitation compared with sevoflurane anesthesia. Tang et al., 1999 compared the recovery characteristics of propofol and sevoflurane in pediatric outpatients and their results were nearly similar to our study [16]. The emergence from anesthesia was slower with propofol than with sevoflurane, but the time to discharge from hospital was not significantly different. The incidence of agitation was higher with sevoflurane group than with propofol group.

There was no significant difference in the incidence of intraoperative complications, except for struggling with induction which was much more prominent with the inhalation groups due to refusal of the face mask application. Fredman et al., found no significant differences in complications between sevoflurane and propofol [6].

Halothane is considered a good inhalation anesthetic in pediatric outpatients with non-pungent odour, smooth and rapid induction, few

intraoperative complications, favorable recovery profile but with somnolence. But halothane was not a good choice in our study on children undergoing diagnosis or follow up of Hodgkin's disease or leukemia, in which the anesthesia is, repeated in short time intervals and the patients are usually under treatment with chemotherapy which usually affects the liver functions.

Propofol is a good induction agent in outpatient anesthesia, with rapid induction, good titration as needed, fewer side effects in children and with good recovery profiles. Its major disadvantage was the need for an intravenous line, which was very difficult in small children under treatment with chemotherapy.

Sevoflurane was an excellent agent for inhalation anesthesia in our study. It had a short induction time, rapid emergence, a low incidence of airway complications or other intraoperative or postoperative side effects. It showed no liver affection with repeated patient exposure, with no need for an intravenous line and provided a shorter stay in the recovery area, thus allowing fast-track anesthesia in the outpatient setting.

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