A Comparative Study of Induction, Maintenance and Recovery Characteristics of Sevoflurane and Halothane Anaesthesia in Pediatric Patients (6 months to 6 years)

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ABSTRACT

Patients & Methods: In a randomized , double blind clinical study, we studied 30 children, aged 6 months to 6 years, to compare halothane and sevoflurane anaesthesia in patients undergoing short surgical procedures under general anaesthesia. All the patients were premedicated with atropine 0.02mg kg^{-1} and midazolam 0.1mg kg^{-1} body weight intravenously and received inhalation induction using nitrous oxide in oxygen supplemented with either halothane (maximum inspired concentration of 5%) or sevoflurane (maximum inspired concentration of 8%). Induction was by inhalation of increasing concentrations of sevoflurane (1%) or halothane (0.5%) in the vaporizing setting after every three breaths of the patient.

Results: Time to loss of eyelash reflex and tracheal intubation was more rapid using sevoflurane. Cardiac arrhythmias were significantly more frequent during halothane than sevoflurane anaesthesia. Psychomotor recovery was more rapid after sevoflurane anaesthesia. Children who received sevoflurane had comparatively less nausea and vomiting and the incidence of clinically important side effects was significantly less with sevoflurane anaesthesia.

Conclusion: We conclude that induction with sevoflurane in nitrous oxide and oxygen leads to fast loss of consciousness and provides ideal conditions for managing the airway without supplemental opioids or muscle relaxants with haemodynamic stability and is therefore a reasonable alternative to halothane for paediatric patients.

KEYWORDS: Halothane, Sevoflurane , paediatric, children

The introduction of fluorinated hydrocarbons into clinical practice provides one of the greatest landmarks in the development of anaesthesia. Nowadays these fluorinated hydrocarbons are practiced very frequently in pediatric patients as inhalational agents because of difficult venous access.

Halothane was prepared and examined by Raventos J. It was introduced into clinical practice by Johnstone & Bryce-Smith & O Brien[1]. Halothane is a halogenated alkane derivative that exists as a clear, noninflammable liquid, has a sweet, non pungent odour, an intermediate solubility in blood combined with a high potency, permits rapid onset and recovery from anaesthesia when used alone or in combination with nitrous oxide. Its halogenated structure provides no inflammability, intermediate blood solubility, anaesthetic potency and molecular stability.Specifically carbon – fluoride bond decreases flammability and the trifluorocarbon contribute to molecular stability[2]. Halothane is still the first choice inhalational agent for paediatric anaesthesia due to above stated reasons.

Sevoflurane is fluorinated methyl isopropyl ether. It has minimal non pungent odour, produces bronchodilation and least degree of airway irritation among the currently available volatile agents. For these reasons, sevoflurane like halothane is acceptable for inhalation induction.[3]

In childhood, uptake of inhaled agents is particularly rapid although clearly the recovery profile, cardiovascular stability, minimal metabolism in soda lime, lack of central nervous system excitation and antiemetic effect during recovery are as important as they are in adults. This study was conducted to compare quality of anaesthesia, incidence of clinically important side effects with both the agents and recovery after sevoflurane and halothane anaesthesia.

PATIENTS & METHODS

After approval from the College Academic Committee, this comparative study was conducted on 30 paediatric patients, of either sex belonging to ASA grade I and II in the age group of 6 months to 6 years undergoing elective short surgical procedures (less than an hour). The patients were assigned randomly to one of the two groups:

Group I : included children who received halothane + nitrous oxide + oxygen anaesthesia (n=15)

Group I : included children who received sevoflurane + nitrous oxide + oxygen anaesthesia (n = 15)

Patients with prior history of any bleeding disorder,

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known cardiovascular, respiratory, neurological or gastrointestinal ailments were excluded from the study.

Electrocardiographic limb leads were attached to the patient before induction and lead II was continuously monitored.The ECG readings were analysed by a physician. Oxygen saturation was continuously monitored throughout the procedure and at the time of recovery using a peadiatric pulse oximetry probe.

Patients were premedicated with atropine sulphate(0.02mg kg^{-1}) and midazolam(0.1mg kg^{-1}) intravenously. Pulse oximeter saturations, heart rate and non invasive blood pressure measurements were recorded at 1 minute intervals. Face mask of correct size was held close to the patient's face and mixture of either 1% sevoflurane or 0.5% halothane with nitrous oxide 6L/min and oxygen 3L/min was started. Increase in concentration of volatile agents was done after every three breaths of patient (an increase of 0.5%halothane in the halothane vaporizing setting or 1% for sevoflurane).Concentration of halothane and sevoflurane was increased until the child was breathing 8%sevoflurane or 5% halothane. Air sealed face mask was not applied to the face until the child was asleep which was confirmed by the disappearance of the eyelash reflex. The duration of this period was called induction time-1.Now patient was allowed to take breaths through the facemask which was held tightly close to the child's face.

At the time of induction, pupil size and position was assessed continuously. When pupil became small and central and the patient was fully relaxed, the trachea was Intubated without using any muscle relaxant. Duration of induction until tracheal intubation performed, was noted as induction time-2.

After induction, halothane administration was continued at the concentration of 2% to 3% or in case of sevoflurane, concentration for maintenance was 3% to 4%.

After completion of the surgical procedure, inhalation agent and nitrous oxide were stopped, extubation done.

Time was recorded,at which inhalational agent was ceased and in the recovery room, when the child first attempted to remove his/her chin from the supporting hand. Reflex action, heart rate, cardiac rhythm, any intra operative or emergence complications were noted.

Data are presented as mean (SD). Statistical analysis were performed using the students t test. $p<0.05$ was considered statistically significant.

RESULTS

Demographic data were comparable in both the groups. No statistical significant difference among groups with regard to age, male female ratio, average duration of surgery, type of surgery and ASA physical status were observed.

We compared the induction times, intubating conditions, incidence of arrhythmias during anaesthesia, intraoperative complications and time taken for adequate recovery from anaesthesia in both the groups.

The time to loss of eyelash reflex(induction time-1) was significantly shorter in the sevoflurane group, $p<0.05$ (77.06±13.06) as compared to halothane group (96.06±15.59). The mean time taken to complete induction (tracheal intubation with endotracheal tube, induction time-2)was shorter in the sevoflurane group suggesting more rapid induction times with sevoflurane as the inhalational agent (Table I). Comparison of scoring system for intubating conditions which included ease of laryngoscopy, position of vocal cords, coughing, jaw relaxation and limb movements between the two groups showed no statistical significant difference, $p=0.25$(Table 2).

The lowest and highest values of heart rate and arterial pressure were similar in both the groups.

The incidence of cardiac arrhythmias was higher during halothane anaesthesia (60%) as compared during sevoflurane anaesthesia (33.3%). The ECG recordings which were analyzed by a physician showed that most of the arrhythmias were ventricular in origin in both the groups, commonest type being premature ventricular beats (Table 3).

Children who had been administered sevoflurane had significantly less intraoperative complications. The incidence of breath holding, cough, laryngospasm and movements of patients were more with halothane anaesthesia (Table 4). At the time of emergence from anaesthesia, agitation and abnormal excitatory movements were observed more in the

Table 1
Intubation time

	T1(sec)	T2(sec)
Halothane	96.06 ±15.59	274.46 ±48.20
Sevoflurane	77.06 ±13.06	222.8 ±23.80
t value, p value	3.61, 0.002	3.72, 0.002

Table 2
Comparison of intubating conditions

	Halothane	Sevoflurane
Intubating Score	4.73± 0.59	4.93± 0.25

t value, p value : 1.20, 0.25 (not significant)

Table 3
Incidence of arrhythmia during anaesthesia

	Number of cases which had arrhythmia	Percentage
Halothane	9	60%
Sevoflurane	5	33.33%

sevoflurane group while somnolence was the most common side effect of halothane anaesthesia.(Table 5).

Adequate recovery from anaesthesia as indicated by the time when patient attempted to remove chin from the supporting hand was significantly rapid after sevoflurane as compared to the patients to the patients who had been given halothane as the inhalational agent, $p<0.05$ (Table 6).

Table 4
Intra operative Complications

Complications	Halothane	Sevoflurane
Breath holding	2	-
Cough	1	1
Laryngospasm	2	1
Movements	4	3
Increased Secretion	-	-
Episodes of oxygen desaturation	-	-
Bradycardia	2	-

Table 5
Emergence Conditions

	Halothane	Sevoflurane
Nausea and vomiting	1	1
Somnolence	13	3
Agitation	2	9
Abnormal excitatory movements	0	5

Table 6
Recovery time- when patient attempted to remove chin from the supporting hand

	Halothane	Sevoflurane
Time (seconds)	360.0± 60.0	202 ±59.9

t value, p value : 7.21, 0.0001

DISCUSSION

Inhalation induction remains the most preferred technique for paediatric age group. Sevoflurane is a suitable agent for paediatric patients as it produces highly satisfactory anaesthesia with very few intraoperative and postoperative complications

The overall quality of anaesthesia delivered with both halothane and sevoflurane was similar.

In this comparative study, the loss of eyelash reflex(induction time -1) and the time taken till tracheal intubation (induction time - 2) was significantly rapid with sevoflurane than with halothane.Black and coworkers[4] also compared the induction times between sevoflurane and halothane and had same results that sevoflurane had a shorter induction time than halothane.

Similar results were observed by Jehan M et al[5] but they found that though loss of eyelash reflex was significantly rapid with sevoflurane, the difference in total induction time i.e.till tracheal intubation was significantly not different in both the groups. Sarner and colleagues[6] compared times to intubation with both the inhalational agents and found that they were the same. They found that though induction was rapid with sevoflurane, the time needed to achieve deeper planes of anaesthesia was similar to that of halothane. Paris ST and coworkers[7] suggested that limitation of induction time for sevoflurane may be a function of the vaporizer. The maximum concentration of the agents that they could deliver were 5% halothane and 8% sevoflurane which corresponded to 5 MAC and 4 MAC respectively. In addition, sevoflurane being a more respiratory depressant than halothane at concentration greater than 1.4 MAC which made induction slower as at deeper planes of anaesthesia, the uptake of the vapour was slower than halothane.

The incidence of cardiac arrhythmias was higher during halothane anaesthesia which is in agreement with the study of Paris S T, et al[7].Calderone E and coworkers[8] also observed in their study that supraventricular beats appeared in 22.5% of patients in the halothane group and in 5% of the sevoflurane group. Meretoja O.A.,et al[9] also observed cardiac arrhythmias to be the most common side effect.

The incidences of intraoperative complications like breath holding, laryngospasm, cough and movements of the patients were observed to be more with halothane anaesthesia; though these results did not interfere with the technique of inhalation induction. Two patients in the halothane group developed bradycardia intraoperatively that necessitated us to decrease the delivered concentration of halothane for some time.

No significant differences among the two groups with regard to emergence from anaesthesia and recovery were noted. Though agitation and abnormal excitatory movements were the most common emergence phenomenon with sevoflurane anaesthesia, somnolence was found more commonly with halothane and this was noted by other investigators as well.[10]

We found that incidence of postoperative nausea and vomiting was less in the sevoflurane group than in the halothane group, indicating that sevoflurane anaesthesia produced little nausea and vomiting

Recovery was rapid with sevoflurane which can be attributed to its low blood-gas solubility.Similar results were observed by Smith, et al and Sury, et al.[11]

We conclude that sevoflurane is the most suitable agent for paediatric age groups because of its rapid onset of action, few intraoperative and postoperative complications, quick recovery and no risk of repeated sevoflurane exposure to patients.

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