Original Article

Induction characteristic of general anaesthesia in children- a comparative study between sevoflurane and halothane

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Abstract

Background *Inhalational induction of anaesthesia remains of fundamental technique in paediatric anaesthesia. Halothane used most frequently for inhalational induction in children. Halothane is not an ideal induction agent because of its potential to cause bradycardia, hypotension and ventricular ectopy. The pleasant nonpungent order of sevoflurane, faster induction of anaesthesia and stable vital signs during induction suggest that it may be a suitable alternative to halothane for use in paediatric anaesthesia.*

Objectives *The aim of study is to compare the induction time and haemodynamic response during induction of sevoflurane and halothane.*

Methods *A total number of 60 patients, age within 1-12 years (ASA grade I & II) were selected randomly into two groups, thirty in each group. Group A induction was done by halothane and Group B induction was done by sevoflurane. Anaesthesia was induced with 60% N_2O and 40% O_2 and starting inspired concentration of halothane was 1% or sevoflurane was 2% followed by stepwise increases in the inspired concentrations of either sevoflurane (1.5-2% increments) or halothane (0.5-1% increments) every three to four breath until the patients no longer blinked in response to touching the eye lashes. Arterial pressure, heart rate, oxygen saturation (S_PO_2) were recorded every minute for 3 minutes during induction and induction time was recorded.*

Results *Induction time was significantly shorter in the sevoflurane group compared to the halothane group ($P < 0.001$). In haemodynamic profile heart rate and mean arterial pressure were significantly reduced in halothane group while no significant changes were observed in sevoflurane group during induction period ($P < 0.001$).*

Conclusion *The study concludes that induction of anaesthesia was faster with sevoflurane than halothane. Vital signs were stable with sevoflurane during induction period.*

Key words *Paediatric anaesthesia, inhalational induction, sevoflurane, halothane.*

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Introduction

The primary objective of anaesthesia is to facilitate surgery at minimal risk to the patient and to ensure smooth induction and optimal recovery following the procedure.

Researchers are continuously looking for safety in anaesthesia by improving the quality of drugs, instruments and different procedures to provide a smooth induction from anaesthesia and better operative condition.

In western countries, it is customary to use of one of the five modern volatile anaesthetic agents like Desflurane, Sevoflurane, Enflurane, Isoflurane, Halothane vaporized in a mixture of nitrous oxide in oxygen[2]. In recent years, the use of halothane has declined because of medicolegal pressure

relating to hapatotoxicity and there has been a clear trend to avoidance of repeated halothane anaesthesia. Desflurane produces rapid recovery from anaesthesia but it is very irritants to the airway and is therefore not used as an inhalational induction agent of choice.[3] Isoflurane has pungent odour which makes inhalational induction relatively unpleasant particularly in children. Inhalational anaesthetics are particularly useful in the induction of paediatric patients in whom it may be difficult to start an intravenous line.

In contrast, adults usually prefer rapid induction with intravenous agents, although the non-pungency and rapid onset of sevoflurane have made inhalation induction practical for adults[5]. Three factors affect anaesthetic up take: Solubility in the blood, alveolar blood flow and the difference in partial pressure between alveolar gas and venous blood. The greater the uptake of anaesthetic agents, the greater the difference between inspired and alveolar concentrations and slower the rate of induction. Halothane, Isoflurane and Sevoflurane are used in Bangladesh. Isoflurane and sevoflurane is costly drugs and in terms of cost benefit ratio, use of halothane technique is cheaper. Cost of Sevoflurane can be reduced by induction with Sevoflurane and maintenance with Halothane.

Most children arrive in the operating room without an intravenous line in place and dread the prospect of being stuch with a needle. In the unpremedicated subject, halothane anaesthesia is associated with an increase in ventilatory rate and reduction in tidal volume. $PaCo_2$ increases as the depth of halothane anaesthesia increases.

Arrhythmia are very common during halothane anaesthesia and increased myocardial excitability augmented by increased circulating catecholamines. Bradycardia caused by central vagal stimulation[3].

Some clinicians use a single breath induction technique with sevoflurane (7-8% Sevoflurane in 60% nitrous oxide) to speed up induction[4]. Cardiovascular depression, bradycardia, and arrhythmia are significantly less with sevoflurane than with halothane. Sevoflurane is associated with the least respiratory depression. There are no reported instances of renal toxicity from inorganic fluoride production during Sevoflurane anaesthesia in children. Overall sevoflurane appears to have a greater therapeutic index than halothane and has become a preferred induction agent in paediatric anaesthesia[4].

Sevoflurane has many of the features of an ideal volatile anaesthetic agent. It is non irritant and has a low blood gas solubility means that induction of anaesthesia can be achieved rapidly by inhalation which makes it particularly useful in children where it now competes with halothane. It is also suitable for vital capacity induction by inhalation of a single large breath of a high concentration e.g. 8 percent in O_2. It is beginning to replace halothane as an induction agent of choice in patients with upper airway obstruction[5]. In this study, we have observed the effects of induction characteristics of halothane and sevoflurane in paediatric patient.

Methods

With approval from departmental ethical committee, written informed consent was obtained from the parents of 60 ASA physical status 1 and 2 children age 1-12 years who was scheduled for out patient day care surgery of genitourinary, lower abdominal and plastic surgery. The children was randomly assigned to received either halothane or sevoflurane. Demographic data including age, weight and type of surgery was recorded for all subjects. Vital signs including heart rate, MAP, respiratory rate and temperature were recorded one minute before induction of anaesthesia (baseline). All children were remains fasted and unpremedicated. After application of standard monitors including pulse oximeter and non invasive blood pressure, anaesthesia was induced with 60% N_2O and 40% O_2 and starting inspired concentration of halothane was 1% or sevoflurane was 2% followed by stepwise increases in the inspired concentrations of either sevoflurane (1.5-2% increments) or halothane (0.5-1% increments) every three to four breath. The vaporizer concentration was increased by an amount equal to the starting concentration of the drug until the patients no longer blinked in response to touching the eye lashes termed as induction time.

Following loss of the eye lash reflex. The vaporizer concentration was decreased to 5% Sevoflurane or 1.6% halothane (approximately 2

MAC). Anaesthetic gas concentration was maintained at 1 MAC throughout surgery until skin closure. Anaesthesia was delivered via face mask through Bain circuit or Ayre's t piece. During induction fresh gas flows were adjusted to 3-6 $L.min^{-1}$ for children aged 1-7 years and 6-10L/min for those aged 8-12 year. Arterial pressure, heart rate, oxygen saturation (SPO_2) were recorded every minute for 3 minute during induction. Immediately after induction of anaesthesia intravenous cannulation was established. Dextrose 5% + NaCl 0.225% solution was administered during anaesthesia at a maintenance rate appropriate for the child's age and fasting internal.

Anticholinergic medication was administered only for the treatment of bradycardia. Tracheal intubation was facilitated with succinylcholine 1-2 mg/kg I.V. All patients received fentanyl 1µg/kg intravenously immediately following induction. Neuromascular block was maintained by atracurium 0.5mg/kg I.V. N_2O and inhalation agent were continued until the surgical procedure was completed. At the time of placement of the last suture all anaesthetic agents were discontinued and 100% O_2 was administered for 1-2 minutes. Neostigmine 50ìg/kg with atropine 20ìg/kg I.V. were administered to antagonize residual neuromascular blockade.

Tracheal extubation was performed when the patient was judged to be awake (making purposeful movements), breathing regularly and demonstrating adequate muscle strength. For statistical analysis, induction time and induction vital signs were compared. Induction characteristics including coughing, laryngospasm, breath holding, nausea and vomiting, secretions, bronchospasm, excitement and any other unanticipated events was recorded.

Data was collected in a specially designed data sheet. It was compiled and analyzed for statistical significant by student's 't' test where appropriate using SPSS Window 11.6 software. Data was presented as mean ± SD or in frequencies as applicable. A 'p' value of less than 0.05 was considered statistically significant (CL-95%).

Results

This study groups became statistically matched for age in years (halothane 6.50±0.53; sevoflurane 6.20±0.57, p=0.701). Weight in kg (halothane 18.93±1.27; sevoflurane 18.12±1.13, p = 0.633), as shown in Table-I

Table I *Age and weight distribution of the study subjects*

Variable	Halothane	Sevoflurane	P value
No of patients	30	30	
Age (years)	6.50±0.53	6.201±0.57	0.701
Weight (kg)	18.93±1.27	18.12±1.13	0.633

Values are expressed as mean ± SD; analysis was done by unpaired student's 't' test.

Induction of anaesthesia was more rapid with sevoflurane than with halothane measured from the start of the inhalation agent and face mask.

Induction time was significantly shorter in the sevoflurane group compared to the halothane group (Table-II).

Table II *Induction time of the study subjects.*

Time	Halothane	Sevoflurane	P value
Time to loss of eyelash reflex (induction time in sec)	110.67± 3.42	43.33± 1.40	0.001

Values are expressed as mean ± SD; analysis was done by unpaired student's 't' test.

In haemodynamic profile, heart rate was significantly reduced in halothane group while no significant changes were observed in sevoflurane group during induction period (Table-III).

Table III *Changes of heart rate from baseline, during induction of anaesthesia.*

Heart rate	Halothane	Sevoflurane	P value
Baseline	93.10±1.59	96.43±1.86	0.178
During induction 1min	91.03±1.58	96.43±1.86	0.031
During induction 2min	88.33±1.57	95.33±1.76	0.004
During induction 3min	85.57±1.55	96.00±1.87	0.001

Values are expressed as mean ± SD; analysis was done by unpaired student's 't' test.

Mean arterial pressure was significantly reduced in halothane group while no significant changes was observed in sevoflurane group during induction period (Table-IV).

Table IV *Changes of mean arterial pressure from baseline, during induction of anaesthesia.*

Mean arterial pressure	Halothane	Savoflurane	P value
Baseline	76.50±0.60	77.77±0.33	0.070
During induction 1min	74.04±0.49	78.10±0.25	0.001
During induction 2min	71.70±0.44	76.83±0.31	0.001
During induction 3min	68.64±0.49	76.83±0.32	0.001

Values are expressed as mean ± SD; analysis was done by unpaired student's 't' test.

Anaesthesia related complications during induction shown in table-V.

Table-V: *Anaesthesia related complications during induction.*

Induction	Halothane		Sevoflurane	
	No.	%	No.	%
Coughing	6	(20%)	2	(6%)
Breath holding	8	(26%)	3	(10%)
Excitement	2	(6%)	8	(26%)
Vomiting	1	(3%)	0	
Bradycardia	7	(23%)	0	

Values are expressed as frequencies; within parenthesis are percentages over column total.

Estimated cost of Halothane and Sevoflurane group is displayed in Table-VI in Bangladeshi currency. Induction cost was significantly lower in halothane than sevoflurane.

TableVI *Induction cost of halothane vs sevoflurane.*

Variable	Halothane	Sevoflurane	P-value
Induction cost	11±0.34	52±1.68	0.001

Values are expressed as mean ±SD; analysis was done by unpaired students 't' test.

Discussion

Inhalational induction of anaesthesia remains of fundamental technique in paediatric anaesthesia.[6] Halothane remains the anaesthetic used most frequently for inhalational induction in children because it produces less airway irritation than enflurane[7], isoflurane[8] or desflurane. Despite its efficacy and frequency of use, however halothane is not an ideal induction agent because of its potential to cause bradycardia, hypotension and ventricular ectopy[9]. The pleasant non pungent odour of sevoflurane and its low blood gas partition coefficient suggest that it may be a suitable alterative to halothane for use in paediatric anaesthesia[10].

The blood gas partition coefficient predicts that induction should be more rapid with sevoflurane than with halothane[10]. In our study sevoflurane causes loss of eyelash reflex more quickly than halothane by 67.34 sec (p=0.001). This result is similar to that of a study by Veronique Piat et al. (1994)[11] who found that sevoflurane achieves induction faster than halothane by 30 sec. Another study by A Black et al. (1996)[6] found similar result of induction time approximately 40 sec. faster by sevoflurane than halothane. Haga et al.[12] induced anaesthesia in 180 children using a constant inspired concentration of either 4% or 6.4% Sevoflurane. These investigators measures induction times of 56 seconds and 47 seconds respectively. Our result of sevoflurane induction time was 43.33±1.40sec; (P=0.001). Study of Richard et al. (1995)[13] found induction was faster with sevoflurane (97±31 sec.) than halothane (120±36 sec, p<0.06). In our study result induction of sevoflurane was 43.33±1.40sec vs halothane 110.67±3.42sec, is similar with the study of Richard et al. (1995)[13] and during induction they given 7% sevoflurane and 5% halothane. In our study during induction we have used 7% sevoflurane and 4.5% halothane.

In our study children receiving halothane (80.20±1.70, beats/min) tended to have a decrease in heart rate during the anaesthetic induction period where as children receiving sevoflurane (96.43±1.79, beats/min) maintained or increased heart rate. This result is similar with the study of Joel B. Sarner et al. (1995)[10], they found heart rate of halothane was 89±18 (beats/min) and sevoflurane was 105±22 (beats/min).

The decrease in mean arterial blood pressure during induction was greater in patients receiving halothane than in those receiving sevoflurane, MAP of halothane was 61.45±0.47 vs MAP of sevoflurane was 77.96±0.28 which was similar with the study of Joel B. Sarner et al. (1995)[10] and they found MAP of halothane 63±16 vs MAP of sevoflurane 69±18. Our study suggests that sevoflurane is a satisfactory drug for the induction of anaesthesia in children compared with halothane.

The study concludes that induction of anaesthesia was faster with sevoflurane than halothane. Vital signs were stable with sevoflurane during induction period. Sevoflurane is an excellent drug for inhalation induction in paediatric patients.

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