Scholars Journal of Applied Medical Sciences (SJAMS) **ISSN 2320-6691 (Online)**
Sch. J. App. Med. Sci., 2017; 5(6B):2123-2128 **ISSN 2347-954X (Print)**

(An International Publisher for Academic and Scientific Resources)
www.saspublishers.com DOI: 10.36347/sjams.2017.v05i06.019

Original Research Article

A Comparative Study of Sevoflurane versus Halothane as Induction agents in Paediatric Age Group

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Abstract: Inhalation induction is practiced more commonly in children. Children of different ages vary in their response to the anesthetic experience. Infants younger than six months generally do not object to inhalational induction. Aim of the study was to compare 8% Sevoflurane and 5% Halothane in Nitrous Oxide and Oxygen mixture as induction agents in paediatric age group for the induction time, haemodynamic changes and any complications. This study was conducted in 100 children aged 6 months to 12 years. The patients were divided randomly into two groups, group S and group H, 50 in each group undergoing elective and emergency surgical procedures in M.G.M. Hospital, Warangal. All patients were planned to receive general anesthesia, induction with either 8% sevoflurane or 5% halothane in 50% nitrous oxide and oxygen mixture. Group–S patients induced with 8% sevoflurane in 50% nitrous oxide and oxygen. Group-H patients induced with 5% halothane in 50% nitrous oxide and oxygen. Each patient was studied in relation to the times taken for acceptance of facemask, loss of consciousness and completion of induction. The hemodynamic variables viz., heart rate, SpO_2, arterial pressures, electrocardiogram was recorded. Struggling and excitement, the body movements occurring before and after the loss of consciousness were graded and noted. The children in sevoflurane Group took slightly less time for acceptance of the facemask compared to the halothane group. However, the difference in time for acceptance of facemask between the two groups is statistically insignificant ($P>0.05$). The time taken for loss of consciousness is recorded at the time of loss of eyelash reflex from start of induction. The children in the sevoflurane group lost consciousness at a much shorter interval compared to the children in the sevoflurane group which is statistically significant ($P<0.05$). Struggling, the body movements that occur before the loss of eyelash reflex Children in the halothane group struggled more severely compared to the sevoflurane group and the difference is statistically significant ($P<0.05$). 8% sevoflurane with nitrous oxide in oxygen is a suitable alternative to 5% halothane with nitrous oxide in oxygen for high initial inspired concentration inhalational induction. The significant difference in struggling score suggests that sevoflurane provided more pleasant induction.
Keywords: Sevoflurane, Halothane, Induction agent in Pediatrics

INTRODUCTION

General anesthesia has been the anesthetic technique of choice in paediatric age group because the lack of understanding of reality makes the children to be uncooperative for regional anesthetic technique. In addition, children may not properly communicate in the event of any untoward incident with regional anesthesia. The regional anesthesia techniques though increasingly done in recent years are most of the time confined to providing analgesia and require an adequately sedated child to co-operate. Majority of the children do not like to be awake while their bodies being cut and become restless though appear to be self-assured in the preoperative period. Sevoflurane is polyfluorinated anesthetic structurally related to isoflurane and desflurane, but the solubility in blood and tissue as well as potency are less than isoflurane and desflfurane [1]. Induction and emergence from anesthesia are fast and rapid changes in depth can be achieved. It is pleasant and can be administered by face mask it poses no problem in induction and is frequently selected this purpose and acceptability is good by pediatric patients [2]. The minimum alveolar concentration [MAC] of sevoflurane is reported in

between 1.71% to 2.05% [3, 4]. The MAC for sevoflurane in common with other anesthetics and is somewhat higher in children. Typically values of 2.6% (reduced to 2.0% by nitrous oxide in children and 3.3% in neonates [5]. Halothane is a volatile liquid with sweet odour, non-irritating and non-inflammable solubility in blood is intermediate when used for as induction agent induction is reasonably quick and pleasant. Clinical experience has suggested that inhalation induction with sevoflurane was smoother as compared to halothane in children [6]. Some other studies on contrary have suggested that inhalation induction times in children to be similar, irrespective of whether sevoflurane or halothane were administered [7, 8]. With this background we tried to compare 8% Sevoflurane and 5% Halothane in Nitrous Oxide and Oxygen mixture as induction agents in paediatric age group for the induction time, haemodynamic changes and any complications.

MATERIALS AND METHODS

This study was conducted in 100 children aged 6 months to 12 years. The patients were divided randomly into two groups, group S and group H, 50 in each group undergoing elective and emergency surgical procedures in M.G.M. hospital, Warangal. An informed consent was taken from all patients. All patients were planned to receive general anesthesia, induction with either 8% sevoflurane or 5% halothane in 50% nitrous oxide and oxygen mixture.

Group–S patients induced with 8% sevoflurane in 50% nitrous oxide and oxygen.

Group-H patients induced with 5% halothane in 50% nitrous oxide and oxygen.

The following observations were made, compared and statistically analyzed.

- The time taken for acceptance of facemask.
- The time taken for loss of consciousness- eyelash reflex.
- The time taken for completion of induction.
- Hemodynamic variables- heart rate, noninvasive arterial pressure, electro cardiogram, SpO_2
- Any untoward events (cough, laryngospasm, secretions, breath holding, vomiting, bronchospasm) were noted and scored (1-mild, 2-moderate, 3- severe).
- Movements – before loss of consciousness were classified as struggling and those afterwards as excitement. A struggling score of 1- head movement only, 2- mild struggling with head and limb movements and 3- more severe struggling.

METHOD

The present study was conducted in 100 children, age group between 6months to 12 years, ASA Grade-I undergoing different elective and emergency surgical procedures in pediatric surgery, ENT surgery, orthopedic surgery, requiring general anesthesia after taking informed consent from their parent/Guardian. All the cases were assessed pre-operatively for cardiac and respiratory status and fitness for anesthesia. All the patients were clinically assessed and investigated pre-operatively to rule out any systemic disease. The following investigations were carried out before subjecting the patient for surgery viz., blood hemoglobin, blood chemistry, bleeding time, clotting time, etc,.

Before getting the patient into the operating room, the necessary drugs were loaded and kept ready in labeled syringes. Anesthesia machine, endotracheal tubes of appropriate size, laryngoscope, Guedel's airway, working suction apparatus, sphygmomanometer, pulse oximeter, multichannel monitor, IV cannula(20,22 & 24G) and the resuscitation equipment checked and kept ready. No premedication was prescribed. Anesthesia was induced by standard anesthesia technique using one of the two inhalational agents. The angle piece (without a mask) of the pediatric circuit was kept as close to the patient's face as could be tolerated and 100% oxygen was delivered for 5 minutes. Then the selected inhalational agent was administered with 50% nitrous oxide in oxygen at a vapouriser setting of either 5% for halothane or 8% for sevoflurane. The times taken to loss of consciousness (eye lash reflex), acceptance of face mask and end of induction (small pupils, no gross bodily movements and regular respirations) were recorded for all the patients.

During induction, the vaporizer setting could be reduced by step wise reductions if clinically indicated. When the induction was complete, anesthesia was continued with the maintenance doses of the either agent with 66% nitrous oxide in oxygen. As soon as possible, during induction of anesthesia I.V. line is established and atropine 0.01mg was given intravenously. Pulse oximeter saturations (Biosys, BPM 200), ECG lead II & heart rate (Datex Ohmeda, F-CM1) and non-invasive arterial pressure with a manual sphygmomanometer were recorded at 1-minute intervals. In some children it was possible to apply the pulse oximeter probe, ECG leads, blood pressure cuff before induction, and in most of the children they were applied immediately after loss of consciousness. The arterial pressure recording was difficult to perform manually and in majority of the children, it was not

possible to record at 1-minute intervals, however, it was recorded in all the children at the end of 5 minutes. Any untoward events such as cough, laryngospasm, secretions, breath holding, vomiting and bronchospasm were noted and scored as 1-mild, 2-moderate and 3-severe. Movements before the loss of consciousness were classified as struggling and afterwards as excitement. A struggling score of 1 was given for head movement only, 2 for mild struggling with head and limb movements and 3for more severe struggling.

Endotracheal intubation if required was accomplished by Inj. Succinyl choline 1.5-2 mg/kg and connected to pediatric circuit (Jackson Rees modification of Ayres 'T' piece). Anesthesia is maintained with either 0.5-3% sevoflurane or 0.5-2% halothane with 66% nitrous oxide in oxygen according to the hemodynamic response of the child. Muscle relaxation was continued with either vecuronium bromide or atracurium besylate. Inj Ondansetron 0.08mg/kg given intravenously to prevent post-operative nausea and vomiting.

Statistical Analysis:

All the data were expressed as mean ± SD. Graph pad prism, version 4, was used for statistical analysis. P value less than 0.05 was considered statistically significant.

RESULTS

The mean age of the patients involved in Sevoflurane group was 5.19 ± 2.34 years and mean weight in the same group was 14.11±3.282 Kgs and in Halothale group mean age was 5.21 ± 2.30 and mean weight was 15.00±3.00 Kgs given in table 1.

Table 1: Age and Weight Distribution of Patients in Two Groups

	Group S	Group H
Age in years	5.19±2.34	5.21±2.30
Weight in kilogram	14.11±3.282	15.00±3.00

The difference in age & weight between group S and group H is insignificant (P>0.05).

The children in sevoflurane group took slightly less time for acceptance of the facemask compared to the halothane group. However, the difference in time for acceptance of facemask between the two groups is statistically insignificant (P>0.05) given in table 2.

Table 2: Comparison of the Time Taken To Acceptance of Face Mask

Time in seconds	Group S	Group H
<30	6	0
31-60	36	41
61-90	8	9
Mean ± S.D	48.58±12.31	52.52±10.61

The difference between group S and group H is insignificant (P>0.05).

The time taken for loss of consciousness is recorded at the time of loss of eyelash reflex from start of induction. The children in the sevoflurane group lost consciousness at a much shorter interval mean time in seconds [67.2±14.59] compared to the children in the Halothane group mean time in seconds was [77.86±13.98] which is statistically significant (P<0.05).

Table 3: Comparison of the Time Taken For the Loss of Consciousness

Time in seconds	Group S	Group H
31-60	21	10
61-90	29	31
91-120	0	9
Mean ± S.D	67.2±14.59*	77.86±13.98*

P values < 0.05 statistically significant.

The time taken for completion of induction is determined by observing the disappearance of body movements, small pupils and regular respiration from the start of induction. The children in the sevoflurane group were induced in a slightly shorter time [113.0±17.27] compared to the children in the halothane

group [118.2±16.73]. However, the difference was statistically insignificant (P>0.05) given in table 4.

Table 4: Comparison of the Time Taken For the Completion of Induction

Time in seconds	Group S	Group H
60-90	7	0
91-120	33	29
121-150	9	21
151-180	1	0
Mean±S.D.	113.0±17.27	118.2±16.73

Mean Arterial Pressures were measured at 0 minute interval and 5 minutes intervals and recorded. The values were decreased in both the groups compared to the basal values. However, the magnitude in change appears to be similar between the two groups given in table 5.

Table 5: Pattern of Change in Mean Arterial Pressure [MAP]

	MAP-0	MAP-5
Group S	74.88±7.10	65.44±6.12
Group H	74.6±6.88	65±6.26

There were only few complications recorded with secretions in both s group and H group however the secretions were mild and few patients in S group showed excitement which was managed successfully given in table 6.

Table 6: Complications that Occurred With Less Frequency.

	Group S (No. of Pts.)	Group H (No. of Pts.)	Comment on severity
Cough	0	0	-
Secretions	29	41	Mild
laryngospasm	0	0	-
vomiting	0	0	-
Breath holding	0	0	-
Bronchospasm	0	0	-
Excitement	5	0	Mild

DISCUSSION

Inhalational induction remains a widely used technique in paediatric anesthesia, particularly in small as well as uncooperative children in whom I.V cannulation may be difficult. Because of its lack of airway irritation and smooth relatively rapid induction qualities, halothane has remained the preferred agent for inhalational induction in children, despite its potential for hepatic damage and increased incidence of arrhythmias. Sevoflurane has lower blood-gas solubility and a less pungent odour, suggesting that induction may be more rapid than with halothane with a low incidence of complications during induction.

The present study demonstrated no significant difference between ends of induction times for the two agents at maximum inspired concentrations. However, the use of maximum inspired concentrations allowed achieving shorter times for loss of consciousness: 1 min 7 sec and 1min 17 sec with sevoflurane and halothane respectively, compared with 1 min 41 sec and 2 min 17 sec in a study undertaken by Black A *et al.;* using a gradual increase in vapour concentration. [9] P.E.Sigston *et al.;* recorded the times for loss of consciousness: 1 min 12 sec and 1 min 16 sec with sevoflurane and halothane respectively that are similar to the data obtained in the present study [10]. These short induction times are in keeping with previous studies examining the use of high inspired concentrations of sevoflurane. Jehan M. Kamal *et al;* reported the loss of eye lash reflex more rapid with sevoflurane (38.8 ±6.9 sec) compared to halothane (44.5±9.3 sec). [11]. The subjects he chose for the study were leukemic patients who were posted for bone marrow biopsy, the faster induction with both the agents compared to the present study and other published data would probably point to the selection of the different patient group.

In the present study the time taken for end of induction was slightly shorter in children who received sevoflurane (113±17.27 sec) than in who received halothane (118.2±16.73 sec). However, the difference is statistically insignificant. Kajal N. Dedhia *et al.;* reported the mean induction times with gradual increasing inspired concentrations of 164.8±29.73 sec for sevoflurane and 249.83± 40.58 sec for halothane. [12] M Yurino *et al.;* reported that the mean time for induction of anesthesia with halothane (153±46 sec) was slower than with sevoflurane (81±22 sec) using approximately 2.6 times the minimum alveolar concentration of either agent. [13] This study probably reflects the advantage of low blood gas solubility of sevoflurane. Jehan M. Kamal *et al.;* recorded the time for completion of induction was similar in both the groups (133.3±25.8 sec –sevoflurane to 137.5±23.2 –halothane). [11].

The more rapid induction seen with sevoflurane compared with halothane with the use of gradual increase in inspired concentration may reflect the fact that equipotent concentrations were not used. In the present study, inspired concentrations of 8% sevoflurane and 5% halothane are used, as these are the maximum concentrations that could be delivered by the vapourizers available. The induction times largely depend on the inspired concentrations delivered by the vapouriser. Halothane vapouriser delivers seven times the minimum alveolar concentration whereas the sevoflurane vapouriser four and a half times the minimum alveolar concentration for the available maximum dial setting (MAC halothane- 0.7: MAC sevoflurane- 1.8 for a forty year human). Sevoflurane was not associated with any major airway complications. Majority of the patients in both the groups had minimal increase in secretions. This in comparison to the previous studies that reported secretions in few patients might be due to the avoidance of anti sialogogue in the preoperative period in present study. Although the use of atropine as a premedicant is not universal, it is indicated in infants less than six months old to prevent airway related complications and bradycardia, as the cardiac output in infants is dependent on heart rate due to the under-developed ventricular muscle mass.

Atropine given in the present study soon after the establishment of IV line is intended for preventing the complications of succinyl choline and intra-operative complications with the maintenance doses of volatile agents, as the previous studies suggest that arrhythmias(decreased discharge from S A node and slow conduction through the A V node) are more common in the maintenance period. Excitement, a term used to describe involuntary movements occurring after loss of consciousness, occurred exclusively in the sevoflurane group, but did not interfere with the course of induction. This excitement occurred with a less frequency (10%) than documented in previous study (20%) using a technique involving a gradual increase in sevoflurane concentration by Black A *et al.* and Singston *et al.;* [9,10].

It is difficult to determine preference for any particular induction agent in patients of this age group, although adult volunteers have found the smell of sevoflurane more acceptable than halothane. In the present study, an attempt was made to assess this factor, by assessing the degree of patient struggling during induction. The degree of struggling was severe in both the groups compared to the previous studies; 40% of patients in sevoflurane induced compared to 65% in halothane induced in study done by P.E. Singston *et al.;* In the present study 64% children induced with sevoflurane and 84% children induced with halothane had struggling. This may be attributed to the environment in which children were induced [10]. Most the inhalational induction studies were conducted with the child in close proximity to their parents. In the present study, children were not induced in a non-threatening environment. However, the struggling was more severe in children who received halothane compared to the children in sevoflurane group. None of the patients in two groups had episodes of significant desaturation, however, the pulse oximeter probe applied in most of the patients as soon as they lost consciousness and the first recording was obtained only after one minute after start of induction. In the study done by P.E. Singston *et al.;* one child had a saturation of 92% [10], Kajal N. Dedhia *et al.;* [12] reported two children desaturated to 90%. Absence of episodes of desaturation in the present study might be because of preoxygenation and use of initial low nitrous oxide concentration. Shruti R *et al.;* showed that heart rate increases with sevoflurane induction whereas decreases with halothane. [14] In the present study, change in mean arterial is consistent with the previous studies, heart rate progressively and gradually increased in sevoflurane group whereas there was initial decrease in heart rate followed by increase in heart in halothane group.

CONCLUSION

8% sevoflurane with nitrous oxide in oxygen is a suitable alternative to 5% halothane with nitrous oxide in oxygen for high initial inspired concentration inhalational induction. The significant difference in

struggling score suggests that sevoflurane provided more pleasant induction.

Conflict of interest: None

Source of support: Nil

Ethical Permission: Obtained

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