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Induction characteristics of sevoflurane in children: A comparison with halothane

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Abstract

Introduction: Halothane has been the inhalational induction agent most often used in paediatric anaesthesia as it provides smooth induction with good intubating conditions. However, it is associated with disadvantages like myocardial depression and arrhythmias. Sevoflurane having low blood-gas solubility allows for rapid induction, has less myocardial depression and its pleasant odour may make it a suitable agent of inhalational induction in children. Hence, the present study was undertaken to compare the induction and intubation characteristics of sevoflurane and halothane.

Methods: The study population consisted of 200 children aged 1-12yrs, who were randomly assigned into two groups. Group H received incremental concentrations of halothane 0.5-5% and Group S received incremental concentrations of sevoflurane 1-7%. Induction and intubation times, induction and intubation characteristics, and haemodynamics were studied.

Results: The induction and intubation times were shorter with sevoflurane compared with halothane (Group H v/s Group S; induction time 108.6 sec ± 13.3 v/s 64.2 sec ±12.7, intubation time 282.8sec ±34.1 v/s 213sec ±42.6 ($P<0.05$)). The induction related side effects were minimal with both agents and did not come in the way of smooth induction. 93% children with halothane and 88% children with sevoflurane had acceptable intubating conditions. Halothane was associated with slight decrease in heart rate and mean arterial pressure, whereas sevoflurane was not associated with any significant haemodyamic changes.

Conclusion: Sevoflurane produces rapid induction than halothane and intubation time is achieved faster with sevoflurane than halothane. Induction with both agents is associated with minimal induction complications and acceptable intubating conditions are obtained with both agents in majority of children.

Keywords: Paediatric anaesthesia, Halothane, Sevoflurane, Inhalational induction, Inhalational intubation

Introduction

Inhalational induction of anaesthesia remains the most popular technique of inducing anaesthesia in paediatric age group. Halothane has been the cornerstone of paediatric inhalational induction despite its propensity to cause bradycardia, hypotension, arrhythmias and rarely hepatitis.[1,2] Sevoflurane is the next generation inhalational agent that is now increasingly available and has several advantages over halothane. It has a lower blood gas solubility co-efficient,[3] is less myocardial depressant than halothane,[4] and is less extensively metabolised.[5] In addition, it has a pleasant odour and is non-irritant making it a suitable agent for inhalational induction in children. The objectives of the present study were to compare the induction and intubation times, as well as induction and intubation characteristics of halothane and sevoflurane inhalational anaesthesia in children.

Materials and Methods

After obtaining ethical committee clearance and parental consent, 200 ASA grade 1 and 2 children aged 1-12yrs scheduled to undergo elective surgery were randomly assigned to be induced with either halothane (Group H) or sevoflurane (Group S). Children with recent upper respiratory tract infection, recent pneumonia, asthma, bronchospastic disorders, previous hepatitis, and use of anticonvulsants or hepatic enzyme inducers were excluded from the study. All children were premedicated with syrup triclofos 25mg/kg. After instituting minimal mandatory monitoring, which included ECG, NIBP, pulse oximetry and a precordial stethoscope; children were induced with either halothane or sevoflurane depending on the group to which they were randomised.

Inhalational induction of anaesthesia was accomplished in all children using Jackson-Rees modification of Ayre's T-piece or Bain's system and an unscented face mask using 50:50 nitrous oxide and oxygen mixture with incremental concentrations of the studied volatile anaesthetic. In group H the initial dial concentration of halothane was set at 0.5% followed by a stepwise increase by 0.5% every four breaths to a maximum of 5%. In group S the initial dial concentration of sevoflurane was set at 1% followed by a stepwise increase by 1% every four breaths to a maximum of 7%. After loss of eyelash reflex, an intravenous line was secured and orotracheal intubation with the appropriate size endotracheal tube was carried out once there was loss of conjugate eye movements and pupils were centrally placed mid dilated. After trachea was intubated, the child continued to breathe 1-1.5% halothane or 1.5-3% sevoflurane until all measurements were complete. Induction time, intubation time, quality of induction and quality of intubation were noted. Heart rate, blood pressure, and SpO_2 were recorded during induction and immediately after intubation at 1min, 2min and 3min intervals. The

study ended at this point. The anaesthesiologist involved in carrying out inhalational induction and intubation was not aware of the agent being used as the vaporizers were covered with a screen. Another anaesthesiologist not involved in data collection changed the vapourizer dial settings every four breaths.

Induction time was defined as the time interval from the placement of facemask to loss of eyelash reflex and intubation time was defined as the time interval from the placement of facemask to loss of conjugate eye movements and pupils were centrally placed and mid dilated. The quality of induction was assessed with the following parameters:[6] intolerance, coughing, salivation, laryngospasm, vomiting, breath holding, SpO_2<90%, rigidity, movement and shivering; each of the parameters were graded on a scale from 0 to 3 (0=not present, 1=present but not troublesome, 2=causing interference with the technique or requiring treatment, 3=so troublesome that technique had to be abandoned). Quality of intubation was assessed using the scoring system as depicted in Table 1.[7-9] The best possible score was 5. Intubating condition was considered unacceptable if a score more than 2 was noted in any individual category. The chi-square test and Mann_Whitney U test were used for non-parametric data and Student's t test for parametric data. SPSS for windows version 18 (SPSS Inc., Chiacago, USA) was used for data handling and statistical analysis. P<0.05 was considered statistically significant.

Results

The demographic characteristics in the two groups were comparable (Table 2). Children in the sevoflurane group were induced more rapidly and were ready for intubation earlier when compared to halothane group (Table 3). The mean induction time was 108.6 seconds in group H compared to 64.2 seconds in group S (P<0.05). The mean intubation time was 282.8 seconds in group H compared to 231.6 seconds in group S (P<0.05). Among the various characters observed in the two groups, laryngospasm, vomiting, SpO_2<90% and shivering were not observed in any children in either groups. Children in the halothane group had less intolerance to the vapour and involuntary movements during induction than in the sevoflurane group (Table 4; Group H v/s Group S, 16% v/s 23% and 27% v/s 40% respectively; P<0.05). The quality of intubation assessed using scoring system showed that 7 children in group H and 12 children in group S had a score of 3 in any one of the characters and hence intubating conditions were deemed unacceptable in these children. Also, a significantly more number of children had their vocal cords moving or closing in the sevoflurane group compared to halothane group (Table 5, P<0.05). The heart rate remained relatively stable throughout induction in the sevoflurane group compared to halothane group, in whom there was a progressive reduction in the heart rate; with the least being 5minutes from the beginning of induction. Following intubation the heart rate increased in both the groups (Fig. 1). The mean arterial pressure decreased progressive during induction, with an increase following intubation in both the groups (Fig. 2).

Table 1: Scoring system used for assessing quality of intubation[7-9]

Score	Laryngoscopy	Vocal cords	Coughing	Jaw relaxation	Limb movement
1	Easy	Open	None	Complete	None
2	Fair	Moving	Slight	Slight	Slight
3	Difficult	Closing	Moderate	Stiff	Moderate
4	Impossible	Closed	Severe	Rigid	Severe

Table 2: Demographic characteristics

Variable	Group H (n=100)	Group S (n=100)
Age (years)*	4.6±3.01	4.6±3.05
Gender (male:female)	86:14	84:16
Weight (kg)*	13.5±5.7	14.1±5.9

*mean±SD

Table 3: Induction and intubation times

Variable	Group H (n=100)	Group S (n=100)
Induction time (seconds)*†	108.6±13.3	64.2±12.7
Intubation time (seconds)*†	282.8±34.1	231±42.6

*mean±SD; †P<0.05

Table 4: Induction characteristics

Induction characteristic	Grade	Group H (n=100)	Group S (n=100)	P value
Intolerance	0 1 2 3	84 16 - -	77 23 - -	<0.05
Coughing	0 1 2 3	93 7 - -	90 10 - -	>0.05
Salivation	0 1 2 3	97 3 - -	95 5 - -	>0.05
Laryngospasm	0 1 2 3	100 - - -	100 - - -	>0.05
Vomiting	0 1 2 3	100 - - -	100 - - -	>0.05
Breath holding	0 1 2 3	88 12 - -	90 10 - -	>0.05
SpO_2<90%	0 1 2 3	100 - - -	100 - - -	>0.05
Rigidity	0 1 2 3	94 6 - -	93 7 - -	>0.05
Movement	0 1 2 3	73 27 - -	60 40 - -	<0.05
Shivering	0 1 2 3	100 - - -	100 - - -	>0.05

Table 5: Intubation characteristics

	Score	Group H (n=100)	Group S (n=100)	P value
Laryngoscopy	1 2 3 4	90 10 - -	85 15 - -	>0.05
Vocal cords	1 2 3 4	80 15 5 -	65 25 10 -	<0.05

Coughing	1 2 3 4	88 10 2 -	83 15 2 -	>0.05
Jaw relaxation	1 2 3 4	92 8 - -	90 10 - -	>0.05
Limb movement	1 2 3 4	90 10 - -	88 12 - -	>0.05

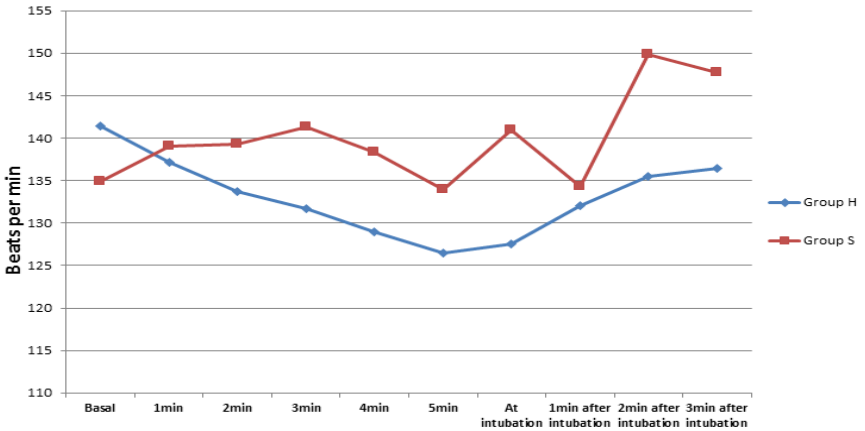

Fig. 1: Mean heart rate changes during induction and intubation

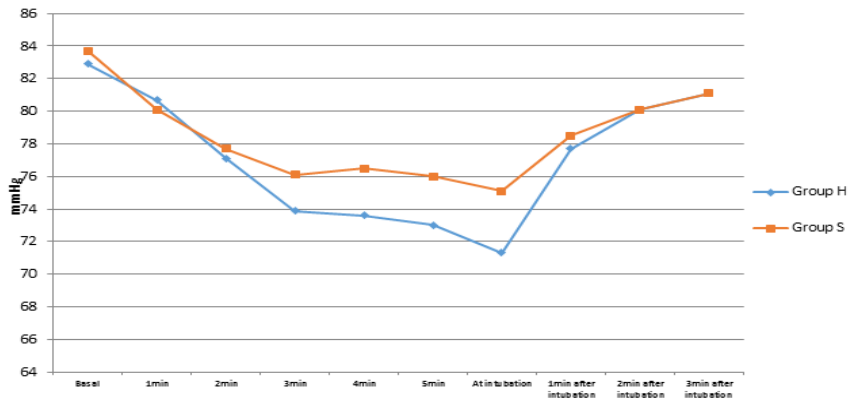

Fig. 2: Mean arterial pressure changes during induction and intubation

Discussion

Inhalational induction of anaesthesia is one of the most common methods of induction employed in paediatric practice.[10] Though intravenous induction has also been employed in children, the need to secure an intravenous line in an awake child, which is psychologically traumatic and unpleasant to the child, makes inhalational induction still the commonly used and popular method of induction in paediatrics. Halothane, the commonly employed agent for induction is associated with disadvantages like myocardial depression,[7,11] sensitisation of myocardium to catecholamines,[12,13,14] and rarely the serious complication of hepatitis. Sevoflurane, which has a pleasant odour and low blood-gas solubility, thus allowing for smooth and rapid induction; minimal effects on the cardiovascular system, has rapidly gained popularity as the inhalational agent of choice in paediatric anaesthesia.

The present study showed that sevoflurane in incremental concentrations provides faster induction and intubation conditions compared to halothane. The

induction and intubation conditions are acceptable in majority of children with minimal side-effects. In addition, sevoflurane is not associated with any significant cardiovascular changes. The induction and intubation time was achieved much faster with sevoflurane than halothane in the present study which is similar to that noted by others.[6,7,11,15-17]

Inhalational induction is associated with side-effects like; coughing, laryngospasm, breath-holding, bronchospasm, salivation, excitatory movements, vomiting, intolerance to vapour, hypoxemia, rigidity, and shivering. In the present study the commonest side-effect noted was excitatory movements, which was observed in both the groups. The incidence of excitatory movements was 27% and 40% with halothane and sevoflurane respectively. Paris ST et al[6] observed excitatory movements in 66% of their patients with both halothane and sevoflurane. The other side-effect of importance was intolerance to the vapour which was observed in 16% and 23% of children with halothane and sevoflurane respectively. This was almost similar to that noted by Paris ST et al.[6] The other induction related side-effects were minimal and was similar to other studies.[6,11,16,17] These induction related side-effects were minimal and they did not come in the way of smooth induction in all children in both the groups.

The intubating conditions in the present study was assessed employing the scale used by O'Brein et al[7] and Bithal PK et al.[8] Acceptable intubating conditions were noted in 76.9% and 81.3% of children with halothane and sevoflurane respectively by Bithal PK et al,[8] whereas O'Brein et al[7] noted acceptable intubating conditions in 95% of children with both halothane and sevoflurane. In both the studies the vocal cords were more likely to be moving or closing with sevoflurane intubation. In the present study intubating conditions were acceptable in 93% and 88% of children with halothane and sevoflurane respectively, which was similar to O'Brein et al.[7] We also noted that the vocal cords were more likely to be moving or closing in the sevoflurane group, similar to the other studies.[7,8] Though the intubating conditions were rated as not acceptable as per the scale, we were able to intubate all children in first attempt in both the groups.

In the present study the heart rate decreased progressively with halothane, whereas it remained stable throughout induction with sevoflurane. The mean arterial pressure decreased with both the agents, but the decrease was greater with halothane than those receiving sevoflurane. These cardiovascular changes were similar to that observed by Sarner JB et al.[16]

The limitations of the study was, though vaporizers were covered from direct vision of the anaesthesiologist involved in inhalational induction, an experienced person may still be able to detect the agent involved by its odour and hence may lead to bias during data collection.

Conclusion

Both halothane and sevoflurane produce acceptable induction and intubation characteristics in majority of children. Induction and intubation times are shorter with sevoflurane compared with halothane. Heart rate remains relatively stable with sevoflurane during induction and intubation. This makes sevoflurane a suitable alternative to halothane for inhalational induction of anaesthesia in children.

Conflict of Interest: None to declare

References

1. Keenna JG, Neuberger J, Mieli-Vergani G, et al. Halothane hepatitis in children. Br Med J 1987;294:1209-1211.
2. Walton B. Halothane hepatits in children. Anaesthesia 1986;41:575-578.
3. Malviya S, Lerman J. The blood/gas solubilities of sevoflurane, isoflurane, halothane, and serum constituent concentrations in neonates and adults. Anesthesiology 1990;72:793-796.
4. Hatakeyama N, Ito Y, Momose Y. Effects of sevoflurane, isoflurane and halothane on mechanical and electrophysiologic properties of canine myocardium. Anesth Analg 1993;76:1327-1332.
5. Holaday DA, Smith FR. Clinical characteristics and biotransformation of sevoflurane in healthy human volunteers. Anesthesiology 1981;54:100-106.
6. Paris ST, Cafferkey M, Tarling M, et al. Comparison of sevoflurane and halothane for outpatient dental anaesthesia in children. Br J Anaesth 1997;79:280-284.
7. O'Brein K, Kumar R, Morton NS. Sevoflurane compared with halothane for tracheal intubation in children. Br J Anaesth 1998;80:452-455.
8. Bithal PK, Soudagar A, Paul M, Bali A. Comparison of halothane with sevoflurane inhalation in children for tracheal intubation. Ind J Anaesth 2000;44:47-54.
9. Steyn MP, Quinn AM, Gillespie JA, et al. Tracheal intubation without neuromuscular block in children. Br J Anaesth 1994;72:403-406.
10. Hatch DJ. New inhalation agents in paediatric anaesthesia. Br J Anaesth 1999;83:42-49.
11. Black A, Sury MRJ, Hemington L, et al. A comparison of the induction characteristics of sevoflurane and halothane in children. Anaesthesia 1996;51:539-542.
12. Collins VJ. Physiologic and Pharmacologic Bases in Anesthesiology. Baltimore, Williams and Willikins, 1996. 663-707.
13. Katz RL, Matteo RS, Papper EM. The injection of epinephrine during general anesthesia with halogenated hydrocarbons and cyclopropane in man: 2. Halothane. Anesthesiology 1962;23:597-600.
14. Katz RL, Katz GJ. Surgical infiltration of pressor drugs and their interaction with volatile anaesthetics. Br J Anaesth 1966;38:712-718.
15. Taivainen T, Tiainen P, Meretoja OA, et al. Comparison of the effects of sevoflurane and halothane on the quality of anaesthesia and serum glutathione transferase alpha and fluoride in paediatric patients. Br J Anaesth 1994;73:590-595.
16. Sarner JB, Levine M, Davis PJ, et al. Clinical characteristics of sevoflurane in children: A comparison with halothane. Anesthesiology 1995;82:38-46.
17. Lerman J, Davis PJ, Welborn LG, et al. Induction, recovery, and safety characteristics of sevoflurane in

children undergoing ambulatory surgery: A comparison with halothane. Anesthesiology 1996;84:1332-1340.
18. Pait V, Dubios MC, Johanet S, Murat I. Induction and recovery characteristics and haemodynamic responses to sevoflurane and halothane in children. Anesth Analg 1994;79:840-844.