Comparison of Sevoflurane with Halothane as Inhalational Anaesthetic Agent in Neonate and Paediatric Patients

Manish Patil[1], Sachin Padmawar[1]

ABSTRACT

Introduction: Inhalational anaesthesia the commonly used in the pediatric patients. The present study was designed to compare induction and recovery characteristics of sevoflurane with halothane in neonate and paediatric patients, and to assess the hemodynamic profile of both anesthetics during induction, maintenance and recovery from the anaesthesia.

Material and Methods: We prospectively studied 120 patients aged between 1 day to 7 years of either sex and ASA grade I, II or III posted for elective as well as emergency surgeries. Children were randomly assigned into two anaesthetic groups receiving either sevoflurane or halothane in a mixture of O_2 and N_2O (50:50) for mask induction and maintenance of anesthesia. Induction time, intubating condition and haemodynamic changes were recorded. At the end of surgery, recovery time and post operative complications were noted and compare between two groups.

Results: Induction of anaesthesia was smooth and without any complications in both the group, but induction was fast in sevoflurane group with excellent intubating conditions compared to halothane group. All patients in sevoflurane group were intubated in first attempt, were as in halothane group 90% of patients were intubated in first attempt and rest in second. There was fall in heart rate in both the groups during induction, but significant fall in halothane group. Maintenance of anaesthesia was satisfactory in both the groups. Recovery from anaesthesia was significantly rapid with sevoflurane group than halothane group. None of the patients experienced any side effects.

Conclusion: We conclude that sevoflurane was superior to halothane for induction and maintenance of anaesthesia in neonate and paediatric patients.

Keywords: Sevoflurane, Halothane, Anesthesia, Induction, Intubation, Elective and Emergency Surgeries, Neonate, Paediatric

INTRODUCTION

Induction and maintenance of anaesthesia in paediatric patients can be done using inhalational method or intravenous method, though lack of intravenous access in these patients makes inhalational anaesthesia the commonly used modality. Both sevoflurane and halothane are inhalational anaesthetic agents used for general anaesthesia in paediatric patients. But neonates and especially formerly preterm infants are susceptible to apnea and ventilator depression after general anaesthesia, an effect of the residual drug may be responsible. Hence drugs required in these patients must have minimal storage and rapid elimination.[1] Halothane was prepared and examined by Raventos J and it was introduced into clinical practice by Johnstone and Bryce-Smith and O Brien in 1956[2] as a non -irritant inhalational anaesthetic agent. Hence is most commonly used for inhaled induction of anesthesia in chil- dren, although its extensive metabolism may be responsible for extremely rare, but potentially fatal, hepatitis.[3,4] However it exerts cardiac and hepatic side effects and shows delayed recovery. While sevoflurane is a new inhaled anesthetic, introduced into clinical practice in 1990 and has several theoretical advantages over halothane. It has a lower blood solubility[5] allowing for more rapid recovery, it has less myocardial depressant effects than halothane[6], and it is less extensively metabolized.[7] In addition, it has a pleasant smell, which may make it suitable for an inhaled induction of anesthesia in children.

Induction and recovery from anaesthesia depends on the solubility of the drug, less the blood gas and oil gas solubility more rapid is the achievement of brain concentration, less storage in tissues and hence rapid elimination. Recovery from anaesthesia continues to be an area of interest, particularly in terms of postoperative morbidity and its effects on hospital discharge.

With the availability of this agent in our institute, present study was carried out to compare the induction, maintenance and recovery characteristics of sevoflurane with halothane in neonate and paediatric patients.

MATERIAL AND METHODS

After obtaining institutional ethical committee approval and parent's written informed consent, the study was conducted in 120 neonate and pediatric patients, aged 1 day to 7 years of ASA grade I, II and III, posted for elective as well as emergency surgeries. This prospective comparative study was carried out in the department of anaesthesiology at Shri. Chhatrapati Shivaji Maharaj General Hospital, Solapur. Paediatric patients with deranged hepatic and renal functions and having family history of malignant hyperthermia were excluded from the study. A detailed pre-anaesthetic evaluation was done before surgery and patients were weighed. The patients were kept nil by mouth for 6 hours as per ASA guidelines. The patients were randomly divided into two groups of 60 patients each. On arrival in the pre-operation room intravenous access was taken after application of prilox cream.

In the operation theatre standard monitoring devices like pulse oximeter and ECG monitor were applied to the patient and base line heart rate and SpO_2 were measured. All patients were premedicated with intravenous injection of glycopyrrolate 0.004 mg/kg, midazolam 0.03 mg/kg and pentazocine 0.3

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mg/kg, 3-5mins prior to induction of anaesthesia. Also each patient was preoxygenated with 100% oxygen for 3 minutes with Ayer's T piece with J.R. modification. Patients from group I (Sevoflurane) were induced on O_2:N_2O (50:50%) with sevoflurane 3-7% in increments while the patients from group II (Halothane) were induced on O_2:N_2O (50:50%) with halothane 1-3% in increments. The induction time was noted (time starting from start of inhalational agent to loss of eye lash reflex). After induction patients were intubated with appropriate sized plain disposable portex endotracheal tube and attached to Ayer's 'T'piece with modified J.R. circuit. After confirmation of air entry tube was fixed. The ease of intubation and number of attempts required for intubation were recorded.

Ease of intubation was graded as follows

- *Excellent:* no vocal cord movement or coughing/bucking,
- *Good:* no vocal cord movement but coughing/bucking present,
- *Fair*: partial vocal cord movement and coughing/bucking present,
- *Poor*: vocal cord not relaxed and coughing/bucking present

Anaesthesia was maintained on O_2:N_2O (50:50%) with 2% sevoflurane for group I patients and O_2:N_2O (50:50%) with 1% halothane for group II patients. All the patients received intravenous injection of vecuronium 0.08 mg/kg as a skeletal muscle relaxant. Heart rate and Sp O_2 were recorded before induction, after induction, immediately after intubation, 3 minute and 5 minute after intubation and every 10 minutes throughout the procedure. At the end of surgery, residual neuromuscular blockade was reversed with combination of neostigmine (0.05 mg/kg) and glycopyrrolate (0.008 mg/ kg), given intravenously. All the inhalational anaesthetic agents were stopped. The recovery time (elapsed time from discontinuation of inhalational agent to spontaneous activity and cry) was noted. Post operative complications if any were also noted.

STATISTICAL ANALYSIS

Statistical analysis was performed using chi-square test. Data are presented as mean ±SD. P<0.05 was considered statistically significant.

RESULTS

One twenty patients with in the age group of 1 day to 7 years were included in the study, out of which sixty belonged to sevoflurane group and sixty to halothane group. There were no differences between the two groups with regard to patient age, sex, physical status and weight (Table-1). The most common surgery performed in both the groups was herniotomy and V P shunt. Other type of surgeries performed was shown in table-2. Induction of anaesthesia was smooth and without any complications in both the group, but induction was fast in sevoflurane group (91.57 ± 6.74 seconds) as compared to halothane group (122.91 ± 5.78 seconds) and which was highly significant (P <0.001) (Table-3). Forty eight (80%) patients from sevoflurane group had excellent intubating condition whereas 12 (20%) patients from this group had good intubating conditions. Although in halothane group 42 (70%) patients had good intubating conditions, 6 (10%) patients had excellent condition and rest 12 (20%) patients fair intubating conditions (Figure-1). All patients in sevoflurane group were intubated in first attempt, were as in halothane group 90% of patients were intubated in first attempt and rest in second.

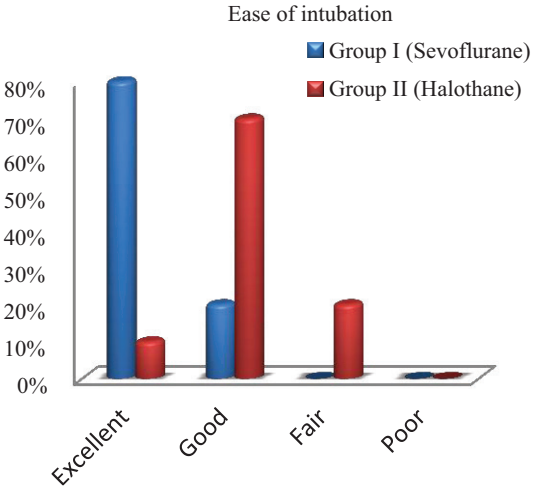

Figure-1: Comparison of intubating condition (i.e. ease of intubation)

Age	Group I (n=60)	Group II n=60)	P Value
1 day - 28 days	15 (25%)	15 (25%)	P > 0.05 (NS)
29 days - ≤1 year	15 (25%)	15 (25%)	
>1 year - 4 years	15 (25%)	15 (25%)	
>4 years- 7 years	15 (25%)	15 (25%)	
Male/Female	31/29	28/32	
Weight 1 Kg - 10 Kgs	32	30	
11 Kgs-20Kgs	28	30	
Demographic data i.e. age, sex and weight in Group I and Group II are statistically comparable (p > 0.05).			

Table-1: Demographic data of the patients

Sr. No.	Type of Surgeries	Group I	Group II
1	Herniotomy	13	11
2	Hypospadiasis repair	3	3
3	Orchidopexy	5	5
4	Cystolithotomy	4	4
5	Anoplasty	2	5
6	Colostomy closure	3	2
7	Colostomy	1	2
8	Gastroschisis repair	0	1
9	Ramsted's operation	0	1
10	Resuturing	0	1
11	V P Shunt	15	10
12	Meningocele repair	5	7
13	Omphalocele repair	2	2
14	Umbilical Hernia repair	4	2
15	Tracheo esophageal fistula repair	2	0
16	Exploratory laparotomy	1	4
	Total no. of patients	60	60

Table-2: Type of surgeries

Parameters (Second)	Group I (Mean±SD)	Group II (Mean±SD)	P Value
Induction time	91.57 ± 6.74	122.91 ± 5.78	<0.001
Recovery time	520.34 ± 66.02	720.34 ± 75.69	<0.001

Table-3: Induction and recovery time

We found no significant difference (P >0.05) in mean heart rates before premedication and pre induction but there was significant difference in the post induction values in both the groups. During induction we observed fall in heart rate in both the groups, but significant fall in halothane group. Comparison of haemodynamic changes between two groups is shown in Figure-2. Maintenance of anaesthesia was satisfactory in both the groups. Recovery from anaesthesia was significantly rapid with sevoflurane group (520.34 ± 66.02 seconds) than halothane group (720.34 ± 75.69 seconds) and which was highly significant on applying Z test (P < 0.001) (Table-3). None of the patients experienced any side effects.

DISCUSSION

Using inhaled anesthetics for induction and maintenance of general anesthesia in pediatric patients provide rapid and smooth induction and emergence, hemodynamic stability, analgesia and amnesia. Halothane with its negligible pungency and minimal effects on airway reactivity has enjoyed popularity as the inhalational agent of choice for paediatric anesthesia. Sevoflurane with low blood gas solubility allows rapid induction and early emergence. It has a pleasant odor and non irritant to the airway which makes it an attractive alternative for inhalational induction in children. Bearing in mind, we used age old inhalational agent halothane and newer agent sevoflurane for induction and maintenance of anaesthesia in neonate and paediatric patients. These two agents were compared in regards to induction time and characteristics, haemodynamic changes, recovery characteristics and side effects.

We found comparable result with respect to demographic data and type of surgery. The time from start of inhalant agent to loss of eyelash reflex (mean time of onset of induction) was shorter for sevoflurane as compared to halothane, (P<0.001). The faster induction time of sevoflurane could be related to its low blood: gas solubility (0.69 versus 2.5). Our result correlates with the result of Epstein et al[8], Calderon E et al[9] and K.O'Brien et al[10], they did a comparative study of sevoflurane versus halothane in paediatric patients in general anaesthesia and had similar result of mean time of onset of induction. Considering intubating condition, 80% of patients receiving sevoflurane had no vocal cord movement and no coughing/bucking i.e. excellent intubating conditions were as only 20% had no vocal cord movement but coughing/bucking present i.e. good conditions, as compared to halothane group which had 70% having good, 20% with partial cord movements and coughing/bucking present i.e. fair intubating conditions and only 10% excellent conditions. However intubating conditions were satisfactory in both groups in majority of cases. We found similar result of intubating conditions with study done by V.N. Swadia, Mamta Patel.[11] All patients from sevoflurane group were intubated in first attempts reason being the excellent intubating condition and speed of loss of consciousness where as 10% of patients from halothane group required 2 attempts. Rest all were intubated in first attempt.

Heart rate values before premedication and induction in both the groups are comparable (P >0.05, insignificant). Following induction the mean heart rate in sevoflurane group showed marginal fall in mean heart rate (119.44 ± 20.87) while in halothane group there was significant fall in mean heart rate

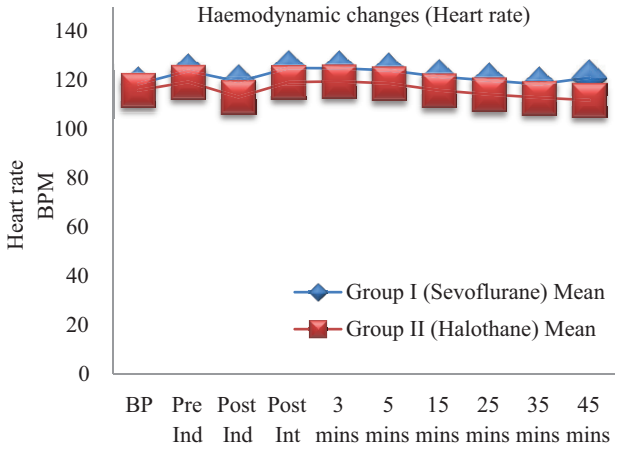

Figure-2: Comparison of haemodynamic changes (Heart rate) between two groups

(113.13 ± 20.12). Using Z test we found that the fall in mean heart rate in halothane group was significant P <0.05, while in sevoflurane group was not significant. Again this can be explained on the basis of myocardial depression and blunting of baroreceptor reflexes shown by halothane used in high concentrations during induction. After intubation there was increase in heart rate in both the groups and also we observed changes in mean heart rate throughout the surgery, which was insignificant statistically. Our study was comparable to those done by Woodey E et al[12] and Rivenes SM et al.[13]

Early recovery is an essential prerequisite for the expanding outpatient surgical concept. Inhalational agents with high blood: gas coefficience and tissue: gas coefficience tends to have slower elimination. In our study we found that patients with sevoflurane group regained their spontaneous activity in 520.34 ± 66.02 secs after cessation of sevoflurane while halothane group patients took 720.34 ± 75.69 secs. All these results are statistically significant (P<0.001). Halothane has a blood: gas coefficience of 2.5 and oil: gas solubility of 224 resulting in its slower onset and recovery as compared to sevoflurane which has a blood: gas coefficience of 0.69 and oil: gas solubility of 47, resulting in rapid emergence. Our study was comparable to that of Greenspun JC et al[14] and Epstein RH et al.[15] The recovery time of sevoflurane group was similar to study done by A Villani et al but the recovery time of halothane group was less. Recovery times in both the groups in our study are lower when compared to that observed in Chiu CL et al[16] and Michalek-Sauberer A et al[17] and other studies.[18]

In the present study we found no complications in both the groups. Post operative agitation is a known complication following general anaesthesia especially with sevoflurane may be due to its rapid recovery. But in this study none of the patients had this, the probable reason for this being adequate pain relief and midazolam use. Midazolam produces sedation, decreases separation anxiety and improved the quality of anaesthesia, it has also shown to decrease the post operative agitation, usually observed on recovery from inhalational anaesthesia. Pentazocine acted as the analgesic.

CONCLUSION

From the observations of the present study, we concluded that sevoflurane provides a smooth, rapid, pleasant induction with

excellent intubating condition, minimal haemodynamic effects and fast recovery with no complications. Thus sevoflurane was favorable on comparison with halothane as an inhalational anaesthetic agent for induction and maintenance of anaesthesia in neonate and paediatric patients.

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REFERENCE

1. Eger EI. Characteristics of anesthetic agents used for induction and maintenance of general anesthesia. Am J Health Syst Pharm. 2004;61:S3-10.
2. Brice smith R, O' Brien H.D. fluothane: a non explosive volatile anaesthetic agent. BMJ. 1956;2:969.
3. Kenna JG, Neuberger J, Mieli-Vergani G, et al. Haiothane hepatitis in children. Br Med J. 1987;294:1209-1211.
4. Walton B. Halothane hepatitis in children [editorial]. Anaesthesia. 1986;41:575-578.
5. 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.
6. 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.
7. Holaday DA, Smith FR. Clinical characteristics and biotransformation of sevoflurane in healthy human volunteers. Anesthesiology. 1981;54:100-106.
8. Epstein RH, Mendel HG, Guarnieri KM, Staudt SR, Lessin JB, Marr AT. Sevoflurane versus halothane for general anesthesia in pediatric patients: a comparative study of vital signs, induction, and emergence. J Clin Anesth. 1995;7:237-244.
9. Beskow A, Westrin P. Sevoflurane causes more postoperative agitation in children than does halothane. Acta Anaesthesiol Scand. 1999;43:536-541.
10. Calderón E, Torres LM, Aguado JA, de Antonio P, Mora R, Almarcha JM. Comparative study of sevoflurane and nitrous oxide versus halothane and nitrous oxide in pediatric anesthesia: efficacy and hemodynamic characteristics during induction. Rev Esp Anestesiol Reanim. 1998;45:126-129.
11. K.O'Brien, R. Kumar and N.S. Morton. Sevoflurane compared with halothane for tracheal intubation in children. British Journal of Anaesthesia. 1998;80:452-455.
12. Wodey E, Copin C, Pladys P, Joly A, Ecoffey C. Comparative hemodynamic effects of sevoflurane and halothane at tele-expiratory concentration in intubation of infants. Ann Fr Anesth Reanim.1998;17:108-112.
13. Rivenes SM, Lewin MB, Stayer SA, Bent ST, Schoenig HM, McKenzie ED, Fraser CD, Andropoulos DB. Cardiovascular effects of sevoflurane, isoflurane, halothane, and fentanyl-midazolam in children with congenital heart disease: an echocardiographic study of myocardial contractility and hemodynamics. Anesthesiology. 2001;94:223-229.
14. Greenspun JC, Hannallah RS, Welborn LG, Norden JM. Comparison of sevoflurane and halothane anesthesia in children undergoing outpatient ear, nose, and throat surgery. J Clin Anesth. 1995;7:398–402.
15. Epstein RH, Mendel HG, Guarnieri KM, Staudt SR, Lessin JB, Marr AT. Sevoflurane versus halothane for general anesthesia in pediatric patients: a comparative study of vital signs, induction, and emergence. J Clin Anesth. 1995;7:237-244.
16. Chiu CL, Chan YK, Ong G, Delilkan AE. A comparison of the induction and emergence characteristics of sevoflurane and halothane in children. Med J Malaysia.1999;54:346-351.
17. Michalek-Sauberer A, Wildling E, Pusch F, Semsroth M. Sevoflurane anaesthesia in paediatric patients: better than halothane? Eur J Anaesthesiol. 1998;15:280-286.
18. Priti Kolarkar, Gunjan Badwaik, Jitendra Kalbande, Ajay Watve, Amol Bhalerao, Anurag Giri. Does intravenous low dose dexmedetomidine supplementation has beneficial effects on spinal anaesthesia?. International Journal of Contemporary Medical Research. 2016;3:1547-1550.

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