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A Comparative Study of Halothane versus Sevoflurane for Induction of Anaesthesia and Tracheal Intubation in Children

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Abstract : *Inhalational anaesthesia is the most commonly employed technique in paediatric age group since it is associated with rapid induction and emergence. Halothane has been very popular as it is non-irritant and well tolerated by the upper airways. However, it can cause bradycardia, hypotension and arrhythmias. Sevoflurane, a newer inhalational agent, fulfils the advantageous properties of Halothane without the associated side effects and is becoming very popular as the inhalational agent of choice in paediatric surgery. Aim was to compare Halothane and Sevoflurane as inhalational agents in paediatric surgery with respect to Induction & Intubation time; Haemodynamic responses during induction and intubation. This study was conducted on 60 paediatric patients of ASA grade 1 and 2 in the age group of 1 to 5 years of either sex posted for elective surgeries under general anaesthesia. General anaesthesia was induced and the trachea intubated with either Halothane or Sevoflurane in 50:50 O2 and N2O without the use of any intravenous inducing agents or muscle relaxants. Both Halothane and Sevoflurane produce acceptable conditions for induction and intubation although it is much faster with sevoflurane. Haemodynamic stability is also better with Sevoflurane compared to Halothane. We conclude that Sevoflurane is a better alternative to Halothane for induction of anaesthesia in children with a shorter induction and intubation time and with better haemodynamic stability.*

Keywords: *Halothane, Induction, Intubation , Paediatric, Sevoflurane .*

I. Introduction

In adult patients, intubation is generally facilitated by a muscle relaxant. In children, however, we prefer inhalational anaesthetic agents. The continued dominance of inhalational methods of anaesthesia over other techniques is mainly attributed to their inherent safety and almost universal application. Halothane, introduced in 1956 is the main drug for inhalational induction of anaesthesia in children [1, 2].It is non-irritant producing a rapid smooth induction. However, it may cause myocardial depression and cardiac arrhythmias and also the serious complication of hepatitis and rarely triggers malignant hyperthermia [3]. Continued effort to manufacture an inhalation agent which would match the induction properties of halothane with minimal side effects led to the introduction of sevoflurane [4]. It has a low blood gas solubility allowing rapid induction and recovery[7] with less myocardial depressant action and undergoes minimal metabolism [5].Therefore, the present study was undertaken to compare the induction and intubation characteristics of halothane with sevoflurane in paediatric patients.

II. material & methods

A clinical comparative study of halothane and sevoflurane as inhalational agents for induction and intubation was carried out in 60 children aged between 1 to 5 yrs posted for elective surgical procedures at R.L.Jalappa Hospital attached to Sri Devaraj Urs Medical College, Kolar. The study was conducted during a twentyseven month period. Inclusion criteria were Paediatric patients of 1-5 years of either sex, posted for elective surgical procedures with ASA Grade I and II. Exclusion criteria was Head injury cases, history of drug allergy, haemorrhagic diathesis, neurological involvement/diseases, anticipated difficult airway. Pre-Anaesthetic evaluation was done a day before the proposed surgery; after taking relevant history, Physical examination was carried out; and complete haemogram, bleeding time, clotting time, urine Routine Analysis was adviced. The children were randomly assigned into 2 groups of 30 each, Group H and Group S.**Group H** – Consisting of 30 patients induced and intubated with incremental concentration of halothane 0.5% to 5% in 50% nitrous oxide and 50% oxygen mixture. **Group S** – Consisting of 30 patients induced and intubated with incremental concentration of sevoflurane 1% to 8% in 50% nitrous oxide and 50% oxygen mixture. After obtaining ethical committee clearance and informed written consent from the parents or guardians, all the patients were kept fasting for a period of 4-6 hours according to the age. Premedicated with Inj Midazolam

$0.1mgKg^{-1}$ and Inj Atropine $0.03mgKg^{-1}$ intramuscularly 45 mins before surgery. On the OT table, patient's base-line pulse, non-invasive blood pressure, SpO_2, ECG were recorded. Induction and tracheal intubation was done in both the groups without the use of muscle relaxants. Inhalation induction of anaesthesia was accomplished in all patients using Jackson-Rees modification of Ayre's T-piece breathing system and an unscented face mask using 50% nitrous oxide and 50% oxygen mixture with incremental concentrations of the study volatile anaesthetic using a Datex-Ohmeda S/5 Aespire anaesthesia work-station equipped with vaporisers for both halothane and sevoflurane. In group H, the inspired concentration of halothane was initially set at 0.5% followed by a stepwise increase by 0.5% every 3-4 breaths to a maximum of 5% until the loss of eye-lash reflex. In group S, the inspired concentration of sevoflurane was initially set at 1% followed by a stepwise increase by 1% every 3-4 breaths upto a maximum of 8% till the loss of eyelash reflex. No other drugs were used during the induction period. As soon as the child falls asleep, an intravenous line was secured and EP started. Proper sized oral endotracheal tube was inserted when the eyeballs were centralised and jaw relaxed. After the trachea was intubated, the child continued to breathe 1-1.5% halothane or 1.5-3% sevoflurane until all measurements were complete. Recordings of heart rate, blood pressure, SpO2 and were recorded during induction at half minute intervals, at intubation and 1 min post intubation. The HR (heart rate), MAP (Mean Arterial Pressure) and SpO_2 changes were compared between the two groups at post- induction, immediate post-intubation and 1 minute post-intubation. The study ended at this point. During the study the following parameters were taken into consideration: **Induction time** – It is the time interval between the placements of facemask to loss of eyelash reflex.**Intubation time** – It is the time interval between the placements of facemask to loss of conjugate eye movements (centrally placed mid dilated pupils). Intubation characteristics were assessed using the following scoring system [6]

Table 1: Intubation characteristics

Characteristic	**Scores**			
	1	**2**	**3**	**4**
Laryngoscopy	Easy	fair	Difficult	Impossible
Vocal cords	Open	moving	Closing	Closed
Coughing	None	slight	Moderate	Severe
Jaw relaxation	Complete	slight	Stiff	Rigid
Limb movement	None	slight	Moderate	Severe

As shown above, the variables were given a score of 1-4, 1 being the ideal condition. Therefore, the best possible score was 5. A score of more than 2 was considered unfavourable for intubation. All the observations and measurements were made by the same independent trained observer throughout the study. The results of the study were statistically analysed using Student t-test and Mann-Whitney test.

III. Results

Table 2: Age distribution of patients studied

Age in years	**Group H**		**Group S**	
	No	**%**	**No**	**%**
1-2 years	5	16.7	9	30.0
3-5 years	25	83.3	21	70.0
Total	30	100.0	30	100.0
Mean ± SD	3.70±1.23		3.18±1.29	

Samples are age matched with p=0.118

Table 3: Gender Distribution

Gender	**Group H**		**Group S**	
	No	**%**	**No**	**%**
Male	21	70.0	20	66.7
Female	9	30.0	10	33.3
Total	30	100.0	30	100.0

Samples are gender matched with p=0.781

Table 4:Comparison of Induction and intubation time (seconds)

	Group H (n=30)	**Group S (n=30)**	**P value**
Induction time(seconds)	98.00±49.22 (40-180)	57.50±22.88 (30-120)	<0.001**
Intubation time (seconds)	244.67±86.10 (90-420)	186.17±87.58 (60-390)	0.012*

*indicates significant value **indicates very significant value

Table 5: Comparison of Intubation characteristics in two groups of patients

Intubation characteristics	Group H (n=30)	Group S (n=30)	P value
Laryngoscopy			
• Easy	30(100.0%)	30(100.0%)	NS
• Fair	-	-	
• Difficult	-	-	
• Impossible	-	-	
Vocal cords			
• Open	24(80.0%)	20(66.7%)	0.126
• Moving	6(20%)	7(23.3%)	
• Closing	-	3(10.0%)	
• Closed	-	-	
Coughing			
• None	25(83.3%)	23(76.7%)	0.188
• Slight	3(10.0%)	7(23.3%)	
• Moderate	2(6.7%)	-	
• Severe	-	-	
Jaw relaxation			
• Complete	27(90.0%)	25(83.3%)	0.706
• Slight	3(10.0%)	5(16.7%)	
• Stiff	0	0	
• Rigid	0	0	
Limb movement			
• None	28(93.3%)	24(80.0%)	0.254
• Slight	2(6.7%)	6(20.0%)	
• Moderate	0	0	
• Severe	0	0	

Table 6:Comparison of mean heart rate in two groups of patients studied

HR (bpm)	Group H		Group S		P value
	No of patients	Mean ± SD	No of Patients	Mean ± SD	
Basal	30	148.27±18.40	30	136.27±19.28	0.017*
0.5min	30	146.30±17.41	30	135.50±19.68	0.028*
1min	30	143.63±15.85	30	135.37±20.44	0.085
1.5min	30	141.70±14.86	29	134.72±23.07	0.171
2min	28	139.21±13.23	27	132.85±23.55	0.220
2.5min	27	136.59±13.36	21	140.76±21.29	0.411
3min	23	135.04±14.58	17	146.06±17.68	0.037*
3.5min	20	134.55±13.10	13	145.23±19.49	0.068
4min	19	133.32±13.80	8	140.38±17.36	0.271
4.5min	13	131.23±14.22	6	134.33±6.19	0.619
5min	10	129.80±16.57	5	135.40±8.82	0.497
5.5min	7	129.00±12.64	4	137.00±11.11	0.321
6min	4	133.50±4.73	1	130.00±0.00	0.555
6.5min	2	134.00±8.49	1	130.00±0.00	0.766
7min	1	125.00±0.00	-	-	-
Pint	30	131.30±12.81	30	137.80±25.90	0.223
1minpint	30	139.50±12.33	30	145.40±18.79	0.156

*indicates significant value

Table 7:Comparison of MAP (mm Hg) in two groups of patients studied

MAP (mm Hg)	Group H		Group S		P value
	No of Patients	Mean ± SD	No of Patients	Mean ± SD	
Basal	30	86.30±13.90	30	83.13±14.06	0.384
0.5min	30	83.77±13.70	30	82.30±14.09	0.684
1min	30	81.30±14.24	30	80.60±13.87	0.848
1.5min	30	79.10±14.24	29	79.28±13.92	0.962
2min	28	76.25±15.16	27	77.89±14.14	0.680
2.5min	27	73.00±15.54	21	77.57±15.55	.0.318
3min	23	74.26±14.41	17	78.29±16.98	0.422
3.5min	20	75.05±14.16	13	80.77±20.02	0.343
4min	19	74.63±14.54	8	75.38±14.85	0.905
4.5min	13	73.08±15.93	6	77.83±16.09	0.554
5min	10	70.00±16.01	5	77.60±19.63	0.434
5.5min	7	73.57±15.54	4	77.00±22.24	0.769
6min	4	75.50±11.9	1	91.00±0	0.328

6.5min	2	79.00±12.73	1	91.00±0	0.582
7min	1	88.00	-	-	-
pint	30	70.90±15.41	30	74.40±14.56	0.370
1minpint	30	74.70±16.73	30	78.33±14.6	0.374

**indicates very significant value

Induction time was defined as the time interval between placement of face mask and loss of eyelash reflex.The mean induction time with halothane was 98 secs (SD 49.22secs) while with sevoflurane it was 57.50 secs (SD 22.88secs). As the p value <0.05 i.e. 0.001, it is statistically significant. Intubation time was defined as the time interval between the placements of facemask to centrally placed mid dilated pupils. Mean intubation time with halothane was 244.67secs (SD 86.1secs) and that with sevoflurane was 186.57secs (SD 87.58 secs). As p<0.05 this was statistically significant. Two patients in group H and three patients in group S had a score of 3 in any one category and hence intubating condition was considered unacceptable in these patients.Thus 98% patients in halothane group and 97% patients in sevoflurane group had acceptable intubating conditions.In all the characteristics studied for comparison, the p value was > 0.05, and so was statistically insignificant.

Basal heart rate was 148.27 bpm in halothane group and 136.27 in the sevoflurane group. With induction of anaesthesia the heart rate decreased progressively in the halothane group from 141.4bpm to 125.0bpm, at 7 min. Where as, in the sevoflurane group there was a very reduction in the heart rate compared to basal value at 6.5min. After intubation an increase in heart rate was observed in both the groups. Heart rate increased from 131.30bpm at intubation to 139.50bpm 1min after intubation in the halothane group and from 137.80.bpm at intubation to 145.7bpm 1min after intubation in the sevoflurane group.

Basal MAP was 86.3mmHg in halothane group and 83.13mmHg in the sevofluranre group. With induction of anaesthesia there was a progressive decrease in the MAP in both the groups. MAP decreased from 86.3mmHg to 70.0mmHg at 5min in halothane group and from 83.13mmHg to 77.6mmHg at 5min in the sevoflurane group. After intubation an increase in MAP was observed in both the groups. MAP increased from 70.9mmHg at intubation to 74.7mmHg 1min after intubation in the halothane group and from 74.4mmHg at intubation to 78.3mmHg 1min after intubation in the sevoflurane group.SpO2 remained stable in both the groups throughout the course of the study.

IV. Discussion & Conclusion

Inhalational induction of anaesthesia is one of the most common methods of induction employed in paediatric practice [7]. 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. Various inhalational agents like ether, chloroform, cyclopropane, trichloroethylene and methoxyflurane have been used for induction of anaesthesia. Ether had several disadvantages like high inflammability, airway irritability, prolonged induction and recovery, which led to its downfall. Chloroform went into disrepute because of its deleterious effect on heart. Trichloroethylene could not be used in closed circuits and cyclopropane was highly explosive and arrhythmogenic. Methoxyflurane caused high output renal failure [7]. The characteristics of an ideal inhalational agent are pleasant odour, rapid and smooth induction with rapid recovery, non-inflammable, chemically stable during storage and while in contact with metals used in anaesthesia, bio-chemically stable and non toxic to parenchymatous organs even with prolonged and repeated use, excreted as it is with virtually no bio-transformation, capable of inducing unconsciousness quickly, allow high inspired oxygen level, produce muscle relaxation, low water solubility, sole anaesthetic, does not sensitise the heart to exogenous and endogenous catecholamines.

Among the present day inhalational agents, halothane satisfies most of these properties and is the induction agent most commonly employed in children. Because of its pleasant smell and low blood gas solubility coefficient it allows smooth and rapid induction [7]. However, it has disadvantage of myocardial depression, sensitizes myocardium to both endogenous and exogenous catecholamines and is associated with serious complication of halothane hepatitis. Sevoflurane, introduced in the year 1990 by Maruishi Company in Japan is the new inhalational agent which is added to anaesthesiologist's armamentarium. Like halothane, it has low blood gas solubility coefficient allowing rapid induction. Because of its non-pungent odour induction is said to be smooth with this agent. In addition it has no much effect on cardiovascular system. It neither sensitizes the myocardium nor produces myocardial depression. In view of it sevoflurane is gaining in popularity as the inhalational induction agent of choice in paediatric population. The present study was conducted in 60 paediatric patients aged 1-5yrs. In 30 patients halothane was employed for induction and intubation. And in remaining 30 patients sevoflurane was employed for induction and intubation. The demographic profile was similar in both the groups.

Premedication: Various authors have employed various premedicant drugs in paediatric patients. Piat V et al have used 0.4mgKg^{-1}rectal midazolam 30mins before induction [2]. Black A et al have used atropine 0.02mgKg^{-1}orally or intramuscularly with temazepam 0.5mgKg^{-1}[3]. Swadia VN et al have used a combination of midazolam 0.5mgKg^{-1}and atropine 0.03mgKg^{-1}orally 45mins before surgery[4].O'Brein K et al have used trimeprazine 2mgKg^{-1} 1-1.5hrs before induction [8]. As halothane administration is associated with the risk of bradycardia, it is common to administer intramuscular atropine 30-45mins before surgery. However, the question of using atropine premedication for sevoflurane induction is controversial as sevoflurane is said to be cardio-stable. In the present study, to have the common methodology of induction we employed atropine in the dose of 0.03mgKg^{-1} and midazolam 0.1mgkg^{-1} given intramuscularly 45mins before the proposed surgical procedure.

Concentration of halothane and sevoflurane used:

Various techniques of inhalational induction have been adopted by different authors. Some authors have used the rapid inhalational induction (Agnor R et al , Sigston et al ,and Baum VC et al) while others have used the tidal technique of incremental concentrations[9.10.11]. The incidence of airway complications such as breath holding and laryngospasm were more frequent with rapid inhalational induction than with incremental technique. Hence in our present study we adapted the incremental technique as used by Piat V et al, Black et al, Swadia VN et al and others [2,3,4]. Various authors have used different concentrations of halothane and sevoflurane. O'Brein K et al, Swadia VN et al,Black A et al,Paris ST et al and Bithal PK et al,have used 0.5-5% halothane and 1-7 or 8% sevoflurane[3,4,5,6,8]. Piat V et al have used 1-3.5% halothane and 2-7% sevoflurane [2]. In our present study we have used 0.5-5% halothane and 1-8% sevoflurane.

Induction time:

Piat V et al, Black A et al, Swadia VN et al, Tainvainen T et al, and Naito et al have defined induction time as the time interval from the placement of face mask to loss of eye lash reflex[2,3,4,12,13]. In the present study the above definition was employed for induction time. Our groups induction times are almost similar to Lerman J etal (Group H 96 ± 66 Group S 78 ± 47.4) [14].

Intubation time:

It is the time interval between the placements of face mask to centrally placed mid dilated pupils. The above definition for intubation time is similar to that employed by O'Brein K et al, Taivainen et al and P Bithal PK et al [6, 8, 12].

Intubating conditions:

Various authors have assessed the intubating conditions with halothane and sevoflurane as induction agents. In the present study we assessed intubating conditions employing the scale used by O' Brein K et al and Bithal PK et al [6,8]. Our findings are almost similar to O' Brein K et al (group H 95% & group S 95%)[8].

Haemodynamic characteristics:

Non-invasive haemodynamic measurements such as heart rate and blood pressure have often been used to evaluate the cardiovascular responses of anaesthetic agents. In the present study also non-invasive measurements like heart beat and blood pressure were used to evaluate the cardiovascular effects of halothane and sevoflurane. Sarner JB et al observed that children receiving halothane tended to have a decrease in heart rate during anaesthetic induction, where as children receiving sevoflurane maintained or increased heart rate[15]. In the present study the heart rate decreased progressively in the halothane group from 148.27bpm (SD 18.40) to 125bpm (SD 0) at intubation, where as in the sevoflurane group heart rate increased slightly from 136.27bpm (SD 19.28) to 137.80bpm (SD 25.90) at intubation, which concurs with the study of Sarner JB et al [15].Sarner JB et al observed a decrease in the MAP during induction with both halothane and sevoflurane, but the decrease was greater in patients receiving halothane than in those receiving sevoflurane [15]. In the present study MAP decreased from 86.30mmHg (SD 13.90) to 70.90mmHg (SD 15.41) in the halothane group and from 83.13mmHg (SD 14.06) to 74.40mmHg (SD 14.56) in the sevoflurane at intubation, which concurs with the study of Sarner JB et al [15].

From the present study it is seen that halothane in gradually increasing concentration of 0.5-5% and sevoflurane in increasing concentration of 1-8% provides rapid and smooth induction with an induction of 98secs for halothane and 57.50secs for sevoflurane. Halothane produces acceptable intubating conditions in 98% of patients in a mean time of 244.67secs. Sevoflurane produces acceptable intubating conditions in 97% of patients in a mean time of 186.17secs. Halothane administration is associated with slight decrease in heart rate and slight reduction in MAP, where as sevoflurane administration is not associated with any significant cardiovascular changes. The SpO_2 was stable in both the groups throughout the course of the study.

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