

Comparison of Sevoflurane Versus Ketamine for Induction of Anaesthesia in Children

Afia Rahna, Kiran Ayesha, Javeriah Khan, Rana Imran Sikander, Naheed Fatima

Department of Anaesthesia, Pakistan Institute of Medical Sciences. Islamabad, Pakistan

ABSTRACT

Objective: To find out ideal induction agent in paediatric cases. We compared induction time, hemodynamic variation and oxygen saturation with ketamine and sevoflurane in paediatric patients undergoing different surgeries.

Methodology: A randomized controlled trial was conducted at Department of Anaesthesia Children Hospital, PIMS, Islamabad from December 2018 to May 2019. We enrolled a total of 130 paediatric patients of either gender with age 4-12 years, who were planned for surgery under general anaesthesia. Patients were randomly allocated into two groups for anaesthesia induction. Group S patients received 8% Sevoflurane given via face mask in 100% oxygen at FGF of 6L/min and group K patients received Ketamine 1 mg/kg body weight via intravenous route. Mean time of induction, heart rate response, mean arterial pressure (MAP) response and oxygen saturation after induction was measured at one and two minutes and compared in both groups. All information was recorded via study Proforma and SPSS version 17 was used for data analysis.

Results: Mean age of group S patients was 6.8 years \pm 2.9 and in group K patients was 7.3 years \pm 2.5 (P=0.372). There were 73.8% males and 26.2% females in group S and 61.5% males and 38.5% females in group K. Mean induction time in group S patients was 56.2 seconds \pm 27.7 and in group K patients was 71.2 seconds \pm 37.3 (P=0.011). The induction time was significantly shorter in group S patients as compared to group K patients. At one minute, mean heart rate in group S patients was 112.4 bpm \pm 18.8 and in group K patients was 121.9 bpm \pm 18.7 (P=0.005). At two minutes, mean heart rate in group S patients was 115.4 bpm \pm 17.5 and in group K patients was 123.9 bpm \pm 18.8 (P=0.008). At one minute, MAP in group S patients was 60.1 mmHg \pm 6.1 and in group K patients was 73.6 mmHg \pm 9.2 (P=0.001). At two minutes, MAP in group S patients was 60.4 mmHg \pm 6.4 and in group K patients was 76.3 mmHg \pm 10.8 (P=0.001). At one minute, mean oxygen saturation in group S patients was 99.8% \pm 0.54 and in group K patients was 99.7% \pm 0.44 (P=0.477). At two minutes, oxygen saturation in group S patients was 99.8% \pm 0.54 and in group K patients was 99.6% \pm 1.53 (P=0.253).

Conclusion: Sevoflurane as an inhalational induction agent is a better choice in children due to shorter induction time and stable hemodynamic response as compared to ketamine, an intravenous induction agent.

Key words: Anaesthesia induction, ketamine, sevoflurane

Authors' Contribution:

^{1,2}Conception; Literature research; manuscript design and drafting; ^{3,4}Critical analysis and manuscript review; ⁵Data analysis; Manuscript Editing.

Correspondence:

Javeriah Khan
Email: javeriah86@gmail.com

Article info:

Received: March 28, 2023
Accepted: August 20, 2024

Cite this article. Rahna A, Ayesha K, Khan J, Sikander RI, Fatima N. Comparison of Sevoflurane Versus Ketamine for Induction of Anaesthesia in Children. J Islamabad Med Dental Coll. 2024; 13(4). 590-595. DOI: <https://10.35787/jimdc.v13i4.967>

Funding Source: Nil
Conflict of interest: Nil

Introduction

Induction of anaesthesia in children is a challenging task for Anaesthesiologists. The children are irritable, anxious and uncooperative preoperatively because of fear of separation from their parents.¹

The induction period might be shorter but is importance as is associated with risk of developing adverse systemic hemodynamics in various surgical procedures.^{2,3} In paediatrics, both inhalational and intravenous anesthetics are used for anaesthesia

induction. Commonly used agents include sevoflurane, ketamine and propofol. Sevoflurane is most commonly used inhalational anesthetic in children.⁴ Sevoflurane has been considered as well tolerated because of its pleasant smell. It is associated with rapid induction time, rapid emergence and easy control of depth of anesthesia.⁵ With the emergence of sevoflurane, an efficient and instant approach of anaesthesia induction has been established. Sevoflurane is better tolerated in cardiac patients as well.⁶ Ketamine is widely used intravenous anesthetic in children undergoing any surgery and is preferred by many anesthesiologists because of its potent analgesic effect.^{7,8} Ketamine also has sedative amnestic and bronchodilator effect. It preserves respiratory function.⁹ Propofol is commonly used induction agent but it causes pain on injection as well as cardiorespiratory depression. It does not provide analgesia.¹⁰ Many studies have been conducted to compare induction time and hemodynamic response with sevoflurane and ketamine. A study by Yu M et al. reported a significantly shorter induction time with sevoflurane compared to ketamine (28 ±7 s vs. 195 ±34 s), similarly they noted a shorter recovery time from anaesthesia with sevoflurane.⁷ A study by Nakayama S et al. concluded that ketamine was significantly associated with decreased oxygen saturation (<96%) compared to sevoflurane (18.0% vs. 3.0%).¹¹ In our department both intravenous and inhalational induction techniques are in use based on the choice of anaesthetist. In our clinical observation inhalational agents have more rapid onset of action as compared to intravenous agents. We aimed to gather an evidence-based data to find out which technique is well suited at our set up.

Methodology

This randomized control trial was conducted at Department of Anaesthesia, Children Hospital, Pakistan Institute of Medical Sciences, Islamabad.

Duration of study was six months (December 2018 to May 2019). The study was carried out after getting approval from hospital ethical committee. Consecutive non probability sampling technique was used. Children of age 4 to 12 years, both genders, undergoing surgery under general anaesthesia and in whom intravenous line was already in place were included. Paediatric patients having allergy to sevoflurane & ketamine, diagnosed cardiac & respiratory diseases and anticipated difficult airway were excluded. Preoperative assessment was done one day before surgery and patients were kept nil per month for 6 hours for solid food and 2 hours for clear fluids. Written informed consent was taken from parents or guardian of patients. In preoperative period intravenous line was secured. Upon arrival in operation theatre, blood pressure cuff, pulse oximeter and electrocardiograph leads were attached. Monitoring of blood pressure, oxygen saturation, heart rate and electrocardiograph was initiated. Patients were premedicated with 0.05mg/kg midazolam given intravenously for anxiolytic effect. Patients were randomly allocated to two groups by the lottery method. Group S patients received 8% SEVOFLURANE given via face mask with 100% Oxygen at 6 L/minute and group K patients received KETAMINE 1mg/kg body weight via intravenous route. Anesthesia induction time was noted from start of medications to loss of eyelash reflex or loss of communication. This time was measured with a stop watch used by anaesthesia assistant. The hemodynamic parameters in terms of heart rate (HR), systolic, diastolic blood pressure, mean arterial pressure (MAP) and oxygen saturation were monitored and noted before induction then at 1 minute and 2 minutes. The study outcome was measured in terms of comparison of time of induction, heart rate, mean arterial pressure and oxygen saturation between the two study groups. The collected data was entered and analyzed using SPSS version 17.0.

Results

A total of 130 patients were enrolled in this study. Mean age of group S patients was 6.8 years \pm 2.9 and in group K patients was 7.3 years \pm 2.5 ($p = 0.372$) Table I. There were 73.8% males and 26.2% females in group S and 61.5% males and 38.5% females in group K ($p = 0.134$) Table II.

Table I: Mean age in both groups			
Groups	Mean Age (Years)	SD	P-value t-test
Sevoflurane	6.8	2.9	0.372
Ketamine	7.3	2.5	

Table II: Demographic Profile of the study Population (gender distribution)				
Gender	Group		Total	P-Value Chi-Square
	Sevoflurane	Ketamine		
Males	48	40	88	0.134
	73.8%	61.5%	67.7%	
Females	17	25	42	
	26.2%	38.5%	32.3%	
Total	65	65	130	
	100.0%	100.0%	100.0%	

Table III: Mean induction time in both groups			
Groups	Mean Induction Time (Seconds)	Std. Dev	P-value t-test
Sevoflurane	56.2	27.7	0.011
Ketamine	71.2	37.3	

Table IV: Mean heart rate at different times in both groups				
Mean heart rate	Groups	HR (beats/min)	SD	P-value t-test
Time Zero	Sevoflurane	109.2	23.4	0.621
	Ketamine	107.3	19.7	
1 Mint	Sevoflurane	112.4	18.8	0.005
	Ketamine	121.9	18.7	
2 Mint	Sevoflurane	115.4	17.5	0.008
	Ketamine	123.9	18.8	

Table V: MAP at different times in both groups				
Mean Artrial Pressure (MAP)	Groups	MAP (mmHg)	SD	P-VALUE t-TEST
TIME ZERO	Sevoflurane	63.1	9.5	0.185
	Ketamine	64.9	6.6	
1 MIN	Sevoflurane	60.1	6.1	0.001
	Ketamine	73.6	9.2	
2 MIN	Sevoflurane	60.4	6.4	0.001
	Ketamine	76.3	10.8	

Table VI Mean oxygen saturation at different times in both groups				
Oxygen Saturation	Groups	Mean (%)	SD	P-VALUE t-TEST
Time Zero	Sevoflurane	99.5	0.64	0.548
	Ketamine	99.6	0.52	
1 Mint	Sevoflurane	99.8	0.54	0.477
	Ketamine	99.7	0.44	
2 Mint	Sevoflurane	99.8	0.54	0.253
	Ketamine	99.6	1.53	

Mean induction time in group S patients was 56.2 seconds \pm 27.7 and in group K patients was 71.2 seconds \pm 37.3 ($p = 0.011$) Table III. The induction time was significantly shorter in group S patients as compared to group K patients. At the time of induction, mean heart rate in group S patients was 109.2 bpm \pm 23.4 and in group K patients was 107.3 bpm \pm 19.7 ($p = 0.621$). At one minute, mean heart rate in group S patients was 112.4 bpm \pm 18.8 and in group K patients was 121.9 bpm \pm 18.7 ($p = 0.005$). At two minutes, mean heart rate in group S patients was 115.4 bpm \pm 17.5 and in group K patients was 123.9 bpm \pm 18.8 ($p = 0.008$) Table IV. Induction with Ketamine was associated with significantly higher mean heart rate at one and two minutes as compared to induction with Sevoflurane. At the time of induction, MAP in group S patients was 63.1 mmHg \pm 9.5 and in group K patients was 64.9 mmHg \pm 6.6 ($p = 0.185$). At one minute, MAP in group S patients was 60.1 mmHg \pm 6.1 and in group K patients was 73.6 mmHg \pm 9.2 ($p = 0.001$). At two minutes, MAP in group S patients was 60.4 mmHg \pm 6.4 and in group K patients was 76.3 mmHg \pm 10.8 ($p = 0.001$) Table V.

Induction with Ketamine was associated with significantly higher MAP at one and two minutes as compared to induction with Sevoflurane. At the time of induction, mean oxygen saturation in group S patients was 99.5% \pm 0.64 and in group K patients was 99.6% \pm 0.52 ($p = 0.548$). At one minute, mean oxygen saturation in group S patients was 99.8% \pm 0.54 and in group K patients was 99.7% \pm 0.44 ($p = 0.477$). At two minutes, oxygen saturation in group S patients was 99.8% \pm 0.54 and in group K patients was 99.6% \pm 1.53 ($p = 0.253$) Table 6. The oxygen saturation was not statistically significant in both groups at one and two minutes.

Discussion

Induction of anaesthesia in children is a difficult task. Preoperatively, children are anxious because of separation anxiety, fasting and fear of feeling pain.¹²

Several agents are used for anaesthesia induction in paediatric population. This randomized control study was planned to compare the efficacy of sevoflurane versus ketamine in terms of induction time, hemodynamic variations and respiratory effects in paediatric surgeries. Our current study showed that induction time was significantly shorter in patients with sevoflurane induction as compared to patients with ketamine induction. Induction with ketamine was also associated with significantly higher mean heart rate and MAP at one and two minutes as compared to induction with sevoflurane. However, oxygen saturation after induction was not statistically significant in both intervention groups. Our results are similar with already published data on the subject. Yu M et al. compared effects of sevoflurane anaesthesia induction and compared them with those of ketamine anaesthesia in pediatric patients. Their results showed that sevoflurane group showed shorter time for anaesthesia induction, lower HR and higher oxygen saturation, when compared with ketamine.⁷ However, in the present study, we did not find any significant difference in oxygen saturation in both the groups. Our results are in agreement with the study by Han D et al. They compared the effects of sevoflurane-midazolam-sufentanyl and ketamine-midazolam-sufentanyl during anaesthesia induction in children. They demonstrated higher heart rate and mean arterial pressure with ketamine as compared to sevoflurane. They concluded that sevoflurane resulted in more stable hemodynamic effects after induction as compared to ketamine.² Kocabas S et al. in their study assessed the hemodynamic responses after anaesthesia induction with sevoflurane and ketamine-midazolam in paediatric patients undergoing lithotripsy. Their results demonstrated that systolic and diastolic arterial blood pressure at all measurements throughout the procedure were higher with ketamine-midazolam than with sevoflurane.¹³ In another study, Zeyneloglu P et al.

investigated the induction characteristics of sevoflurane in children with congenital heart disease and compared them with healthy controls. Their results showed that induction with sevoflurane was effective and resulted in stable hemodynamic response.⁶

Use of sevoflurane is also associated with early emergence. Result of another study showed that sevoflurane was associated with early recovery time when compared to intravenous agent propofol.¹⁴ In a randomized control trial by Liu W et al., induction with sevoflurane was compared with intranasal ketamine for MRI anaesthesia in children and patients in which sevoflurane induction was done had earlier induction and quick recovery.¹⁵

Sevoflurane is safe and reliable agent for anaesthesia induction in paediatric patients. Literature review and present study demonstrated shorter anesthesia induction time and stable hemodynamics with sevoflurane as compared to ketamine and other intravenous induction agents.

This study was a single center study. Multi-center studies are believed to provide more accurate results, especially with large number of patients involved in the study

Conclusion

Sevoflurane as an inhalational induction agent is a better choice in children due to shorter induction time and relatively stable hemodynamic response as compared to ketamine, an intravenous induction agent.

References

1. Sadeghi A, Tabari A, Mahdavi KA, Salarian S, Razavi SS. Impact of parental presence during induction of anaesthesia on anxiety level among paediatric patients and their parents. *Neuropsychiatr Dis Treat.* 2017;12: 3237- 3241 <https://doi.org/10.2147/NDT.S119208>
2. Han D, Liu YG, Luo Y, Jia Li MD, Yang OC. Real-Time Systemic Hemodynamic Monitoring in Children with Congenital Heart Disease: Comparison of Two Anesthetic Induction Protocols. *J Anesth Clin Res.* 2017;8:731-4. <https://doi.org/10.4172/2155-6148.1000731>
3. Dahmani S, Stany I, Brasher C, Lejeune C, Bruneau B, Wood C. Pharmacological Prevention of Sevoflurane- and Desflurane-Related Emergence Agitation in Children: A Meta-Analysis of Published Studies. *Br J Anesth.* 2010;104: 216-23. <https://doi.org/10.1093/bja/aep376>
4. Abdelhalim AA, Alarfaj AM. The effect of ketamine versus fentanyl on the incidence of emergence agitation after sevoflurane anaesthesia in paediatric patients undergoing tonsillectomy with or without adenoidectomy. *Saudi J Anaesth.* 2013;7(4):392-398 <https://doi.org/10.4103/1658-354X.121047>
5. Zhao Y, Qin F, Liu Y, Dai Y, Cen X. The safety of Propofol versus Sevoflurane for General Anaesthesia in Children: A Meta Analysis of Randomized Control Trials. *Front Surg.* 2022; 9:924647 <https://doi.org/10.3389/fsurg.2022.924647>
6. Zeyneloglu P, Donmez A, Sener M. Sevoflurane induction in cyanotic and acyanotic children with congenital heart disease. *Adv Ther.* 2008; 25:1-8 <https://doi.org/10.1007/s12325-008-0008-z>
7. Yu M, Han C, Zhou Q, Liu C, Ding Z. Clinical effects of sevoflurane anaesthesia induction with a portable inhalational anesthetic circuit in paediatric patients. *Arch Med.Sci :* 2015;11(4):796-800 <https://doi.org/10.5114/aoms.2015.50230>
8. Bhutta AT, Schmitz ML, Swearingen C, James LP, Wardbegnoche WL. Ketamine as a neuroprotective and anti-inflammatory agent in children undergoing surgery on cardiopulmonary bypass: *Pediatr Crit Care Med.* 2012; 13:328-37 <https://doi.org/10.1097/PCC.0b013e31822f18f9>
9. Simonini A, Brogi E, Cascella M, Vittori A. Advantages of ketamine in pediatric anesthesia. *Open Med.* 2022;17(1):1134-1147 <https://doi.org/10.1515/med-2022-0509>
10. Guo P, Ran Y, Ao X, Zou Q, Tan L. Incidence of Adverse Effects of Propofol for Procedural Sedation/Anesthesia in the Pediatric Emergency Population: A Systemic Review and Meta-Analysis. *Comput Math Methods Med.* 2021; 23:3160154 <https://doi.org/10.1155/2021/3160154>
11. Nakayama S, Furukawa H, Yanai H. Prospective, Randomized Comparisons of Induction of Anaesthesia with Ketamine, Propofol and Sevoflurane for Quality of Recovery from Short Sevoflurane Anaesthesia in Pediatric Patients. *Open J Anesth.* 2015; 5:163-9. <https://doi.org/10.4236/ojanes.2015.57029>
12. Coşkun, A.S. Comparing the effects of propofol and ketamine on the emergence agitation of male children undergoing circumcision. *Ann Pediatr Surg*

- 18, 2 (2022). <https://doi.org/10.1186/s43159-021-00136-1>
13. Kocabas S, Ugur G, Erhan E, Ozyar B, Nazli O. Randomised, cross-over comparison of sevoflurane and ketamine-midazolam anaesthesia in children undergoing extracorporeal shock-wave lithotripsy. *Adv Ther.* 2008;25(2):89-98 <https://doi.org/10.1007/s12325-008-0023-0>
14. Wu G, Xu X, Fu G, Zhang P. General Anesthesia Maintained with Sevoflurane versus Propofol in Pediatric Surgery Shorter Than 1 hour: A Randomized Single- Blind Study. *Med Sci Monit.* 2020;26:e923681-1–e923681-6 <https://doi.org/10.12659/MSM.923681>
15. Liu W, Yu Q, Jiang R, Liu F, Dong Y, Tang W. Comparison of Low – Dose Sevoflurane Inhalation with Intranasal Ketamine as Rescue Sedation After Intranasal Dexmedetomidine Failure in Outpatient Children Undergoing MRI: A Randomized Control Trial. *J Perianesth Nurs.* 2021;36(5):492-498 <https://doi.org/10.1016/j.jopan.2020.11.001>