Comparative Sedation with Sevoflurane and Thiopental in Children Undergoing MR Imaging

Nurettin Kurt[1], Duygu Karakose Caliskan[2] and Haci Yusuf Gunes[1]

[1]*Department of Anaesthesiology and Reanimation, Faculty of Medicine, Van Yuzuncu Yil University, Van, Turkey*
[2]*Department of Anaesthesiology and Reanimation, SBU Van Training and Research Hospital, Van, Turkey*

ABSTRACT

Objective: To compare the use of propofol and thiopental in children undergoing MRI.

Study Design: Descriptive, comparative study.

Place and Duration of Study: University of Health Sciences, Van Training and Research Hospital, Van, Turkey, between January 01 and December 31, 2019.

Methodology: One thousand two hundred and twenty two paediatric patients having MRI were included and divided into two groups. Patients aged 2-18 years who were administered Propofol were classified as Group I, and the patients under the age of 2 years who were administered Thiopental were classified as group II. All patients received Sevoflurane insufflation *via* face mask after induction agent. Patient's demographic data, ASA scores, anaesthesia-procedure-recovery times, comorbidities, type of MRI examination and complications were recorded.

Results: Age, body weight and ASA score of the patients in Group I were higher than Group II ($p<0.05$). Epilepsy, cerebral palsy, mental retardation, speech retardation and autism were more prevalent in Group I than in Group II ($p<0.05$). Neuromuscular growth retardation, hydrocephalus, and metabolic disease were less common in Group I than in Group II ($p<0.05$). With this Apnea and desaturation was higher in Group I, and bradycardia was higher in Group II.

Conclusion: Sevoflurane insufflation with a face mask can be safely used in children after induction of anaesthesia with propofol or thiopental.

Key Words: *Sedation, Paediatric patients, Propofol, Thiopental, Sevoflurane.*

How to cite this article: Kurt N, Caliskan DK, Gunes HY. Comparative Sedation with Sevoflurane and Thiopental in Children Undergoing MR Imaging. *J Coll Physicians Surg Pak* 2022; **32(11)**:1381-1385.

INTRODUCTION

Today, various invasive and non-invasive interventions have been put into practice in non-operating room environments for the purpose of diagnosis and treatment of patients. With these Non-Operating Room Anaesthesia (NORA) applications, the need for sedation or sedoanalgesia and general anaesthesia have emerged. NORA applications are most commonly seen in diagnostic and interventional radiology, dentistry, gastroenterology, cardiology, urology for paediatric cases, and magnetic resonance imaging (MRI) is the most frequently used diagnostic/follow-up imaging method in NORA applications for paediatric patients.[1,2]

Correspondence to: Dr. Nurettin Kurt, Department of Anaesthesiology and Reanimation, Faculty of Medicine, Van Yuzuncu Yil University, Van, Turkey
E-mail: dr.nurettinkurt@gmail.com
Received: June 29, 2022; Revised: September 21, 2022; Accepted: October 11, 2022
DOI: https://doi.org/10.29271/jcpsp.2022.11.1381

Sedation applications that are performed outside the operating room are riskier when compared to operating room conditions. For example, anaesthesiologists have difficulty in reaching a patient's airway during an MRI procedure. MRIs are one of the most critical procedures that require anaesthesia for children. During the MRI procedure, the most common problems are related to monitoring. In addition, mental retardation, cerebral palsy, epilepsy, and limitations of the anaesthesia environment accompanying the cases are added to these problems.[3] Therefore, the prepared guidelines recommend providing appropriate monitoring and adequate equipment, prioritising patient safety.[4]

Ideal sedation in NORA applications for patients in the paediatric age group state that it should reduce anxiety, awareness and fear, provide immobility and early recovery from the procedure, increase amnesia and ensure patient safety.[5,6] The effects of anaesthetic drugs used for this purpose, which affect the respiratory, cardiovascular, haematological and neurological systems, should be minimal, and the patient should be recovered as soon as possible.[7] For NORA applications, there are different sedation applications used for children. Since the

satisfaction, side effects and complication rates of these applications are different, there is no consensus on which application is better.[8]

The aim of this study was to compare, according to the drug combinations used, the side effect profiles, complications and discharge status of paediatric patients who were sedated during MRI.

METHODOLOGY

After obtaining ethics committee approval, number 2021/01 and dated 07.01.2021, at the University of Health Sciences Van Training and Research Hospital, the anaesthesia forms of 1,222 paediatric patients, who had undergone an MRI procedure under anaesthesia between January 01, 2019, and December 31, 2019, were analysed using the hospital's automated database and anaesthesia follow-up form. All paediatric patients under the age of 18 years who underwent an MRI under anaesthesia with full and complete data available included study. Cases whose data could not be accessed from either the anaesthesia follow-up form or from the hospital's automated database were excluded from the study.

The anaesthetic agents used, age, gender, ASA (American Society of Anaesthesiologists) score, comorbidities, organs examined, demographic data, discharge status, duration of the procedure, duration of anaesthesia, and complications (apnea, hypoxia, bradycardia, cardiac arrest) were recorded.

A 25% decrease in heart rate from normal was considered as bradycardia and was intervened with 0.02 mg/kg atropine. It was accepted as hypoxia when peripheral oxygen saturation decreased below 90% at any time during the study. In case of hypoxia, intervention was to change the patient's head position, increasing the oxygen flow or switching to mask ventilation. It was determined that the patients who were scheduled for MRI were evaluated in the outpatient clinic before the procedure and written consent was obtained from their parents. It was seen in the patient consent files that the fasting periods were indicated as 2 hours for clear liquids, 4 hours for breast milk, 6 hours for formula, and 8 hours for solid foods before the MRI scan.

On the morning of the procedure, vascular access was established with a 22G or 24G cannula, and the patients were routinely monitored, followed by blood pressure, heart rate, and SpO_2. To prevent carbon dioxide retention, 4 L/minute oxygen was given with a face mask. All patients were routinely administered 0.05 mg/minute midazolam as premedication. The files of the patients were examined, and the patients were divided into two groups according to the drug combinations used for the MRI procedure. The patients aged 2-18 years who were administered propofol were classified as Group I (n=884), and the patients under the age of 2 years who were administered thiopental were classified as Group II (n=338).

All patients were taken to the room where the MRI was going to be taken and monitored, and then administered 0.05 mg/kg midazolam. After the anaesthetic agent (propofol or thiopental) was administered, 2 MAC (Minimum Alveolar Concentration) sevoflurane insufflation *via* a face mask and 4L/min oxygen was opened for all patients. Sevoflurane insufflation *via* a face mask was turned off 2 minutes before the end of the imaging procedure. At the end of the procedure, the patients were transferred to the *post anaesthesia care unit* (PACU). Recovery time was defined as the time between the end of the procedure and the patient's admission to the PACU.

Statistical analyses were done with SPSS 15.5 for Windows package program. In the descriptive statistics of the data, mean, standard deviation, median minimum, maximum, frequency, and percentage values were used. The distribution of variables was measured with the Kolmogorov-Smirnov test. The Mann-Whitney U-test was used in the analysis of quantitative non-normally distributed data. The chi-square test was used in the analysis of qualitative independent data. Type-I error level was accepted as 0.05 in all analyses.

RESULTS

For the 1,222 paediatric patients who underwent NORA for an MRI procedure between January and December 2019 at the Health Sciences University in the Van Training and Research Hospital, the gender distribution was 705 (57.7%) males, 517 (42.3%) females, the median age was 3.0 years and the interquartile ratio (IQR) was 1.0 – 5.0, the median weight was 13.0 kilograms and the IQR was 9.0 – 18.0, the median anaesthesia time was 12.0 minutes and the IQR was 11.0 – 14.0, the median procedure time was 11.0 minutes and the IQR was 10.0 – 13.0. Of the 1,222 paediatric patients, 545 (44.6%) were ASA I and 677 (55.4%) were ASA II.

While age, body weight, and ASA score of the patients in Group I were statistically higher than Group II ($p<0.05$), their gender distribution and comorbidity rates did not differ ($p<0.05$, Table I).

The most common region scanned with MRI was the brain, followed by spine imaging (Table II).

Intubation was not applied to any of the sedated patients. Apnea and desaturation rates were higher in Group I, and bradycardia rates were higher in Group II ($p<0.05$). However, discharge rates did not differ between groups ($p<0.05$, Table II).

DISCUSSION

Choosing the sedation agent to be used for radiological imaging in the paediatric age group is quite challenging for clinicians. The selected agent should induce immobilisation but not cause respiratory depression. The ideal sedative agent should be effective, provide rapid onset and recovery, and have no side effects. For this purpose, many agents such as chloralhydrate, midazolam, ketamine, propofol, thiopental, dexmedetomidine, and sevoflurane are used singly or in combinations. Even in the use of short-acting sedatives, one should be prepared for the unexpected, prolonged effects of the drug.[9,10]

Table I: Demographic and procedural data of patients by group.

		Group I (Median / IQR / n%)	Group II (Median / IQR / n%)	p
Age (years)		4.0 / 3.0-6.0	1.0 / 0.0-1.0	<0.001[m]
Weight (Kg)		16.0 / 12.0-21.0	7.0 / 6.0- 9.0	<0.001[m]
Gender	Male	522 / 59.0%	183 / 54.1%	0.120[x²]
	Female	362 / 41.0%	155 / 45.9%	
ASAscore	I	366 / 41.4%	179 / 53.0%	<0.001[x²]
	II	518 / 58.6%	159 / 47.0%	
Anaesthesia duration (min)		12.0 / 11.0-0.13.0	13.0 / 12.0-15.0	<0.001[m]
Procedure duration (min)		11.0 / 10.0-12.0	12.0 / 11.0-13.0	<0.001[m]
Recovery time (min)		1.0 / 1.0-2.0	1.0 / 1.0-2.0	<0.001[m]
Co-morbidity	(-)	819 / 92.6%	319 / 94.4%	0.285[x²]
	(+)	65 / 7.4%	19 / 5.6%	
	Epilepsy	47 / 5.3%	12 / 3.5%	0.443[x²]
	Other	18 / 2.0%	7 / 2.1%	0.443[x²]

[m] Mann-Whitney u test / [x²] Ki-kare test.

Table II: Scanned region complications and discharge status for each group.

		Group I (n/%)	Group II (n/%)	p
Brain MRI		787 / 89.0%	306 / 90.5%	0.870[x²]
Brain + total spine MRI		42 / 4.8%	13 / 3.8%	
Lumbar spine MRI		17 / 1.9%	7 / 2.1%	
Joint MRI		23 / 2.6%	6 / 1.8%	
Others		15 / 1.7%	6 / 1.8%	
Intubation	Not required	884 / 100.0%	33 / 100.0%	>0.99[x²]
	Required	0 / 0.0%	0 / 0.0%	
Complication	Nil	848 / 95.9%	322 / 95.3%	0.635[x²]
	Present	36 / 4.1%	16 / 4.7%	
	Desaturation	24 / 2.7%	5 / 1.5%	
	Apnea	10 1.1%	3 / 0.9%	0.001[x²]
	Bradycardia	2 / 0.2%	8 / 2.4%	
Discharge status	Discharged	878 / 99.3%	335 / 99.1%	
	Service	5 / 0.6%	2 / 0.6%	0.703[x²]
	Intensive care	1 / 0.1%	1 / 0.3%	

[x²] Ki-kare test

In this study, thiopental was used in patients under 2 years of age and propofol was used in patients 2 to 18 years. In addition to the IV anaesthetic agent used, sevoflurane insufflation *via* face mask of 2 MAC (with 4 L/min Oxygen) was used for maintenance in all patients. No additional doses of an IV anaesthetic agent were used in any of the patients.

In this study comparing propofol and thiopental, no difference was found between the duration of anaesthesia in the propofol Group I and thiopental Group II patients. The incidence of apnea and desaturation in the propofol-administered patients were higher, while bradycardia rates were higher in the thiopental-administered group. There was no need for intubation and cardiac arrest did not develop in any of the cases, and discharge rates were similar. Especially since a homogeneous age was not planned for the groups in this study, it can be said that the complications developed are not only affected by the anaesthetic agent used but also by the age of the patient.

In a study, the authors stated that propofol alone could not provide the immobilisation required for an MRI procedure and that it required repeated doses, while repeated doses caused respiratory depression and the loss of protective airway reflexes.[11] Unlike this study, sevoflurane insufflation was used, instead of repeated doses of propofol, for maintenance after a single dose of propofol or thiopental was used. In this way, it was observed that less respiratory depression and less loss of airway reflexes were encountered.

To avoid the possible side effects of propofol, paediatric anaesthesiologists combine it with various agents such as midazolam and dexmedetomidine, although this prolongs the recovery period of the patient.[12,13] In this study, 0.05 mg/min midazolam was administered to all patients for premedication.

In a case-control study conducted by Tith *et al.*, with patients who underwent a non-cardiac MRI, 10% of sedated patients experienced complications, of which 96% of the complications experienced were reported as minor complications such as airway obstruction and transient oxygen desaturation requiring intervention. It has been emphasised that the combined use of propofol and thiopental reduces the risk of complications compared to the use of only propofol or repeated doses of the drug.[14] The authors believe that the lower complication rate (4.3%) in this study is due to the absence of repeated dose use and the use of sevoflurane insufflation *via* face mask for maintenance instead. It is also supported by other studies that propofol in paediatric diagnostic imaging procedures causes more respiratory side

effects and physiological changes compared to other drugs.[15,16] However, these respiratory effects can often be successfully managed with simple airway interventions.[17]

In the study of Kim *et al.*, in which they examined the risk factors for unplanned intubation during sedation-guided MRI, a high ASA score, prematurity, presence of gastroesophageal reflux and congenital heart disease were found to be risk factors for unplanned intubation during MRI.[18] Although comorbidities such as epilepsy, cerebral palsy, and motor mental retardation were found in this study, no complications that would cause unplanned intubation were observed.

In a study conducted by Mallory *et al.*, they compared the use of propofol and thiopental in paediatric patients undergoing an MRI under sedation and found vomiting and allergic reactions were more common in patients that were administered thiopental, and the need for antiemetic drugs increased. They emphasised that this situation prolongs the recovery period and reduces parental satisfaction.[16]

In a study in which the combination of propofol and remifentanil was compared with the use of sevoflurane, it was reported that the use of propofol plus remifentanil provided faster recovery and caused less delirium but stated that an additional dose was needed due to movement in children during the imaging.[19] In this study, using an IV anaesthetic only in induction, not using it in repetitive doses, and using sevoflurane insufflation in maintenance, it was observed that this caused fewer complications in patients and does not require additional anaesthetic by causing less movement in children during imaging.

This study has several limitations. First, this study was designed retrospectively. The data was obtained from the anaesthesia follow-up form and the hospital's automated database, which may lead to suspicions of bias. Moreover, additional monitoring, such as bispectral index monitoring, to help evaluate the depth of sedation, could not be performed on the patients.

CONCLUSION

Since MRI is a long scan, it has been observed that a single dose IV anaesthetic agent is insufficient, and that additional anaesthetic drugs are needed for maintenance, as well as sevoflurane insufflation, which is used as an additional anaesthetic drug for this purpose and provides sufficient immobility in patients. Sevoflurane insufflation can be used safely after induction of anaesthesia with propofol or thiopental and it reduces recovery times.

ETHICAL APPROVAL:

The study was approved by Health Sciences University in the Van Training and Research Hospital, Clinical Research Ethics Committee (Approval No. 07.01.2021/01).

PATIENTS' CONSENT:

The study was conducted in accordance with the principles of the Declaration of Helsinki.

COMPETING INTEREST:

The authors declared no competing interest.

AUTHORS' CONTRIBUTION:

NK: The acquisition, analysis and interpretation of data for the work, drafting and revising the manuscript critically for important intellectual content.
DKC, HYG: The acquisition and analysis of data for the work.
All authors approved the final version of the manuscript to be published.

REFERENCES

1. Iyilikci L, Cakmak S, Ogdul E, Canduz B, Boyaci F, Ozdemir E, *et al*. Our experience in non-operating room anaesthesia applications. *Turkish J Anaesthesiol Reanimation* 2006; **34(3)**:169-76.
2. Soyalp C, Yuzkat N. Our non-operating room anaesthesia applications in paediatric patients: A retrospective study. *Van Medical* 2019; **26(2)**: 248-53, doi: 10.5505/vtd.2019.46514.
3. Keskin, G. Non-operating room anaesthesia applications in children. *Pediatr Pract Res* 2017; **5(3)**:32-6.
4. Arpacı AH. Outpatient anaesthesia in paediatric patients. *Turkey Clinics J Anest Reanim* 2016; **14(2)**:7.
5. Hodgson E. Airway management outside the operating theatre. *Saudi J Anaesthesia* 2008; **2**:35-9.
6. Gozal D, Drenger B, Levin PD, Kadari A, Gozal Y. A paediatric sedation/anaesthesia program with dedicated care by anaesthesiologists and nurses for procedures outside the operating room. *J Pediatr* 2004; **145(1)**:47-52. doi: 10.1016/j.jpeds.2004.01.044.
7. Vardi A, Salem Y, Padeh S, Paret G, Barzilay Z. Is propofol safe for procedural sedation in children? A prospective evaluation of propofol *versus* ketamine in paediatric critical care. *Crit Care Med* 2002; **30(6)**:1231-6. doi: 10.1097/00003246-200206000-00010.
8. Sethi D, Gupta M, Subramanian S. A randomised trial evaluating low doses of propofol infusion after intravenous ketamine for ambulatory paediatric magnetic resonance imaging. *Saudi J Anaesthesia* 2014; **8(4)**:510-6. doi: 10.4103/1658-354X.140871.
9. Cutler KO, Bush AJ, Godambe SA, Gilmore B. The use of a paediatric emergency medicine-staffed sedation service during imaging: A retrospective analysis. *Am J Emerg Med* 2007; **25(6)**:654-61. doi: 10.1016/j.ajem.2006.11.043.
10. Schulte-Uentrop L, Goepfert MS. Anaesthesia or sedation for MRI in children. *Curr Opin Anaesthesiol* 2010; **23(4)**:513-7. doi: 10.1097/ACO.0b013e32833bb524.
11. Sethi D, Gupta M, Subramanian S. A randomised trial evaluating low doses of propofol infusion after intravenous ketamine for ambulatory paediatric magnetic resonance imaging. *Saudi J Anaesth* 2014; **8(4)**:510-6. doi: 10.4103/1658-354X.140871.

12. Boriosi JP, Eickhoff JC, Klein KB, Hollman GA. A retrospective comparison of propofol alone to propofol in combination with dexmedetomidine for paediatric 3T MRI sedation. *Paediatr Anaesth* 2017; **27(1)**:52-9. doi: 10.1111/pan.13041.

13. Kang R, Shin YE, Gil N, Kim KY, Yeo H, Jeong JH, *et al*. A comparison of the use of propofol alone and propofol with midazolam for paediatric magnetic resonance imaging sedation-a retrospective cohort study. *BMC Anesthesiol* 2017; **17(1)**:138. doi: 10.1186/s12871-017-0431-2.

14. Tith S, Lalwani K, Fu R. Complications of three deep sedation methods for magnetic resonance imaging. *J Anaesthesiol Clin Pharmacol* 2012; **28(2)**:178-84. doi: 10.4103/0970-9185.94837.

15. Zgleszewski SE, Zurakowski D, Fontaine PJ, D'Angelo M, Mason KP. Is propofol a safe alternative to pentobarbital for sedation during paediatric diagnostic CT? *Radiology* 2008; **247(2)**:528-34. doi: 10.1148/radiol.2472062087.

16. Mallory MD, Baxter AL, Kost SI. Paediatric sedation research consortium. Propofol *vs* pentobarbital for sedation of children undergoing magnetic resonance imaging: Results from the paediatric sedation research consortium. *Paediatr Anaesth* 2009; **19(6)**:601-11. doi: 10.1111/j.1460-9592.2009.03023.x.

17. Machata AM, Willschke H, Kabon B, Kettner SC, Marhofer P. Propofol based sedation regimen for infants and children undergoing ambulatory magnetic resonance imaging. *Br J Anaesth* 2008; **101(2)**:239-43. doi: 10.1093/bja/aen153.

18. Kim D, Lee EK, Jeong JS, Gil NS, Hahm TS, Shin YH. Incidence and risk factors of unplanned ıntubation during paediatric sedation for MRI. *J Magnetic Resonance Imaging* 2019; **49(4)**:1053-61. doi: 10.1002/jmri.26314.

19. Pedersen NA, Jensen AG, Kilmose L, Olsen KS. Propofol-remifentanil or sevoflurane for children undergoing magnetic resonance imaging? A randomised study. *Acta Anaesthesiol Scand* 2013; **57(8)**:988-95. doi: 10.1111/aas.12151.