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Research Article

The Effect of Dexmedetomidine and Ketamine on Core Body Temperature Changes in Children Undergoing Sedation during MRI

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ABSTRACT

Background: Magnetic resonance imaging (MRI) is widely used for diagnosing various diseases. This technique may lead to an elevation in temperature within the targeted imaging area, while intravenous anesthetics may induce hypothermia, particularly in pediatrics. The impact of different anesthetics on core body temperature in children undergoing such procedures has been partially explored with agents such as propofol and ketamine; however, findings associated with dexmedetomidine remain contentious. Therefore, this study aimed to investigate the influence of dexmedetomidine and ketamine on core body temperature in the pediatric population during MRI procedures.

Methods: This study was a prospective, randomized, double-blind clinical trial conducted on children aged 6 months to 10 years who underwent MRI and anesthesia at Mofid Hospital (Tehran, Iran) in 2025. Patients were randomly assigned to receive ketamine and dexmedetomidine for performing an MRI. Demographic, hemodynamic, and sedation data were compared between the two groups. The significance level was considered less than 0.05.

Results: Twenty-six pediatrics were assessed in each group receiving dexmedetomidine and ketamine. The sedation scores did not demonstrate significant differences between the two groups (P value: 0.55). Dexmedetomidine exhibited significantly lower heart rates (P value: 0.001) and core body temperatures (P value: 0.02).

Conclusion: Dexmedetomidine significantly reduces heart rate and core body temperature compared to ketamine in pediatrics undergoing MRI.

Introduction

Magnetic resonance imaging (MRI) is a widely utilized imaging technique for the diagnosis of diseases in pediatric populations. To enhance image quality, it is imperative that the imaging area remain stationary. Consequently, MRI is frequently performed on children under general anesthesia or sedation. During the imaging process, the body absorbs the radiofrequency (RF) waves emitted by the MRI machine, resulting in an increase in temperature within the targeted area of imaging.

This increase in temperature can lead to a considerable elevation in overall body temperature, particularly due to the high body surface area (BSA) to weight ratio commonly observed in children. Conversely, body temperature may also decrease as the ambient

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temperature required for optimal MRI machine operation is set at a low 20°C. Active warming devices are generally prohibited due to incompatibility with MRI equipment. Furthermore, intravenous anesthetics may impair regulation of the body temperature [1-2].

Intravenous anesthetics disrupt thermoregulation, primarily through peripheral vasodilation, which often leads to hypothermia as body temperature shifts from the core to the periphery. Propofol, known for its strong vasodilating effect, is particularly associated with this risk. In contrast, ketamine helps preserve thermoregulation by stimulating the sympathetic nervous system and increasing peripheral vascular resistance. Combining ketamine with propofol during anesthesia maintenance can reduce the onset of hypothermia [3-6].

Dexmedetomidine is an alpha2-adrenergic agonist with tenfold greater receptor specificity than clonidine. It is anticipated to inhibit central thermoregulation, reduce hypothermia, and effectively treat shivering. However, the thermoregulatory effects of dexmedetomidine have not been documented in humans [7-8]. Therefore, we evaluated the impact of a dexmedetomidine + ketamine on pediatric body temperature during MRI.

Methods

This prospective, randomized, double-blind clinical trial was conducted on children aged 6 months to 10 years with American Society of Anesthesiologists (ASA) class I-II [9], who underwent MRI and anesthesia at Mofid Hospital in 2025.

The inclusion criteria were severe cardiac or pulmonary disease, allergy to intravenous anesthetics, elevated intracranial pressure or epilepsy, initial body temperature ≥ 37.5°C, and signs of dehydration in the patient. Also, if the parents didn’t have consent to participate in the study, their children were excluded from the study.

Based on the Fullerton study [10], and considering that the intervention could increase the temperature by 25% compared to the no-intervention group, considering a type I error of 5% and a type II error of 20%, the minimum sample size required for each group was estimated to be 26 pediatrics.

Parents accompanied the children to the sedation injection site, and induction of anesthesia with inhalation anesthesia was started, and during this time the parents were transferred to the waiting room. Inhalation anesthesia using sevoflurane was administered following the monitoring of patients' heart rates, SpO2 levels, and non-invasive blood pressure (NIBP). Continuous hemodynamic monitoring was maintained during MRI. Prior to entry into the MRI unit, all patients underwent intravenous cannulation and inhalation induction with sevoflurane. Additionally, midazolam at a dosage of 0.1 mg/kg and atropine at a dosage of 0.01 mg/kg were administered intravenously.

Patients were assigned to two groups utilizing the sealed envelope method: dexmedetomidine group (group I) and ketamine group (group II).

All participants received a number from 1 to 52 and were randomly assigned to one of the dexmedetomidine and ketamine groups by using the randomizer application (www.randomizer.org).

The sedation level of patients was evaluated using a 12-point sedation scale. Patients who presented with a sedation score of 3 or lower were subsequently transferred to the MRI department. The assessment of sedation levels and the recording of hemodynamic parameters were conducted by the same anesthesiologist, who was blinded to the medications utilized for the study groups. The MRI procedures were carried out using a Siemens MAGNETOM Avanto 1.5T system. For those patients with a sedation score of 4 or higher, the appropriate medications were administered intravenously. Prior to entering the MRI unit, bilateral tympanic membrane temperature measurements were taken and recorded by an anesthesiologist who remained blinded to the study groups.

Patients were transported to the MRI room attired in single-layer cotton gowns, with headphones positioned to cover both ears. No active warming measures were administered, and all patients were adequately covered with a hospital blanket up to the shoulder level. The temperature of the MRI room was regulated at 20°C, and the humidity level was maintained at less than 50%. Supplemental oxygen was provided to patients at a flow rate of four liters per minute using an appropriate mask. During the MRI procedure, heart rate and SpO2 were continuously monitored. Noninvasive blood pressure measurements were recorded at both the commencement and conclusion of the imaging session.

Upon completion of the MRI procedure, patients were escorted from the examination room, and bilateral tympanic membrane temperature measurements were subsequently conducted. During the temperature assessment, the child's ear was gently elevated and posteriorly retracted by grasping its upper portion, while the thermometer sensor was carefully introduced into the ear canal. The thermometer was removed from the ear a few seconds after the initiation of the measurement, and the recorded value was noted. Both pre-imaging and post-imaging temperature measurements, along with patient follow-up evaluations, were carried out by the same anesthesiologist. In instances where a temperature variance of 1°C or greater was observed between measurements, the measurement process was repeated, and the two values were averaged to ensure accuracy. Following the completion of the temperature assessment, the sedation score was re-evaluated and documented. Additionally, relevant patient data, including age, sex, body surface area, imaging region, and duration of the imaging procedure, were meticulously recorded.

Statistical analysis

The data obtained in this study will be analyzed using SPSS version 26 software. In the evaluation of data, count, percentage, mean, and standard deviation will be used as descriptive statistical methods. The t-test will be used to compare continuous (or quantitative) data between two independent groups. The difference between repeated measurements will be analyzed using the paired t-test. The difference between repeated measurements analyzed using the paired t-test. A 95% confidence interval and at a significance level of 0.05 were considered.

Ethical issue

This study was approved by the Ethics Committee of Shahid Beheshti University of Medical Sciences (IR.SBMU.RETECH.REC.1404.214) and was registered in the Iranian Registry of Clinical Trials (IRCT) under the registration code IRCT20250722066589N1.

Results

We assessed 26 pediatrics in each group, and all results are presented in (Tables 1-3). Based on our findings, post-imaging heart rate and temperature were significantly lower in the dexmedetomidine group compared to the ketamine group (P values: 0.001 and 0.02, respectively).

Discussion

In this study, we compared dexmedetomidine and ketamine effects on the temperature body of children during performing MRI. It was found that pediatrics who received dexmedetomidine had significantly lower heart rates and core body temperatures. Sedation scores didn't significantly differ between the groups. Previous studies indicate body temperature can increase by 0.2 to 0.5°C during MRI. Using propofol sedation, Machata et al. reported a median temperature change of 0.2°C in children under 6 years at 1.5 T and 0.5°C at 3.0 T. Conversely, a recent study noted several infants and children under 8 years experienced hypothermia, with temperatures below 36°C. Additionally, Bryan et al. found a temperature change of 0.5°C in pediatrics younger than 15 years undergoing MRI [1,11-12].

Ketamine is often used for procedural sedation, with the method of parenteral administration influenced by the anesthesiologist's preferences and research on pediatric sedation [13]. On the other hand, dexmedetomidine is a selective α2-adrenergic agonist that induces sedation resembling natural sleep, along with anxiolytic effects, sympatholysis, and an anesthetic-sparing effect, all without causing significant respiratory depression. This sedation is primarily mediated through α2 adrenoceptors in the locus coeruleus of the central nervous system [14-15]. Dexmedetomidine is an effective alternative to halogenated general anesthesia for pediatric MRI sedation, aimed at reducing exposure to conventional anesthetics and the need for invasive ventilation [16].

Ketamine has been observed to reduce the decline in core body temperature commonly associated with anesthesia in children during imaging. This characteristic may provide theoretical advantages for patients experiencing hypothermia; however, this specific application has not been extensively researched [17-18]. There is a lack of data regarding the effects of dexmedetomidine in this condition. Therefore, this study's novelty lies in the comparative analysis of the effects of these medications in pediatric patients undergoing MRI. Eldeek et al. compared the sedative effects of ketamine and dexmedetomidine in pediatrics undergoing MRI. They demonstrated that the onset of sedation was significantly shorter in the ketamine group.

Table 1- Patients characteristics

	DEX (n=26)	Ketamine (n=26)	P value
Age (years)	4.8 ± 1.2	4.5 ± 1.3	0.45
Gender (male)	14 (53.8%)	13 (50.0%)	0.80
BMI (Kg/m²)	16.8 ± 2.1	17.0 ± 2.3	0.75

Table 2- MRI

	DEX (n=26)	Ketamine (n=26)	P value
Brain MRI	20 (76.9%)	18 (69.23%)	0.22
Duration (min)	18.3 ± 2.7	19.7 ± 0.3	0.39

Table 3- Vital signs

		DEX (n=26)	Ketamine (n=26)	P value
HR (/min)	Pre	105 ± 10	108 ± 12	0.40
	Post	97 ± 10	108 ± 9	0.0001*
SBP (mmHg)	Pre	110 ± 8	112 ± 9	0.45
	Post	108 ± 7	111 ± 8	0.50
T(°C)	Pre	36.9 ± 0.2	37.0 ± 0.3	0.30
	Post	37.2 ± 0.2	37.4 ± 0.9	0.02*

Sedation Score	Pre	2.5 ± 0.8	2.4 ± 0.9	0.65
	Post	3.2 ± 0.7	3.1 ± 0.8	0.55

The heart rate and mean arterial pressure decreased significantly from baseline during sedation in the dexmedetomidine group [19]. In the current study, we did not assess mean arterial pressure. Although we assessed the blood pressure of two groups, there was no difference between the groups in this regard. We found that the heart rate was lower in dexmedetomidine compared to ketamine, which was similar between these two studies. One of the concerns about sedation of pediatric patients during the MRI is temperature changes, and this was assessed in the current study. Based on our findings, the dexmedetomidine group had significantly lower core temperature than the ketamine group, and this assessment was one of the advantages of our study because there is limited data in this regard. Qiu and Luo compared analgesic effects of ketamine and dexmedetomidine during dental surgery. They reported that dexmedetomidine significantly reduced the heart rate of pediatrics compared to ketamine, but they had similar sedation and analgesic effects [20]. These results were observed in the current study. We found that sedation scores were similar between the ketamine and dexmedetomidine groups, but pediatrics in the dexmedetomidine group had significantly lower heart rates compared to the ketamine group. Although the understudied participants differed between the two studies, the results were similar regarding the agents' heart rate and sedation effects. This issue may confirm the difference in the partial effects of dexmedetomidine and ketamine, but further studies should evaluate it.

Some studies showed that ketamine had similar sedation effects to dexmedetomidine in pediatrics undergoing imaging [21-23]. The current study confirmed these studies' results because, based on our findings, the sedation score was no different between dexmedetomidine and ketamine.

Conclusion

It is concluded that dexmedetomidine and ketamine have similar effects on the sedation depth in pediatrics undergoing MRI. However, dexmedetomidine significantly reduces the heart rate and core body temperature of these pediatrics, compared to ketamine.

The current study's limitations included a lack of sample size and a lack of consent to participate. It is recommended that further studies be performed with a larger sample size.

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