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### Key Words

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## The Impact of Sedation Techniques on MRI Imaging Quality and Diagnostic Accuracy in Young Children

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### Abstract

Magnetic Resonance Imaging (MRI) is a critical diagnostic tool in paediatric healthcare. However, obtaining high-quality images in young children can be challenging due to their inability to remain still during the procedure. Sedation is commonly used to mitigate this issue, but the impact of different sedation techniques on MRI imaging quality and diagnostic accuracy remains under explored. This study was conducted over one year at a tertiary care center, involving 60 children aged 1-6 years who required MRI scans. Participants were randomly assigned to one of three sedation groups: oral midazolam, intravenous propofol, or inhalational sevoflurane. MRI imaging quality was assessed using a standardized scoring system by radiologists blinded to the sedation technique. Diagnostic accuracy was determined by comparing MRI findings with clinical outcomes and follow-up data. Of the 60 participants, 20 were assigned to each sedation group. The average imaging quality scores were as follows: oral midazolam ( $4.2 \pm 0.5$ ), intravenous propofol ( $4.8 \pm 0.3$ ) and inhalational sevoflurane ( $4.5 \pm 0.4$ ) on a scale of 1-5, with 5 being the highest quality. Diagnostic accuracy was 85% for oral midazolam, 95% for intravenous propofol and 90% for inhalational sevoflurane. The propofol group demonstrated significantly better imaging quality and diagnostic accuracy compared to the midazolam group ( $p < 0.05$ ). Intravenous propofol sedation provides superior MRI imaging quality and diagnostic accuracy in young children compared to oral midazolam and inhalational sevoflurane. These findings suggest that propofol may be the preferred sedation technique for paediatric MRI, improving diagnostic outcomes and reducing the need for repeat imaging.

## INTRODUCTION

Magnetic Resonance Imaging (MRI) is a non-invasive diagnostic tool that provides high-resolution images of soft tissues, making it invaluable in paediatric healthcare for diagnosing a range of conditions from neurological disorders to abdominal pathologies<sup>[1]</sup>. However, MRI requires patients to remain completely still during the procedure, which is particularly challenging for young children due to their natural restlessness and anxiety in medical settings<sup>[2]</sup>. As a result, sedation is frequently used to facilitate MRI in paediatric patients<sup>[3]</sup>.

Various sedation techniques have been employed to improve compliance and image quality in paediatric MRI, including oral, intravenous/inhalational agents<sup>[4]</sup>. Oral midazolam is commonly used due to its ease of administration and anxiolytic properties, but it has a slower onset and variable absorption rates<sup>[5]</sup>. Intravenous propofol is favored for its rapid onset and short recovery time, though it requires venous access and careful monitoring<sup>[6]</sup>. Inhalational agents such as sevoflurane are also popular for their rapid induction and ease of titration, but they may pose risks such as airway irritation and emergence delirium<sup>[7]</sup>.

The choice of sedation technique can significantly impact the quality of MRI images and the accuracy of diagnostic interpretations<sup>[8]</sup>. Poor image quality can result in diagnostic errors, delayed treatment the need for repeat imaging, which increases costs and exposes children to additional sedation risks<sup>[9]</sup>. Despite the widespread use of sedation in paediatric MRI, there is limited comparative data on the efficacy of different sedation techniques in terms of imaging quality and diagnostic accuracy<sup>[10-15]</sup>.

This study aims to evaluate the impact of three commonly used sedation techniques-oral midazolam, intravenous propofol/inhalational sevoflurane-on MRI imaging quality and diagnostic accuracy in young children. By assessing these parameters, we hope to identify the most effective sedation method to optimize diagnostic outcomes and reduce the need for repeat procedures.

## MATERIALS AND METHODS

**Study Design:** This prospective, randomized, controlled study was conducted over a period of one year at a tertiary care center. The study aimed to compare the impact of three different sedation techniques on MRI imaging quality and diagnostic accuracy in young children.

**Participants:** A total of 60 children aged between 1 and 6 years who required MRI scans for various clinical indications were enrolled in the study. Participants were randomly assigned to one of three sedation

groups: oral midazolam, intravenous propofol, or inhalational sevoflurane, with 20 children in each group.

### Sedation Protocols:

- **Oral Midazolam Group:** Children received oral midazolam at a dose of 0.5 mg/kg, administered 30 minutes before the MRI procedure.
- **Intravenous Propofol Group:** Children received an initial bolus of intravenous propofol at a dose of 1 mg/kg, followed by continuous infusion at a rate of 50-100 µg/kg/min to maintain adequate sedation throughout the MRI.
- **Inhalational Sevoflurane Group:** Children were induced with inhalational sevoflurane (8%) and maintained with 2-3% sevoflurane in a mixture of nitrous oxide and oxygen during the MRI procedure.

**MRI Procedure:** All MRI scans were performed using a 1.5 Tesla MRI scanner. Standard imaging protocols were followed for each clinical indication the duration of the scans ranged from 30-60 minutes, depending on the specific requirements of each case.

**Imaging Quality Assessment:** The quality of MRI images was assessed by two experienced radiologists who were blinded to the sedation techniques used. Imaging quality was scored on a scale of 1-5, with 1 being poor quality (significant motion artifacts) and 5 being excellent quality (no motion artifacts).

**Diagnostic Accuracy:** Diagnostic accuracy was determined by comparing MRI findings with clinical outcomes and follow-up data. A third radiologist, also blinded to the sedation methods, reviewed the MRI results and clinical records to determine the accuracy of the diagnoses.

**Statistical Analysis:** Data were analyzed using SPSS software version 25.0. Descriptive statistics were used to summarize the demographic data and sedation outcomes. The imaging quality scores and diagnostic accuracy rates were compared among the three groups using ANOVA and chi-square tests, respectively. A  $p < 0.05$  was considered statistically significant.

## RESULTS AND DISCUSSIONS

**Participant Demographics:** A total of 60 children participated in the study, with 20 children in each sedation group. The mean age of the participants was 3.5 years (range: 1-6 years) the gender distribution was balanced across the groups (30 males and 30 females).

**Table 1: The average imaging quality scores for each sedation group**

Sedation Group	Average Imaging Quality Score ( $\pm$ SD)
Oral Midazolam	4.2 $\pm$ 0.5
Intravenous Propofol	4.8 $\pm$ 0.3
Inhalational Sevoflurane	4.5 $\pm$ 0.4

**Table 2: The diagnostic accuracy rates for each sedation group**

Sedation Group	Diagnostic Accuracy (%)
Oral Midazolam	85
Intravenous Propofol	95
Inhalational Sevoflurane	90

**Table 3: The incidence of adverse events during the sedation and MRI procedures is summarized**

Sedation Group	Adverse Events (%)
Oral Midazolam	10
Intravenous Propofol	15
Inhalational Sevoflurane	20

**Imaging Quality:** The average imaging quality scores for each sedation group are presented in Table 1. The intravenous propofol group had the highest average imaging quality score, followed by the inhalational sevoflurane group and the oral midazolam group.

ANOVA analysis revealed a significant difference in imaging quality scores among the three groups ( $p < 0.05$ ), with the intravenous propofol group showing significantly better imaging quality compared to the oral midazolam group ( $p < 0.05$ ).

**Diagnostic Accuracy:** The diagnostic accuracy rates for each sedation group are shown in Table 2. The intravenous propofol group demonstrated the highest diagnostic accuracy, followed by the inhalational sevoflurane group and the oral midazolam group.

Chi-square analysis indicated a significant difference in diagnostic accuracy rates among the three groups ( $p < 0.05$ ). The intravenous propofol group had significantly higher diagnostic accuracy compared to the oral midazolam group ( $p < 0.05$ ).

**Adverse Events:** The incidence of adverse events during the sedation and MRI procedures is summarized in Table 3. The most common adverse events were mild and included transient hypoxia and nausea.

There were no serious adverse events reported in any of the sedation groups. The differences in the incidence of adverse events were not statistically significant ( $p > 0.05$ ).

Overall, intravenous propofol provided the best imaging quality and highest diagnostic accuracy with an acceptable safety profile, making it a preferred sedation technique for paediatric MRI procedures in this study.

The findings of this study highlight the impact of different sedation techniques on MRI imaging quality and diagnostic accuracy in young children. Our results indicate that intravenous propofol sedation provides superior imaging quality and diagnostic accuracy compared to oral midazolam and inhalational sevoflurane, with a manageable safety profile.

The average imaging quality score was highest in the intravenous propofol group (4.8 $\pm$ 0.3), followed by the inhalational sevoflurane group (4.5 $\pm$ 0.4) and the oral midazolam group (4.2 $\pm$ 0.5). These findings are consistent with previous studies that have demonstrated the efficacy of propofol in reducing motion artifacts and providing high-quality images in paediatric MRI<sup>[1,2]</sup>. Propofol's rapid onset and controllable sedation levels are likely contributing factors to its superior performance<sup>[3]</sup>. In contrast, oral midazolam, while easier to administer, may not achieve the same level of sedation, resulting in lower imaging quality<sup>[4]</sup>.

The diagnostic accuracy was highest in the propofol group (95%), compared to the sevoflurane group (90%) and the midazolam group (85%). This difference is clinically significant, as higher diagnostic accuracy can lead to more precise treatment planning and better patient outcomes<sup>[5]</sup>. The superior diagnostic accuracy with propofol sedation can be attributed to the higher imaging quality, which reduces the likelihood of diagnostic errors<sup>[6]</sup>. Our results are supported by previous research showing that propofol sedation enhances diagnostic accuracy in paediatric imaging<sup>[7,8]</sup>.

The incidence of adverse events was relatively low across all groups, with no serious adverse events reported. The most common adverse events were mild and included transient hypoxia and nausea, which aligns with the safety profiles reported in other studies<sup>[9]</sup>. The incidence of adverse events was slightly higher in the propofol (15%) and sevoflurane (20%) groups compared to the midazolam group (10%), but these differences were not statistically significant. Propofol's short duration of action and rapid recovery time make it a safe choice for paediatric sedation when appropriately monitored<sup>[10]</sup>.

This study has several limitations. The sample size was relatively small; the study was conducted at a single center, which may limit the generalizability of the findings. Additionally, the study did not assess long-term outcomes related to the use of different sedation techniques. Future research with larger, multi-center trials and long-term follow-up is needed to validate these findings and further explore the impact of sedation techniques on paediatric MRI.

## CONCLUSION

Intravenous propofol sedation provides the best combination of imaging quality and diagnostic accuracy in young children undergoing MRI, with an acceptable safety profile. These findings suggest that propofol may be the preferred sedation technique for pediatric MRI, improving diagnostic outcomes and potentially reducing the need for repeat imaging.

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