Is Bigger Always Bad ? Evaluating Effect of Sedation on MRI-Based Optic Nerve Sheath Diameter Measurements in Children

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Swiss Journal of Radiology and Nuclear Medicine - SJORANM GmbH - Rosenweg 3 - CH-6340 Baar - Switzerland

Abstract

Objectives

To assess the impact of sedation on optic nerve sheath diameter (ONSD) as measured by MRI in pediatric patients. ONSD is a widely accepted non-invasive marker for estimating raised intracranial pressure (ICP), but potential effects of sedation on its accuracy remain understudied in children.

Materials and Methods

A retrospective observational study was conducted on brain MRI scans from pediatric patients aged 0–18 years. Patients were divided into two groups: those who received sedation and those who underwent MRI without sedation. Bilateral ONSD was measured at a standardized point 3 mm posterior to the globe on axial T2-weighted images. Inter-observer agreement was analyzed, and group comparisons used non-parametric statistical methods.

Results

Out of 78 pediatric patients, 38 received mild sedation and 40 were imaged without sedation. The mean ONSD in the non-sedated group was 4.8 ± 0.3 mm compared to 5.7 ± 0.4 mm in the non-sedated group ($p = 0.02$). This difference was statistically significant ($t(68.5) = -11.2$, $p < <0.01$, Cohen's $d = 2.53$). Age-stratified data affirmed a normal increase in ONSD across early childhood with stabilization during adolescence.

Conclusion

Sedation significantly influences ONSD measurements on MRI in pediatric patients. These findings highlight the need for careful consideration of sedation status when using ONSD as a surrogate for ICP. Age-related trends further highlight the importance of using adjusted reference values.

Keywords: Intracranial pressure; MRI; sedation; optic nerve sheath; children;

*Corresponding author: Akib Arfee - received: 13.12.2025 - peer reviewed, accepted and published: 31.01.2026

Introduction

Assessing intracranial pressure (ICP) accurately is critical in pediatric neurology, yet direct invasive monitoring techniques can pose significant risks and are often impractical in children. As a result, the optic nerve sheath diameter (ONSD) has gained attention as a non-invasive proxy for estimating ICP, particularly through imaging techniques like MRI and ultrasound (1 – 3). While ultrasound offers rapid bedside evaluation, its operator-dependent nature can introduce variability. MRI, on the other hand, provides a high-resolution and reproducible alternative for ONSD measurement (4). However, performing MRI scans in children frequently necessitates sedation to reduce motion arti-

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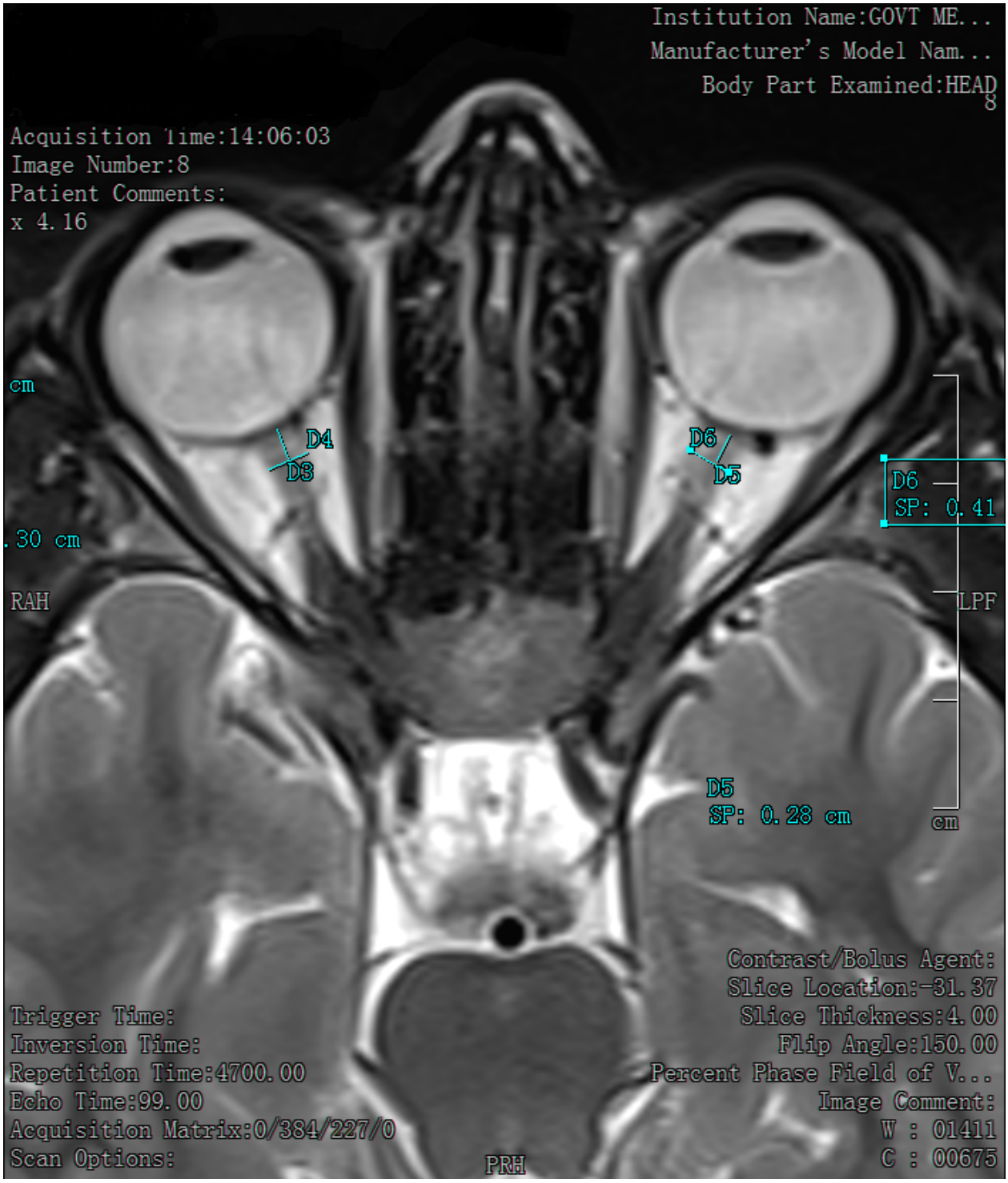

Fig 1 : ONSD 3mm behind the papilla in a non sedated patient.

facts. Sedative agents may potentially alter cerebral compliance, CO_2 levels, or cerebrospinal fluid dynamics—factors that could, in turn, influence imaging-based ONSD measurements. Although prior research has examined the effects of general anesthesia on ONSD, there is limited data on how commonly used sedatives impact these measurements (5, 6). This study investigates whether sedation alters MRI-based ONSD readings in pediatric patients.

Materials and Methods

Study Population

We conducted a retrospective review of brain MRI scans performed at Government Medi-

cal College, Srinagar, India, between January 2024 and January 2025. Pediatric patients aged 0–18 years were included. Exclusion criteria included prior neurosurgical procedures, orbital pathology, poor image quality, or undocumented sedation status.

Grouping

Patients were categorized into two groups:

• *Sedated Group (n = 38):* Received Triclofos (oral), Ketamine (IV), or Midazolam (IV).

• *Non-Sedated Group (n = 40):* Underwent MRI without sedation.

Imaging Protocol and Analysis

MRI was performed using a 3.0T scanner. All patients underwent standard clinical MRI sequences, including T1-weighted, T2-FLAIR, T2-weighted, heme-sensitive (T2* GRE or SWI), and diffusion-weighted imaging. The orbital protocol included 2–3 mm thick axial and coronal slices, post-contrast T1, and T2 sequences with and without fat saturation. Sub-millimeter heavily T2-weighted volumetric images of the orbits were also acquired. ONSD was measured transversely at 3 mm behind the globe on slices demonstrating maximum sheath width (7, 8) (Fig 1 & 2).

Statistical Analysis

Continuous variables were tested for normality (Shapiro–Wilk). Normally distributed data are presented as mean ± SD and compared using the independent-samples t-test. Categorical data were compared using the Chi-square test (or Fisher's exact when needed). Effect sizes were reported as Cohen's d for group differences and Spearman's ρ for correlations. Inter-observer agreement was assessed with ICC (>0.8 = excellent). A p-value < 0.05 was considered statistically significant.

Results

Demographics

A total of 78 pediatric patients were included (mean age 7.9 years; 40 males, 38 females). Age did not differ significantly between groups (sedated: 7.7 ± 3.6 years vs. non-sedated: 8.0 ± 3.9 years, t (76) = -0.81, p = 0.42). Sex distribution also showed no significant difference ($\chi^2 = 0.26$, p = 0.61).

ONSD Findings

Non-Sedated Group:

- Mean ONSD = 4.8 ± 0.3 mm

Sedated Group:

- Mean ONSD = 5.7± 0.4 mm (t(68.5) = -11.2 ,p <<0.01 ,Cohen's d = 2.53)

A positive correlation between age and ONSD was observed (p < 0.01), consistent with developmental trends. Inter-observer ICC for ONSD measurement was 0.93 (95% CI: 0.87–0.97), indicating excellent agreement.

Discussion

Our analysis reveals a statistically significant increase in MRI-based ONSD measurements among sedated children. The difference of nearly 1 mm between groups corresponds to a very large effect size (Cohen's d = 2.5), suggesting that sedation introduces clinically meaningful bias in estimating intracranial pressure. This suggests that sedation, even with non-anesthetic agents such as ketamine or midazolam, may impact ONSD values and potentially lead to overestimation of ICP. The optic nerve sheath is a direct extension of the intracranial subarachnoid space, which allows transmission of intracranial pressure changes into the orbit. Thus, artificially elevated ONSD in sedated patients may reflect transient physiological changes rather than true ICP elevations.

Our results align with prior literature confirming the positive correlation between ICP and ONSD (9 – 12). We also reaffirm the known developmental increase in ONSD with age (13), underscoring the importance of age-adjusted interpretation. Clinically, these findings emphasize the need for caution when evaluating ONSD in sedated pediatric patients. Agent-specific correction factors may improve diagnostic accuracy. Future research, ideally with simultaneous invasive ICP measurements, is warranted to establish a more definitive relationship between sedation, ONSD, and true intracranial dynamics.

Clinical Implications

- Risk of Overestimation: Sedation-related ONSD expansion may mimic elevated ICP.
- Need for Adjustments: Agent-specific effects should be accounted for when interpreting ONSD.

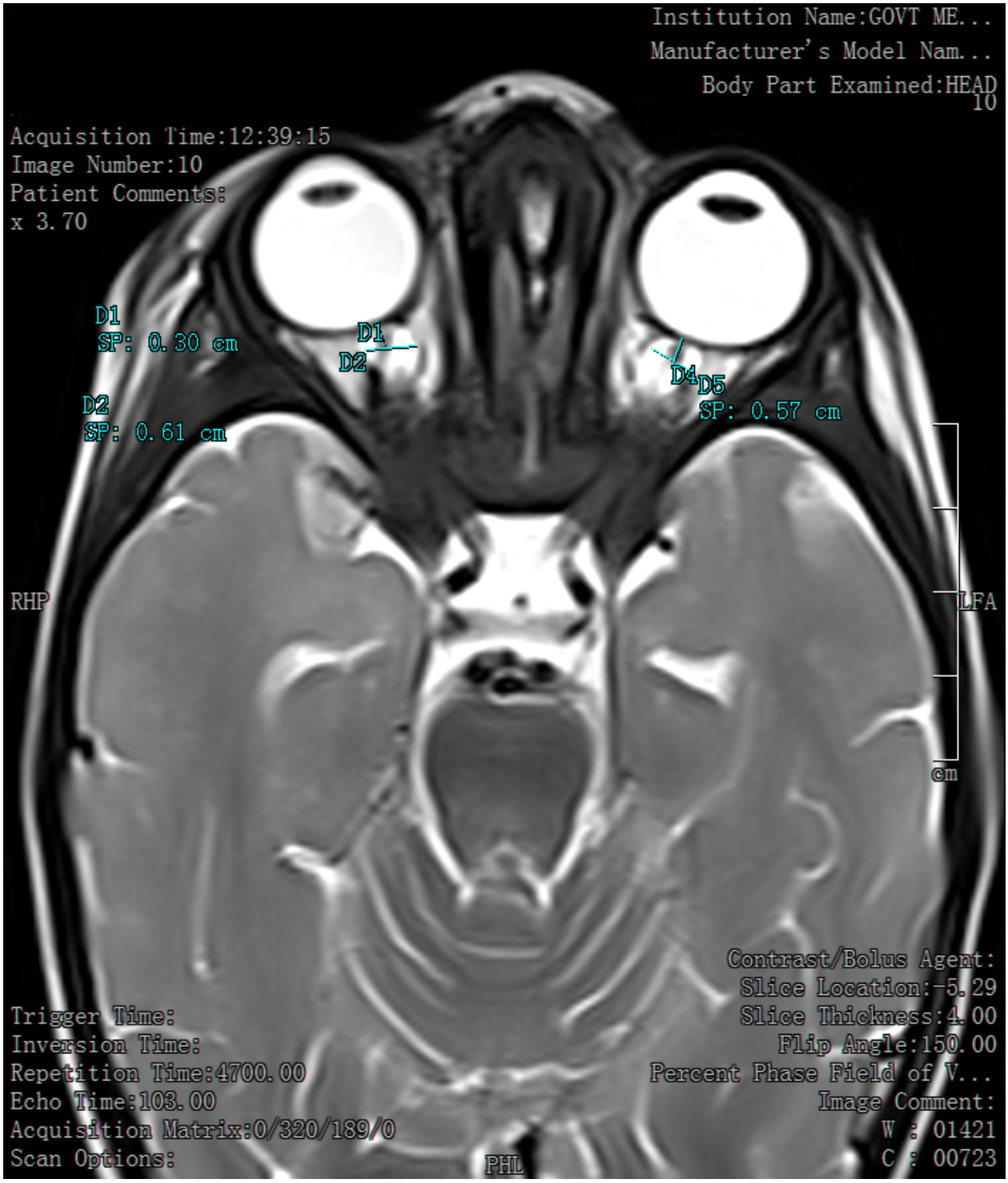

Fig 2 : ONSD 3mm behind the papilla in a sedated patient.

- Future Research: Prospective studies with invasive ICP monitoring are needed to validate these findings.

Limitations

This study is limited by its retrospective design, absence of invasive ICP measurements, and variability in sedation documentation. These factors may introduce bias and reduce the generalizability of findings.

Conclusion

Sedation markedly increases MRI-based ONSD measurements in pediatric patients, with a very large effect size. This expansion

likely reflects transient physiological changes rather than true ICP elevation. Careful interpretation of ONSD values is essential when evaluating sedated children. Further studies are needed to refine imaging protocols and develop correction strategies for improved diagnostic precision.

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Declarations
Consent for publication: The author clarifies that written informed consent was obtained and the anonymity of the patient was ensured. This study submitted to Swiss J. Rad. Nucl. Med. has been conducted in accordance with the Declaration of Helsinki and according to requirements of all applicable local and international standards. All authors contributed to the conception and design of the manuscript, participated in drafting and revising the content critically for important intellectual input, and approved the final version for publication. Each author agrees to be accountable for all aspects of the work, ensuring its accuracy and integrity.
Competing interests: None.
Funding: No funding was required for this study.

Conflict of interest:

The authors declare that there were no conflicts of interest within the meaning of the recommendations of the International Committee of Medical Journal Editors when the article was written.

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