Saudi Journal of Radiology
December 2025 4(2), 01-20
Original Article

OCULAR SONOGRAPHIC PATTERNS AND PREDICTORS OF RAISED INTRACRANIAL PRESSURE IN PAEDIATRIC HEAD INJURY AT MUHIMBILI ORTHOPAEDIC INSTITUTE.

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Received 04 June 2025
Revised 13 July 2025
Accepted 09 September 2025
Published 15 September 2025

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eISSN: 1658-8959

ABSTRACT

Background: Raised intracranial pressure (ICP) is a life-threatening complication of traumatic brain injury (TBI) in children and demands prompt recognition. Conventional ICP monitoring methods like External Ventricular Drainage, though effective, are invasive and carry procedural risks. Ocular sonography, particularly measurement of the optic nerve sheath diameter (ONSD), offers a non-invasive, accessible alternative for early ICP assessment. However, its utilization in pediatric trauma care remains limited.

Objective: To determine the Ocular Sonographic patterns and associated predictors of raised Intracranial Pressure among pediatric patients with head injury attending Muhimbili Orthopedic Institute from June 2024 to March 2025

Materials and Methods: A prospective cross-sectional study was conducted involving 113 pediatric TBI patients (GCS ≤14) recruited through convenience sampling. Clinical data were collected using structured tools. Ocular ultrasound of the right eye was performed using B-mode sonography to measure ONSD 3 mm posterior to the globe. Data analysis was conducted using SPSS v25. Chi-square tests and logistic regression analyses were used to explore associations between clinical features and raised ICP.

Results: Among 113 participants (mean age 8.09 years; 69.9% male), 74.3% had moderate TBI. Ocular sonography revealed optic disc elevation in 6.2% of cases; no instances of retinal detachment or vitreous hemorrhage were found. Mean ONSD increased with age. Clinical features such as seizures (68.1%) and vomiting (61.9%) were common, while hydrocephalus (0.9%) and papilledema (1.8%) were rare. Lower GCS scores were significantly associated with suspected raised ICP (p = 0.035), whereas seizures and vomiting lost significance in multivariate analysis.

Conclusion: Glasgow Coma Scale score is a significant predictor of raised

ICP in pediatric head injury patients. The absence of papilledema and other ocular sonographic patterns does not exclude raised ICP, supporting the utility of ONSD measurement as a rapid, non-invasive screening tool for early ICP assessment in resource-limited settings.

الملخص

الخلفية:

يُعد ارتفاع الضغط داخل القِحف (ICP) من المضاعفات المهدِّدة للحياة لدى الأطفال المصابين بإصابات الدماغ الرضحية (TBI)، ويتطلب التشخيص المبكر والدقيق. ورغم أن الطرق التقليدية لمراقبة الضغط داخل القِحف مثل التصريف البطيني الخارجي تُعد فعّالة، إلا أنها إجراءات باضعة وتنطوي على مخاطر مرتبطة بالتداخل الجراحي. في المقابل، يوفر التصوير العيني بالموجات فوق الصوتية، وبالأخص قياس قطر غمد العصب البصري (ONSD)، بديلاً غير باضع وسهل الوصول لتقدير الضغط داخل القِحف في المراحل المبكرة. ومع ذلك، لا يزال استخدامه في رعاية الأطفال المصابين بالرضوح محدودًا.

الهدف:

تحديد الأنماط التصويرية العينية بالموجات فوق الصوتية والمؤشرات المرتبطة بارتفاع الضغط داخل القِحف لدى الأطفال المصابين بإصابات الرأس والذين يتلقّون الرعاية بمعهد موهيمبيلي لجراحة العظام خلال الفترة من يونيو 2024 إلى مارس 2025.

المواد والطُرُق:

أُجريت دراسة مقطعية مستقبلية شملت 113 طفلًا مصابًا بإصابات دماغية رضحية (GCS ≤14)، جرى اختيارهم بطريقة العينة المريحة. جُمعت البيانات السريرية باستخدام أدوات مُنظَّمة. أُجري التصوير بالموجات فوق الصوتية للعين اليُمنى باستخدام نمط B لقياس قطر غمد العصب البصري على بُعد 3 ملم خلف المقلة. تم تحليل البيانات باستخدام برنامج SPSS الإصدار 25. استُخدمت اختبارات مربع كاي وتحليل الانحدار اللوجستي لدراسة العلاقة بين الصفات السريرية وارتفاع الضغط داخل القِحف

النتائج:

من بين المشاركين الـ 113 (بمتوسط عمر 8.09 سنوات؛ 69.9% ذكور)، كان لدى 74.3% إصابة دماغية متوسطة الشدة. أظهر التصوير العيني بالموجات فوق الصوتية ارتفاعًا في القرص البصري لدى 6.2% من الحالات، ولم تُسجَّل أي حالات لانفصال الشبكية أو نزف زجاجي. لوحِظ أن متوسط قطر غمد العصب البصري يزداد مع التقدم في العمر. كانت التشنجات (68.1%) والقيء (61.9%) من المظاهر السريرية الشائعة، بينما كان كل من الاستسقاء الدماغي (0.9%) والوذمة الحُليمية (1.8%) نادرين. وُجد ارتباطٌ معنوي بين انخفاض مقياس غلاسكو للغيبوبة وارتفاع الضغط داخل القِحف المُحتمل (قيمة $p = 0.035$)، في حين فقدت التشنجات والقيء دلالتهما الإحصائية في التحليل المتعدد المتغيرات.

الاستنتاج:

يُعد مقياس غلاسكو للغيبوبة مؤشرًا تنبؤيًا هامًا لارتفاع الضغط داخل القِحف لدى الأطفال المصابين بإصابات الرأس. كما أن غياب الوذمة الحُليمية أو غيرها من الأنماط التصويرية العينية لا ينفي احتمالية ارتفاع الضغط داخل القِحف، مما يدعم أهمية قياس قطر غمد العصب البصري كوسيلة فحص سريعة وغير باضعة للتقييم المبكر للضغط داخل القِحف في البيئات محدودة الموارد.

الكلمات المفتاحية:

إصابة الدماغ الرضحية (TBI)، الضغط داخل القِحف (ICP)، التصوير العيني بالموجات فوق الصوتية، قطر غمد العصب البصري (ONSD)، مقياس غلاسكو للغيبوبة (GCS).

Keywords: Ocular Sonographic Patterns, Intracranial Pressure, Paediatric Patients, Head Injury, Muhimbili Orthopaedic Institute

1. INTRODUCTION

Raised intracranial pressure (ICP) is a critical condition frequently observed in children with head injuries and, if left untreated, can result in severe neurological complications and death [1]. Early detection of elevated ICP is essential for timely intervention and improved patient outcomes [2]. The normal range of ICP in children varies based on age, body position, and clinical condition. For example,

in term newborns, the range is typically 1.5–6 mmHg, and in older children, it is 3–7 mm Hg [3,4]. Treatment thresholds also differ depending on the condition—for instance, in hydrocephalus, intervention is often initiated when ICP exceeds 15 mmHg, while in traumatic brain injury (TBI), treatment may begin at 20 mm Hg [5].

TBI accounts for a substantial burden in pediatric trauma, comprising around 80% of cases, with mild TBI representing approximately 75% and affecting about 700 per 100,000 children under age 15 [6]. However, access to invasive ICP monitoring such as intraventricular catheterization remains limited in resource-constrained settings due to associated risks, high costs, and the need for neurosurgical expertise [7]. External ventricular drainage (EVD), the gold standard, is further limited by complications such as hemorrhage, infections, and mechanical failure, and is often unavailable in regional or referral hospitals lacking neurosurgeons or resources [5,7,8].

In Tanzania, these limitations mean that ICP monitoring is rarely implemented. Clinical assessments and serial CT scans are more commonly used, despite their limitations in timely and accurate detection. Consequently, non-invasive alternatives such as ocular sonography have garnered interest. This technique measures the optic nerve sheath diameter (ONSD), which dilates in response to elevated ICP due to its connection to the subarachnoid space [11]. ONSD assessment by ocular ultrasound is safe, quick, widely available, and devoid of ionizing radiation—making it a suitable option in resource-limited environments. Several studies support the strong correlation between ONSD measurements and raised ICP [10].

Given these circumstances, it is imperative to investigate the reliability and applicability of ONSD as a diagnostic tool for elevated ICP in pediatric patients in Tanzania. Local validation and standardization of this technique are essential to address current clinical gaps and improve outcomes.

1.2 RESEARCH OBJECTIVE

1.2.1 MAIN OBJECTIVE

To determine the Ocular Sonographic patterns and associated predictors of raised Intracranial Pressure among paediatric patients with head injury attending MOI from June 2024 to March 2025

1.2.2 SPECIFIC OBJECTIVES

1. To determine the ocular sonographic patterns observed in pediatric patients with head injury and suspected raised ICP at M.O.I from June 2024 to March 2025.
2. To determine predictors for diagnosing raised ICP in pediatric patients with head injury attending M.O.I from June 2024 to March 2025.
3. To determine the association between predictors of raised intracranial pressure and the ocular sonographic patterns in pediatric patients with head injury and suspected raised ICP at M.O.I from June 2024 to March 2025.

2. METHODOLOGY

2.1 STUDY DESIGN AND SETTING

This was a prospective cross-sectional study that aimed to investigate the utility of ocular sonography in diagnosing raised intracranial pressure (ICP) among pediatric patients with head injury at Muhimbili Orthopedic Institute and MNH – Mloganzila. in Tanzania from June 2024 to March 2025.

2.2 STUDY PARTICIPANTS

The study included pediatric patients aged 0 to 17 years, 11 months, and 29 days who were diagnosed with traumatic brain injury, presented with a Glasgow Coma Scale (GCS) score of 14 or lower, and were admitted to Muhimbili Orthopedic Institute or MNH-Mloganzila between June 2024 and March 2025, provided their parents or guardians had given written informed consent. Patients with a GCS score of 15 were intentionally excluded because they are less likely to develop elevated intracranial pressure, which was the focus of this study. For this reason,

we defined mild TBI operationally as a GCS score of 13–14, moderate TBI as a GCS score of 9–12, and severe TBI as a GCS score of 3–8. Patients were excluded if they had obvious facial or ocular trauma, known pre-existing ocular diseases, or if consent was not obtained from their parents or guardians. A total of 113 participants were recruited through consecutive enrollment and this sample size was determined using Yamane's formula (1967) for finite populations based on medical records at Muhimbili Orthopaedic Institute (MOI).

2.3 DATA COLLECTION

Data collection was conducted using a standardized questionnaire completed by the investigator. Ocular ultrasound measurements were performed by trained radiographers and a radiology resident, with all images independently reviewed by an experienced radiologist. To minimize inter-observer variability and ensure quality, sonographic measurements followed a standardized protocol, and any discrepancies were resolved by consensus. Furthermore, regular calibration of ultrasound equipment and inter-rater reliability assessments were conducted throughout the study to maintain measurement accuracy and consistency. The dates of accident and enrollment/ONSD measurement were documented for each participant to account for the interval between trauma and examination. Ocular ultrasound B-mode imaging was performed on the right eye using high-frequency linear transducers (5–12 MHz) with Alpinon® E Cube 8 and Vivid S5 ultrasound machines. The questionnaire with all the information collected is attached as attachment A. All participants underwent bedside ocular ultrasonography with gel applied to closed eyelids; although sedation was considered for uncooperative patients, none required it. The ONSD was measured 3 mm behind the globe, with 5 mm set as the cut-off value, correlating with an intracranial pressure above 20 mmHg. Optic disc elevation (ODE) was assessed, with a mean diameter exceeding 0.6 mm from the retinal plane used as the cut-off for diagnosis (36). Papilledema was primarily diagnosed clinically via fundoscopy and further corroborated by ocular ultrasound findings including optic disc elevation.

2.4 ETHICAL APPROVAL AND CONSIDERATION

The research carried out following the rules of the Declaration of Helsinki of 1975 (https://www.wma.net/what-we-do/medical-ethics/declaration-ofhelsinki),

revised in 2013 with Ethical approval (MUHAS-REC-06-2024-2329) was obtained from the MUHAS Ethics Review Committee. Written permission to conduct the study was granted by MOI and MNH-Mloganzila. Parents or guardians were informed about the study's purpose, and those who agreed provided written informed consent. For illiterate participants, the consent form was read aloud, and a thumbprint was taken, witnessed by a third party. Confidentiality was ensured using unique study identification numbers. No discomfort to participants or technical challenges were encountered during Optic Nerve Sheath Diameter measurements All pediatric TBI patients received standard care regardless of study participation.

2.5 DATA ANALYSIS

Data were collected by recording demographic information, performing ocular sonography to measure optic nerve sheath diameter (ONSD), and identifying pediatric patients with traumatic brain injury (TBI) and suspected raised intracranial pressure (ICP). Descriptive analysis was used to summarize sonographic patterns. Associations between clinical predictors and raised ICP were assessed using Chi-square tests and logistic regression. Finally, the relationship between ocular sonographic patterns and clinical predictors was analyzed using cross-tabulation, regression, and correlation methods.

3. RESULTS

3.1 Socio-demographic characteristics

There were 113 paediatric patients with head injury who were recruited during the study period. Most of the patients were males (69.9%) with a male-to-female ratio of 2.3:1. The mean and median age of participants were 8.09 and 7.00 years respectively however the most common age group among these were school based children group, 41 (36.3%) and the least common were preschoolers 20 (17.7%). Participants were interviewed and underwent ocular ultrasounds relatively soon after the accident, with a median time of 1.54 days and a mode of 1 day. The mean time to assessment was slightly longer, at 2.94 days. The socio-demographic characteristics are depicted in Table 1.

Table 1. Socio-demographic characteristics of pediatric patients with head injury from June 2024 to March 2025

Variable	Frequency (N, %)
Age group	
Infants and toddlers (0-2 years)	22 (19.5)
Preschoolers (3-5 years)	20 (17.7)
School-based children (6-12 years)	41 (36.3)
Adolescents (13-17 years)	30 (26.5)
Total (N)	**113 (100)**
Mean age	8.09
Median age	7
Standard deviation	5.76
Sex	
Male	79 (69.9)
Female	34 (30.1)
Male: Female	2.3:1
Total (N)	**113 (100)**
Duration (Days)	
Median	1.54
Mean	2.94
Mode	1
Standard deviation	5.95

Note: A total of 113 pediatric head injury patients were recruited. Most were male (69.9%), with a male-to-female ratio of 2.3:1. The mean age was 8.09 years, median 7.00 years. School-aged children were the most affected group (36.3%), while preschoolers were the least (17.7%). Participants underwent interviews and ocular ultrasounds soon after injury, with a median time of 1.54 days, mode 1 day, and mean 2.94 days.

3.2 Ocular sonographic patterns observed in pediatric patients with head injury

In the sonographic patterns analysis of 113 pediatric patients with head injury, optic disc elevation was observed in 7 cases, accounting for 6.2% of the recruited participants. The average Optic Nerve Sheath Diameter (ONSD) appeared elevated in all age groups. Ocular sonographic patterns observed in pediatric patients with head injury are depicted in Table 2.

Table 1. Ocular sonographic patterns observed in pediatric patients with head injury (June 2024 to March 2025)

Variable		**Frequency (%)**		
Sonographic pattern				
Optic Disc Elevation	No	106 (93.8)		
	Yes	7 (6.2)		
	Total	**113 (100.0)**		
Retinal Detachment	No	113 (100.0)		
Posterior Vitreous Hemorrhage	No	113 (100.0)		
Lens Detachment	No	113 (100.0)		
Optic Nerve Sheath Diameter	**Mean**	**Minimum**	**Maximum**	**Std. Deviation**
Infants and toddlers (0-2 years)	0.4868	0.33	0.62	0.76
Preschoolers (3-5 years)	0.5325	0.42	0.64	0.61
School-based children (6-12 years)	0.5088	0.37	0.60	0.55
Adolescents (13-17 years)	0.5227	0.35	0.62	0.61

Note. Among the 113 pediatric head injury patients, optic disc elevation was seen in 7 cases (6.2%). Elevated Optic Nerve Sheath Diameter (ONSD) was noted across all age groups.

3.3 Clinical features of raised ICP observed in pediatric patients with head injury

The data reveals that Seizures and vomiting were observed in 68.1% and 61.9% of cases, respectively. In contrast, hydrocephalus and Papilledema were infrequently observed in only 0.9% and 1.8% of the participants respectively, suggesting they were significant clinical features in this dataset of pediatric patients with head injury. This suggests that while seizures and vomiting may be important clinical feature to consider, hydrocephalus and papilledema may not be strong clinical feature of raised ICP in this particular sample of pediatric patients with head injury. Clinical features of raised ICP observed in pediatric patients with head injury are depicted in Table 3.

Table 3. Clinical features of raised ICP observed in pediatric patients with head injury (June 2024 to March 2025)

Clinical features		**Frequency (N, %)**
Hydrocephalus	No	112 (99.1)
	Yes	1 (0.9)
	Total	**113 (100.0)**
Seizures	No	36 (31.9)
	Yes	77 (68.1)
	Total	**113 (100.0)**
Papilledema	No	111 (98.2)
	Yes	2 (1.8)
	Total	**113 (100.0)**
Vomiting	No	43 (38.1)
	Yes	70 (61.9)
	Total	**113(100.0)**

Note: Seizures (68.1%) and vomiting (61.9%) were common symptoms, while hydrocephalus (0.9%) and papilledema (1.8%) were rare. This suggests seizures and vomiting may indicate raised ICP, whereas hydrocephalus and papilledema were less significant in this sample.

GCS scores measured at hospital presentation and during interview show a minimum of 3 and a maximum of 14, with mean values indicating a slight improvement from hospital presentation to interview. ONSD ranges from 0.33 to 0.64 with a mean of 0.5124 and a standard deviation of 0.06322, indicating variability in the measurements. The majority of participants (n = 84; 74.3%) exhibited a Glasgow Coma Scale (GCS) score between 9 and 12, indicative of moderate head injury. A further 27 participants (23.9%) were classified as having severe head injury, while only 2 participants (1.8%) presented with a mild head injury. Glasgow Coma Scale (GCS) scores and head injury severity obtained from pediatric patients with head injury are depicted in Table 4.

Table 4. Glasgow Coma Scale (GCS) scores and ONSD observed in pediatric patients with TBI (June 2024 to March 2025)

Variable	Mean	Minimum	Maximum	Range	Std. Deviation
GCS score	8.66	3	13	10	2.63
At Hospital Presentation	11.41	3	14	11	2.73
During Interview	11.85	3	14	11	2.64
GCS score range			**Frequency (N, %)**		
Mild head injury (13-14)			02 (1.8)		
Moderate head injury (9 – 12)			84 (74.3)		

Severe head injury (3 – 8)	27 (23.9)
TOTAL	113 (100)

Note: GCS scores ranged from 3 to 14, with a slight improvement from hospital presentation to interview. Most participants (74.3%) had moderate head injury (GCS 9–12), 23.9% had severe, and 1.8% had mild injury. ONSD ranged from 0.33 to 0.64 cm (mean 0.5124, SD 0.06322), showing measurement variability.

Chi-square test, univariate and multivariate logistic regression analyses were carried out to explore the relationship between clinical features of raised intracranial pressure and the ocular sonographic patterns in pediatric patients with head injury and suspected raised ICP, the following were identified:

In a sample of 113 Pediatric patients with head injury whose data were analysed using Chi-square test and univariate logistic regression, the presence of seizures, vomiting and GCS score were found to be statistically significant clinical features in pediatric patients with head injury and suspected of having raised ICP with p values < 0.05. Patients experiencing seizures were found to have crude OR 2.39 (95% Confidence Interval: 1.04–5.47), while those with vomiting had (crude OR 2.51, 95% Confidence Interval: 1.12–5.66) and GCS score had crude OR 2.57 (95% Confidence Interval: 0.91–7.23) indicating that lower GCS scores are associated with increased odds of having raised ICP.

On multivariate analysis, GCS score continued to demonstrate strong statistical association with raised intracranial pressure having a p =0.035, OR 0.802 (95% Confidence Interval: 0.654 – 0.984) suggesting that, lower GCS scores were associated with increased odds of suspected raised ICP however seizure and vomiting demonstrated no statistical association. An odds ratio less than 1 for GCS indicates that for each unit increase in GCS score (indicating better neurological status), the odds of having raised ICP decrease — meaning lower GCS scores are linked to a higher likelihood of raised ICP. The relationship between Optic Disc Elevation, Hydrocephalus and papilledema with raised Intracranial Pressure (ICP) in 113 pediatric patients recruited whose association were analysed using the Pearson Chi Square test and univariate logistic regression

demonstrated no strong statistical association between Optic Disc Elevation, hydrocephalus and papilledema. (Optic Disc Elevation p = 0.052, Hydrocephalus p = 0.475, papilledema p = 0.251). The association of clinical features and sonographic patterns of pediatric participants with head injury and suspected raised intracranial pressures are depicted in Table 5.

Table 5. Association of clinical features and sonographic patterns of pediatric participants with head injury and suspected raised intracranial (June 2024 to March 2025)

Clinical and sonographic features		Raised ICP		Crude odds ratio		Adjusted Crude odds ratio	
		Yes (n, %)	No (n, %)	COR 95%CI	P - value	AOR (95% CI)	P - Value
Seizures	No	19 (52.8)	17 (47.2)	2.39	0.039	0.499	0.149
	Yes	56 (72.7)	21 (27.3)	(1.04–5.47)		(0.18–1.37)	
Vomiting	No	23 (53.5)	20 (46.5)	2.51	0.025	0.499	0.231
	Yes	52 (74.3)	18 (25.7)	(1.12 - 5.66)		(0.18–1.37)	
GCS score	Severe	22 (81.5)	5 (18.5)	2.57	0.029	0.802	*0.035
				(0.91 - 7.23)		(0.654 – 0.984)	
	Moderate	53 (63.1)	31 (36.9)				
	Mild	0 (0.0)	2 (100.0)				
Hydrocephalus	No	74 (66.1)	38 (33.9)	2.08	0.475		
	Yes	1 (100.0)	0 (0.0)	(0.08 - 52.7)			
Papilledema	No	73 (65.8)	38 (34.2)	2.62	0.251		
	Yes	2 (100.0)	0 (0.0)	(0.47 – 14.5)			

Optic disc elevation	No	68 (64.2)	38 (35.8)	8.43 (1.6 – 44.3)	0.052
	Yes	7 (100.0)	0 (0.0)		

*Statistically significant p value at <0.05 significant level

Note. **Inferential statistical methods** were applied to assess associations between clinical features and ocular sonographic findings in 113 pediatric head injury patients, univariate logistic regression revealed seizures (crude OR 2.39, 95% CI: 1.04–5.47), vomiting (crude OR 2.51, 95% CI: 1.12–5.66), and GCS scores (crude OR 2.57, 95% CI: 0.91–7.23) were significantly associated with suspected raised ICP (all $p < 0.05$). Multivariate analysis, however, showed only GCS score independently associated with suspected raised ICP ($p = 0.035$; adjusted OR 0.802, 95% CI: 0.654–0.984), indicating lower GCS scores correlate with increased odds. An odds ratio below 1 here means that as GCS decreases, the odds of raised ICP increase — underscoring that a lower GCS indicates greater injury severity and higher ICP risk. Seizures and vomiting lost significance after adjustment (adjusted ORs 0.499, $p = 0.149$ and $p = 0.231$, respectively). No significant associations were found between optic disc elevation ($p = 0.052$), hydrocephalus ($p = 0.475$), or papilledema ($p = 0.251$) and suspected raised ICP. Despite a strong crude OR of 8.43 (95% CI: 1.6–44.3) for optic disc elevation, its p-value of 0.052 prevented confirmation of a strong statistical association.

4. DISCUSION

4.1 Comparison With Other Studies

In our study, the average age of participants was 8.09 years (median 7.0 years), with most being school-aged children. This is consistent with findings from similar international studies [11,12]. However, age distributions vary worldwide; for example, a study in Brazil reported teenagers (15–19 years) as the most affected group (38.6%), while research in Korea found the highest TBI rates in children under four [13, 14, 15]. Such differences may reflect regional variations in civil infrastructure, child supervision, and public health policies.

A male predominance was observed in our cohort (male-to-female ratio 2.3:1), aligning with many previous reports [13], although some studies note a less marked sex difference [14]. These variations may relate to differences in population demographics, cultural behaviors, and study design.

Ocular findings in our study differed from some reports. Optic disc elevation was observed in 6.2% of participants, lower than the 39% reported elsewhere [12]. This likely reflects differences in patient selection, timing of examination, and operator expertise, as our scans were performed by radiographers and residents. We found no retinal detachment, vitreous hemorrhage, or lens detachment, in contrast to studies focused on patients with clear ocular trauma, which naturally show higher frequencies [12].

We observed a trend of increasing optic nerve sheath diameter (ONSD) with age, supporting prior findings [17]. However, the higher mean ONSD among preschoolers contrasts with previous linear trends, possibly due to differences in age grouping or patient population.

4.2 Main Findings And Clinical Implications

A key finding is that a lower Glasgow Coma Scale (GCS) score was the only independent predictor of raised intracranial pressure (ICP), reinforcing its value in assessing pediatric head trauma, especially where advanced monitoring is not feasible (18). Although seizures and vomiting were frequent and showed significance in univariate analysis, they did not remain independent predictors after adjustment, suggesting they reflect overall injury severity rather than directly indicating ICP elevation.

Papilledema and hydrocephalus were rare in our cohort, consistent with other hospitalized pediatric TBI studies [19, 20]. Their low prevalence, coupled with the short time from injury to assessment, suggests these signs may be unreliable indicators of early ICP elevation in children. This highlights the value of timely ocular ultrasound as a supportive, non-invasive tool for early ICP assessment; however, it should complement not replace thorough clinical evaluation. Accurate measurement also depends on adequate operator training and experience.

4.3 Study Limitation

Our study, while conducted under a single institutional review board approval and managed by a central research team, involved data collection at two tertiary hospital sites. Therefore, the findings may still not be fully generalizable to the wider paediatric head injury population beyond these specialized settings.

Sample size for our study was small hence lacking a strong evidence base

4.4 Recommendations

i. There is a need for a study to determine normative Optic Nerve Sheath Diameter (ONSD) measurements in healthy African pediatric populations using sonography. This study would provide essential baseline data for clinical comparison.
ii. A larger sample size is advised in future research to strengthen the evidence base and enhance the precision and power to detect subtle but significant effects.
iii. Multi-center studies would enhance the generalizability of the findings.
iv. Further research could also explore the association between TBI severity (using classifications like the Marshall CT classification) and the observed ocular sonographic patterns and ICP predictors.
v. Only the right eye was used for ONSD measurement to reduce examination time. Although right and left eye measurements are usually similar, bilateral assessment is recommended for greater accuracy.

5. CONCLUSION

This study highlights the Glasgow Coma Scale (GCS) score as a significant predictor of raised intracranial pressure (ICP) in pediatric patients with head injury. Common clinical features such as seizures and vomiting were not found to be reliable independent predictors. The low occurrence of hydrocephalus and papilledema, along with their lack of association with elevated ICP, suggests that the absence of these signs does not exclude the presence of raised ICP in the acute phase. These findings support the value of optic nerve sheath diameter (ONSD) measurement as a practical, non-invasive, and rapid screening tool for early ICP assessment in resource-limited settings.

6. CONFLICT OF INTEREST

The authors state that they have no conflicts of interest related to the publication of this article.

7. FUNDING

The authors received a grant of approximately 1,500,000 TSH (equivalent to 588 USD) from the Ministry of Health as part of a sponsorship.

8. ACKNOWLEDGMENT

I offer my deepest gratitude to Almighty God, the source of all blessings. I sincerely thank my supervisors, Dr. Lulu L. Sakafu and Dr. Mwajabu A. Saleh, for their invaluable guidance. I am grateful to the faculty and staff of the Departments of Radiology and Imaging at Muhimbili Orthopaedic Institute, Muhimbili National Hospital - Mloganzila, and Muhimbili University of Health and Allied Sciences for their support. Thanks to my MUHAS classmates for their camaraderie. Special appreciation goes to my mother for her prayers and dedication, and to my beloved wives for their love and grace.

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