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COMPARISON OF COMPUTED TOMOGRAPHY AND POINT-OF-CARE ULTRASOUND'S ACCURACY IN IDENTIFYING SKULL FRACTURES IN PEDIATRIC MILD HEAD INJURIES

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ABSTRACT

Background & Aim: Head trauma, particularly in children, is a significant public health concern, requiring urgent diagnosis. CT scans are preferred for closed head injury diagnosis, but concerns over radiation dose, cost, and sedation may limit accessibility. POCUS, with its portability and lack of radiation, presents a potential alternative for pediatric skull fracture diagnosis. The study evaluates POCUS's diagnostic accuracy compared to CT scans, aiming to improve rapid, cost-effective, and minimally invasive emergency diagnosis.

Methods: A six-month cross-sectional study was conducted at Ziauddin Hospital's Department of Emergency, North Campus, Karachi, involving 78 children aged ≤14 with head trauma, Glasgow Coma Scale scores of 13-15, suspected CHI with possible skull fractures, and needed CT scans. Consecutive sampling was used, excluding patients requiring airway management, hemodynamic instability, neurological deterioration, open deformities, or uncooperative for POCUS. Physical scalp assessment was conducted, and POCUS performed when CT scans were indicated. Descriptive statistics, diagnostic values, and post-stratification analysis were performed.

Results: Of the total 78, nearly two-third was male. The mean age of the study sample was 5.97(SD±4.59) years. The age group less than 6 years had more the 50% of the study sample. Scalp hematoma was observed in 33(42.31%) and based on the clinical findings the most affected area of the skull was the frontal and left and right parietal areas. Among the mechanism of injury, fall had the highest frequency. POCUS had a sensitivity and specificity of 70.27% (53.02-84.13%) and 95.12 %(

83.47-99.40), respectively. Positive and negative predictive values were 92.86% and 78.00%, with an accuracy of 83.33% in comparison with CT scan in the diagnosis of skull fracture.
Conclusion: The findings demonstrated that POCUS, carried out by the resident emergency medicine, has a high degree of diagnostic accuracy and may be used as a tool in the treatment of patients with CHI.

Keywords: Closed Head Injury; Traumatic brain injuries; Skull fracture; Ultrasonography; POCUS; Emergency department

INTRODUCTION

Head trauma, especially in children, is a major public health concern, often leading to death or disability, and necessitating urgent and precise diagnosis upon presentation to emergency departments (1, 2). An estimated 8-10% of children between the ages of 3 and 17 years have had a major head trauma in their life and skull fractures are associated with nearly 30% of cases. Early diagnosis and treatment are critical for reducing morbidity and death (3, 4).

Traumatic brain injury (TBI) often follows head trauma, leading to a various complications, including skin and soft tissue damage, bone fractures, and brain tissue injuries (5). TBI affects both children and adults, with differing pathophysiology and management (6, 7). Severe head injuries are typically easier to diagnose and treat, but even those with low TBI risk may have significant injuries (8). The dura mater is vulnerable to injury when the skull bone is fractured. Due to its implications, dural lacerations are frequent and are associated with diastatic skull fractures and should be investigated (9).

Skull fracture and TBI are frequently diagnosed using the X-ray-based modality called Computed tomography (CT) scan (10). CT scan is a preferred choice for diagnosing CHI, but high radiation dose, cost, and sedation are concerns and may not always be available in some settings (11). Children are more susceptible to ionizing radiation, making them more susceptible to cancer (12, 13). Physicians aim to minimize the use of X-rays and CT scans due to associated risks, relying on clinical guidelines and alternative modalities like MRI and ultrasonography, with ultrasonography preferred over MRI for its availability and ease of use in emergency settings, particularly in assessing the condition of the dura.(7).

Point-of-care ultrasonography (POCUS) has drawn interest as a result because of how quickly; reproducible and non-invasive it is in helping practitioners. POCUS provides a radiation-free bedside diagnostic tool, effectively detecting intracranial injuries when operated by skilled practitioners, with immediate availability of results(14). Studies suggest its effectiveness in detecting various intracranial injuries, including hemorrhage, and propose its use as a complement to clinical assessment in children with CHI (14-16). It can be used as a triage instrument when CT is not available in disaster zones and for identifying longitudinal bone fractures in children and young adults with open growth plates (17). The tool focuses on diagnosing skull fractures but does not assess brain injuries, which are critical for high-risk patients, who should still undergo CT scans for accurate diagnosis. Despite efforts to minimize CT scans in mild head injuries, children with skull fractures have a significantly higher risk of intracranial injury. Professionals have shown ultrasound's accuracy in detecting fractures, suggesting POCUS as a potential tool for identifying infant skull fractures (18). In blunt head traumas, POCUS exhibits high sensitivity and specificity for detection, suggesting potential as an adjunct to refine clinical decision guidelines for CT scan usage in pediatric head trauma, though further studies are warranted to clarify its role.

Several studies have evaluated the accuracy of POCUS in pediatric CHI skull fracture diagnosis compared to the reference standard CT scan. In summary, POCUS shows promise in identifying skull fractures in this population, with its accuracy dependent on fracture characteristics and operator experience. According to Rabiner et al.,(16) the advantages of POCUS include early patient diagnosis and consultation, decreased reliance on CT scans, its utility as a diagnostic tool when CT scans are unavailable, and its effectiveness as a triage instrument in challenging situations such as disaster

zones. Moreover, POCUS, which can be used as a rapid substitute to find wrist fractures, was found by Weinberg et al. (20) to be more accurate in diagnosing longitudinal bone fractures, particularly in young population with open growth plates. POCUS may identify skull fractures but cannot rule out brain lesions, which pose greater risk; hence, high-risk patients should undergo CT scans (14,16,19). POCUS is gaining popularity among general practitioners and family physicians, with increasing incorporation into residency training programs, yet research in this domain remains limited compared to more established specialties like emergency medicine. However, it is presumed that findings pertinent to emergency medicine also hold relevance for general practitioners, given their shared context of working with unselected populations as generalists (16).
The studies assessing ultrasonography's accuracy in identifying skull fractures show promising results with high sensitivity and specificity compared to clinical diagnosis, despite minor methodological limitations such as small sample sizes, indicating the need for further research to gather sufficient evidence for widespread application (19).
The study compares POCUS and CT scan for diagnosing skull fractures in children with closed head injuries, aiming to enhance TBI diagnosis in emergency settings. With no prior studies from this region, its findings could expedite and streamline diagnosis, emphasizing POCUS's role in cost-effective, immediate evaluation without radiation exposure, and underscoring its usefulness alongside clinical assessment.

METHODS

This cross-sectional study was carried out over a period of 6 months at Department of Emergency (ED), Ziauddin Hospital, North Campus, Karachi. The Arkin and Wachtel (21) method was used to determine sample size, with a 10% precision level. The expected sensitivity and specificity of POCUS in children with closed head injury (CHI) were set at 81.8% and 100%, respectively as reported by Dehbozorg, A et al., (22) while comparing POCUS vs. CT scan in CHI, with a local (23) estimated prevalence of 0.81 based on a study validating PECARN in pediatric trauma patients in comparison to CT, and desired level of significance of 5% at 95% confidence interval. Moreover, an expected dropout rate of 10% was also considered. A total of 78 children were included in the final largest sample size.
Consecutive sampling technique was used and those with age ≤14 presenting to the ED with head trauma, either genders, Glasgow Coma Scale of 13–15, suspected CHI with possible skull fractures on clinical assessment, and those who have a site of injury that may be identified by a hematoma, abrasion, or other particular signs (focal discomfort) needing a CT scan in accordance with current algorithms to rule out TBI were included. Those who required airway management, chose to withdraw from the study, had hemodynamic instability, neurological deterioration, open deformities, clinically obvious simple depressed fractures, or were uncooperative for POCUS were among the exclusion criteria.

Data collection procedure

Eligible patients who needed a CT scan for head trauma at the emergency room were part of the data collection process. A physical assessment of the scalp was done after informed consent was acquired. When a CT scan was required, POCUS was used, and the investigator used this information to determine whether any skull fractures were present. The quality of clinical care was maintained, and attempts were made to perform POCUS prior to the availability of CT scan results. There was an attempt at non-pharmacological sedation including desensitization or distraction otherwise pharmacological sedation such as midazolam (0.1mg/kg) was used, and a portable device (Mindray Z5, made in China) with a linear probe (frequencies ranging 7–10 MHz) was used for POCUS which has been defined as one of the subjects of Emergency Medicine (EM) syllabus and is taught to EM residents in Pakistan, during their training.
The method includes applying an ultrasound gel or a water-separating pad to the impact site, which is frequently marked by a hematoma or other indicators that indicate the site of injury, the transducer

was implanted there. Images were scanned at two horizontal levels along the length of the impact site using a high-frequency linear transducer. Based on the physical differences in the anatomy of the skulls of children and adults, the two-sided symmetric discontinuity typically reveals the position of skull sutures.
A skull bone fracture is reported when the bone under the impact location stops growing and is not symmetrical compared to the other side of the skull (22). Since CT scan is a preferred choice for diagnosing skull fracture, radiology residents (first/ second year), supervised by consultant radiologist reported all the CT scan images. The radiologists were blinded to the results of the ultrasound. All patients enrolled in this study were screened for background data (including age, sex, and injury mechanism, scalp hematoma) and was documented using a structured format.

Data analysis
Data analysis was performed using SPSS V 22. Distribution of the data was assessed using Shapiro-Wilk test. Descriptive statistics such as mean and standard deviation were computed for normally distributed numerical variables, while median along with interquartile range were calculated for skewed data. Frequency and percentages were used to represent qualitative variables. Diagnostic values such as sensitivity, specificity, predictive value (PPV and NPV), positive likelihood ratio (PLR), negative likelihood ratio (NLR) and the accuracy of POCUS in diagnosis of skull fracture in children with CHI in comparison with CT scan were calculated using 2×2 contingency table.

Receiver operating curve was plotted in order to determine area under curve of POCUS in diagnosis of skull fracture in comparison with CT scan. Kappa statistics were used to evaluate the agreement level between residents' POCUS report and consultant's radiologists' results. Post-stratification sensitivity, specificity, PPV, NPV and diagnostic accuracy of POCUS was calculated for each stratum such as age groups, gender and scalp hematoma and mechanism of injury by using 2x2 contingency table, taking CT findings as gold standard. P-value < 0.05 was taken statistically significant with a 95% confidence interval.

RESULTS
Of the total 78 patients, nearly two-third was male. The mean age of the total study sample was 5.97(SD±4.59) years. The minimum age was 2.04 months and the maximum age was 15 years (range=14.83), while the median age was 5.00(IQR=8.00). The age group less than 6 years had more the 50% of the study sample. Scalp hematoma was observed in 33(42.31%) and based on the clinical findings the most affected area of the skull was the frontal and left and right parietal areas. Among the mechanism of injury, fall had the highest frequency. Ultrasonography detected 28(35.90%) fractures, whereas CT scan was able to identify 37(47.44%). The association between background characteristics and the presence or absence of skull bone fractures in CT scans was examined. The analysis revealed no significant associations except for the presence of scalp hematoma ($p<0.001$) and the mechanism of injury ($p=0.013$). The details are given in **Table 1**.

Cohen's kappa (κ) was calculated to determine the agreement between the POCUS results conducted by residents and the CT analyses provided by radiologists or residents. A significant agreement was observed between the interpretations, $\kappa = 0.66$ (95% CI: 0.50-0.83, $p< 0.001$) as shown in **Table 2**.
POCUS had a sensitivity and specificity of 70.27% (95%CI, 53.02–84.13%) and 95.12% (95%CI, 83.47–99.40%), respectively compared to CT scan, the positive and negative predictive values were 92.86% and 78.00%, correspondingly, with a diagnosis accuracy of 83.33%. ROC curve of POCUS in diagnosing skull fracture in study sample, with the AUC obtained at 0.66 (95%CI, 0.50–0.83, $P < 0.001$) as shown in **Figure 1**.

Table 1: Patients background and clinical characteristics

Characteristics		Skull fracture on CT scan No	Skull fracture on CT scan Yes	Total sample	P-value
Age (years), median[IQR]		5.00[13.83]	5.00[14.83]	5[8.00]	0.594
Age groups, N (%)	<6 years	23(56.10)	19(51.35)	42(53.85)	0.675
	>6 years	18(43.90)	18(48.65)	36(46.15)	
Gender, N (%)	Male	28(68.29)	23(62.16)	51(65.38)	0.570
	Female	13(31.71)	14(37.84)	27(34.62)	
Scalp hematoma presence, N (%)	Yes	2(4.88)	31(83.78)	33(42.31)	0.000
	No	39(95.12)	6(16.22)	45(57.69)	
Scalp hematoma location, N (%)	Frontal	1(50.00)	14(45.16)	15(45.45)	0.768
	Occipital	0(0.00)	4(12.90)	4(12.12)	
	Left parietal	0(0.00)	5(16.13)	5(15.15)	
	Right parietal	1(50.00)	4(12.90)	5(15.15)	
	Right temporal	0(0.00)	2(6.45)	2(6.06)	
	Left temporal	0(0.00)	2(6.45)	2(6.06)	
Mechanism of injury, N (%)	Bicycle crash	1(2.44)	10(27.03)	11(14.10)	0.013
	Fall	26(63.41)	17(45.95)	43(55.13)	
	Motor vehicle crash	4(9.76)	5(13.51)	9(11.54)	
	Unknown	10(24.39)	5(13.51)	15(19.23)	
Ultrasound report, N (%)	Normal	39(95.12)	11(29.73)	50(64.10)	0.000
	Fractured	2(4.88)	26(70.27)	28(35.90)	

IQR= interquartile range; CT=computed tomography

Table 2: The findings of POCUS in diagnosis of skull fracture in study sample with head trauma

		CT scan report		Total
		Normal N (%)	Injured N (%)	
POCUS	Normal	39(95.12)	11(29.73)	50(64.10)
	Fracture	2(4.88)	26(70.27)	28(35.90)
Total		41	37	
P-value	<0.001			
Level of agreement	0.66(95%,CI: 0.50-0.83)			

Table 3: Diagnostic values of POCUS in diagnosis of skull fracture in children with head injury in comparison with reference standard CT scan

Diagnostic values	Estimated value	95% CI Lower Limit	95% CI Upper Limit
Sensitivity	70.27	53.02	84.13
Specificity	95.12	83.47	99.40
Positive predictive value (PPV)	92.86	76.80	98.08
Negative predictive value (NPV)	78.00	68.25	85.39
Positive likelihood ratio (PLR)	14.41	3.67	57.57
Negative likelihood ratio (NLR)	0.31	0.19	0.52
Accuracy	83.33	73.19	90.82
Diagnostic Odds	46.09	9.43	225.2
Area under curve (AUC)	0.662	0.50	0.83
P-value	< 0.0001*		

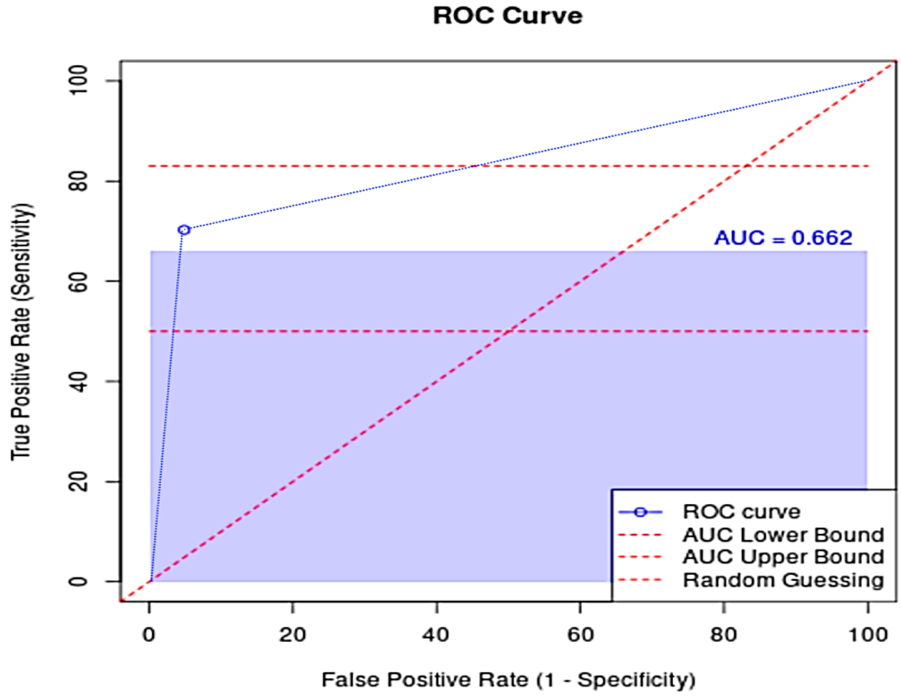

Figure 1: ROC curve of POCUS in diagnosis of skull fracture in children with CHI in comparison with CT scan.

[Area under the curve is 0.66 (95%CI, 0.50–0.83, P < 0.001)]

Those who aged less than 6 years, POCUS showed high sensitivity (89.47%) and specificity (91.30%), with a PPV of 89.47% and NPV of 91.30%. The diagnostic accuracy was 90.48%, signifying strong performance (p < 0.001). On the other hand, those with age group of 6 years or older, the sensitivity dropped to 50.0%, but specificity remained at 100.0%. PPV was 100.0%, NPV was 66.67%, and diagnostic accuracy was 75.00% (p = 0.001). Similarly, when stratified by gender, males demonstrated a sensitivity of 69.57% and specificity of 100.0%, with PPV and NPV at 100.0% and 80.0% respectively. The diagnostic accuracy was 86.27% (p < 0.001). Females displayed a sensitivity of 71.43%, specificity of 84.62%, PPV of 83.33%, NPV of 73.33%, and diagnostic accuracy of 77.78% (p = 0.006). Notably, the presence of scalp hematoma yielded a sensitivity of 80.65%, specificity of 50.00%, PPV of 96.15%, NPV of 14.29%, and diagnostic accuracy of 78.79% (p = 0.384). On the other hand, the absence of scalp hematoma resulted in a sensitivity of 16.67%, specificity of 97.44%, PPV of 50.00%, NPV of 88.37%, and diagnostic accuracy of 86.67% (p = 0.252). Among the mechanisms of injury, falls demonstrated a sensitivity of 85.71%, specificity of 82.76%, PPV of 70.59%, NPV of 92.31%, and diagnostic accuracy of 83.72% (p < 0.001). Similarly, when the mechanism of injury was unknown, sensitivity was 80.00%, specificity was 100.0%, PPV was 100.00%, NPV was 90.91%, and diagnostic accuracy was 93.33% (p = 0.004) the details are given in table 4.

Table 4: Post-stratification chi square analysis and diagnostic values

Characteristics	**Diagnostic values**							
	Sensitivity(95% CI)	**Specificity(95% CI)**	**PPV(95% CI)**	**NPV(95% CI)**	**PLR**	**NLR**	**Accuracy(95% CI)**	**p-value**
Age groups								
Age <6 years	89.47(66.86-98.70)	91.30(71.96-98.93)	89.47(69.14-96.99)	91.30(73.78-97.51)	10.29(2.71-39.03)	0.12(0.03-0.43)	90.48(77.38-97.34)	<0.001
Age ≥6 years	50.00(26.02-73.98)	100.0(81.47-100.00)	100.0(66.37-100.00)	66.67(55.75-76.04)	-	0.50(0.32-0.79)	75.00(57.80-87.88)	0.001

Gender Male Female	69.57(47.08-86.79) 71.43(41.90-91.61)	100.0(87.66-100.00) 84.62(54.55-98.08)	100.0(79.41-100.00) 83.33(57.25-94.91)	80.0(68.32-88.12) 73.33(53.78-86.67)	- 4.64(1.24-17.33)	0.30(0.16-0.56) 0.34(0.14-0.80)	86.27(73.74-94.30) 77.78(57.74-91.38)	<0.001 0.006
Scalp hematoma presence Yes No	80.65(62.53-92.55) 16.67(0.42-64.12)	50.00(1.26-98.74) 97.44(86.52-99.94)	96.15(86.08-99.02) 50.00(6.69-93.31)	14.29(3.38-44.26) 88.37(84.11-91.60)	1.61(0.40-6.52) 6.50(0.47-90.65)	0.39(0.08-1.84) 0.86(0.60-1.23)	78.79(61.09-91.02) 86.67(73.21-94.95)	0.384 0.252
Scalp hematoma location Frontal Parietal	92.86(66.13-99.82) 100.0(63.06-100.00)	0.00(0.00-97.50) 50.0(1.26-98.74)	92.86(91.83-93.76) 88.89(67.67-96.97)	- 100.0(2.50-100.00)	0.93(0.80-1.07) 0.50(2.00-8.00)	- -	86.67(59.54-98.34) 90.55(55.50-99.75)	1.000 0.200
Mechanism of injury Bicycle crash Fall Motor vehicle crash Unknown	100.0(66.37-100.00) 85.71(57.19-98.22) 20.00(0.51-71.64) 80.00(28.36-99.49)	50.0(1.26-98.74) 82.76(64.23-94.15) 100.0(39.76-100.00) 100.0(69.15-100.00)	90.0(69.24-97.30) 70.59(51.25-84.57) 100.0(2.50-100.00) 100.0(39.76-100.00)	100.0(2.50-100.00) 92.31(76.69-97.77) 50.00(39.22-60.78) 90.91(63.40-98.30	2.0(0.50-8.00) 4.97(2.18-11.35) - -	- 0.17(0.05-0.63) 0.80(0.52-1.24) 0.20(0.03-1.15)	90.91(58.72-99.77) 83.72(69.30-93.19) 55.56(21.20-86.30) 93.33(68.05-99.83)	0.182 <0.001 1.000 0.004

DISCUSSION

Head trauma, especially in youth, is a significant public health issue, and Point-of-Care Ultrasound (POCUS) emerges as a promising non-invasive and portable diagnostic method for identifying skull fractures and intracranial injuries, potentially enhancing patient outcomes and decreasing the need for unnecessary CT scans (2, 10, 22).

The prevalence of skull fracture in this study was found to be 47.44%. In contrast, other studies have reported a range of figures, from 11% in the study conducted by Rabiner et al. (16) to 76.5% in the research conducted by Parri et al. (24). It appears that the stricter inclusion criteria in those studies may have resulted in the inclusion of patients with a higher risk of skull fracture and TBI. For instance, in the study by Parri et al. (24) only hematoma was considered as indicative of fracture. Given the notable correlation between skull fracture and TBI, it is advisable to incorporate POCUS alongside established clinical protocols to minimize reliance on X-ray exposure (25). Additionally, individuals presenting negative findings on POCUS should undergo monitoring in the emergency department within a timeframe of 2-4 hours, while their caregivers should receive instruction on recognizing warning signs prior to discharge (26). Aligned with our findings, Dehbozorgi et al. also observed the frontal section (34.5%) as the most affected region of the skull. In our study, we noted a slightly higher prevalence, with the frontal section (45.45%) being identified as the most severely impacted area.

This study finding showed that POCUS had high sensitivity, specificity, and accuracy. Although a wide range of 95%CI for sensitivity (53.02% - 84.13%) may be a high chance of false negatives (due small sample size in patients with positive skull fracture in CT scan), high positive and negative predictive values in comparison with CT scan show that this tool can detect true-positive and truenegative cases, correctly; hence, POCUS can be considered a diagnostic tool in the screening of skull fractures in children with CHI when the risk of intracranial lesions is low. Also, obtained NLR less than 0.5 in our population [0.31 (95%CI, 0.19 - 0.52)] means that lower probability of skull fracture to be present in suspicious children with a negative POCUS. But, due to low prevalence of skull fracture in our population with wide range of 95%CI, POCUS can be used in combination of other signs or findings in order to rule out more efficiently the existence of skull fracture in the patients with low risk. Our results were in line with Gordon et al.'s study that they found pooled PLR of 14.4 and NLR of 0.14, although our patients with positive skull fracture in CT scan were low. Even though they showed in their study that POCUS significantly increases the probability of skull fracture in children with CHI with pooled sensitivity of 91%and specificity of 96% (14). The specificity of this modality in the current study was 95.12%, while in the study by Parri et al. (24), which had the highest number of sample size compared to this study, it was reported to be 85.2%. This significant difference might be due to the number of patients diagnosed with skull fracture in the mentioned study, and the number might be closer to reality.

Rabiner et al. (16) reported that POCUS had a sensitivity of 88% and a specificity of 97%, while our results showed a sensitivity of 70.27% (95%CI, 53.02-84.13) and a specificity of 95.12% (95%CI, 83.47- 99.40). Weinberg et al. (20) obtained a sensitivity of 100% (95%CI, 20–100) and a specificity of 100% (95%CI, 79–100), but their sample size was only 10 patients. Choi et al. found that in 87 children 0–4 years, POCUS had the sensitivity and specificity of 76.9% and 100% (20). Masaeli et al. reported a sensitivity and specificity of 92.3%and 95.9%, for POCUS in diagnosing skull fractures (19). Dehbozorgi et al. reported the sensitivity and specificity of 81.8% (95%CI, 48.2–97.7%) and 100% (95%CI, 97.7–100%), respectively (21). Alexandridis et al. compared CT scans with POCUS and found that POCUS demonstrated a pooled sensitivity of 91% and a pooled specificity of 96% (7). In Dehbozorgi et al study, they found that compared to CT scans, the positive and negative predictive values were 100% and 98.7%, respectively, with an overall diagnostic accuracy of 98.8%. This highlighted the high diagnostic accuracy of POCUS, suggesting its potential for managing patients with CHI. In our study, we obtained positive and negative predictive values of 92.86% and 78.00%, respectively, with an overall diagnostic accuracy of 83.33% (21). Overall, while there are similarities in findings across studies, there are also variations due to differences in sample sizes, populations studied, methodologies, and diagnostic criteria, highlighting the importance of considering multiple studies when evaluating the diagnostic accuracy of POCUS for skull fractures in children with CHI.

In Choi et al.'s study (15), 3 false negatives were observed, whereas in the current study, 2 false negatives were detected. The fracture in these two individuals went unnoticed, as it was not detected in POCUS. Nevertheless, study has indicated that POCUS is an efficient method for diagnosing and assessing brain injuries (10). Therefore, the lack of diagnosis could be attributed to the operator's proficiency and precision in diagnosing.

In their study, Rabiner et al. (16) reported that POCUS for detecting skull fractures demonstrated a sensitivity of 88% (95% CI: 53%–98%), specificity of 97% (95% CI: 89%–99%), PLR of 27 (95% CI: 7–107), and NLR of 0.13 (95% CI: 0.02–0.81). The κ coefficient for inter observer agreement was determined to be 0.86 (95% CI: 0.67–1.0). In our study the level of agreement, as measured by the κ coefficient, was 0.662 (95% CI: 0.50–0.83). Masaeli et al. (19) reported that the strength of agreement between head ultrasound and brain CT scan in diagnosing skull fractures and hemorrhages in the age groups under 2 years is 0.73 (0.49 - 0.98).

Caroselli et al. suggest that POCUS is a promising tool for identifying skull fractures in children with closed head injuries, but its accuracy may vary based on the fracture's specific characteristics and operator's experience (27). POCUS demonstrated potential in the diagnosis of brain injuries and skull fractures. The study suggests that achieving relaxation and stillness during POCUS ultrasounds in children is a common challenge. It suggests explaining the procedure to the child and creating a cooperative environment with parental assistance before resorting to sedation. The patient's cooperation and stillness are necessary to achieve reliable results. POCUS should prioritize infection prevention by sanitizing the probe before and after each use using appropriate solutions and using a protective pad with specialized gel to prevent direct contact with the patient's skin. Another limitation lies in its reliance on the operator (28). Moreover, this study has certain limitations. Worth mentioning is that it was conducted at a single center using convenience sampling. Given the low prevalence of skull fractures in our study population, further research involving larger samples and the integration of POCUS with other diagnostic signs could enhance the inclusion of POCUS in diagnostic algorithms for patients with closed head injuries

Conclusion:

The findings indicate that POCUS exhibits a high degree of diagnostic accuracy in identifying skull fractures. Moreover, there is moderate agreement between POCUS interpretations by residents and CT analyses. The findings suggest that POCUS can offer a non-invasive and efficient means of diagnosing skull fractures in patients with head trauma, thereby enhancing clinical management and patient care.

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