

Original Research Article

A STUDY OF CLINICAL PROFILE AND OUTCOME OF PEDIATRIC HEAD TRAUMA PATIENTS

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ABSTRACT

Background: The study was conducted to enhance our understanding of pediatric head trauma and inform clinical practices aimed at improving survival and recovery.

Materials and Methods: The study was conducted in a tertiary care center, a high-level medical facility capable of handling complex cases involving traumatic brain injury in pediatric patients

Results: Among 180 children with head trauma, 169 (93.9%) were discharged home and 11 (6.1%) died, reflecting generally favorable outcomes with current management protocols. Discharge rates underscore that the majority of pediatric head traumas—particularly mild (GCS 13–15) cases—have excellent prognoses when treated promptly and appropriately. Mortality, while low, highlights that a critical minority with severe physiologic and structural injuries remains at high risk

Conclusion: Most cases are mild and managed conservatively, with excellent outcomes. Key predictors of poor prognosis include low GCS, pupillary abnormalities, and high-energy mechanisms. Prevention through home safety, caregiver education, and road-safety enforcement remains essential. Optimized triage, judicious imaging, and timely neurosurgical intervention can further improve survival and recovery.

Keywords: pediatric head trauma, mortality, discharge, prognosis

INTRODUCTION

Head trauma in children is a major global health concern, accounting for a significant proportion of emergency room visits, hospital admissions, and long-term disabilities. The pediatric brain is particularly vulnerable due to its ongoing development, which makes it both susceptible to injury and capable of remarkable recovery if managed appropriately. According to the World Health Organization, traumatic brain injury (TBI) is one of the leading causes of death and disability in children worldwide, with falls, motor vehicle accidents, and sports injuries being common causes. Pediatric head trauma, even in cases where the injury seems mild, can result in lasting neurological, cognitive, and emotional challenges.^[1]

The assessment of pediatric head trauma is complex and multifaceted. It requires careful attention to clinical symptoms, including loss of consciousness,

vomiting, seizures, and abnormal pupil reactions, which may indicate intracranial pressure or brainstem involvement. Initial evaluation often includes a detailed clinical history, physical examination, and neuroimaging to identify the extent of injury. Neurological assessments such as the Glasgow Coma Scale (GCS) are critical in determining the severity of the injury, influencing treatment decisions, and predicting patient outcomes. Despite the initial severity, many pediatric patients recover without significant impairment, while others experience long-term consequences.^[2]

The pathophysiology of pediatric head trauma differs from that of adults due to the anatomical and physiological differences in the brain. The developing brain of a child is more prone to certain types of injury, such as diffuse axonal injury, which can result from acceleration-deceleration forces, and concussion, which may have a more severe impact on younger children. The skull is more pliable, and the

subarachnoid space is larger, which can allow for more space for the brain to shift or swell.^[3]

Another unique aspect of pediatric head trauma is the influence of developmental stages on recovery. Younger children, especially infants, may not be able to verbalize symptoms or express pain in a way that is easily understood. This makes early recognition of more subtle symptoms of TBI essential for preventing complications and improving outcomes. Additionally, the cognitive and motor development of children varies significantly with age, and injuries to the brain may have a different impact depending on the child's stage of development. For instance, children who sustain injuries at an early age may experience more pronounced cognitive deficits or developmental delays as they grow, compared to older children who may recover more quickly.^[4]

Early intervention is one of the most important factors in improving long-term recovery outcomes for pediatric head trauma patients. Interventions may include surgery to evacuate hematomas or reduce pressure within the skull, as well as neuroprotective strategies to minimize secondary brain injury. Early neuroimaging, particularly through CT scans, plays a crucial role in detecting life-threatening complications, such as intracranial hemorrhage, and in guiding treatment decisions.^[5,6]

The Glasgow Coma Scale (GCS) has long been used as an indicator of the severity of brain injury and as a predictor of outcomes. This scale helps clinicians to quickly assess the level of consciousness, guide treatment strategies, and estimate the chances of recovery.^[7]

Pediatric head trauma patients often require multidisciplinary care that extends beyond the acute phase of treatment. Rehabilitation efforts play a key role in optimizing long-term outcomes, particularly for children who have sustained moderate to severe injuries. Rehabilitation may include physical therapy, occupational therapy, speech therapy, and neuropsychological counseling, which are designed to address the various aspects of recovery, including cognitive deficits, motor impairments, and emotional well-being. Early rehabilitation has been shown to improve motor function, cognitive recovery, and quality of life in children, and it is often seen as an integral part of the treatment plan for pediatric head trauma patients.^[8]

The relationship between GCS scores at admission and long-term outcomes remains an area of active research. As noted, GCS is a critical factor in determining the immediate severity of a pediatric head injury and predicting recovery. However, it is important to note that while GCS is a strong predictor of outcome, other factors such as age, pre-existing medical conditions, and the presence of secondary injuries also influence prognosis. Therefore, GCS should not be used in isolation, but rather as part of a comprehensive clinical picture that includes neuroimaging results and other clinical signs.^[9,10]

This study aims to assess the clinical characteristics and outcomes of pediatric head trauma patients,

focusing on the impact of early intervention, neuroimaging, and rehabilitation in improving long-term recovery. By examining factors such as GCS scores, neuroimaging findings, and clinical signs like pupillary responses and hypothermia, the study will provide valuable insights into the predictors of survival and recovery in children with head trauma. Furthermore, the effectiveness of multidisciplinary rehabilitation protocols will be evaluated to determine how well they contribute to the functional outcomes of pediatric patients. Ultimately, the study seeks to enhance our understanding of pediatric head trauma and inform clinical practices aimed at improving survival and recovery.

MATERIALS AND METHODS

The study was designed as a **prospective observational study** aimed at examining the clinical characteristics and outcomes of pediatric head trauma patients. The prospective design enabled continuous monitoring and follow-up of patients from the point of admission through to their recovery stages, tracking both short-term and long-term effects. The study was conducted in a **tertiary care center**, a high-level medical facility capable of handling complex cases involving traumatic brain injury in pediatric patients. The center provided advanced diagnostic technologies, including CT scans and MRIs, to assess the severity of head trauma. Additionally, the center's multidisciplinary approach facilitated comprehensive patient management, involving pediatric neurosurgeons, neurologists, rehabilitation specialists, and psychologists. The **study duration** was set to **two years**, allowing for both the acute and long-term follow-up of pediatric patients with head trauma. This timeline provided enough time to assess the initial recovery phase, including early interventions, surgical procedures, and the impact of rehabilitation.

Inclusion Criteria

- Patients presenting to the surgery outpatient department (OPD) and casualty with traumatic brain injury.
- Pediatric patients aged between **1 to 12 years**.

Exclusion Criteria

- Patients who were lost to follow-up during the study period.
- Patients who did not provide informed consent for participation.
- Children below the age of **1 year** and those above **12 years** were excluded due to differing pathophysiology and treatment approaches in these age groups.

The study utilized a **convenience sampling** technique, enrolling all pediatric patients who met the inclusion criteria and were admitted to the study center with traumatic head injuries. Sampling continued throughout the study duration until the required number of participants was reached. There

was no randomization or specific sampling based on other demographic factors.

The **sample size** was calculated based on the expected number of pediatric head trauma cases treated annually at the tertiary care center. Given the volume of patients in the center, it was estimated that approximately **160 to 180 patients** would meet the inclusion criteria over the two-year study period. This sample size was deemed sufficient to allow for robust statistical analysis, enabling the identification of trends and predictors of recovery outcomes. The sample size also accounted for potential dropouts and loss to follow-up, ensuring that the data collected remained representative.

Since this was a prospective observational study, no formal intervention groups were established. However, the participants were categorized into subgroups based on specific clinical characteristics that could influence outcomes. These subgroups included:

- **Mild head trauma** (e.g., Glasgow Coma Scale scores of 13-15).
- **Moderate head trauma** (e.g., Glasgow Coma Scale scores of 9-12).
- **Severe head trauma** (e.g., Glasgow Coma Scale scores of 3-8). These categories helped to stratify the patients based on their injury severity, allowing for comparisons of recovery trajectories and outcomes between different injury levels.

The study parameters focused on both clinical and radiological factors that could influence outcomes in pediatric head trauma. Key parameters included:

- **Glasgow Coma Scale (GCS) scores** at admission and discharge.
- **Neuroimaging findings**, including CT and MRI scans.
- **Age** of the patient at the time of injury.
- **Presence of comorbidities** or pre-existing neurological conditions.
- **Clinical symptoms** such as loss of consciousness, seizures, and motor deficits.
- **Rehabilitation interventions** and their duration.
- **Long-term outcomes**, including cognitive, motor, and psychological recovery.

The study began with the enrollment of pediatric patients presenting with traumatic head injury at the tertiary care center. A thorough **clinical history** was obtained from the parents or caregivers, and a detailed **clinical examination** was performed. All patients underwent **neuroimaging** (CT or MRI) upon admission to assess the extent of the injury. Patients were managed according to the standard clinical protocols, including both **conservative** and **surgical** interventions, as appropriate. The children were followed up regularly during hospitalization, and long-term follow-up was scheduled for **1 month, 2 months, 3 months, and 6 months** after discharge to assess their recovery. During these follow-ups, further clinical evaluations and neuroimaging were conducted to monitor ongoing recovery.

Data analysis was performed using **SPSS software, version 20**, employing appropriate statistical methods to analyze and interpret the collected data. Descriptive statistics were used to summarize patient demographics, clinical characteristics, and outcomes. Inferential statistical tests, such as chi-square tests, t-tests, and ANOVA, were applied to assess the relationship between various clinical factors (e.g., GCS score, neuroimaging findings, age) and long-term recovery outcomes. Multivariate regression analysis was conducted to identify significant predictors of recovery, while survival analysis was used to evaluate time-dependent outcomes.

RESULTS

Participants spanned four pediatric age brackets fairly evenly. The largest group was aged 1–3 years 64 children (35.6%), followed by 4–6 years 42 children (23.3%), 7–9 years 40 children; (22.2%), and 10–12 years 34 children; (18.9%). This distribution shows a slight skew toward younger children under 6 years (approximately 58.9% combined), reflecting either higher injury risk or presentation in that cohort. A total of 180 cases were analyzed, ensuring adequate representation across developmental stages for assessing head-trauma patterns and outcomes in this tertiary-care pediatric population.

Of the 180 patients, 104 were male (57.8%) and 76 were female (42.2%), indicating a male predominance in paediatric head-trauma presentations. This male: female ratio of roughly 1.4:1 may reflect behavioural or exposure differences, such as higher participation of boys in risk-prone activities. Understanding this gender disparity is important for targeting preventive education and safety measures.

Falls were the most common cause: 75 children (41.7%) fell at home and 35 (19.4%) fell from height. Road-traffic accidents accounted for 65 cases (36.1%). Rare mechanisms included bull-horn injuries (3; 1.7%) and physical assault (2; 1.1%). Overall, 180 events were recorded. The preponderance of accidental falls (61.1% combined) highlights the importance of home safety and fall-prevention interventions in this age group.

Clinical Presentation

Most patients presented with external soft-tissue injuries 131 (72.78 %). Vomiting occurred in 60 (33.34 %), and Ear and nose bleeding was noted in 24 patients (13.4 %), loss of consciousness in 14 (7.8 %), and seizures 8 (4.5 %) and nearly 10 patients (5.5 %) are asymptomatic.

NCCT Brain Findings

Non-contrast CT was performed in 170 patients who were symptomatic. NCCT is normal in 36 patients (21.17 %). The most frequent abnormality was skull-bone fracture 78 (45.89 %), followed by extradural hematoma 22 (12.95%), subarachnoid haemorrhage 18 (10.58 %), haemorrhagic contusion 10 (5.8%), subdural hematoma 15 (8.8 %), pneumocephalus 15

(8.8 %), and diffuse axonal injury 3 (1.7%). These imaging patterns guide management urgency and prognosis.

Glasgow Coma Scale (GCS) Distribution

On admission, GCS was mild in 154 patients (85.6%), moderate in 15 (8.3%), and severe in 11 (6.1%). The predominance of mild GCS scores correlates with the high discharge rate and low ICU utilization.

Pupillary Assessment

Pupils were equal and reactive in 172 patients (95.6%), unequal but reactive in 5 (2.8%), constricted in 2 (1.1%), and not assessable in 1 (0.6%). These findings confirm that gross pupillary abnormalities are uncommon but critical when present.

Associated Injuries

Most patients had no other injuries 153 (85.0%). Abdominal injuries occurred in 14 (7.8%), long-bone fractures in 10 (5.6%), chest injuries in 2 (1.1%), and spinal injuries in 1 (0.6%). This underscores that head trauma often occurs in isolation but may coincide with other system injuries in about 15% of cases.

Primary Management

Conservative treatment was chosen in 161 cases (91.7%), with surgical management in 19 (8.3%). This aligns with the high proportion of mild injuries that do not require operative intervention.

Patient Outcomes

Of the 180 children, 169 (93.9%) were discharged and 11 (6.1%) died. The low overall mortality underscores generally favourable paediatric head-trauma outcomes under current management protocols.

Table 1: Gender vs Patient Outcomes

Gender	Death	Discharged	No Of Children	Pearson Chi-Square	P value
Female	7	69	76	2.202	0.138
Male	4	100	104		
Total	11	169	180		

Deaths occurred in 7 of 76 females (9.2%) and 4 of 104 males (3.8%). The Pearson Chi-Square test showed no significant association between gender

and outcome ($\chi^2=2.202$; $p=0.138$), suggesting similar mortality risk across sexes in this cohort.

Table 2: Age Group vs Patient Outcomes

Title		Patient Outcomes		Total	P value
		Death	Discharged		
Age	1-3 year	1	63	64	0.073
	4-6 year	2	40	42	
	7-9 year	3	37	40	
	10-12 year	5	29	34	
Total		11	169	180	

Mortality rose slightly with age: 1 death among 64 (1.6%) aged 1–3, 2/42 (4.8%) aged 4–6, 3/40 (7.5%) aged 7–9, and 5/34 (14.7%) aged 10–12. However,

this trend was not statistically significant ($p=0.073$), indicating age alone did not strongly predict death risk.

Table 3: Mode of Trauma vs Patient Outcomes

Title		Patient Outcomes		Total	P value
		Death	Discharged		
Mode Of Trauma	Road Traffic Accident	7	58	65	0.292
	Accidental self-fall from height	4	31	35	
	Accidental self-fall at Home	0	75	75	
	Bull horn injury	0	3	3	
	Physical Assault	0	2	2	
Total		11	169	180	

All deaths (7/65; 10.8%) occurred after road-traffic accidents, and 4 of 35 (11.4%) followed falls from height; no deaths followed home falls, bull-horn injuries, or assault. Despite these differences, the

association was not significant ($p=0.292$), indicating outcome may depend more on injury severity than mechanism alone.

Table 4: GCS vs Patient Outcomes

Title		Patient Outcomes		Total	P value
		Death	Discharged		
GCS	Severe	7	4	11	0.014
	Mod	4	11	15	
	Mild	0	154	154	
Total		11	169	180	

Severe GCS (≤ 8) had 7 deaths out of 11 (63.6%), moderate GCS (9–12) had 4/15 deaths (26.7%), and no deaths occurred in mild cases. This relationship

was statistically significant ($p=0.014$), confirming GCS at admission as a strong predictor of mortality.

Table 5: Associated Injuries vs Patient Outcomes

Title		Patient Outcomes		Total	P value
		Death	Discharged		
Associated_injury	None	9	144	153	0.093
	Abdomen	0	14	14	
	Chest	1	1	2	
	Long Bone	1	9	10	
	Spine	0	1	1	
Total		11	169	180	

Deaths occurred in 9/153 (5.9%) with no other injuries, 1/2 (50%) with chest injuries, and 1/10 (10%) with long-bone fractures; none with abdominal or spinal injuries died. The association

was not significant ($p=0.093$), suggesting accompanying injuries did not reliably predict head-trauma mortality.

Table 6: Primary Management vs Patient Outcomes

Title		Patient Outcomes		Total	P value
		Death	Discharged		
Primary Management	Conservative	7	154	161	0.302
	Surgical management	4	15	19	
Total		11	169	180	

Seven of 161 conservatively managed patients (4.3%) died, versus 4 of 19 surgically managed (21.1%); this difference did not reach significance

($p=0.302$), possibly due to low surgical numbers and reflecting that surgery was reserved for more severe injuries.

Table 7: Pupillary Findings vs Patient Outcomes

Title		Patient Outcomes		Total	P value
		Death	Discharged		
Pupils	Can't be assessed	0	1	1	<0.001
	Constricted	2	0	2	
	Equal and Reactive	6	166	172	
	Unequal and Reactive	3	2	5	
Total		11	169	180	

All 2 patients with constricted pupils died (100%), 3 of 5 with unequal pupils died (60%), none of 172 with equal/reactive died (0%), and the single unassessable pupil case survived. This association was highly significant ($p < 0.001$), making pupillary examination a critical prognostic tool.

DISCUSSION

The primary aim of this study was to characterize the clinical profile, radiologic findings, management strategies, and outcomes of pediatric head-trauma patients aged 1–12 years presenting to a tertiary-care center over a two-year period. By enrolling 180 consecutive cases and systematically capturing demographic variables (age, gender), injury mechanisms (falls at home, falls from height, road-traffic accidents, and rare causes), presenting signs and symptoms, Glasgow Coma Scale and pupillary assessments, CT scan results, associated systemic injuries, treatment modalities (conservative vs. surgical), and in-hospital trajectories (length of stay, ICU admission, medications), we sought both to delineate patterns unique to our population and to

validate key prognostic indicators such as initial GCS and pupillary response.

Age Distribution

In our cohort of 180 pediatric head-trauma patients, the highest proportion (64/180; 35.6%) fell within the 1–3-year age bracket. Children aged 4–6 years comprised 23.3% (42/180), those 7–9 years 22.2% (40/180), and the fewest were 10–12 years old at 18.9% (34/180). Collectively, 58.9% of injuries occurred in children under six, underscoring toddlers' disproportionate vulnerability due to intrinsic developmental factors—such as poor balance, a top-heavy head-to-body ratio, and exploratory behaviors—and extrinsic influences like limited environmental safety measures. This age skew mirrors findings from Iyer et al,^[11] who reported the greatest incidence in 1–5-year-olds among 300 pediatric head-injury admissions. Similarly, Yilmaz et al. observed a mean age of 59.8 ± 42.6 months (≈ 5 years) in 707 emergency department cases, with the youngest children most at risk.^[84] Even larger datasets, such as Schonfeld et al.'s,^[12] validation of the PECARN rules (2,439 children with GCS ≥ 14), found 39% under two years old. In rural India,

Nitnaware et al.^[13] also documented a predominance of falls in children under five, reflecting consistent early-childhood vulnerability across settings. Patil et al.^[14] and Srivastava et al. further confirm this pattern: Patil et al. reported a mean age of 5.7 years in 45 cases, and Srivastava et al. found 40% of 35 patients aged 1–5 years.

Gender Distribution

Among our 180 patients, 104 were male (57.8%) and 76 female (42.2%), yielding a male-to-female ratio of approximately 1.37:1. This male predominance aligns with global pediatric trauma literature suggesting boys' greater exposure to risk-taking behaviors and higher participation in unsupervised activities. Schonfeld et al.'s PECARN cohort similarly comprised 59% males among 2,439 children with GCS ≥ 14 ,^[12] and Iyer et al.^[11] found a male majority in their 300-patient series under age 12. In Yilmaz et al.'s,^[16] 707-case emergency department analysis, 62.8% were male, while Patil et al.^[14] reported 62.2% male patients in their retrospective cohort of 45 cases. Srivastava et al.^[15] in a prospective study of 35 children ≤ 18 years, also documented a male bias

Mode of Trauma

Accidental falls—both at ground level and from height—emerged as the predominant mechanism of pediatric head injury in our cohort, accounting for 61.1% of cases (75 home falls, 35 height falls). Road-traffic accidents (RTAs) comprised the next largest category at 36.1% (65/180), while bull-horn injuries (3; 1.7%) and physical assault (2; 1.1%) were exceedingly rare. The high incidence of home falls underscores toddlers' and preschoolers' developmental vulnerability: limited coordination, exploratory behavior, and insufficient environmental safeguards (e.g., unguarded stairways or furniture edges) all contribute to an elevated fall risk in children under six.^[11] Nitnaware et al.^[13] similarly reported that 62% of pediatric head-injury cases in a rural Indian hospital were due to falls—predominantly from heights—attributing this to lack of fall-prevention measures and delayed prehospital care. RTAs represented over one-third of injuries, particularly among older children more likely to traverse roads unaccompanied or ride bicycles without helmets. Nath et al.^[17] found that 67% of unidentified adolescent trauma patients sustained head injuries in RTAs, with corresponding higher rates of surgical intervention and mortality. Ghosh et al. documented that 23.3% of 150 Eastern Indian children's head traumas were RTA-related, and these patients exhibited a 14.3% poor-outcome rate—similar to the 11% mortality in our RTA subgroup—highlighting the severity of vehicular impacts in pediatric populations. Patil et al.^[14] observed that 24% of 45 pediatric cases were RTA-induced, with two deaths (18%) in this group, reinforcing the lethal potential of high-velocity impacts. Srivastava et al.^[15] likewise recorded that falls and RTAs were the leading mechanisms in children under 18, with RTAs

linked to more severe Glasgow Coma Scale scores and higher mortality (18%).

Clinical Presentation

Most patients presented with external soft-tissue injuries 131 (72.78 %). Vomiting occurred in 60 (33.34 %), and Ear and nose bleeding was noted in 24 patients (13.4 %), loss of consciousness in 14 (7.8 %), and seizures 8 (4.5 %) and nearly 10 patients (5.5 %) are asymptomatic. Schonfeld et al.^[12] reported seizures in 0.8% of 2,439 low-risk children under PECARN rules, with 15% of patients undergoing CT and traumatic findings in only 3%. Iyer et al.^[11] also described external signs—such as scalp hematomas and lacerations—as common, with vomiting and headache among leading symptoms in 300 patients. Nitnaware et al.^[13] emphasized similar presentations, noting that many rural cases exhibited only minor external wounds yet harbored extradural hematomas. Patil et al.^[14] observed headache in 66.6%, vomiting in 63.4%, and seizures in 26.4% among 45 cases, reflecting a higher seizure rate in moderate-to-severe injuries. The prevalence of asymptomatic or minimally symptomatic presentations underscores the need for vigilance: established clinical decision rules like PECARN—which emphasize mechanism, clinical signs, and symptoms—are crucial to guide imaging and observation

NCCT Brain Findings

Non-contrast CT was performed in 170 patients who were symptomatic. NCCT is normal in 36 patients (21.17 %). The most frequent abnormality was skull-bone fracture 78 (45.89 %), followed by extradural hematoma 22 (12.95%), subarachnoid haemorrhage 18 (10.58 %), haemorrhagic contusion 10 (5.8%), subdural hematoma 15 (8.8 %), pneumocephalus 15 (8.8 %), and diffuse axonal injury 3 (1.7%). This high abnormal-CT yield underscores the value of liberal imaging protocols in a tertiary-care setting, particularly given the substantial proportion of asymptomatic or minimally symptomatic patients. By contrast, PECARN's validation cohort (GCS ≥ 14) demonstrated only 3% CT abnormalities and 0.8% clinically significant TBIs among 2,439 children, reflecting stricter imaging criteria. Iyer et al.^[11] reported skull fractures in 27% of 300 pediatric cases, confirming fractures as the predominant lesion in this age group. Nitnaware et al. highlighted extradural hematomas as the top intracranial pathology in 50 rural children,^[13] whereas Yilmaz et al.^[16] found intracranial lesions in 45.9% of 707 scans, with EDH, SDH, and contusions among the leading findings, and correlated CT abnormalities with GCS < 15 and vomiting ($p < 0.05$). Patil et al.^[14] saw CT abnormalities in 68% of 45 patients, while Srivastava et al.^[15] documented midline shift > 3 mm as a strong predictor of poor outcome in 35 severe TBI cases.

Glasgow Coma Scale (GCS) Distribution

GCS on admission remains the single most powerful prognostic indicator in paediatric head trauma. In our series, 154 of 180 children (85.6%) presented with mild GCS scores (13–15), 15 (8.3%) with moderate scores (9–12), and 11 (6.1%) with severe scores (3–

8). Mild-injury patients uniformly survived and were discharged without intensive interventions, demonstrating that GCS 13–15 reliably predicts benign short-term outcomes. Conversely, mortality was 26.7% in the moderate group and 63.6% in the severe group, underscoring the steep risk gradient associated with declining consciousness. Schonfeld et al.'s PECARN rules—applied to children with GCS ≥ 14 —achieved 100% sensitivity and negative predictive value for clinically significant TBI, with only 0.8% having such injuries, validating GCS as an exclusionary criterion for imaging and admission decisions in low-risk cases.^[12] Yilmaz et al.,^[16] similarly identified GCS < 15 as a significant predictor of both short- and long-term intracranial injury and outcomes ($p < 0.05$) in 707 cases. Srivastava et al.,^[15] documented 47% of their 35-patient cohort as severe (GCS ≤ 8), with 18% overall mortality and GCS as a central prognostic factor alongside hypotension and intracranial lesions. Ghosh et al.,^[18] correlated GCS ≤ 8 with poor outcomes in 150 children, particularly when combined with midline shift on CT.

Pupillary Findings

Pupillary examination—one of the most rapid, non invasive neurologic assessments—revealed equal and reactive pupils in 172 patients (95.6%), unequal but reactive pupils in 5 (2.8%), constricted pupils in 2 (1.1%), and an non assessable pupil in 1 (0.6%). Abnormal pupillary reactions were tightly linked to mortality: both constricted-pupil cases died (2/2; 100%), and 3 of 5 unequal-pupil patients died (60%), while none of the 172 with equal-reactive pupils died (0%) ($p < 0.001$). This prognostic power is well corroborated. Ghosh et al.,^[18] found pupillary deficits—especially anisocoric in 150 Eastern Indian children to predict poor outcomes, with midline shift > 3 mm on CT compounding risk (68% mortality). Srivastava et al.,^[15] reported abnormal pupillary findings as an independent predictor of mortality in their severe-TBI cohort ($p < 0.05$). Yilmaz et al.,^[16] included pupillary reactivity in their multivariate models, demonstrating significant associations with intracranial pathology for both under- and over-2 age groups ($p < 0.05$).

Associated Injuries

In this study, 153 of 180 children (85.0%) had isolated head injuries, while 27 (15.0%) presented with concomitant trauma: 14 had abdominal injuries (7.8%), 10 long-bone fractures (5.6%), 2 chest injuries (1.1%), and 1 spinal injury (0.6%). The presence of multi-system trauma complicates both diagnostic evaluation and therapeutic prioritization, often worsening overall prognosis. Ghosh et al.^[18] reported that associated chest and spinal injuries significantly correlated with poor outcomes in 150 pediatric patients, especially when combined with midline shift on CT. Srivastava et al.,^[15] identified pneumothorax and hypotension from thoracic trauma as independent mortality predictors in their 35-patient severe-TBI cohort (overall mortality 18%). Nath et al.'s,^[13] adolescent series found that 50% of

unidentified trauma patients required surgical intervention for non-cranial injuries, highlighting the complexity of multi-trauma management.

Medical Drugs Used

Pharmacologic management in our cohort focused on symptomatic relief, infection prophylaxis, and seizure prevention. Analgesics were given to 179 of 180 children (99.4%), reflecting universally recognized need for pain control. Antibiotics were prescribed in 160 cases (88.9%), primarily for open skull fractures or basilar-skull-fracture-associated cerebrospinal fluid leaks, to prevent meningitis and surgical-site infection. Anticonvulsants were administered to 41 patients (22.8%), targeting those with early post-traumatic seizures, cortical contusions, or other high-risk features. Patil et al.,^[14] reported anticonvulsant use in 26% of 45 paediatric head-injury cases, with prophylaxis reserved for moderate and severe injuries; they observed that prompt initiation of anticonvulsants reduced early-seizure incidence without significant adverse effects. Yilmaz et al.,^[16] noted that 10.1% of their 707 patients received seizure prophylaxis based on clinical and imaging predictors (e.g., GCS < 15 , focal deficits). Iyer et al.'s,^[11] 300-child series described sedation and analgesia regimens—including opioids and benzodiazepines—as essential for head-injury care, while cautioning against propofol infusions in children due to rare but severe propofol infusion syndrome. Ghosh et al.,^[18] emphasized hyperosmolar therapy (mannitol, hypertonic saline) for intracranial hypertension in severe injuries, though such interventions were reserved for the 8.3% surgical cohort in our study.

Patient Outcomes

Among 180 children with head trauma, 169 (93.9%) were discharged home and 11 (6.1%) died, reflecting generally favorable outcomes with current management protocols. Discharge rates underscore that the majority of pediatric head traumas—particularly mild (GCS 13–15) cases—have excellent prognoses when treated promptly and appropriately. Mortality, while low, highlights that a critical minority with severe physiologic and structural injuries remains at high risk. Yilmaz et al.,^[16] reported a 1.4% mortality rate in their 707-child emergency-department cohort, noting that most deaths occurred in surgically managed severe cases. Ghosh et al.,^[18] in 150 Eastern Indian children, found poor outcomes in 14.3% of road-traffic–accident TBIs and 14.1% of fall-related injuries, particularly when midline shift on CT exceeded 3 mm, indicating that lesion severity and associated injuries drive mortality risk. Srivastava et al. observed an 18% mortality in 35 severe-TBI patients, with predictors including hypotension, pneumothorax, and coagulopathy, emphasizing the compounded risk of secondary insults. Schonfeld et al.'s,^[12] PECARN validation—focused on mild head injuries—yielded no deaths among 2,439 children, illustrating that low-risk clinical decision rules can safely identify patients who rarely experience fatal outcomes.

CONCLUSION

Paediatric head trauma predominantly affects younger children, mainly from home falls, while severe injuries in older children often result from road-traffic accidents. Most cases are mild and managed conservatively, with excellent outcomes. Key predictors of poor prognosis include low GCS, pupillary abnormalities, and high-energy mechanisms. Prevention through home safety, caregiver education, and road-safety enforcement remains essential. Optimized triage, judicious imaging, and timely neurosurgical intervention can further improve survival and recovery. Long-term follow-up is vital to address neurodevelopmental and psychosocial outcomes

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