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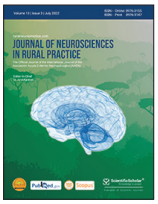

Original Article

Correlation of clinical features with neuroimaging in children with mild head injury

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ABSTRACT

Objectives: Mild head injury is defined as a pediatric Glasgow Coma Scale (GCS) score of 13–15 at admission following head trauma. There are no clear indications for neuroimaging in such children. The aim of our study was to analyze the correlation of symptoms commonly encountered following mild head injury with any abnormality on the computed tomography (CT) scan.

Materials and Methods: This is a retrospective and observational study done in a tertiary care hospital. Records of all the children fulfilling the inclusion criteria were retrieved. Demographic details such as age, gender, and type of injury (hit by a blunt object, fall from height, and road traffic accident), symptoms such as presence and number of episodes of vomiting, presence and duration of loss of consciousness (LOC), presence of drowsiness, headache, giddiness, seizures, focal deficits and the GCS score, and CT scan findings were noted in a predesigned proforma. A CT scan with any of the following abnormalities such as skull fracture, cerebral edema, intracranial bleed (epidural hematoma, subdural hematoma, intracerebral hematoma, and subarachnoid hemorrhage), and cerebral contusion was considered as abnormal. Any neurosurgical intervention done was also noted.

Results: A total of 134 children in the age group of 1 month to 18 years with mild head injury were included in this study. The median (interquartile range) age of the children was 5 (2, 8) years, with majority being males. Road traffic accidents (34.3%) were the most common cause of injury, followed by fall from lesser than 3 feet height (31.3%). The most common symptoms were vomiting (43.6%), scalp/facial abrasions (37.2%), and LOC (31.9%). CT scan was abnormal in 53.7% of the cases, with skull fracture (35.1%) being the most common finding, followed by cerebral edema (13.4%). Among all the symptoms, ear/nosebleed or cerebrospinal fluid (CSF) otorrhea/rhinorrhea had a statistically significant association with a positive CT scan with $P = 0.05$ and an odds ratio of 1.4 (95% confidence interval, 1–1.9).

Conclusion: Children with mild head injury presenting with clinical features such as bleeding from the ear or nose and CSF otorrhea/rhinorrhea are more likely to have an abnormal CT scan. Hence, such children require close neurological observation and prompt intervention if necessary. However, abnormality on CT scan cannot be reliably ruled out based on the symptoms alone.

Keywords: Mild head injury, Computed tomography scan, Children, Clinical features

INTRODUCTION

Mild head injury is defined as a pediatric Glasgow Coma Scale (GCS) score of 13–15 at admission following trauma to the head.[1] Such children are usually conscious with a few common symptoms. Although children rarely develop intracranial complications, those who do so can have rapid clinical deterioration. The chances of positive computed tomography (CT) scan finding in mild head injury is 15%, with <1% requiring any neurosurgical intervention.[2] Such children, therefore, pose a dilemma to the attending pediatrician regarding the need to subject these children to a CT scan.

Several clinical decision rules aid in this decision-making, such as Canadian assessment of tomography for childhood head injury,[3] Children's Head Injury Algorithm for the Prediction of Important Clinical Events,[4] Paediatric Emergency Care Applied Research Network,[5] and National Institute for Health and Care Excellence (NICE)[6] guidelines. The NICE guidelines, updated in 2014, recommend CT scan to be done in any child with presence of risk factors such as suspected non-accidental injury, post-traumatic seizure without history of prior seizures, GCS score of <14 (GCS <15 in an infant), or GCS <15 at 2 h following injury, if suspected open or depressed skull fracture or presence of tense fontanelle. Neuroimaging is also recommended in the presence of signs of basal skull fracture, focal neurological deficit, presence of any bruise, or swelling or laceration of more than 5 cm on the head of an infant. The presence

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of any of the following clinical symptoms such as loss of consciousness (LOC) >5 min, abnormal drowsiness, and three or more discrete episodes of vomiting also warrants a CT scan according to the guidelines.

Although imaging studies help detect a significant intracranial lesion which will facilitate the clinician regarding prognostication of the injury and discharge, they may expose the patient to radiation which may be a slight risk for cancer.[7] In addition, neuroimaging adds to the financial burden and there are also issues with availability in remote areas in developing countries. At present, there are no clear-cut guidelines that are followed for neuroimaging among children with head injury in most countries. Hence, there is a need to identify symptoms that can predict clinically significant CT scan findings among children with a mild head injury.

This study aims to analyze the association of common clinical symptoms as per NICE guidelines with CT scan findings in children with mild head trauma. This study may help guide practitioners to judiciously advise CT scans in children with mild head injury, especially in resource-limited settings and help to reduce exposure to radiation.

MATERIALS AND METHODS

A retrospective and observational study was conducted in a tertiary health-care center after obtaining clearance from the Institutional Ethics Committee. Children in the age range of 1 month to 18 years with mild head injury presenting to the hospital during the study period between January and December 2022, in whom CT scan reports were available, were included in the study. Records of all the children fulfilling the inclusion criteria were retrieved. Demographic details such as age, gender, and clinical data such as type of injury (hit by a blunt object, fall from height, and road traffic accident), presence and frequency of vomiting, period of LOC if present, presence of drowsiness, headache, and giddiness if any were also noted. History of seizures, presence of focal deficits, and the GCS score were recorded in a predesigned proforma. The CT scan findings were noted and the report was considered abnormal if any of the following such as fracture of skull, cerebral edema, epidural, subdural and intracerebral hematoma, cerebral contusion, and subarachnoid hemorrhage were present. Neurosurgical intervention if done was also noted.

Statistical methods

Qualitative variables like gender are expressed using frequency and percentage. Continuous variables like age are expressed using mean and standard deviation. An Independent Student's *t*-test was employed to compare the mean age between the normal and abnormal groups of CT scan results. The Chi-square test was used to assess the association of gender, presence of symptoms, and type of injury between the two groups. Analysis was done using SPSS. Inc. for Windows version 18.0 released in 2009. $P < 0.05$ was considered statistically significant.

RESULTS

A total of 134 children presented with mild head injury during the period of the study. The median (interquartile range) age was 5 (2, 8) years. The demographic profile of the children is given in [Table 1]. The children were predominantly male, with a M: F ratio of 1.8:1.

Table 1: Demographic profile of children.

Characteristics	*n*=134 *n* (%)
Age in years Median (IQR)	5 (2, 8)
Gender	
Male	71 (64.5)
Female	39 (35.5)
Cause of injury	
Hit by blunt object	9 (6.7)
Fall from height ≥3 feet	37 (27.6)
Fall from height < 3 feet	42 (31.3)
RTA	46 (34.3)
Symptoms	
Any symptom	101 (91.8)
Vomiting	
≥3 episodes	34 (25.4)
<3 episodes	26 (19.4)
Loss of consciousness	
≥5 min	25 (18.7)
<5 min	13 (9.7)
Abrasions	49 (36.6)
Ear/nosebleed or CSF otorrhea/rhinorrhea	27 (20.1)
Headache	16 (11.9)
Seizures	12 (9)
Drowsiness	10 (7.5)
Giddiness	3 (2.2)
Focal deficit	2 (1.5)
GCS	
15	125 (93.3)
14	4 (3)
13	5 (3.7)
CT Brain scan finding	
Normal	62 (46.3)
Abnormal	72 (53.7)
Fracture	47 (35.1)
Edema	18 (13.4)
EDH	13 (9.7)
SDH	9 (6.7)
Contusion	7 (5.2)
SAH	4 (3)
ICH	6 (4.5)

IQR: Interquartile range, RTA: Road traffic accident, GCS: Glasgow coma scale, EDH: Epidural hematoma, SDH: Subdural hematoma, SAH: Subarachnoid hemorrhage, ICH: Intracerebral hemorrhage

The most common cause of injury present in 34.3% of the cases was road traffic accidents, followed by fall from a height of < 3 feet (31.3%). Majority of the children (92.7%) presented with a GCS of 15. The common symptoms were vomiting in 43.6%, abrasions on the head/face in 37.3%, LOC in 31.9%, and ear/nosebleed or cerebrospinal fluid (CSF) otorrhea/rhinorrhea in 21.9%. An abnormal CT scan was seen in 53.7% (n = 72), of which the most common abnormality was skull fracture (35.1%, n = 47), followed by cerebral edema (13.4%, n = 18). Four children required neurosurgical intervention.

Among the clinical symptoms, ear/nosebleed or CSF otorrhea/rhinorrhea had a statistically significant association with an abnormal CT scan with P = 0.05 and an odds ratio (OR) of 1.4 (95% confidence interval [CI], 1–1.9) [Table 2]. Other symptoms such as drowsiness, headache, focal deficits, and vomiting (>3 episodes) had a high OR for an abnormal radiologic report, but none was statistically significant. The presence of vomiting and abrasions together was the most common combination of symptoms, but did not have statistically significant correlation with the CT scan findings.

Neuroimaging was indicated in 120 out of the 134 cases according to the NICE guidelines, out of which CT scan abnormality was seen in 68 cases. An abnormal CT scan would be missed in four cases that did not satisfy the NICE guidelines indication for neuroimaging. However, none of those cases required neurosurgical intervention. Having a positive indication for CT scan according to the NICE guidelines had an OR of 1.9 (95% CI: 0.9–4.6, P = 0.046) for detecting an abnormality.

DISCUSSION

Children presenting to the casualty with mild head injury pose a dilemma to the attending pediatrician regarding the need for a CT scan. During a 12-month follow-up of children with mild head injury, it was found that neuropsychological improvement was related with abnormal CT.[8] It was also found that performance in cognitive domains was poorer in children with abnormal CT as opposed to those with normal or linear skull fracture on CT scan.[8] On the other hand, the radiation from the CT scan may carry a marginal risk for cancer.[7] Many children with history of mild head injury are hospitalized for neurologic observation even though they have a normal CT scan, which may not be required.[9] Hence, the benefits must outweigh these small absolute risks to justify using a CT scan. We attempted to find any correlation

Table 2: Comparison of symptoms between normal and abnormal neuroimaging.

Characteristics	Total (n=134)	Normal CT scan (n=62)	Abnormal CT scan (n=72)	OR (95% CI)	P-value
Age (years) median (IQR)	5 (2, 8)	4 (2, 7.5)	5 (2.6, 8.7)		0.2
Gender n (%)					
Male	87	41 (47.1)	46 (52.3)	0.9 (0.7–1.3)	0.772
Female	47	21 (44.7)	26 (55.3)	1.1 (0.7–1.9)	
Type of injury					
Hit by blunt object	9	4 (44.4)	5 (55.6)		
Fall from ≥3 feet	37	15 (40.5)	22 (59.5)		
Fall from <3 feet	42	23 (54.8)	19 (45.2)		
RTA	46	20 (43.5)	26 (56.5)		
Presence of any symptom	121	55 (45.5)	66 (54.5)	1.2 (0.6–2.2)	0.564
Vomiting					
≥3 episodes	34	14 (41.2)	20 (58.8)	1.1 (0.8–1.6)	0.491
<3 episodes	26	12 (46.2)	14 (53.8)	1 (0.7–1.5)	0.99
LOC					
≥5 min	25	13 (52)	12 (48)	0.8 (0.6–1.4)	0.524
<5 min	13	6 (46.2)	7 (53.8)	1 (0.6–1.7)	0.993
Abrasions	49	26 (53.1)	23 (46.9)	0.8 (0.6–1.2)	0.231
Ear/nosebleed or CSF otorrhea/rhinorrhea	27	8 (29.6)	19 (70.4)	1.4 (1–1.9)	0.05
Both abrasions and any of ear/nosebleed or CSF otorrhea/rhinorrhea	5	1 (20)	4 (80)	1.5 (1–2.4)	0.23
Seizures	12	7 (58.3)	5 (41.7)	0.8 (0.4–1.5)	0.38
Focal deficits	2	0	2 (100)	1.9 (1.6–22)	0.186
Drowsiness	10	3 (30)	7 (70)	1.3 (0.9–2.1)	0.283
Headache	16	6 (37.5)	10 (62.5)	1.2 (0.8–1.8)	0.453
Giddiness	3	2 (66.7)	1 (33.3)	0.6 (0.1–3)	0.474

RTA: Road traffic accident, LOC: Loss of consciousness, OR: Odds ratio, CI: Confidence interval, CSF: Cerebrospinal fluid

between the standard clinical features and abnormality in the CT scan.

The cases were predominantly males, as seen in other studies.[10,11] Road traffic accident (RTA) and fall from height formed the principal mechanism of head injury in our study. Similar observations were made in other studies[12-14] on head injury in pediatric patients. Children are common among pedestrians who form a significant group involved in injury during an RTA.[15] Children have relatively larger and heavier heads than the rest of the body. With increasing motor ability and the head being the center of gravity in children, any fall directly impacts the head. Hence, the chance of injury to the head is more in any form of trauma.

The predominant symptoms in our study were vomiting followed by scalp and facial abrasions and LOC. Headache, scalp hematoma, and nausea with or without vomiting were the three main symptoms in one study.[11] In contrast, vomiting, LOC, and ear/nose bleeding were the chief symptoms in another study.[10]

Positive findings in CT scan were seen in 50% of the cases, with skull fracture being the predominant finding, followed by epidural hematoma (EDH) in a study.[11] This was similar to our CT scan results. Another study also observed similar results with EDH and fracture hematoma as common findings on neuroimaging.[16] The higher incidence of abnormality in CT scan in our study is probably because only cases in which neuroimaging was done were included.

On analyzing the symptoms, it was found that those presenting with features such as ear/nosebleed and CSF otorrhea/rhinorrhea were more likely to have an abnormality on a CT scan. In another similar study[15] where clinical features were compared between normal and abnormal CT scans, ear and nose bleeds had the highest OR for an abnormal CT scan. However, it was not found to be statistically significant. Scalp hematoma, nausea with or without vomiting, and ear/nose bleeds or soft-tissue contusion in the periorbital region were found to have independent association with abnormality on CT scan in children with mild traumatic brain injury and GCS of 15.[11] Absence of vomiting, headache, scalp hematoma, clinical signs suggestive of fracture of the skull, and abnormality in mental status identified children at low risk for traumatic brain injuries on CT scans following blunt head trauma in another study.[17] Differences in study settings and inclusion criteria are probably the reasons for this variance in the risk factors.

Our study has certain limitations, one being that it is a retrospective study. Second, we included only inpatients who underwent CT scans. Further studies on prospectively collected data on all minor head injuries would help identify those clinical symptoms that can be predictors of abnormal neuroimaging.

CONCLUSION

A child following mild head injury presenting with signs of fracture of the base of the skull such as bleeding from the ear or nose and CSF otorrhea/rhinorrhea should be advised a CT scan by the attending pediatrician as it is more likely to be abnormal. Hence, such children require close neurological observation and prompt intervention if necessary. However, abnormality on CT scan cannot be reliably ruled out based on the symptoms alone.

Declaration of patient consent

The authors certify that they have obtained all appropriate consent.

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Nil.

Conflicts of interest

There are no conflicts of interest.

Use of Artificial Intelligence (AI)-Assisted Technology for manuscript preparation

The author(s) confirms that there was no use of Artificial Intelligence (AI)-Assisted Technology for assisting in the writing or editing of the manuscript and no images were manipulated using the AI.

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