ORIGINAL RESEARCH PAPER INTERNATIONAL JOURNAL OF PURE MEDICAL RESEARCH

Paediatrics

KEYWORDS: Head injury , Pediatric age group , Traumatic brain injury, Neuroimaging

Mode of injury in relation to Neuroimaging and outcome in children with head injury.

Volume - 9, Issue - 4, April- 2024 ISSN (O): 2618-0774 | ISSN (P): 2618-0766

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INTERNATIONAL JOURNAL OF PURE MEDICAL RESEARCH

Abstract

Traumatic brain injury (TBI) is the leading cause of death and disability in children. Data regarding mode of traumatic brain injury and severity which is vital for prognostication and epidemiology is limited. The aim of this study is to correlate findings in neuro-imaging with mode of injury and to study the outcome in relation to mode of injury. It is a prospective observational study in children between 1month to 18years of age who presented to the emergency department with head injury . 131 children out of a total of 5435 children seen in the emergency department over 6months presented with head injury. 51 children warranted neuroimaging and were included in the study . CT brain was abnormal in 40% (n=20) of a total of 51 patients. 11 (22%) children who fell from a height and 9 (18%) who sustained road traffic accident had CT evidence of intracranial bleed . 57%(N=29) with significant mode of injury had normal CT cervical spine and 55%(n=18) did not have skull fracture . CT brain was normal in 60% (n=31) . About 13 % with fall at ground level, 15% with fall from a height had minimal disability. In this study we conclude that fall from a height is a serious cause of head injury with abnormalities in neuroimaging and mode of injury with abnormalties in neuroimaging do not correlate with the outcome.

Introduction:

Traumatic brain injury (TBI) is the leading cause of death and disability in children. TBI in children differs in both pathophysiology and management from that in adults due to structural and physiological differences that are age related , mechanism of injuries and the difficulty in neurological examination Data regarding mode of traumatic brain injury and severity is limited. Studies in this aspect are vital for prognostication and epidemiology . The aim of the study is to correlate findings in neuroimaging to mode of injury and outcome of the patient in relation to mode of injury.

Materials and Methods:

It is a Prospective observational study done in the department of Paediatric Emergency Medicine Kanchi Kamakoti Child Trust hospital. This study was done between the period of August 2017 to January 2018. All patients who presented to the emergency department with a diagnosis of head injury between 1month to 18 years of age were included in the study. Details such as demographic profile, place, mode and severity of injury , neuroimaging findings and outcome were documented. Decision to perform computerised tomogram (CT) of the brain was based on CHALICE criteria and CT of cervical spine was decided using National Emergency X Radiography Utilization Study (NEXUS) criteria . Data was analysed using Chi square method.

CHALICE criteria

The children's head injury algorithm for the prediction of important clinical events rule

A computed tomography scan is required if any of the following criteria are present.

- **History**
  - Witnessed loss of consciousness of >5 min duration.
  - History of amnesia (either antegrade or retrograde) of >5 min duration.
  - Abnormal drowsiness (defined as drowsiness in excess of that expected by the examining doctor).
  - ≥3 vomits after head injury (a vomit is defined as a single discrete episode of vomiting).
  - Suspicion of non-accidental injury (NAI, defined as any suspicion of NAI by the examining doctor).
  - Seizure after head injury in a patient who has no history of epilepsy.
- **Examination**
  - Glasgow Coma Score (GCS) <14, or GCS<15 if <1 year old.
  - Suspicion of penetrating or depressed skull injury or tense fontanelle.
  - Signs of a basal skull fracture (defined as evidence of blood or cerebrospinal fluid from ear or nose, panda eyes, Battles sign, haemotympanum, facial crepitus or serious facial injury).
  - Positive focal neurology (defined as any focal neurology, including motor, sensory, coordination or reflex abnormality).
  - Presence of bruise, swelling or laceration >5 cm if <1 year old.
- **Mechanism**
  - High-speed road traffic accident (defined as accident with speed >40 m/h) either as pedestrian, cyclist or occupant.
  - Fall of >3 m in height.
  - High-speed injury from a projectile or an object.

If none of the above variables are present, patient is at low risk of intracranial pathology.

Results

From a total of 5435 children seen in the emergency department, 131 children over 6months presented with head injury. 51 children demanded neuroimaging and were included in the study. 65% (n=33) of children with head injury were males. 59% were between 1 to 5 yrs of age 75% (n=38) of children were treated as inpatient and 25% (n=13) were treated as outpatients 72 % (n=37) of children were brought to hospital within 5hrs of injury.

	Place of injury	Total			P VALUE
	Road	Home	School		
Fall from height	2	20	1	23	0.00
	3.9%	39.2%	2.0%	45.1%	
RTA	17	3	0	20	
	33.3%	5.9%	.0%	39.2%	
Fall at ground level	1	6	0	7	
	2.0%	11.8%	.0%	13.7%	
Non accidental injury	0	1	0	1	
	.0%	2.0%	.0%	2.0%	
Total	20	30	1	51	
	39.2%	58.8%	2.0%	100.0%	

Table 1: Mode and Place of injury

	Place of injury			Total	P VALUE
	Road	Home	School		
Fall from height	2	20	1	23	0.00
	3.9%	39.2%	2.0%	45.1%	
RTA	17	3	0	20	
	33.3%	5.9%	.0%	39.2%	
Fall at ground level	1	6	0	7	
	2.0%	11.8%	.0%	13.7%	
Non accidental injury	0	1	0	1	
	.0%	2.0%	.0%	2.0%	
Total	20	30	1	51	
	39.2%	58.8%	2.0%	100.0%	

59% (n=30) of head injury occured at home , 39% (n=20) were road traffic accidents and 2% (n=1) occurred at school. 45% (n=23) of injuries were due to fall from a height and 39% (n=20) due to road traffic accidents , 2%(n=1) was a non accidental injury . 59% (n=30) of injuries happened at home (TABLE 1) , 39% (n=20)of which were due to fall from height (P=0.00).Children with road traffic accident (RTA) and fall from height 84% (n=43) required admission.

Table 2: Mode of injury and skull fracture

	Skull fracture	Total	Pvalue	
	Yes	No		
Fall from height	8	15	23	0.267
	15.7%	29.4%	45.1%	
RTA	7	13	20	
	13.7%	25.5%	39.2%	
Fall from ground level	0	7	7	
	.0%	13.7%	13.7%	
Non accidental injury	0	1	1	
	.0%	2.0%	2.0%	
Total	15	36	51	
	29.4%	70.6%	100.0%	

CT brain was normal in 60% (n=31) of patients. Ear, nose and throat bleeding were observed in 20% (n=10). Abnormal findings in CT brain included parenchymal bleed (10%) extradural hemorrhage (EDH) (6%), subdural hemorrhage (SDH)(6%), subarachnoid hemorrhage (SAH) (6%) and (14%) had other abnormalities such as subgaleal hematoma. Skull fracture was found in 29.4%(n=15) (TABLE 2). Multiple bone fractures 10% (n=5) , temporal 8% (n=4) , parietal 6%, frontal 4% and occipital bone fractures 2% were detected . 62 % (n=32) required CT cervical spine and 6% of these children had abnormality. 82.4 % (n=42) were clinically normal at discharge , 7.8 % (n=4) had minimal disability, one child (2%) had a sequelae and one died (2%),3 children were discharged against medical advice. 82% (n=42) had a paediatric trauma score of >8 , 18% (n=9) had trauma score of <6 . 66.7% (n=34) of children who fell from height or sustained a RTA had trauma score of more than 8 (Table 3) . Children with abnormality in the CT brain , had a trauma score of more than 8 (p=0.001)

Table 3: CT findings with Paediatric trauma score

CT brain	Pediatric trauma score		Total	P value
	< = 6	> 6		
Normal	1	30	31	0.001
	2.0%	58.8%	60.8%	
Parenchymal bleed	2	3	5	
	3.9%	5.9%	9.8%	
EDH	0	3	3	
	.0%	5.9%	5.9%	
SDH	2	1	3	
	3.9%	2.0%	5.9%	
SAH	1	1	2	
Others	3	4	7	
	5.9%	7.9%	13.7%	
Total	9	42	51	
	17.6%	82.4%	100.0%	

Surgical intervention was needed for 7 children(14%). 11 (22%) children who fell from a height and 9 (18%)who sustained RTA had abnormal findings on CT such as SDH, EDH, parenchymal bleed . CT brain was normal in children with fall at ground level (n=7) and nonaccidental injury(n=1).Parenchymal bleed was more common in RTA, however it is not statistically significant. 57%(n=29) children with significant mode of injury (fall from a height and RTA) had normal CT cervical spine (p=0.04). 55%(n=18)of children with significant mode of injury did not have skull fracture (p=0.267).

Table 4: Mode of injury with Outcome

	Prognosis					Total
	Discharged normally	Discharged with minimal disability	Discharged with sequeale	Death	AMA	
Fall from height	17	3	0	1	2	23
	33.3%	5.9%	.0%	2.0%	3.9%	45.1%
RTA	17	1	1	0	1	20
	33.3%	2.0%	2.0%	.0%	2.0%	39.2%
Fall from ground level	7	0	0	0	0	7
	13.7%	.0%	.0%	.0%	.0%	13.7%
Non accidental injury	1	0	0	0	0	1
	2.0%	.0%	.0%	.0%	.0%	2.0%
Total	42	4	1	1	3	51
	82.4%	7.8%	2.0%	2.0%	5.9%	100.0 %

3 children (15%)who fell from a height and 1 from RTA had minimal disability. 1 child with RTA had neurological sequelae . 1 child who fell from height died. Mode of injury had no association with the outcome (TABLE 4).

Discussion

Head injures are more common in children between of 1& 5 years of age and predominantly occurs in male children . Our observation that 40% of our study population sustained head injury following a motor vehicle accident, 59% of injuries happened at home , 39% of which were due to fall from height is similar to other studies .These mechanisms of injury are preventable and can be reduced by improving safety standards and supervision of children. Accidents at home and school occur when safety measures and legal regulations are lacking . Most (72%) of the children presented to us within 5 hours of injury and it has been observed that children present to pediatric trauma care center between 1to 6 hours after injury, however delays up to 24 hours occur and it needs to be addressed . Minor head injuries are common in children and was observed in 25% of children in our study and all were treated as outpatients . Head injury is much more common than spinal injury in pediatric patients and fall from height is the most common mode of injury which is contrary to western statistics , The incidence of spinal cord injury (SCI) is low (1%) in children because of greater flexibility of their tissues compared to adults , we observed 6% of children satisfying NEXUS criteria had cervical spine injuries on CT .It has been observed that head injuries in children resulting in intracranial injury to the brain or surrounding extra-axial structure is a minor proportion as seen in 27 % in our study population . Intracranial injuries observed on CT in our study included, contusions (10%) EDH (6%),SDH(6%) and SAH 6% .Skull fractures were seen in 29.4% with or without subgaleal bleeds and 60% of children had a normal CT brain. In

infants and toddlers, head injuries from falls are age and mechanism dependent Skull fractures and cerebral contusions have been reported as common injuries in children and extradural hemorrhage is uncommon in infants as the dura is adherent to the inner table of the skull Localized SDH is commonly related to the site of impact or collision of a moving skull with a stationary object and associated brain swelling or death is very rare The pattern and possibility of sustaining an intracranial injury and skull fracture in children is related to the height and velocity of fall, nature of surface and point of contact with head . We observed that impact and loading forces caused by mechanisms of injury such as RTA and fall from height are associated with significant head injury necessitating admission (p=0.001) Parenchymal bleed was more common in children who sustained a RTA . A single focus of intracranial haemorrhage/skull fracture was shown to be more common in young children sustaining head injuries .Also the incidence of radiologically evident intracranial injury is low suggesting a higher threshold for tolerating translational forces associated with low level/velocity and impact , in early life.However radiologically evident parenchymal or hypoxic-ischaemic injuries have been associated with significant forces reported by mechanism of injury It is not clear whether the mechanism of injury obtained from history can explain the radiological abnormalities associated with head injuries and whether outcome can be ascertained based on findings on radiological imaging .The lowest level of force that can cause intracranial injury is also not known .Pediatric trauma score (PTS)of >8 was observed in children with significant intracranial injury identified in CT brain (p=0.001).PTS includes variables which may not be altered in isolated head injuries and parameters such as loss of consciousness, airway , blood pressure , could be normal and fractures or wounds may not occur in an isolated head injury .PTS score is found to be associated with outcome and mortality in children with poly trauma and its relation to mechanism of injury and intracranial injuries in isolated head injuries in children needs to be studied . The mechanism of injury has been reported to influence the extent of brain tissue damage . Motor vehicle accidents are associated with diffuse axonal injury and subsequent secondary injury processes whereas falls are often more focal and may result in different neuropathological features . Pediatric traumatic brain injury , especially when severe, affects various neurological domains and 4 children in our study had minimal disability in the form of cognitive , behavioural and physical impairment and one child had traumatic brain injury induced spasticity. Mortality was observed in 1 child with neurotrauma due to fall from height. Delayed presentation to the emergency causing time lapse of 5 hours for initiation of treatment was observed in a child who was discharged with neurological sequelae and in one who succumbed to severe injuries , however it had no bearing on the outcome as an independent factor.

CONCLUSION

Clinically important head injuries are common between 1 to 5years of age. Children with a trauma score of more than 6 can have significant head injury. Fall from a height is a serious cause of head injury with abnormalities in neuroimaging .Mode of injury and abnormalties in neuroimaging do not correlate with outcome. Larger multicentric studies are needed to ascertain the relationship between mechanism and extent of injury in neuroimaging .

What the study adds

Severity of head injury in relation to mode of injury based on neuroimaging Immediate outcome related to mode of injury

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