



## **Incidence of Skull Fracture in Children Presenting with Brain Contusion**

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### **Authors' contributions**

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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### **ABSTRACT**

**Objective:** The objective of our study is to determine the incidence of skull fracture in children presenting with brain contusion.

**Methods:** The current prospective cross sectional study was conducted at Neurosurgery department of Lady Reading hospital Peshawar during July 2020 to Dec 2020. Total 100 children of age 6 months to 14 years were enrolled in this study by using non-probability consecutive sampling. Children of both gender and age 6 months to 14 years presenting with head injury associated with brain contusion were included in the study. Children with intracranial lesion other than hematoma, gunshot and penetrating injuries were excluded.

**Results:** Out of 100 children's with brain contusion, 89% were diagnosed with skull fracture. The median age of the children with skull fracture was 72(18-108) months, and 70.7% of them were male. However no differences were observed in gender, age group, mechanism of trauma, site of contusion and size of contusion between fracture and non-fracture group. Moreover in children with skull fracture, linear skull fracture was most common followed by depressed skull fracture.

**Conclusion:** In our study prevalence of skull fracture among children presenting with traumatic brain injury is very high. Prompt diagnosis and management is necessary to prevent late neurologic

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complications in such patients. Clinicians should develop standard protocol for the assessment of children with brain contusion in emergency department in order to prevent misdiagnosis. This will help in reducing morbidity and mortality.

*Keywords: Traumatic brain injury; head injury; brain contusion; skull fracture.*

## 1. INTRODUCTION

Traumatic head injury among children is a big public health concern not only in Pakistan but all over the globe. It is the major cause of mortality in both adult and pediatric population [1]. Data shows that majority of patients presenting with traumatic brain injury in UK were belong to age group of under 16 years [2]. Traumatic head injury is associated with high morbidity and mortality in children. Children were more susceptible to head injury as compared to adults [3]. Literature shows that falls, RTA, assault and instrumental delivery are the major causes of traumatic head injury in children. The morbidity and mortality due to TBI is very high, early diagnosis and management can help in reduction in morbidity and mortality [4].

It was estimated that more than 600,000 children in USA visited emergency department for traumatic head injury among them majority of the children's were diagnosed intracranial injuries and approximately 5700 children were die due to those injuries every year. Morbidity and mortality increased in children with head injury when it's associated with extra cranial injuries [5].

In Pakistan morbidity and mortality due to traumatic head injury is very high. A retrospective review shows that the leading cause of head injury in pediatric population was fall accounted for approximately 65% of reported cases followed by RTA 22% [6]. The incidence of skull fracture ranges from 2% to 20% in pediatric population presenting with traumatic head injury in emergency department [7]. Literature shows that boys are more susceptible to traumatic head injuries as compared to girls while history of fall accounted as the major cause of traumatic head injury in Children [8].

Traumatic head injury is considered as common reason of visiting the pediatric emergency and it is also considered as the most common cause of life-threatening trauma. Around 80-90% of head injuries reported in pediatric emergency were mild, only few head injuries required surgical intervention and considered as life threatening [9]. It is challenging for the physician to diagnose

skull injuries when children reported with head injury as a result fall from low height [10].

A CT Scan is the globally endorsed diagnostic tool of choice in analyzing intracranial injuries such as a skull fracture with brain contusion in children [1,2]. However, a CT scan is quite expensive, requires sedations, and always require skilled interpretation. As a result of these drawbacks, a defined set of criteria for head trauma evaluation does not exist. The incidence of a skull fracture varies with severity of the head injury which presents when a considerable force is applied on the cranium. The most common types of skull fractures are linear followed by diastatic, depressed skull fracture, basilar fracture and orbital fracture, with a compound skull fracture as a neurologic emergency [1]. A much shorter distance fall can result frequently in a ping pong fracture in young children. In traumatic brain injury (TBI), the presence of a skull fracture is an important risk factor for intracranial lesions. The most common site for a skull fractures is the parietal followed by frontal, temporal, occipital, and posterior fossa. Intracranial injuries are common in depressed skull fracture [3]. A cerebral contusion is more common in children, and it has significant correlation with skull fractures. A skull fracture alone with no contusion is of less significant in pediatrics.

Skull fracture is most common in children after head trauma. Skull fracture alone has no such great impact to cause disability in children but the association of contusion with fracture causes worse impact in children. In Pakistan traumatic head injuries more common in children than adults in clinical practice. The rationale of this study is to determine the incidence of skull fracture in children presenting with contusion secondary to head trauma at Lady reading Hospital Peshawar. Limited international and local data is available on this topic. The local studies regarding skull fracture in children with brain contusion is very limited and available literature is out dated. As international studies suggested that there is an association between skull fracture and brain contusion. Moreover, as studies reveals that traumatic brain injuries with

skull fracture had poor outcomes as compared to brain injuries without skull fracture. Criteria for assessment of patient with traumatic brain injury in emergency department is not well defined and sometimes patient misdiagnosis due to unavailability of appropriate standard guidelines [11]. Currently actual magnitude of problem is not known so it is important to highlight the magnitude of skull fracture in children presenting with brain contusion. This study will help to generate protocol and guidelines regarding assessment of children presenting with head injuries in emergency department. Early diagnosis and management of skull fractures can help in reducing morbidity and mortality.

## 2. METHODOLOGY

The current prospective cross sectional study was conducted at Neuro-surgery department of Lady Reading hospital Peshawar during July 2020 to Dec 2020. The study was conducted after taking approval from Institutional Review Board (IRB#:349) of Lady Reading Hospital Peshawar. Children of both gender and age 6 months to 14 years presenting with head injury associated with brain contusion were included in the study. Children with intracranial lesion other than hematoma, gunshot and penetrating injuries were excluded. Prevalence of skull fracture in children with brain contusion =20% [12]. Therefore, at 95% confidence interval and margin of error 8%, a sample of total 97 patients was calculated. However, for better results we recruited total 100 patients in our study. Informed consent was taken from care taker of the children prior to enroll in the study. Children were enrolled in the study by using non-probability consecutive sampling technique.

All the collected data was entered into statistical package SPSS version 23 for data analysis. Demographic and clinical variables were presented in terms of mean  $\pm$  standard deviation and frequencies with percentages for quantitative and qualitative variables respectively. Chi square test was used to determine association of skull fracture with independent variables. A two tailed p-value  $\leq 0.05$  was considered as statistically significant.

## 3. RESULTS

A total 100 children's were included in the study. Among 100 children, 72% of patients were male with the median age of 84 (18-120) months while 28% of patients were female with median age of 60 (20-93) months. The children's were age

range from 6 months to 14 years with a median age of 72 (19-120) months. Children under 5 years age group, and school age group 5-10 years, contributed to 40% and 42% of head injuries, respectively. Male were more affected, and they accounted for 37.5%, 43.0%, and 19.4% of head injuries in under fives, 5-10 years, and 11-14 years age groups, respectively.

The major cause of trauma was fall (48%) followed by road traffic accident 47% and assault 4% cases. Thirty three (48.6%) of falls, 33 (45.8%) of road traffic accidents and 4 (5.5%) assault occurred in boys. Concerning to the site of contusion, 36% reported with parietal followed by frontal 30%, occipital 11%, temporal 8% and basilar 7%. Moreover at presentation majority of children's were conscious had a GCS of  $\geq 14$  (57%). The minimum GCS was 10 in four cases, and median GCS at the time of admission was 14(13-14). Details of baseline characteristics of patient mentioned in Table 1.

The distribution of demographic and injury characteristics for children with and without skull fracture is shown in Table 2. Out of 100 children's with brain contusion, 89% were diagnosed with skull fracture. The median age of the children with skull fracture was 72(18-108), and 70.7% of them were male. However no differences were observed in gender, age group, mechanism of trauma, site of contusion and size of contusion between fracture and non-fracture group. Moreover in children with skull fracture, linear skull fracture was found to be 67.80% followed by depressed skull fracture 32.20%.

## 4. DISCUSSION

In current study we explore the different aspects of traumatic head injury in children under 14 years of age, as this age group shows greater vulnerability to head injuries. A study conducted in Nigeria during 1992 to 1995 highlighted that trauma is the leading cause of childhood morbidity and mortality [13]. In our society head injury among children is very common and it requires serious measures in this regards. In countries like Pakistan high quality emergency services are not available. Children with head injuries mostly present with combination of injuries such as hemorrhage (subarachnoid, intraventricular, intracranial, epidural/subdural), contusion, skull fracture and scalp injuries. However the prevalence of head injuries may vary due to difference in definition of head injury. Glasgow Coma scale is used to assess the

severity of head injury in children but there is no uniform criteria is defined for labeling mild, moderate and severe head injuries. Some health specialist defined minor head injury as GCS of less than 15, while other have defined with GCS

of >12. Moreover the prevalence of traumatic brain injury in children presenting with GCS of 13 was around 20%, which makes the indication of CT in most children in order to rule out intra cranial or extra cranial injuries [14].

**Table 1. Baseline characteristics of patients**

Variable	N (%)
<b>Gender</b>	
Male	72(72)
Female	28(28)
<b>Age<sup>€</sup></b>	72(19-120)
<b>GCS at presentation<sup>€</sup></b>	14(13-14)
<b>Mechanism of Trauma</b>	
Fall	48(48)
RTA	47(47)
Assault	4(4)
Others	1(1)
<b>Site of Contusion</b>	
Frontal	30(30)
Temporal	08(8)
Occipital	11(11)
Basilar	7(7)
Parietal	36(36)
Others	8(8)
<b>Size of Contusion (ml)<sup>€</sup></b>	1.55(1.3-2)

€: Median and IQR reported as data not normally distributed

**Table 2. Distribution of Skull Fracture on the basis of baseline characteristics**

Skull Fracture	Yes n(%)	No n(%)	Total n(%)	p-value
<b>Gender</b>				
Male	63(87.5)	9(12.5)	72(100)	0.723
Female	26(92.9)	2(7.1)	28(100)	
<b>Age</b>				
Under 5 years	38(95.0)	2(5.0)	40(100)	0.136
5-10 years	36(85.7)	6(14.3)	42(100)	
11-14 years	15(83.3)	3(16.7)	18(100)	
<b>Mechanism of Trauma</b>				
Fall	42(87.5)	6(12.5)	48(100)	0.735
RTA	43(91.5)	4(8.5)	47(100)	
Assault	3(75.0)	1(25.0)	4(100)	
Others	1(100)	0	1(100)	
<b>Site of Contusion</b>				
Frontal	28(93.3)	2(6.7)	30(100)	0.206
Temporal	8(100)	0	8(100)	
Occipital	10(90.9)	1(9.1)	11(100)	
Basilar	4(57.1)	3(42.9)	7(100)	
Parietal	32(88.9)	4(11.1)	36(100)	
Others	7(87.5)	1(12.5)	8(100)	
<b>Size of Contusion</b>				
≤ 1.50	47(94.0)	3(6.0)	50(100)	0.11
> 1.50	42(84.0)	8(16.0)	50(100)	

In our study, boys of age more than 5 years were most commonly affected by traumatic brain injury. The findings of our study is in agreement with some other studies conducted in different parts of the world. The possible reason of high prevalence of traumatic brain injury among boys could be the outdoor engagement and risky behaviors resulting in high energy transfer [15-18]. Concerning regarding mechanism of traumatic head injury, fall was the most common etiology followed by road traffic accident and assault. These findings were also in line with studies done in developing countries [14,19,20].

In this study, children were evaluated with head CT scan at presentation. In the current study prevalence of skull fracture was found to be 89%. In previous studies the prevalence of skull fracture range from 31.5%-78% [21,22]. The most common type of skull fracture in our study was linear followed by depressed skull fracture. However these finding were contradicting with previous study, finding shows that depressed skull fracture was more prevalent then linear skull fracture [22]. However the most common causes of traumatic skull fracture were fall and road traffic accident in under 5 years of age, it may be due to the developmental immaturity in this particular group. In age group 5-10 years the most common mechanism of injury were RTA and fall, it may be due to small height of children and chasing habit of children on the road may combine to limit their visibility to drivers. While in age group 11-14 years the most common mechanism of injury was RTA, it may be due to the poor driving skills of young drivers and lack impulse control of the kids who hit others. These findings were in line with the study conducted by Hong Wei et al which concluded that fall and RTA were the most common cause of injury [23]. The rate of pediatric fractures were similar between boys and girls. These findings were consistent with other studies in which the fracture rates in younger children were similar between boys and girls [24,25]. Findings of our study suggest that there is an immense need to design appropriate protocol for the assessment children presenting with head injury. As prevalence of skull fracture is very high in children presenting with brain contusion, misdiagnosis or delay in diagnosis may increase the risk of neurological complications in such children.

This study has some limitation. Firstly, the cross-sectional nature of this study limits to draw a causal relationship. Secondly, this study has been conducted in single institute and study

population is very small. Thirdly, long-term follow-up was not done due to limited resources so the neurological outcomes of injuries was not determined.

## 5. CONCLUSION

In our study prevalence of skull fracture among children presenting with traumatic brain injury is very high. Fall and RTA were the most common mechanism of head injury. Linear skull fracture was more common as compared to depressed skull fracture. Timely diagnosis and early management help in preventing late neurological complication in such patients. Closer follow-up of traumatic brain injury is recommended in order to prevent delay in diagnosis of internal injuries. Our study findings suggested that clinicians should develop standard protocol for the assessment of children with brain contusion in emergency department in order to prevent misdiagnosis. This will help in reducing morbidity and mortality. Moreover, multicenter studies with large sample size should be done to determine the actual magnitude of problem.

## CONSENT

As per international standard, parental written consent has been collected and preserved by the authors.

## ETHICAL APPROVAL

As per international standard or university standard written ethical approval has been collected and preserved by the authors.

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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

## REFERENCES

1. Ahsan Aurangzeb EA, Maqbool S, Ihsan A, Asghar A, Bhatti SN, Alvi N, et al. Burr hole evacuation of extradural hematoma in

- mass trauma. A Life Saving and Time Saving Procedure: Our Experience in the Earthquake of 2005. *Turk Neurosurg.* 2016;26(2):205-8.
2. Ciurea A, Gorgan M, Tascu A, Sandu A, Rizea R. Traumatic brain injury in infants and toddlers, 0–3 years old. *J Med life.* 2011;4(3):234.
  3. McGrath A, Taylor RS. Pediatric skull fractures. *Stat pearls.* Treasure Island (FL): StatPearls Publishing Copyright © 2021, StatPearls Publishing LLC.; 2021.
  4. Masoumi B, Heydari F, Hatamabadi H, Azizkhani R, Yoosefian Z, Zamani M. The relationship between risk factors of head trauma with CT scan findings in children with minor head trauma admitted to hospital. *Open access Maced J Med Sci.* 2017;5(3):319.
  5. Sanchez JI, Paidas CN. Childhood trauma. Now and in the new millennium. *Surg Clin North Am.* 1999;79(6):1503-35.
  6. Siraj MU, Haq MU, Malik NA, Aziz A, Saeed R. Head injury in paediatric age group. *J Surg Pakistan.* 2010;15(4):190.
  7. Schutzman SA, Greenes DS. Pediatric minor head trauma. *Ann Emerg Med.* 2001;37(1):65-74.
  8. Parslow RC, Morris KP, Tasker RC, Forsyth RJ, Hawley CA, Group UKPTBISS, et al. Epidemiology of traumatic brain injury in children receiving intensive care in the UK. *Arch Dis Child.* 2005;90(11):1182-7.
  9. Poorman GW, Segreto FA, Beaubrun BM, Jalai CM, Horn SR, Bortz CA, et al. Traumatic fracture of the pediatric cervical spine: etiology, epidemiology, concurrent injuries, and an analysis of perioperative outcomes using the kids' inpatient database. *Int J Surg Spine.* 2019;13(1):68-78.
  10. Bressan S, Daverio M, Barker R, Molesworth C, Babl FE. Paediatric recreational vehicle-related head injuries presenting to the emergency department of a major paediatric trauma centre in Australia: Is there room for improvement? *Emerg Med Australas.* 2016;28(4):425-33.
  11. Hamrah H, Mehrvarz S, Mirghassemi AM. The frequency of brain CT-Scan findings in patients with scalp lacerations following mild traumatic brain injury; A Cross-Sectional Study. *Bull Emerg Trauma.* 2018;6(1):54-8.
  12. Alexiou GA, Sfakianos G, Prodromou N. Pediatric head trauma. *J Emerg Trauma Shock.* 2011;4(3):403-8.
  13. Adesunkanmi AR, Oginni LM, Oyelami AO, Badru OS. Epidemiology of childhood injury. *J Trauma.* 1998;44(3):506-12.
  14. Rasmussen LK, Raghupathi R, Chen S-SL, Huh JW, Felice Su M, FAAP. *Neurocritical Care for Severe Pediatric Traumatic Brain Injury*; 2018. [Cited 2020 December 20]. Available: <https://emedicine.medscape.com/article/909105-overview>
  15. Schrieff LE, Thomas KG, Dollman AK, Rohlwick UK, Figaji AA. Demographic profile of severe traumatic brain injury admissions to Red Cross War Memorial Children's Hospital, 2006-2011. *S Afr Med J.* 2013;103(9):616-20.
  16. Nnadi MO, Bankole OB, Fente BG. Epidemiology and treatment outcome of head injury in children: A prospective study. *J Pediatr Neurosci.* 2014;9(3):237-41.
  17. Collins NC, Molcho M, Carney P, McEvoy L, Geoghegan L, Phillips JP, et al. Are boys and girls that different? An analysis of traumatic brain injury in children. *Emerg Med J.* 2013;30(8):675-8.
  18. Satapathy MC, Dash D, Mishra SS, Tripathy SR, Nath PC, Jena SP. Spectrum and outcome of traumatic brain injury in children <15 years: A tertiary level experience in India. *Int J Crit Illn Inj Sci.* 2016;6(1):16-20.
  19. Punchak M, Abdelgadir J, Obiga O, Itait M, Najjuma JN, Haglund MM, et al. Mechanism of pediatric traumatic brain injury in Southwestern Uganda: A prospective cohort of 100 patients. *World Neurosurg.* 2018;114:e396-e402.
  20. Gupta PP, Malla GB, Bhandari R, Kalawar RPS, Mandal M. Patterns of injury and mortality in pediatric patients attending emergency department in a tertiary care center in Eastern Nepal. *JNMA; J Nepal Med Assoc.* 2017;56(207):331-4.
  21. Rodà D, Trenchs V, Curcoy AI, Martínez AD, Pou J, Luaces C. Epidemiology of fractures in children younger than 12 months. *Pediatr Emerg Care.* 2019;35(4):256-60.
  22. Bedry T, Tadele H. Pattern and outcome of pediatric traumatic brain injury at Hawassa University Comprehensive Specialized Hospital, Southern Ethiopia: observational

- cross-sectional study. *Emerg Med Int*; 2020.
23. Wang H, Zhou Y, Liu J, Ou L, Han J, Xiang L. Traumatic skull fractures in children and adolescents: A retrospective observational study. *Injury*. 2018;49(2):219-25.
24. Hedström EM, Svensson O, Bergström U, Michno P. Epidemiology of fractures in children and adolescents: Increased incidence over the past decade: a population-based study from northern Sweden. *Acta orthopaedica*. 2010; 81(1):148-53.
25. Oral R, Blum KL, Johnson C. Fractures in young children: Are physicians in the emergency department and orthopedic clinics adequately screening for possible abuse? *Pediatr Emerg Care*. 2003;19(3): 148-53.

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