

# Role of Computed Tomography in Pediatric Traumatic Brain Injury and its Correlation with Glasgow Coma Scale at Presentation

Ahmad Imran,<sup>1</sup> Abid Ali Qureshi,<sup>2</sup> Amna Tariq<sup>3</sup>

## Abstract

The study was aimed at documenting the relationship between Glasgow coma score with imaging findings on computed tomography in children with traumatic brain injury. Un-necessary radiation exposure can be detrimental in pediatric age group and can lead to an increased risk of radiation induced malignancies.

**Patients and Methods:** This retrospective study was conducted in Department of Radiology Lahore from 15.8.11 to 15.11.11. It included 48 children who presented in emergency department with history of fall or trauma to head. These patients underwent computed tomography using standard imaging protocols. All the data was analyzed by using SPSS version 17.

**Results:** A total of 48 patients from 6 months to 15 years of age with history of fall or trauma to head who underwent CT scan were included in study. 20 (42%) patients revealed normal study. Extra/intra axial bleed is noted in 11 (23%), evidence of cerebral edema was

noted in 4 (8%) patients. 9 (19%) patients had fracture of skull bones and cephalhematoma was noted among 4 (8%) patients. Imaging findings were seen in majority of the patients with GCS less than 13/15.

**Conclusion:** Neuroimaging can serve as a useful guide regarding management of traumatic brain injury however un-necessary radiation exposure is detrimental in pediatric age group. A correlation between GCS and decision regarding imaging can serve as an effective approach to decrease rates of neuroimaging after pediatric head trauma.

**Key Words:** Computed tomography, head injury, GCS

## Introduction

Pediatric head trauma is one of the most common indication for computed tomography and results in greater than 650,000 emergency department visits in the United States every year.<sup>1</sup> Among all the causes road traffic accidents and falls are the major cause of pediatric head injury.<sup>2,3</sup> Children are more susceptible to head injury as they have large head to torso ratio and thin cranial vault. The common patterns of injury include skull fractures, bleed, hematomas and cerebral edema. As children are very sensitive to radiation induced malignancies the judicious use of CT scan is very important.

Computed tomography has a key role in diagnosis of traumatic brain injury and to guide regarding further management. However un necessary imaging should be avoided as the lifetime risk of death due to radiation induced malignancy from one head CT is 1 in 1500 in a one year old infant and 1 in 5000 in a 10 years old child.<sup>4</sup> In a study conducted by Gulsen I et al in infants

<sup>1</sup> Medical Officer

Dept of Radiology, Children Hospital, Lahore

<sup>2</sup> Associate Professor/ HOD of Radiology

Children Hospital, Lahore

<sup>3</sup> PGR, Dept of Radiology, Children Hospital, Lahore

Date of Submission

Date of Revision Received

Date of Acceptance for Publication

Conflict of Interest: None

Funding Source: None

## Contribution

All Authors have contributed in Study Design, Data Collection, Data Analysis, Data Interpretation, Manuscript Writing and Approval.

and children with minor head trauma, most CT scans were unnecessary and the most common reason for requesting a CT was fear of malpractice litigation of physicians.<sup>5</sup>

Clinical assessment and GCS score plays a key role in decision making regarding CT scan of patient so that unnecessary imaging can be avoided in low risk patients. Mechanism of injury and GCS are related to abnormal CT findings.<sup>6</sup> Identification of children who are having low risk is very important as radiation exposure is detrimental in pediatric age group.

The goal of our study was to establish a correlation between positive CT findings and Glasgow coma scale at presentation so that unnecessary CT scans can be avoided. This will aid in reducing the sedation and radiation risk. Children are ten times more susceptible to radiation induced cancer than adults.<sup>12</sup> Pediatric population has longer life expectancy therefore the chances of manifestation of radiation induced effects are high.<sup>13</sup>

## Patients and Methods

The study was conducted at Department of Radiology, Lahore for a period of three months from 15-08-11 to 15-11-11. A total of 48 patients with ages six months to fifteen years with history of head injury were included. Demographic data. Clinical history and Glasgow coma scale were documented at the time of presentation. The patients having clinical suspicion of non-accidental injury or any bleeding disorder were excluded from the study. CT scan brain from base of skull to vertex with bone window images without intravenous contrast were obtained. Scanning was performed with parameters of 120 KVP tube voltage, 165 m As effective tube current, 24 mm/sec table speed and 512 × 512 matrix size. The data was analyzed by using SPSS version 17.

## Results

A total of 48 patients were included in the study, among those 20 (41.66%) were males and 28 (58.33%) were females. The common presenting complaints were vomiting (31%), loss of consciousness (21%), seizures (06%), irritability (14.5%), bruises/laceration (17%) and (10.05%) patients had no obvious presenting complaints. The mechanism of injury in 52% patients was road traffic accident, 27% had history of

fall from roof, 15% presented with history of fall from bed and 6% had other causes. CT scans were performed for all the children. 20 scans were normal and 28 were abnormal. Of the children with abnormal CT scans, 23% (11) had mild extra/intra axial bleed, 19% (09) had skull fractures 8% (4) had cephalhematoma and 8% (4) demonstrated evidence of cerebral edema (Fig. 1). GCS score was 11 or above in all patients with normal imaging findings (Fig. 2) with only 2 (10%) patients have GCS less than 13/15. In patients with positive CT findings 89.28% patients had GCS score 13 or below. 3 patients with GCS 14 or above had positive CT findings, 2 had linear skull fractures and 1 had cephalhematoma (Fig. 3). Among these three patients two presented with history of vomiting and one had no symptom at the time of presentation.

## Discussion

Head injury is one of the most common reason for pediatric emergency visits. The important causes include automobile accidents, falls and non-accidental injuries. The imaging modality of choice in such cases is computed tomography. Symptoms associated with positive CT scans included headache, nausea, vomiting, seizures and amnesia.<sup>7,8</sup>

Computed tomography has a key role in diagnosing traumatic brain injury but its use must be justified. Literature suggests that CT usage must be justified and controlled.<sup>9-11</sup> The most susceptible age group for radiation induced effects is children aged under two years.

Glasgow coma scale at the time of presentation should be documented by taking into account best eye response, best motor response and best verbal response. In the PECARN study children with altered mental state or palpable skull fracture with GCS 14 or 15 were considered high risk and were subjected to CT scan.<sup>14</sup> According to CHALICE study a child must undergo CT scan if GCS is less than 14 or less than 15 in child younger than one year.<sup>15</sup> In our present study most of the patients with GCS 14 or 15 had normal imaging findings. In patients with GCS 13 or below spectrum of imaging findings in the form of extra/intra Dural bleeds, skull fractures, hematoma and cerebral edema were demonstrated.

Appropriate use of neuroimaging helps in detecting most of the neuro surgical emergencies. Subjecting high risk patients to imaging so that appropriate management can be undertaken is very important. Early

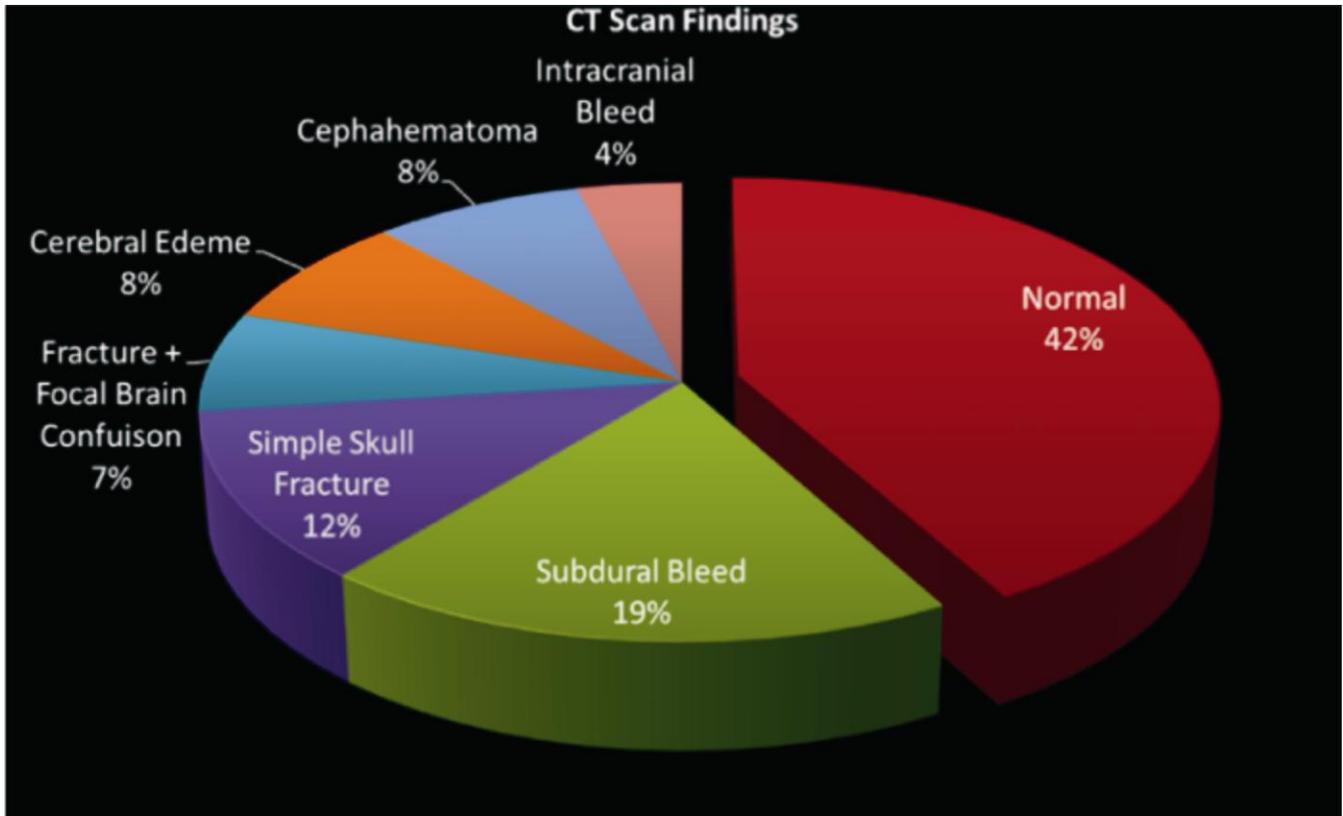


Figure 1:

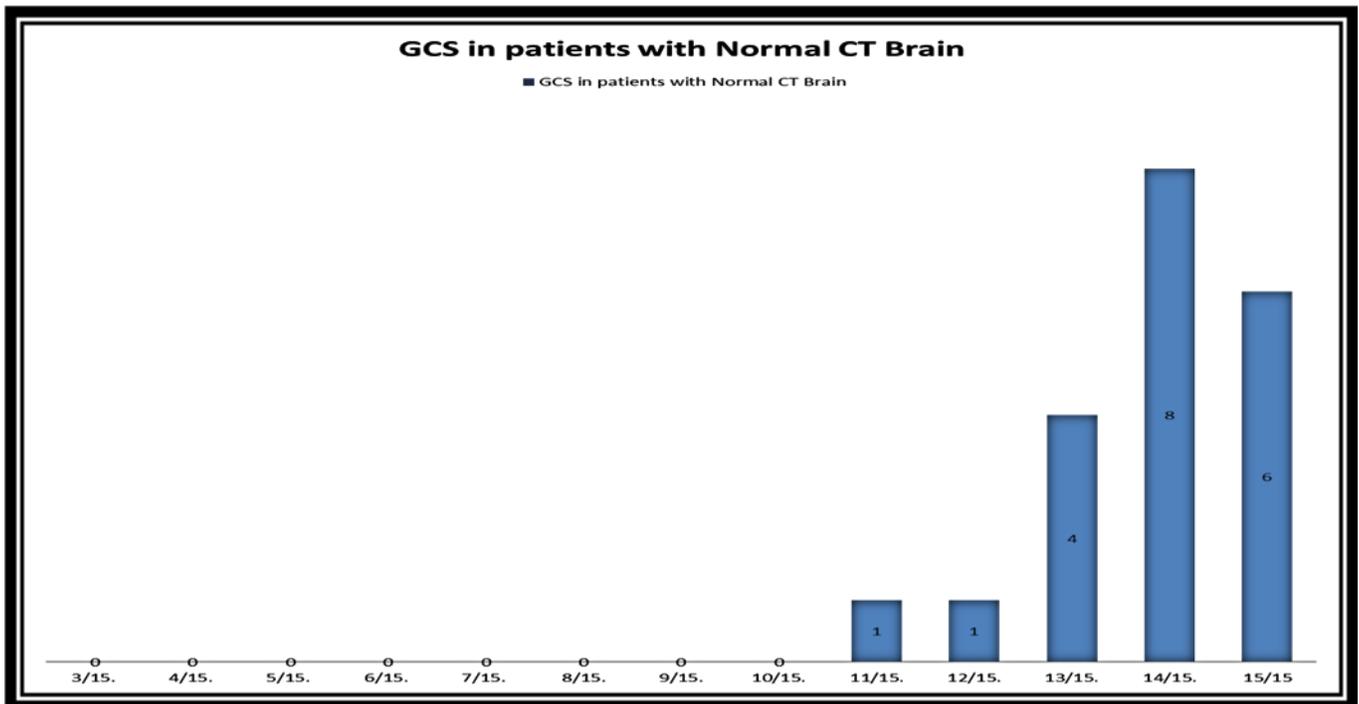


Figure 2:

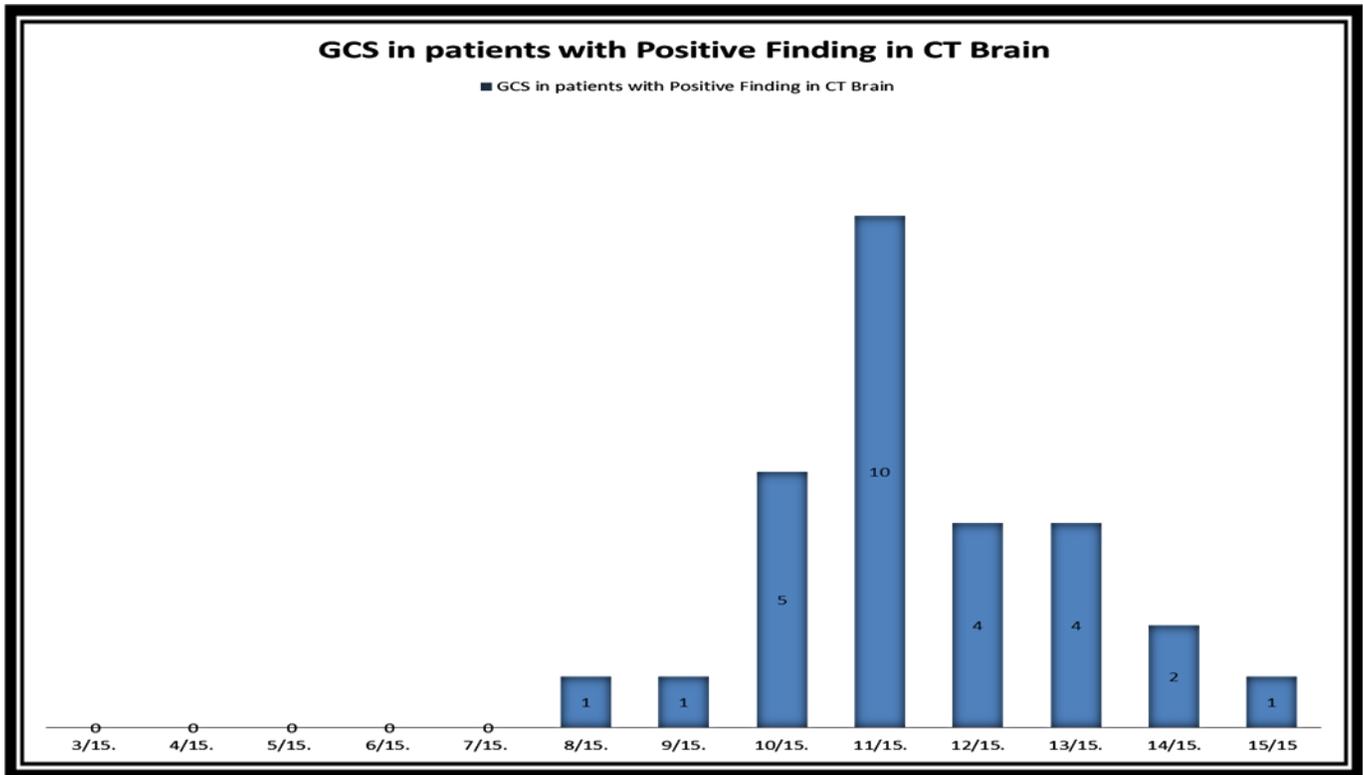


Figure 3:

identification of traumatic brain injury will help in reducing secondary brain damage. Low risk patients as determined by clinical assessment and GCS can be managed symptomatically in order to protect these children from radiation hazard.

Correlation of Glasgow coma scale with imaging is very important in pediatric age group. The benefits gained by CT should always be carefully weighed against the possible harms of radiation exposure. In CATCH study it is emphasized that CT scan must be selectively reserved for those patients who are at a significant risk of traumatic brain injury in order to avoid risks associated with ionizing radiation.<sup>16</sup>

### Conclusion

Traumatic head injury is one of the leading cause of death and disability in children. Computed tomography remains the standard imaging modality in these cases however it has risks of radiation-induced malignancy. Children with apparently minor head injury as indicated by Glasgow Coma Scale of 14 or 15 and absence of any serious presenting complaint can be protected from hazardous effects of ionizing radiation by avoiding injudicious CT examination.

### References

1. Kuppermann N. Pediatric head trauma: the evidence regarding indications for emergent neuroimaging. *Pediatr Radiol.* 2008; 38 (Suppl. 4): S670–4.
2. Tepas JJ, Scala CD, Ramonofsky ML, Barlow B. Mortality and head injury: The pediatric perspective. *Journal of pediatric surgery.* Jan. 1990; 25: 92-96.
3. Alexiou GA, Safakianos G, Prodromou N. Pediatric head trauma. *J Emerg Trauma Shock,* 2011 Jul-Sep; 4 (3): 403–408.
4. Brenner D, Elliston C, Hall E, Berdon W. Estimated risks of radiation-induced fatal cancer from pediatric CT. *AJR Am J Roentgenol.* 2001; 176: 289.
5. Gülşen I, Ak H, Karadaş S, Demir I, Bulut MD, Yaycıoğlu S. Indications of brain computed tomography scan in children younger than 3 years of age with minor head trauma. *Emerg Med Int.* 2014; 2014: 248967.
6. Klassen TP, Reed MH, Stiell IG, Nijssen – Jordan C, Tenenbein M, Joubert G, Jarvis A, Baldwin G, St-Vil D, Pitters C, Belanger F, McConnell D, Vandemheen K, Hamilton MG, Sutcliffe T, Colbourne M. Variation in utilization of computed tomography scanning for the investigation of minor head trauma in children: a Canadian experience. *Acad Emerg Med.* 2000 Jul; 7 (7): 739-44.
7. Miller EC, Holmes JF, Derlet RW. Utilizing clinical factors to reduce head CT scan ordering for minor head

- trauma patients. *J Emerg Med.* 1997; 15: 453-457.
8. Jeret JS, Mandell M, Anziska B, et al. Clinical predictors of abnormality disclosed by computed tomography after mild head trauma. *Neurosurgery*, 1993; 32: 9-15.
  9. Brenner DJ, Elliston CD, Hall EJ, Berdon WE. Estimated risk of radiation induced fatal cancer from pediatric CT. *AJR Am J Roentgenol.* 2001; 176: 289-96.
  10. Pearce MS, Salotti JA, Little MP, McHugh K, Lee C, Kim KP. Radiation exposure from CT scans in childhood and subsequent risk of leukaemia and brain tumours: A retrospective cohort study. *Lancet*, 2012; 380: 499-505.
  11. Mathews JD, Forsythe AV, Brady Z, Butler MW, Goergen SK, Byrnes GB, et al. Cancer risk in 680,000 people exposed to computed tomography scans in childhood or adolescence: Data linkage study of 11 million Australians. *BMJ.* 2013; 346: f2360.
  12. International Commission on Radiological Protection. 1990 recommendations of the International Commission on Radiological Protection. Oxford, England: Pergamon ICRP publication, 1991; 60.
  13. Thukral BB. Problems and preferences in pediatric imaging. *Indian J Radiol Imaging*, 2015 ;25: 359-64.
  14. Kuppermann N, Holmes JF, Dayan PS, et al; Pediatric Emergency Care Applied Research Network (PECARN). Identification of children at very low risk of clinically – important brain injuries after head trauma: a prospective cohort study. *Lancet*, 2009; 374 (9696): 1160–1170.
  15. Dunning J, Daly JP, Lomas JP, Lecky F, Batchelor J, Mackway – Jones K. Children's head injury algorithm for the prediction of important clinical events study group. Derivation of the children's head injury algorithm for the prediction of important clinical events decision rule for head injury in children. *Arch Dis Child*, 2006 Nov; 91 (11): 885-91.
  16. Osmond MH, Klassen TP, Wells GA, et al; Pediatric Emergency Research Canada (PERC) Head Injury Study Group. CATCH: a clinical decision rule for the use of computed tomography in children with minor head injury. *CMAJ*, 2010; 182 (4): 341–34.