International Journal of Radiology and Diagnostic Imaging

E-ISSN: 2664-4444
P-ISSN: 2664-4436
www.radiologypaper.com
IJRDI 2020; 3(2): 01-06
Received: 02-02-2020
Accepted: 05-03-2020

Dr. Urvi Khambhati
Department of Radiology, Lilavati Hospital and Research Centre, Maharashtra, India

Dr. Ruchit Shah
Department of Orthopaedics. Era's Medical College, Lucknow, Uttar Pradesh, India

Dr. Vipul Solanki
Department of Radiology. Sir T Hospital, Bhavnagar, Gujarat, India

Dr. Hadin Matadar
Department of Radiology Sir T Hospital, Bhavnagar, Gujarat, India

Feral Daruwala
Department of Medical Writing, Nephrolife-The Complete Kidney Care, Surat, Gujarat, India

Corresponding Author:
Dr. Urvi Khambhati
Department of Radiology, Lilavati Hospital and Research Centre, Maharashtra, India

Associations of computed tomography imaging findings and Glasgow coma scale in head trauma patients: A cross-sectional, observational study

Dr. Urvi Khambhati, Dr. Ruchit Shah, Dr. Vipul Solanki, Dr. Hadin Matadar and Feral Daruwala

DOI: http://dx.doi.org/10.33545/26644436.2020.v3.i1d.88

Abstract

Objective: This cross-sectional, observational study was undertaken to find out the association between Glasgow coma scale (GCS) with computed tomography (CT) findings in patients with head trauma (HT).

Materials and Methods: In total, 100 participants were enrolled randomly during the period of December 2016 to December 2017. Patients having a history of HT who were advised for brain CT scan were included in the study. In each patient, GCS scoring was noted and, brain CT scans were performed without any medium of contrast.

Results: Mean age of patients was 34.39± 18.31 years. Male: female ratio was 2.6:1. Adults' age group was more commonly involved, with 62% of cases seen in 18-45 years of age group. The most prevalent cause of HT was a road traffic accident in 64% cases, followed by physical assaults in 20% and falls from height in16%. According to GCS, the distribution of patients was estimated to be 44% with mild HT (GCS 13-15), 46% with moderate HT (GCS 9-12) and 10% with severe HT (GCS 3-8). GCS scoring and CT findings (extra-axial hematoma, subarachnoid haemorrhage, fracture of skull bones, contusion, hemosinus, midline shift and pattern of three or more findings) were significantly associated. There was a significant difference in the average GCS of events with a single lesion (M=13.62, SD=0.49) and multiple lesions (M=10.48, SD=1.88); P<0.0001. In addition, the average GCS of the events with multiple lesions and multiple lesions events together with midline shift (7.85±1.61) was also statistically significant (P<0.0001).

Conclusion: There was a significant association between GCS and CT findings in HT cases. The existence of multiple lesions with midline shift in CT scan findings was accompanied with low GCS score, whereas, patients with single lesion had a greater level of GCS.

Keywords: Computed tomography scan findings, Glasgow coma scale, head trauma

Introduction

Head trauma (HT) is also termed as "Traumatic brain injury", described by an assault to the brain produced by an outward physical force that may lead to a situation of modified consciousness. HT is the most dominant causes of death as well as physical and psychological disabilities worldwide. According to data provided in existing literature, male-to-female ratio for HT is nearly 2:1 and, it is much more common in persons younger than 35 years. HT continues to be a tremendous public health concern, even with advanced medicine in the 21st century. In the Indian scenario, the annual incidence of HT has been estimated to be approximately 1.5 to 2 million people suffer injuries [1] and, millions of people die. While various mechanisms may cause HT, the most common causes include accidents, assaults and fall from height. Moreover, alcohol indulgence at the time of injury is also known to occur among 15%-20% cases of head injuries. Today, many developing countries including, India face the severe challenges of prevention, pre-hospital care and rehabilitation in their swiftly altering environments, to reduce the burden of HT [2].

In addition to a detailed history and extensive clinical evaluation, in such cases, the Glasgow Coma Scale (GCS) and Computer Tomography (CT) are the cornerstones of the diagnostic workup. In particular, it is vital to ascertain the root of the trauma, the extent of the effects, and presence of neurological manifestations, convulsion, time duration among the accident and the assessment, vomits [3] and especially, report all information on loss of consciousness [4].

Clinically, the management of HT is based on the GCS which was firstly published by Graham Teasdale and Bryan Jennett in 1974. GCS can provide a complete frame for evaluating the three clinical aspects of responsiveness including, eye-opening, motor, and verbal responses leading proper neurological disability stratification and HT severity. Accordingly, based on the GCS, the severity of HI is classified into mild (3 to 8), moderate (9 to 12), and severe (13 to 15).

Apart from the clinical management in HT patients, the intracraneous lesions in HT patients can be identified even before clinical symptoms can occur with the help of imaging methods which remains the preferred choice in the primary investigation where this service is accessible. Related to this context, previous studies showed that timely identification of neurological lesions by such modalities is beneficial to obtain the proper therapeutic outcome and also preventing undesirable interventional therapies [5]. With this regard, eight hours is the optimal time point for performing CT, especially in the elderly and in the cases where the shreds of evidence of skull fracture, seizure episode, retrograde amnesia, or hazardous mechanical trauma.

CT scanning is the gold standard diagnosis in detecting brain lesions in HT patients, especially, in the early stages, though its use is restricted due to unavailability in settings and contraindicated in almost conditions. Moreover, in some incidence of HT, pre CT scan and post-scan after the intervention is mandatory to assess the development of lesions and, application of inappropriate clinical options or other intervention can result in unnecessary follow-up CT scans. Although CT scan performed routinely in almost cases of HT, there is still a dilemma exists as which group of patients should be subjected to CT to avoid unnecessary exposure to radiation in low-risk cases. Due to this issue, there is a rise in the events of unnecessary time wasted on follow-up diagnostics and treatments and, expenditure behind the use of facilities and manpower, which is pointless. And cost-effectiveness is also one of the dominant concerns as the patient's point of view because the cost of one CT scan in India is almost 800 RS/-.

Keeping these pros and cons in mind, we carried out this research aimed to evaluate the association of computed tomography (CT) findings and Glasgow coma scale (GCS) with the rationale to introduce GCS scale as an admittable CT scan substitute for HT management.

2. Materials and Methods

2.1 Settings of the Study

It is a cross-sectional observational study carried out on HT cases admitted in emergency (Casualty) department of institute. Protocol approval number (IRB (HEC) 647/2016) was obtained after the endorsement of the study protocol by the Institutional Ethics Committee (IEC) and written informed consent was obtained from the participant or legally acceptable representative (LAR), wherever applicable. In the case of the illiterate participant, the impartial witness was used. The study was carried out in accordance with the declaration of Helsinki. In total, 100 participants were enrolled randomly over a period of one year (December 2016 to December 2017).

2.2 Participants of the study

Every patient with a HT history by any means referred from the emergency and meeting the inclusion criteria of the study were considered as study cases. The GCS was noted on arrival by the physician at the emergency ward in all the patients. The patient's demographic features such as age, gender, risk factors like mode of injury and, clinical data including, GSC score and CT findings (tomographic patterns and presence of single or multiple lesions) were also noted. Patient's neurological assessment was done by a trained neurologist.

2.3 Inclusion criteria

Patients having a history of HT who were advised for brain CT scan and have been provided their consent were included in the study regardless of any gender bias.

2.4 Exclusion criteria

The following exclusion criteria included in the study:

1. Patients who sustained a HT and did not have CT scans.
2. Postoperative CT scans were excluded.
3. Patients who had other neurosurgical diseases like intracranial tumour & sustained head injury secondary to the disease.

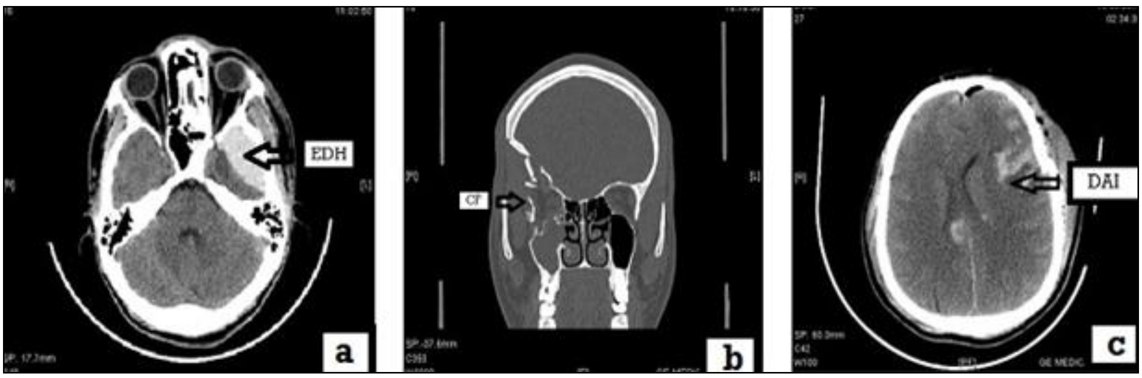
After initial in-depth clinical evaluation, HT severity was graded as follows with the help of GCS scoring [6]: Mild-13 to15, Moderate-9 to12, Severe-3 to 8.

2.5 CT scan procedure

Each involved study patient was subjected to cranial CT without intravenous contrast agent administration. Cranial CT scans were performed in dorsal decubitus, using a single slice, helical GE CT system using 130 kVp and 80 mAs. Parallel to the infraorbitomeatal axis, axial sections were done with 5 mm-thick slices in the region of the posterior fossa and 10 mm in the other regions of the skull. Every cranial CT figure were examined by a radiologist, expertise in trauma, mainly in soft tissue windows (200 W and 40 C for the skull base and 80 W and 35 C for the brain) as well as the bone structures (1500 W and 450 C).

2.6 Tomographic patterns

Here mentioned verdicts were used as tomographic patterns: Extra axial hematoma (Epidural haemorrhage and subdural haemorrhage), subarachnoid haemorrhage, fracture of skull bones, contusion, hemosinus, pneumocranium, midline shift, diffuse axonal injury, cerebral edema and pattern of three or more features [Fig 1].



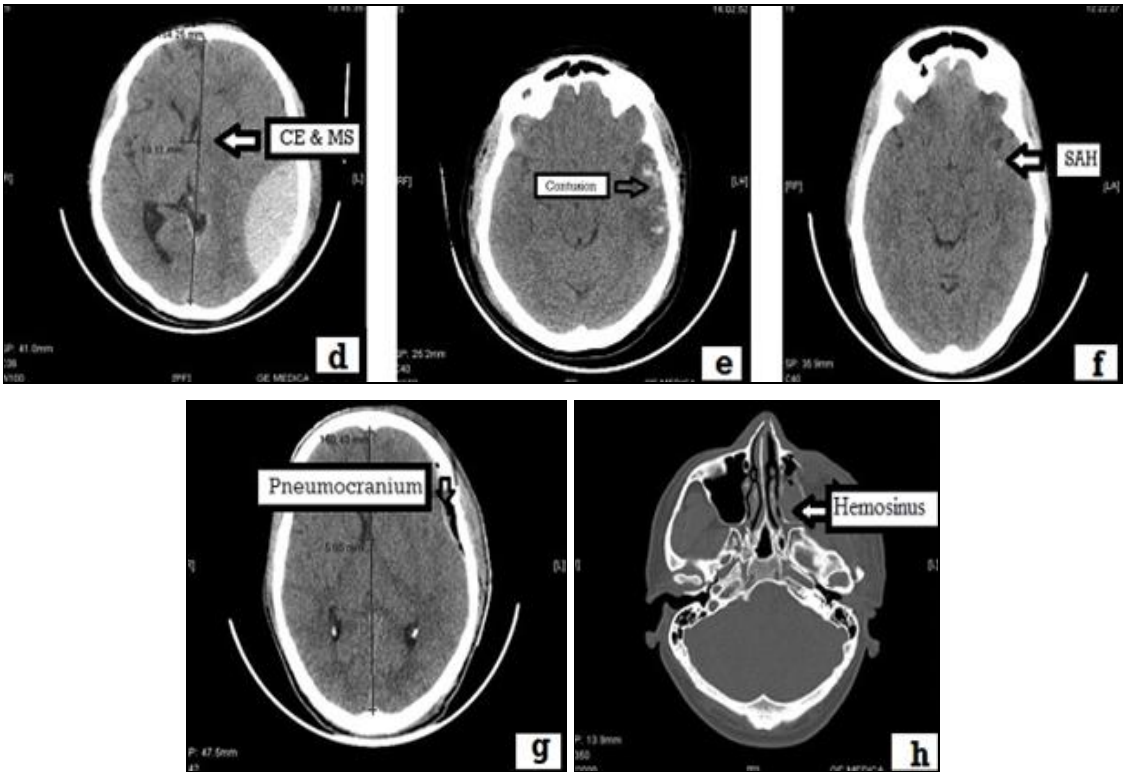


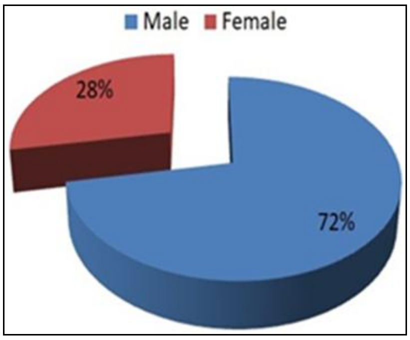
Fig 1: Tomographic patterns showing following features: **(a)** Extra-axial hematoma (EDH: Epidural haemorrhage) **(b)** Comminuted fractures (CF) **(c)** Diffuse axonal injury (DAI) **(d)** Cerebral edema (CE) and midline shift (MS) **(e)** Contusion(CT) **(f)** Subarachnoid haemorrhage (SAH) **(g)** Pneumocranium (h) Hemosinus

2.7 Statistical analysis

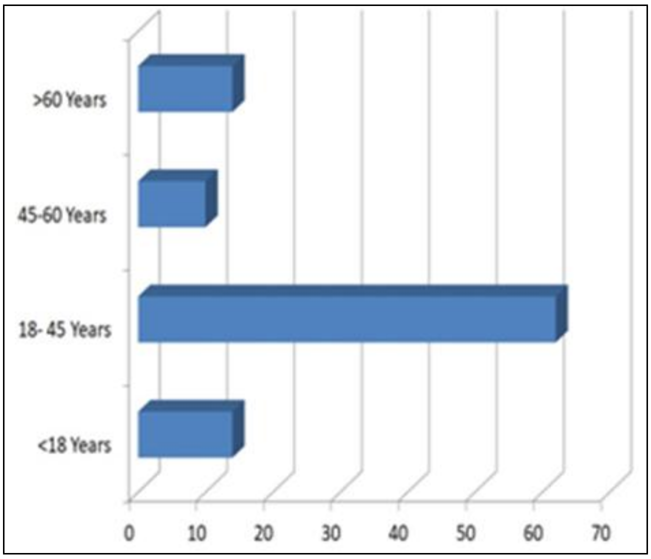
For statistical analysis, mean ±standard deviation was determined to represent continuous variables and frequency (percentage) was used to describe categorical variables. The association between CT scan findings and GCS scale was evaluated using the Fisher exact test. Independent sample t-test was used to study the number of lesions and the presence of midline shift with mean GCS. *P*-value <0.05 was regarded as significant. Data were analyzed using IBM Corp. Released in 2011. IBM SPSS Statistics for Windows, Version 21.0. (Armonk, NY: IBM Corp).

3. Results

This study was conducted in the Department of radiology with association from department of emergency medicine of our institute for one year. In total, 100 patients with a history of HT were included. HT was found to be very common in males comprising of 72% cases and 28% females deriving male: female ratio of 2.6:1 [Graph 1]. Mean age of study participants was found to be 34.39±18.31 years. The age-wise distribution of the cases is displayed in Graph 2.



Graph 1: Graphical representations for gender wise distributions of cases



Graph 2: Graphical representations for age wise distribution of the cases

Adults group was relatively more affected in this study, with almost 62% cases in 18-45 years age group, followed by 14% in paediatric (<18 years) and 24% in geriatric (45 to >60 years) age group. In all age groups above 45 years of age, there was a decrease in the number of cases with increasing age. In the present study, the most usual type of injury was a road traffic accident in 64% cases, followed by physical assaults in 20% and falls from height in16%. As part of routine clinical management, GCS was estimated for all the study participants. According to GCS, 44% of cases were mild HT, 46% were moderate HT and 10% cases were severe HT. Among the studied patients, 61% had altered CT scan report and remaining, 39% of CT scans did not reveal any abnormality. Frequency of tomographic patterns observed in CT findings was listed in Table 1. Association between the GCS scoring and CT findings (extra-axial hematoma, subarachnoid haemorrhage, fracture of skull bones, contusion, hemosinus, midline shift and pattern of three or more findings) was detected as a **s**tatistically significant.

Table 1: Statistical correlation between GCE and CT findings

	Extra axial hematoma (EDH/SDH)	**Subarachnoid haemorrhage**	**Fracture of skull bones**	**Contusion**	**Hemosinus**	**Pneumocranium**	**Midline shift**	**Diffuse axonal injury**	**Cerebral edema**	**Pattern of three or more findings**
Mild HT	1	0	5	1	1	0	0	0	0	0
Moderate HT	21	16	43	16	7	4	4	0	1	20
Severe HT	10	8	10	10	3	1	10	1	1	10
Total	32	24	58	27	11	5	14	1	2	30
	P<0.001	*P*<0.001	*P*<0.001	*P*<0.001	*P*=0.013	*P*=0.096	*P*<0.001	*P*=0.100	*P*=0.191	*P*<0.001

¥ HT, Head trauma; EDH, Epidural haemorrhage; SDH, Subdural haemorrhage. Bold indicate significant value. *P*<0.05 was considered as significant.

An independent t-test was run to compare the average GCS between the events with single and multiple lesions. The group of single and multiple lesions comprised of 39 and 61 randomly allocated participants, respectively. The average GCS for single lesion cases was 13.62± 0.49 and 10.48±1.88 for multiple lesions. Their average GCS was statistically significant (*P*<0.0001). The average GCS of the events with multiple lesions and multiple lesions together with midline shift (7.85±1.61) was statistically significant, too. (*P*-value <0.0001) [Table 2].

Table 2: Grading of type of lesions based on GCS

CT Findings	**No**	**Mean GCS ±SD**	***P*-value**
Single lesions	39	13.62± 0.49	<0.0001*
Multiple lesion	61	10.48±1.88	<0.0001*
Multiple lesion +Midline Shift	13	7.85±1.61	<0.0001*

¥ *Highly significant at 95% CI

When researching the form of the lesion within the GCS scale association, it was confirmed that

a) Multiple lesions have a GCS level lower than the single lesion.
b) Multiple lesions together with midline shift have a lower GCS score compared to single lesion and multiple lesions.

4. Discussion

To date, the occurrence of HT is rising in developing countries due to traffic increases, additionally; other factors such as, industrialization, ballistic trauma and falls also blamed for its root cause. In India, the incidence of mortality, morbidity, and disability in cases of HT due to road traffic means are a real threat to the country. The higher figures are mostly seen in young adults. Immediate and accurate detection of craniocerebral lesions in severe HT is of paramount importance due to associated high mortality from those lesions and, the reality is that timely diagnosis and treatment will remarkably alleviate the untoward effect dramatically. Presently a CT scan is the chief modality for investigation of cases with severe HT. The patients' initial GCS is an essential factor in deciding about preliminary treatment and concerns over the long term. According to Scottish Intercollegiate Guideline Network (SIGN) 2000, GCS was determined as a predictive factor for HT following statistical analysis [7]. Published reports are in favor of a correlation between mortality and severity of injury as per the GCS score [8, 9]. Importantly, the GCS score is a reliable indicator of outcome in other documented studies by *Selladurai et al.* [10] which revealed that 95% of patients with 4 or less score are expected to have poor outcomes relative to those with a score of 8 or more.

In the present study, male predominance (72%) was higher compared to the female. This finding was in coherence with *Morgado et al.* [11] (80.4%), *Farshchian et al.* [12] (89.12%) and *Vignesh et al.* [13] (83.99%). Men are more likely to be exposed to outside work and violence activities than women. Generally speaking, men are more accessible to automobiles such as two-wheelers and, are more exposed to accident threat than women. Also, the indulgence of alcohol before driving is also a major causation for the same. Maximum patients (62%) were from the age group of 18-45 years of age, followed by paediatric and geriatric age group and mean age was found to be 34.39± 18.31 years. These verdicts were more or less similar to the findings reported by *Morgado et al.* [11] (mean age: 37.77 ± 18.69 years), *Farshchian et al.* [12] (mean age: 25 ± 5 years.) and *Sah et al.* [14] (mean age: 35.6± 21.516 years). This emphasizes that HT was most common in the productive age group, as this group people are more involved in outdoor activities making them more prone to HT. In our study, a road traffic accident was the most common (64%) cause of the HT followed by assault (20%) and a history of fall (16%). These findings are in favour of existing data reported in the literature [11-14]. This point toward an unsafe driving practice followed in our country along with alcohol indulgence while driving is a serious safety concern. Condition of roads, especially in the rainy season is equally responsible for the increased incidence of road traffic accidents leading to HT. As per the GCS, the distribution of participants in our study was nearly similar to the previously reported study [11-14]. This finding comes with a positive remark that not all HT are necessarily severe. But the complete evaluation of the patient after HT is a critical part of treatment. In the present study, 61% had altered CT scan report and remaining, 39% of CT scans did not reveal any abnormality. *Farshchian et al.* [12] found 79.86% positive CT scans; *Jain et al.* [15] found 83% positive CT scans. In summary, this fair amount of positive CT scans in patients with HT suggests the sensitivity of CT scan in finding lesions.

These positive findings in the present study included fractures of skull bones being the most common (58%) followed by Epi/subdural haemorrhage (32%) and contusion (27%) while only 1% patient with diffuse axonal injury. These are in agreement with the outcomes of a study by *Vignesh et al.* [13] where they found that 39% fracture, 25% contusion and 5% of patients had multiple injuries. Studies by *Farshchian et al.* [12] had evidence of subgaleal haemorrhage.

Association between the severity of brain lesion measured by the level of consciousness on the GCS scoring system and the existence of lesions in brain CT scan is now viewed as a unique topic in patients with HT to reduce needless CT follow-up. This matter can be meaningful in infants and also in those with complete or partial CT scanning contraindications. Our research tried to establish the association between CT results and GCS scoring system to screen probability of foretelling brain lesions by evaluating the GCS score at the time of admission.

In literature, a few studies evaluated the association between GCS score and CT scan, which is one of the reasons to carry out this study to collect more evidence in this regards. Secondly, its influence in the Indian population is also another focusing point. *Lee et al.* [16] hypothesized that there was a positive correlation between GCS and CT scan findings and, the practice of follow-up CT scans was indicated only in patients with clinical worsening not described by changes in intracranial pressure. In agreement with *Farshchian et al*. [12], only three type lesions including, extra‑axial hematoma, subarachnoid haemorrhage, and hemorrhagic contusion might be correlated with lower GCS scale. *Joseph et al.* [17] proposed that a mild GCS score (GCS 13–15) for patients with an intracranial damage does not prevent progression on repeat head CT and the necessity for neurosurgical treatment. According to *Melo et al.* [18], mild brain injury dependent on GCS scale may be remarkably co-related with CT scan anomalies, involving neurosurgical process and admission to the intensive care unit. In our study, the majority of CT findings were associated with GCS scale except for pneumocranium, diffuse axonal injury and cerebral oedema. Apart from this, low GCS scores have been regarded as a risk factor for severity correlated with an array of tomographic findings. In fact, patients having low GCS scores are impacted by cerebral injuries with more catastrophic effects and present with a tendency for hemodynamic instability as seen in documented studies [19-21]. Patients with multiple lesion together with midline shift had low GCS score, compared to the patients with a single lesion or multiple lesions. GCS score of 12 to 14 was related with mild head injury. Notably, patients having moderate head injury had 8 to 11 and severe head injury patients less than 7.

There are some limitations to this study. First, it was a single centre study. Multi-centric studies in similar context would shade more light on the research topic. Second, due to data collected from one institute, the population is relatively homogenous. So, results can't be extrapolated to the general population. Last but not least, no follow-up or data collection related to patient management. Further studies with inclusion of follow up and patient management would be added more value to the evidence.

5. Conclusion

We concluded that severe HT lowers the value of GSC. In summary, the presence of multiple lesions together with midline shift in CT scan was significantly associated with lesser GCS. Our findings suggested a significant correlation between GCS and CT findings in case of HT. As concluded, more severe HT, lesser the GCS score. Thorough clinical evaluation and selective ordering of the CT scan based on GCS score would lessen the exposure to radiation among pediatric patients and, CT contraindicated patients furthermore pressure on resource-limited settings. However, studies with a larger sample size would be recommended in drawing conclusive statements.

6. Acknowledgement

We are heartily grateful to all study participants for giving the pivotal prop in conducting this study.

References

1. Ainsworth CR, Brown GS. Head Trauma Workup. Medscape. https://emedicine.medscape.com/article/433855-workup#c6. Visited on 7 january, 2020.
2. Gururaj G. Epidemiology of traumatic brain injuries: Indian scenario. Neurol Res. 2002; 24:24-28.
3. Chesnut RM. The management of severe traumatic brain injury. Emerg Clin North Am. 1997; 15:581-604.
4. Weisberg LA. CT and acute head trauma. Comput Radiol. 1979; 3:15-28.
5. Teasdale G, Galbraith S, Murray L. Management of traumatic intracranial haematoma. Br Med J (Clin Res Ed). 1982; 285:1695-1697.
6. Faul M, Xu Likang, Wald MM, Coronado VG. Traumatic Brain Injury in the United States. http://www.cdc.gov/traumaticbraininjury/pdf/blue_book.pdf. Visited on 3 december, 2013.
7. Teasdale GM. Sign Guideline Development Group. Early Management of Patients with a Head Injury. Edinburgh: Scottish Intercollegiate Guidelines Network; 2000.
8. Marshall LF, Gautille T, Klauber MR *et al*. The outcome of severe closed head injury. J Neurol Surg 1991; 75:S28-S36.
9. Rimel RW, Giordani B, Barth JT *et al*. Moderate head injury: completing the clinical spectrum of brain trauma. Neurosurgery. 1982; 11:344-351.
10. Selladurai BM, Jayakumar R, Tan YY *et al*. Outcome prediction in early management of severe head injury: an experience in Malaysia. Br J Neurosurg. 1992; 6:549-557.
11. Morgado FL, Rossi LA. Correlation between the Glasgow Coma Scale and computed tomography imaging findings in patients with traumatic brain injury. Radiol Bras. 2011; 44:35-41.
12. Farshchian N, Farshchian F, Rezaei M. Correlation between Glasgow Coma Scale and brain CT-scan findings in traumatic patients. J Inj Violence Res. 2012; 4:44.
13. Vignesh RS, Chelladuraipandian H, Anandan H. Computed tomography scan findings and Glasgow Coma Scale 15 in head trauma patients. Int J Sci Stud. 2017; 5:195-197.
14. Sah SK, Subedi ND, Poudel K, *et al*. Correlation of Computed Tomography findings with Glassgow Coma Scale in patients with acute traumatic brain injury. J Coll Med Sci Nepal. 2014; 10:1-6.

15. Jain AK, Charokar K, Agrawal P. Co-relation of CT scan findings with Glasgow Coma Scale scores in pediatric head injury. Int Surg J. 2015; 2:676-679.
16. Lee TT, Aldana PR, Kirton OC *et al*. Follow-up computerized tomography (CT) scans in moderate and severe head injuries: correlation with Glasgow Coma Scores (GCS), and complication rate. Acta Neurochir (Wien). 1997; 139:1042-7; discussion 1047.
17. Joseph B, Pandit V, Aziz H *et al*. Mild traumatic brain injury defined by Glasgow Coma Scale: is it really mild? Brain Inj. 2015; 29:11-16.
18. Melo JR, Lemos-Júnior LP, Reis RC *et al*. Do children with Glasgow 13/14 could be identified as mild traumatic brain injury? Arq Neuro Psiquiatr. 2010; 68:381-384.
19. Tien HC, Cunha JRF, Wu SN *et al*. Do trauma patients with a Glasgow Coma Scale score of 3 and bilateral fixed and dilated pupils have any chance of survival? J Trauma. 2006; 60:274-278.
20. Signorini DF, Andrews PJD, Jones PA *et al*. Predicting survival using clinical variables: a case study in traumatic brain injury. J Neurol Neurosurg Psychiatry 1999; 66:20-25.
21. Schreiber MA, Aoki N, Scott BG *et al*. Determinants of mortality in patients with severe blunt head injury. Arch Surg. 2002; 137:285-290.