

## Original Research Article

# Evaluating mild traumatic brain injury in adults: an emergency physician's dilemma

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### ABSTRACT

**Background:** Mild traumatic brain injury (MTBI) is a common presentation in emergency departments across the globe. A controversy about the policy of evaluating them with CT scan and hospital admission or discharge and for these patients. This study is directed towards correlation of clinical profile with CT brain findings of the patients to predict the possibility of an intracranial lesion and need for early neurosurgical intervention.

**Methods:** This prospective observational study was carried out in the Emergency Department (ED) of a tertiary care government medical college and hospital. All patients aged more than 12 years presenting to the ED with mild traumatic brain injury (MTBI) within 24 hours of injury in whom NCCT head (trauma protocol) was done during the Study. Descriptive and analytical statistics were applied. Multiple logistic regression analysis was used to identify factors related to different outcomes.

**Results:** 178 patients with MTBI were enrolled in the study among which intracranial injuries were found by CT scan in 28 patients (15.7%). Odds of finding intracranial injuries were highest with the presence of post-traumatic vomiting, post traumatic amnesia (PTA), pre-existing alcohol use disorder, GCS $\leq$ 14, focal neurological deficit and clinical signs of basal skull fracture. 2.8% patients required urgent neurosurgical intervention.

**Conclusions:** Presence of post-traumatic vomiting, PTA, alcohol use disorder, GCS $\leq$ 14, focal neurodeficit and signs of basal skull fracture in a MTBI patient should be considered as high-risk factors for significant intracranial injuries.

**Keywords:** CT scan, Glasgow coma scale, Mild traumatic brain injury, MTBI, Minor head injury, Traumatic brain injury

### INTRODUCTION

Traumatic brain injury (TBI) is one of the most common injuries as well as cause of injury-related deaths encountered in emergency departments (ED) worldwide. About 75% of patients with brain injuries who receive medical attention can be categorized as having minor injuries, 15% as moderate, and 10% as severe based on Glasgow Coma Scale (GCS) and Computed Tomography (CT) brain findings.<sup>1</sup> However, The label of "mild" is a misnomer as a clinically apparent mild traumatic brain

injury (MTBI) may lead to significant and debilitating short-term and long-term sequelae.<sup>2</sup>

Early diagnosis of MTBI is usually established by taking history of the leading events and detailed clinical examination followed by Computed Tomography (CT) scan of the brain to detect any intracranial pathology as and when indicated. However all patients with mild TBI (MTBI) don't require require a CT scan in ED. But, even after careful examination and negative predictions, intracranial complications are sometimes detected on CT

requiring hospitalization or even neurosurgical interventions.<sup>3</sup> However, indiscriminate use of CT adds substantially to health care costs and exposes a large number of patients, particularly children, to the potentially harmful effects of ionizing radiation.<sup>4,5</sup> Moreover, involving neurosurgery referral for all patients of MTBI in a government hospital will overburden the neurosurgery department.

Therefore the prediction of intracranial pathology and decision to early CT brain in adults and disposition from ED are mostly guided by various clinical features that the patients present within the ED and the clinicians experience. To obviate unnecessary CT scans in MTBI patients, there are a few clinical decision making rules like Canadian CT head rule, New Orleans Criteria, American College of Emergency Physicians (ACEP) criteria etc for adults and PECARN rule, CHALICE rule etc for children.<sup>6-9</sup> However, these western guidelines use various combinations of clinical features and risk factors, which are not uniform, differing from country to country and not exactly validated in vast Indian scenarios.<sup>10,11</sup> Thus there are immense confusions among emergency physicians in this part of the world regarding which guideline to follow, when making clinical decisions about CT scan, neurosurgery referral, admission or discharge of MTBI patients from ED.

Therefore, this study is directed towards correlation of clinical profile with CT brain findings of the patients to predict the possibility of an intracranial lesion and need for early neurosurgical intervention.

## METHODS

This prospective observational study was carried out in the Emergency Department (ED) of a tertiary care government medical college and hospital in Assam for a period of six months from January 2019 till July 2019 after obtaining clearance from the institutional ethical committee.

All patients aged more than 12 years presenting to the ED with mild traumatic brain injury (MTBI) within 24 hours of injury in whom non-contrast CT (NCCT) head (trauma protocol) was done during the Study Period were included. MTBI was defined as GCS of 13-15 on presentation as per Advanced Trauma Life Support (ATLS) protocol.<sup>1</sup> Paediatric patients (aged 12 years or less), pregnant, polytrauma patients, patients presenting with moderate or severe traumatic brain injury, patients suffering from a diagnosed neurologic disorder (including hydrocephalus), patients initially admitted & treated in another hospital and patients who left against medical advice in between the treatment.

Data was collected by interviewing the patient and/or Attendants as feasible, thorough Physical examination, relevant investigations. A scheme of case taking or proforma was filled up meticulously for every patient

included in the study. On admission, in the primary survey, patients were examined for any abnormality in ABCDE i.e., airway, breathing, circulation, disability and exposure and relevant examination and fluid resuscitation were done as per the ATLS guidelines.<sup>1</sup> Detailed history was taken regarding loss of consciousness (LOC), vomiting, alcohol or drug intoxication, aural and nasal discharge or bleed, seizures (generalized and focal), post traumatic amnesia (PTA), headache, presence of alcohol use disorder and previous medical or surgical illness relevant notes on demographics, mechanism of injury, time of injury and rescue time, any pre-hospital care received or not.<sup>12</sup> LOC was considered to have occurred as witnessed by bystanders or any of the relatives and in few cases by the paramedics present at the clinical evaluation. Vomiting was defined as any emesis after the traumatic event. PTA included both retrograde and anterograde memory disturbances. Drug or alcohol intoxication was determined on the basis of the clinical history and findings. NCCT scan was advised to the patients as per the clinical judgement of the emergency physician which were mostly in lieu with Canadian CT Head Rule and ACEP criteria for CT scanning in adults with MTBI.<sup>6,8</sup> Siemens 70503 dual slice CT scan machine was used for this purpose. In all the patients CT scan was reviewed separately from clinical information by the on duty radiologists. CT scan findings like presence of Extra Dural Hemorrhage (EDH), Sub Dural Hemorrhage (SDH), Sub Arachnoid hemorrhage (SAH), cerebral haemorrhagic contusions, Intra Cranial Hemorrhage (ICH), tentorial bleed, inter-hemispheric bleed, skull fractures, degree of mid-line shift, were noted. Any patient with abnormal CT scan or deteriorating GCS were referred to Neurosurgery as per institutional protocol. Patients were taken up for neurosurgery as per their advices.

## Statistical methods

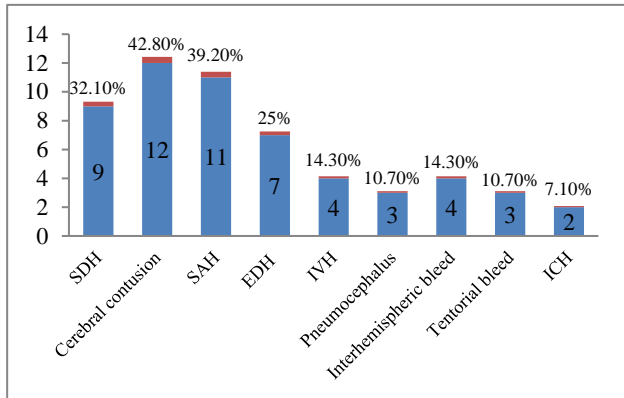
Data are presented as mean  $\pm$  standard deviations (SD) for continuous variables and in number and percentages for categorical variables. Multiple logistic regression analysis was used to identify factors related to different outcomes. The odds ratio (OR) was also calculated. For all statistical analyses, a probability (P value) of less than 0.05 was considered to be statistically significant. All data were statistically analyzed by using IBM SPSS 19 software.

## RESULTS

After satisfying the inclusion and exclusion criteria, 178 patients with MTBI were enrolled in the study with mean ( $\pm$ SD) AIS of  $1.97 \pm 1.1$ . All of our patients had blunt trauma head and most common mode of injury was road traffic accidents (RTA) ( $n=104$ , 58.4%). Among them 25.8% patients belonged to the age group of 31-40 years (Table 1) with a mean age of  $39.95 \pm 15.85$  years which explains the preponderance of head injury among the younger age group.

**Table 1: Age distribution of MTBI patients.**

Age group (years)	Number	Percentage (%)
≤ 20	37	20.7
21-30	30	16.8
31-40	46	25.8
41-50	38	21.3
51-60	13	7.3
>60	14	7.8
<b>Total</b>	<b>178</b>	<b>100</b>



**Figure 1: Different intracranial lesions on NCCT in patients with MTBI.**

Males constituted the majority (127 patients, 71.3%) of our study population. All MTBI patients had undergone NCCT brain (trauma protocol) revealing intracranial injuries in 28 patients (15.7%) which were also having some degree of skull fractures.

Cerebral contusion (41.8%) was the most common intracranial lesion in our study. 7 patients (3.9%) had Midline shift. However only 5 patients (2.8%) required neurosurgical intervention. Among the patients requiring surgery, 2 patients (1.1%) were intubated on urgent basis in ED by the emergency physicians. We analyzed different clinical features associated with MTBI for prediction of intracranial injuries in CT scan.

Multiple logistic regression analysis (Table 2) revealed that presence of post-traumatic vomiting, post traumatic amnesia (PTA), pre-existing alcohol use disorder, GCS of 14, focal neurological deficit and clinical signs of basal skull fracture had significant correlation (P value <0.05) with the presence of intracranial traumatic lesions on CT scan.

All patients with abnormal CT scans including emergency surgery were admitted. Rest were either kept in observations for few hours in ED itself or discharged depending on their clinical features and symptomatic improvement.

**Table 2: Multiple regression analysis for correlation between clinical features and presence of intracranial lesions on CT brain in Mild TBI patients.**

Clinical features	Variables	Total no of patients (n=178)	Abnormal CT Scan (%)	P value	Odds ratio
Age (years)	< 65	167	25(14.9%)	0.317	1.0
	≥ 65	11	3(27.3%)		
Loss of consciousness	No	118	15(12.7%)	0.656	0.7
	Yes	60	13(21.7%)		
Headache	No	109	15(13.7%)	0.168	1.8
	Yes	69	13(18.8%)		
Vomiting	No	115	11(9.6%)	0.015	4.3
	Yes	63	17(26.9%)		
Seizure	No	167	23(13.8%)	0.676	1.4
	Yes	11	5(45.5%)		
Post traumatic amnesia	No	133	14(10.5%)	0.019	3.9
	Yes	45	14(31.1%)		
Intoxication	No	161	23(14.3%)	0.726	0.7
	Yes	17	5(29.4%)		
Alcohol use Disorder	No	147	17(11.6%)	0.044	2.4
	Yes	31	11(35.5%)		
Glasgow coma score	15	119	10(8.4%)	0.049	0.3
	≤14	59	18(30.5%)		
Signs of basal skull fracture	No	153	16(10.5%)	0.007	5.6
	Yes	25	12(48.8%)		
Focal neurodeficit	No	173	24(13.9%)	0.021	20.6
	Yes	5	4(80%)		

## DISCUSSION

In our study majority of the patients belonged to the age group of 31-40 years (25.8%) The mean age was 39.95 years with a standard deviation of 15.85. Fabbria et al and Smits et al in their study on mild head injury observed that the mean age of the study population was 41.4 and 44 years.<sup>13,14</sup> A large number of cases in these age groups can be explained by the fact that individuals in these age groups are more exposed to outdoor environment and thus become vulnerable to accidents and injuries.

In our study majority of the patients were male (71.3%) and where as females were less in number (28.7%). Livingston et al in their study published in the year 2000 observed that 69.3% and 30.7% of their study population were males and females respectively.<sup>15</sup> In 2016 Mata-Mbemba et al in their study on mild traumatic brain injury also found that males comprised 67.6% and females comprised 32.4% of their study population.<sup>16</sup> This reflects the fact that males are the predominant outdoor workers exposing themselves to the everyday hazards of road traffic accidents, assaults more than the female patients.

CT plays as a tricky role in MTBI by aiding in rapid and reliable diagnosis of life-threatening intracranial injuries while on the other hand exposing patients to unnecessary irradiations in most of the asymptomatic cases. Ibanez et al and Steill et al observed that the percentage of abnormal CT in Mild TBI patients was 7.5% and 8.5% respectively.<sup>17,18</sup> Our finding of abnormal CT was 15.7% whereas a recent south-Indian study done at a level-1 Neurotrauma centre found abnormal CT in 43% of MTBI patients.<sup>19</sup> All these observations indicate that MTBI is quite a dubious clinical entity with heterogenous and unpredictable occurrences of intracranial injuries.

We observed that cerebral contusion (42.8%), subarachnoid haemorrhage (39.2%) and subdural haemorrhage (32.1%) were the commonest abnormal CT finding in MTBI patients. These findings are comparable to the observations of Ibanez et al where the commonest lesion was subarachnoid haemorrhage (50.6% ) followed by cerebral contusion in 41% and subdural haemorrhage (SDH) in 38.6% patients.<sup>17</sup> We had no cases of diffuse axonal injury in our MTBI patients.

Urgent neurosurgical interventions were required in 2.8 % of our MTBI patients which was comparable to the findings of Mata-Mbemba et al.<sup>16</sup> Tierney KJ et al conducted a cross-sectional study of MTBI in adults (age > 17 years) admitted to a Level I trauma center in New York in between 2001 and 2010, where they found much higher requirement of neurosurgical intervention (179 out of 1688 patients, 10.6%) in MTBI patients.<sup>20</sup> Mishra et al also reports a 5% incidence of neurosurgical requirements in MTBI patients in level-1 neurotrauma centre based study, possibly reflecting a higher presentation of referred and complicated cases, patients

with more medical co-morbidities or on chronic use of blood thinners etc and round-the-clock availability of neurosurgical facilities in level 1 trauma centres.<sup>19</sup> In a study conducted by Bouida et al out of all the 1122 patients of mild head injury in whom CT head was performed, 5 patients i.e. 0.44% required endotracheal intubation.<sup>21</sup> In our study 1.1% patients required endotracheal intubation in ED. In both the studies, intubation was required in those patients in whom neurosurgical intervention was also performed. A recent meta-analysis by Marincowitz et al showed that estimated pooled risk for adverse outcomes in MTBI patients were : clinical deterioration 11.7% (95% confidence interval [CI]: 11.7%–15.8%), urgent neurosurgical intervention 3.5% (95% CI: 2.2%–4.9%) and death 1.4% (95% CI: 0.8%–2.2%). However, we didnot have any ED mortality reported.<sup>22</sup>

There are different clinical decision making rules for doing CT Scan in MTBI which differ considerably in selection criteria, methodology, predictors, outcomes, and performance with high sensitivity and low specificity for clinically significant intracranial injuries and the need for neurosurgical intervention.<sup>10,11,19</sup> Hence in our study we tried to statistically correlate different clinical features of MTBI with the presence of a traumatic intracranial lesion on CT in MTBI patients. Multiple logistic regression analysis found that vomiting, presence of alcohol use disorder, GCS  $\leq$ 14, PTA, focal neurological deficit and signs of basal skull fracture had a significant correlation (p value <0.05) with presence of intracranial lesions on CT. These findings were similar to the observations by Ibanez et al and Fabbri et al.<sup>17,13</sup> In addition to that Fabbri et al also found that history of alcoholism significantly correlated with presence of an intracranial lesion.<sup>13</sup> Mishra et al also observed that among all the variables, risk factors significantly associated with abnormal CT scan were duration since injury (>12 h) (p<0.001) vomiting (odds ratio 1.89 , p<0.001) and presence of any head-injury related symptoms (odds, ratio 2.36 , p<0.001) e.g LOC, vomiting, ear-nose bleeding and seizures.<sup>19</sup>

Post-traumatic headache is usually a concerning complaint in MTBI patients. However in our study headache following MTBI did not have any significant correlation with presence of CT abnormality which is also comparable to the study by Fabbri et al.<sup>13</sup> On the other hand, Ibanez et al and Smits et al found a significant correlation between presence of headache with presence of intracranial injuries.<sup>17,14</sup> This may be due to the fact that we didn't include patients with a history of prior headache and local cranial pain due to scalp and local bony injury.

Loss of consciousness (LOC) had a significant correlation with presence of intracranial lesions on CT in the studies conducted by and Fabbri et al and Ibanez et al.<sup>13,17</sup> However we got a different result which could be due to the fact that in maximum number of cases the history of LOC was taken from the bystanders and the



relatives of the patient. The reliability of the history in such cases becomes questionable.

In our study, age  $\geq 65$  years did not have any significant correlation with the presence of an intracranial lesion on CT which might be due to the selection of lesser number of cases and shorter duration of study compared to the studies conducted by Fabbri et al and Ibanez et al.<sup>13,17</sup> Post traumatic seizures and intoxication also did not have any significant correlation with presence of an intracranial lesion on CT. These observations were comparable to the observations of Ibanez et al who also found no significant correlation of post traumatic seizures and intoxication with the presence of an intracranial lesion. Sharif-Alhoseini et al also reported that presence of LOC or amnesia ( $p=0.024$ ), headache ( $p=0.006$ ) and alcohol ( $p=0.036$ ) were associated with abnormal brain CT related to the trauma in minor head injuries.<sup>17,23</sup>

Our study is limited by the fact that it was a single centre study without any follow up in the wards or intensive care units. We also could not retrieve the records of return-to-ED patients who were discharged from ED as we lack a fully computerized patient record system in our centre. Hence, our study needs to be conducted as multi-centric study in a larger population in various geographic regions of India to generate a uniform Indian guideline of ED based treatment and disposal of MTBI patients.

## CONCLUSION

Whatever clinical decision rule for scanning and discharging patients with MTBI we use in ED, presence of certain clinical features must never be ignored irrespective of its inclusion in that particular criteria. We concluded that presence of post traumatic vomiting, post traumatic amnesia, alcohol use, GCS score 14 or less, focal neurological deficit and signs of basal skull fracture in isolation or combination, were significantly associated with presence of intracranial injuries in MTBI patients and thus represent the high risk group of MTBI. Hence NCCT head in the ED is mandatory for patients with these clinical features for diagnosis, neurosurgery consultation, admission and discharge.

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