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OUTCOME OF MILD TRAUMATIC BRAIN INJURIES: A PROSPECTIVE STUDY

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Abstract

Summary: Mild traumatic brain injury is the most common type of traumatic brain injuries. Some victims do not consider it serious until it is too late to salvage them. On the Glasgow Coma Scale, scores of 13-15 are considered mild traumatic brain injuries. We prospectively studied mild traumatic brain injury patients managed in our center.

Objective: To determine the treatment outcome of mild traumatic brain injury patients admitted and treated in our center.

Methods: It was a prospective study of mild traumatic brain injury patients admitted in our center from August 2010 to January 2015. Traumatic brain injury patients who scored 13-15 on Glasgow Coma Scale (GCS) after resuscitation in accident and emergency, admitted and treated qualified for the study. The Glasgow outcome score was used to assess the patients on discharge. Data were collected using structured proforma which was component of our prospective data bank that was approved by our Research and Ethics Committee. We analyzed the data with Environmental Performance Index info 7 software.

Results: There were 183 patients in the study. Males were 139.The mean age was 28.56 years. One hundred and twenty two were involved in road traffic accident. Patients with GCS of 15 were 89. One hundred and eighty two had favorable functional outcome. The GCS significantly affected the outcome.

Conclusion: The most common etiology was road traffic accident with males and age group 20-40years most commonly involved. The most common Glasgow coma score was 15. The favorable functional outcome was good.

Keywords: brain, injury, mild, outcome, trauma.

Introduction

Mild traumatic brain injury accounts for 80% of head trauma diagnosed annually in United States of America.[1] Trauma to the head can produce both focal and diffuse injuries. Focal brain injury is produced by collision forces acting on the skull and resulting in local tissue compression beneath the site of impact.[2] Such injuries are commonly characterized by laceration, contusion, and hematoma, with or without overlying skull fracture.[3] Diffuse brain injury occurs from acceleration-deceleration of the head as seen in high speed motor vehicular accidents[4] and includes diffuse axonal and vascular injuries, brain swelling, and hypoxic ischemic damage.[5] The mechanism is due to unequal rotation and/or deceleration/acceleration forces at sites of junction of two different tissue densities causing shear injuries as seen in corpus callosum, centrum semiovale, corticomedullary junction, internal capsule and post-lateral upper brain stem.[6] There is also electrophysiological disruption associated with traumatic brain injuries. There is immediate post-injury cortical spreading suppression characterized by a rapid and almost complete depolarization of large populations of neurons, with global redistribution of ions between intracellular and extracellular compartments that propagates as a wave in brain tissues in regenerative fashion.[7] This suppression is lamina specific with more superficial cortical layers demonstrating a greater degree of suppression than deeper layers.[8,9,10] These anatomical and physiological injuries affect the level of consciousness in the patients, with physiological components faster to recover than the anatomical injuries, depending on extent of injuries. The anatomical injuries are slower to progress and act by pressure effect which brain's resistance can overcome with no further effect on consciousness, but it may overcome brain resistance with later loss of consciousness. In some cases the physiological recovery will be interrupted by anatomical progression with likely stalemate at some point, and then movement in either direction. The anatomical progression could also be stopped by surgical intervention. In our study we recorded the effect on level of consciousness using Glasgow Coma Scale[11] at the turn to recovery or time of surgical interruption of anatomical progression. We prospectively studied the outcome of mild traumatic brain injury patients (those with GCS scores 13-15) admitted and managed in our center.

Methodology

It was a prospective, descriptive and cross-sectional study on mild traumatic brain injury patients admitted and managed in our center from 1st August 2010 to 31st January 2015. Patients were resuscitated using Advanced Trauma Life Support protocols. We ensured euvolemia, normotension, adequate oxygenation and analgesia of patients, using Normal saline for adult and 4.3%Dextrose in 1/5Saline for children, Oxygen via face mask or nasal prongs at 4-7l/min, and Paracetamol at 15mg/kg/dose 8 hourly. Ceftriaxone 1gm daily for adult and 100mg/kg once daily for children with open wounds. After resuscitation, the level of consciousness was assessed using GCS. The scores of the patients were rechecked every two hours as some pathology such as hematomas and contusions could progress and moved the level of consciousness down the scale. Computerized Tomography (CT) scan of the brain was done for those who could afford it. Skull X-ray was done for cases with open skull fractures, closed fractures or suspected fracture of the skull from clinical findings, in patients who could not afford CT scan but could afford skull X-ray. Patients requiring surgery were operated on. Their GCS were taken just prior to induction. Those with GCS 13-15 after resuscitation or at the end of progression, or prior to surgery were included in the study. Other organ injuries were managed by specialist units. Because of our distance coverage, many of the patients with mild traumatic brain injuries were managed in peripheral hospitals. They were referred to us due to the nature of injuries (eg machete cuts), CT findings, or failure of patients' conditions to improve. Those with documented GCS after resuscitation and were 13-15 were included in the study. The minimum observation was 24 hours. Patients with GCS <13, and referred patients with undocumented GCS after resuscitation were excluded from the study. Patients who refused admission were excluded from the study. On admission to the wards patients were given fluids, Paracetamol, Ceftriaxone (or oral Cefuroxime), multivitamin, Vitamin C and adequate nutrition depending on the state of the patients. We used Chlorpromazine 50-100mg 2-3 times daily for patients with frontal lobe syndrome. The duration of stay depended on the clinical state of the patients. On discharge, the Glasgow Outcome Scores (GOS)[12] of the patients were documented. It classifies patients into dead (1), vegetative state (2), severe disability (3), moderate disability (4), and good recovery (5). The length of hospital stay was calculated. The relatives were given instructions thus: 'if there is loss of consciousness, neurological deficit, vomiting, persistent headache, seizure, or aggressive behavior, the patient should be brought back to hospital'.

Data were collected with structured proforma which was component of our prospective Data Bank that was approved by our Research and Ethics Committee. Biodata, etiology, clinical findings, GCS, CT scan findings (for those referred with CT scan or those who did theirs in accident and emergency) were documented in Accident and Emergency (A&E) unit. GCS prior surgery, type of surgery, and surgical findings were documented in theater. The progress of the patients and GOS at discharge was documented in the wards. Data were analyzed with Environmental Performance Index (EPI) info 7 software (Center for Disease Control and Prevention, Atlanta, Georgia, USA).We used 'add analysis gadget' of the visual dashboard of EPI info 7 to analyze the data. We used the frequency or chart components to find frequency of some variables such as etiology. We used the mean component to analyze continuous variables such as age. We recoded age into groups using 'defined variables' component. We used M X N/2X2 component for univariate variable, and M X N/2X2 and its advance option for multivariate variables. At 95% confidence interval P<0.05 was considered significant.

Results

One hundred and eighty three patients qualified for the study. One hundred and six patients were referred to us while seventy seven came direct to our center. There were 139 males (75.96%) and 44 females (24.04%). The mean age was 28.56 years with range of two and half months to 71 years. The most common age group involved was 20-30 years (30.05%). Twenty to forty years patients formed over half of the patients (50.82%), table 1.

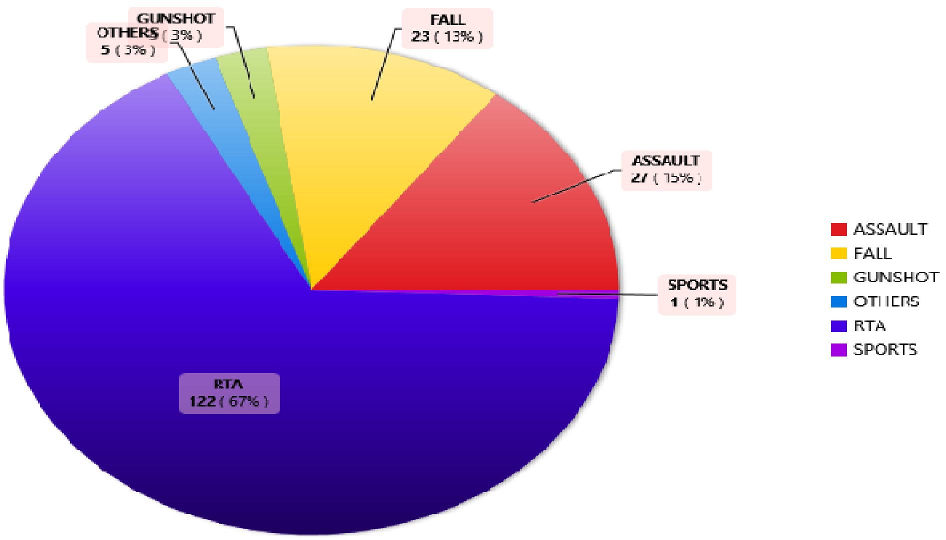
Table 1: age frequency

Age	Number	Percent (%)
0 - <10	28	15.30
10 - <20	18	9.84
20 - <30	55	30.05
30 - <40	38	20.77

40 - <50	25	13.66
50 - <60	10	5.46
60 - <70	6	3.28
70 - <80	3	1.64
Total	183	100

The most common etiology was road traffic accident (66.67%), fig 1.

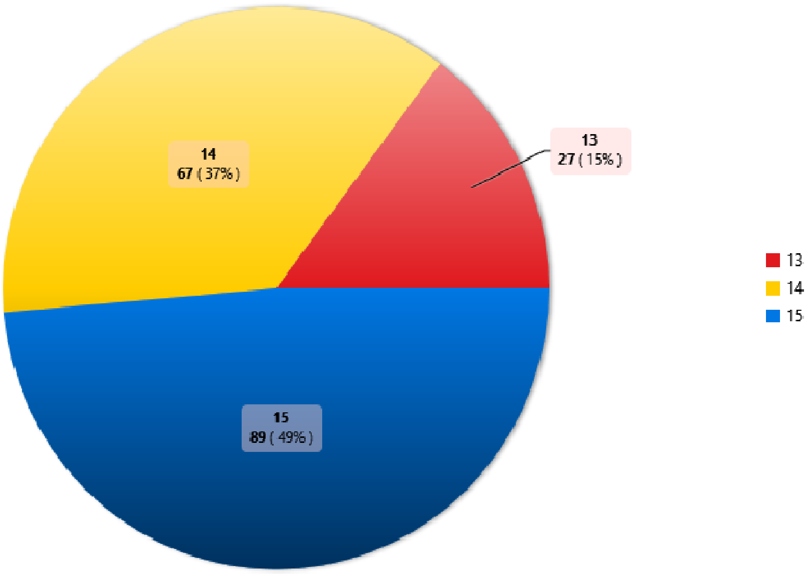
Fig 1: Etiology Frequency



RTA = Road Traffic Accident.

The most common Glasgow Coma Score was 15, 48.63%, fig 2.

FIG 2: GCS FREQUENCY



Eighty patients afforded brain CT scan. The most common lesions found were multiple intracranial lesions, 19, followed by contusions, table 2.

Table 2: CT Findings Frequency

CT Scan findings	Number	Percent (%)
Contusions	18	22.50
Depressed skull fracture	9	11.25
Extradural hematoma	5	6.25
Intracerebral hematoma	3	3.75
Multiple lesions	19	23.75
None	14	17.50
Other fractures	2	2.50
others	1	1.25
Subdural hematoma	9	11.25
Total	80	100

Thirty patients afforded skull x-ray, while the rest could not afford either investigations. Of the eighty patients that did brain CT scan, 59 were referred, while 33 came direct. Sixty six CT had positive findings; forty four (66.67%) were from referred patients, while 22 (33.33%) were from direct patients. Fifteen patients with GCS 13 did CT scan and 14 (93.33%) had positive findings; those with GCS 14 were 32 and 26 (81.25%) had positive findings. Those with GCS 15 were 33 and positive finding was seen in 26 (78.29%) patients.

The CT findings have significant relationship to GCS score, P = 0.0404, table 3.

Table 3: GCS VS CT Findings

GCS	CT findings									
	Contusions	DSF	EDH	ICH	ML	None	Other fractures	Others	SDH	Total
13	7	0	2	0	4	1	1	0	0	15
14	6	4	0	2	5	6	0	1	8	32
15	5	5	3	1	9	7	1	0	1	33
Total	18	9	5	3	18	14	2	1	9	80
P = 0.0404										

Abbreviations: DSF = Depressed skull fracture; EDH = Extradural hematoma; ICH = Intracerebral hematoma; ML = Multiple lesions; SDH = Subdural hematoma.

Thirty seven patients did x-ray and fractures were seen in 27 of them.

One hundred and thirty three patients were managed conservatively, while fifty patients had surgical care. The most common procedure was craniectomy with primary bone fragment replacement, 22. Fifteen patients had sutured scalp avulsions/lacerations, 9 patients had Burr hole, 3 patients had craniotomy, and 1 patient had minicraniectomy. The etiology had significant relationship to type of treatment given, P = 0.0000, table 4.

Table 4: Treatment Vs Etiology

Treatment	Etiology						
	Assault (%)	Fall (%)	Gunshot (%)	Others (%)	RTA (%)	Sports (%)	Total (%)
Conservative	8(29.63)	19(82.61)	2(40)	2(40)	101(82.79)	1(100)	133(72.68)
Surgery	19(70.37)	4(17.39)	3(60)	3(40)	21(17.21)	0(0)	50(27.32)
Total	27(100)	23(100)	5(100)	5(100)	122(100)	1(100)	183(100)
P = 0.0000							

RTA = Road traffic accident

The favorable outcome was 99.45% (182) and mortality 0.55% (1 patient).The outcome was significantly related to GCS scores, P = 0.0225, table 5.

Table 5: GCS VS GOS

GCS	**GOS**				
	1	4	5	≥4	Total
13	0(0)	6(22.22)	21(77.78)	27(100)	27(100)
14	1(1.49)	7(10.45)	59(88.06)	66(98.51)	67(100)
15	0(0)	3(3.37)	86(96.63)	89(100)	89(100)
Total	1(0.55)	16(8.74)	166(90.71)	182(99.45)	183(100)
P=0.0225					

The only patient that died was Diabetic and had multiple long bone fractures. She succumbed to the complications of the fractures.

Co-morbidity related significantly to outcome, P = 0.0000, table 6. The mean hospital stay was 11.92 days with range of 1-120 days.

Table 6: Co-Morbidity VS GOS

Co-morbidity	GOS			
	1(%)	4(%)	5(%)	Total (%)
Asthma	0(0)	0(0)	1(100)	1(100)
Diabetes Mellitus	1(50)	0(0)	1(50)	2(100)
Hypertension	0(0)	0(0)	4(100)	4(100)
None	0(0)	16(9.41)	154(90.59)	170(100)
Others	0(0)	0(0)	5(100)	5(100)
HTN + DM	0(0)	0(0)	1(100)	1(100)
Total	1(0.55)	16(8.74)	166(90.71)	183(100)
P = 0.0000				

HTN: Hypertension, DM: Diabetes Mellitus

Discussions

In our study, one hundred and six patients (57.92%) were referred to us from other health facilities. The higher percentage of referred patients was due to the coverage of our neurosurgical center. Our center gets referral from two states and parts of three adjoining states, totaling about 7million people, with the city where our center is located having 431,200 people.[13] The farthest area is about 600km and it takes them about six hours, due to pot holes, to reach our center. Health facilities in these areas manage mild head injuries. Those referred to us were those that needed neurosurgical procedures such as open depressed skull fractures or patients who failed to improve with their conservative cares. These were patients who were inclined to do CT scan as seen in the result, 49 out of the 80 that did CT scan. Adeleye and Okonkwo[14] in their study found that 75% of their patients were referred to them from other health facilities with no neurosurgical facilities. The dearth of neurosurgical centers and lack of organized trauma system in our country make mild traumatic brain injury patients seek help from the nearest medical facilities, with only those closer to neurosurgical centers, some who needed neurosurgical procedures and those not improving under their cares being referred to neurosurgical centers. In developed countries with organized trauma system, coupled with universal health insurance coverage, trauma patients present to trauma centers where they are triaged and traumatic brain injury patients seen by neurosurgeons. [15, 16]

In our study males formed 75.96%. In Jos, Nigeria, Jasper et al. [17] found 79.9% males. In their study of 'Mild traumatic brain injury defined by Glasgow Coma Scale: is it really mild?' Joseph et al.[18] found that males constituted 65.5%. In their study in University of New Mexico, Carlson et al. [19] found that males constituted 69.2%. High percentage of males had been attributed to high activities of males to provide for the families.

The mean age was 28.56 years with 20-30 year age group having highest percentage of 30.05%. Majority of the patients (50.82%) were 20-40 years. In their study, Akanji et al.[20]in Lagos, found that of the 400 patients they studied, the highest incidence(95) was 21-30 years, followed by 31-40 years with 79 patients. In Asmara, Eritrea, Mebrahtu et al. [21] found highest incidence of 22.7% among 21-30 year age group. McMahon et al.[16] in USA found highest incidence of 38% among 20-40 year age group. These are the most productive age group who are moving around to make ends meet. Road traffic accident was the most common etiology, 66.67%. Emejulu et al. [22] in their study of traumatic brain injuries in accident and emergency department found road traffic accident the most common etiology with 80.8%. Motorcycle related was 58.8%, while vehicular related was 22%. Because of high unemployment rate in our country, many young men resorted to commercial motorcycles and vehicles as means of livelihood. This contrasts with what is seen in developed countries where longevity is on the increase with falls among the elderly taking over from road traffic accident as the most common etiology. Washington and Grubb [23] in their study in Missouri, USA, found fall as the most common etiology, 59%. Among their patients 41% were ≥65 years. Ibańez et al. [24] in their study in Spain, found fall the most common etiology, 49.6%. Patients greater than 65 years formed 29.4%. In our study, only 4.92% were 60 years and above, showing our difference with developed countries in terms of longevity.

Among the patients we studied, those with GCS 13 formed 14.75%, those with GCS 14 formed 36.61%, and those with GCS 15 had 48.63%. Jacobs et al.[15] found GCS 13 had 5%, GCS 14 had 12%, and GCS 15 had 83% in their study. They excluded patients less than 16 years and patients with penetrating injuries. In our study, the bulk of our patients were referred to us from peripheral hospitals due to nature of injuries, failure to improve or due to CT findings. Majority of those with GCS 15 were managed and discharged in the peripheral hospitals. In their own study, their center was a trauma center, hence all patients presented there.

Seddeghi et al. [25] found those with GCS 15 had 96.6%, while GCS 13-14 had 3.4%. They used two hospitals, excluded patients with low risk GCS 15. However, all their patients presented direct to them, making GCS 15 have higher volume than ours. In India, Syed et al. [26] found that patients with GCS 15 were 57.14%, those with GCS 14 had 25.71% and those with GCS 13 had 17.14%. They excluded those with penetrating injuries and those with neurological deficits. This is almost similar to our study, safe the possible effect of excluded patients. This is a developing country like ours and hence shared almost similar characteristics with centers in our country.

Eighty of our patients were able to do brain CT scan. Patients with GCS 13 had 93.33% positive findings, GCS 14 had 81.25%, and GCS 15 had 78.79% positive CT findings. The high percentage of positive findings was due to high percentage of referred patients in our study. In Jacobs et al. [15] study, 71.8% did CT scan and GCS 15 had 16% positive findings, GCS 14 had 27% positive findings, while GCS 15 had 46% with positive findings. Their patients went direct to their hospital and CT was done within 72 hours of injury. In Syed et al. [26] study, positive CT findings was found in 11% in those with GCS 15, 18% in those with GCS 14 and in 29% of those with GCS 13. The CT was done within 4 hours of presenting in Emergency Department. The time lag to CT scanning might have accounted for lower percentages in their studies. Hunter et al. [27] in their discussion of 'Emerging imaging tools for use with traumatic brain injury research' noted that early CT scan immediately following injury may miss later development of hemorrhagic shear injury and enlargement of extra-axial collections which are typically apparent by 24 hours post-injury. Many studies had also shown that CT is not a very reliable method for revealing non-hemorrhagic brain injuries, particularly small contusions or traumatic axonal injuries[28,29], hence many of those with negative findings might not have been negative if Diffusion tensor imaging had been used.[30] Diffuse axonal injury had been reported to be visible only in 20-50% on CT scan.[31]Diffuse axonal injuries occur from rapid acceleration-deceleration of the head as seen in high speed motor vehicle accidents.[4] Syed et al[26]study and our study had RTA as most common etiology, 56% and 66.67% respectively, hence many of these patients must have had diffuse axonal injuries and CT within 4 hours must have missed them. In their review article titled 'Mild head injury: reliability of early computed tomographic findings in triage for admission' af Geijerstam and Briton [32] noted that many clinicians had cases where rapid and dramatic deterioration occurred despite normal findings on the CT scan. [33, 34] Many of these cases occurred long after the injuries (2-120days)[33,34,35,36] with the most common lesion being subdural hematoma, followed by extradural hematoma. Carlson et al. [19] also noted that delayed deterioration in clinical and radiological findings was seen in extradural and subdural hematomas. Early CT like in Syed et al. [26] study might have missed these lesions. Our patients were mainly referred with likely intracranial pathologies causing failure to improve, depressed skull fractures, penetrating injuries or due to CT findings. Also there was no insurance coverage, so relatives had to raise money for the CT scan. The findings on CT scan helped us not only to manage the patients but also to counsel the patients and their relatives with respect to post-traumatic seizures and other long term effects, based on pathologies and their locations, to avoid such occurrence being attributed to somebody's evil machinations or 'spiritual attack' as commonly seen in the villages. Thirty seven patients did skull x-ray only and fractures were seen in 27 of them. These helped us to critically observe these patients because it had been found that in selected group of patients with skull base fractures, the percentage of intracranial abnormalities found on CT might reach 70.2%. [37]

In our study, the treatment given was significantly related to etiology. Over seventy percent of assaulted patients had surgical care. Assaults most of the time cause localized impact which can deform the skull or fracture the skull. Machete, iron rods and planks were most common objects used in our patients. Deformation of skull causes stripping of dura with resultant extradural hematoma formation. All these may require surgical intervention as in our study. Yavuz et al.[38] found that the degree of skull deformation and the type of fracture produced depended on the striking force. Ford et al.[39] found that localized impact strips off the dura from the inner table of the skull with resultant extradural hematoma formation, and the higher the force of the impact, the higher the stripping off, and the larger the volume of the hematoma formed. These findings were likely to have happened in our patients.

The favorable outcome in our study was 99.45% while mortality was 0.55%. This was due to the fact that we clinically monitored our patients including two hourly GCS assessment and assigned Glasgow Coma Scores at the point of reversal of pathological progression by conservative or surgical cares. Washington and Grubb [23] found favorable outcome in 95% of patients and mortality of 1%. They used repeat CT scan done12-24 hours after admission to determine progression of the disease and found that 6% progressed. They did not document the GCS of the progressed patients to know whether they were still mild or had declined to moderate or severe category. The GCS is the manifestation of the pressure effect of the pathology on level of consciousness which is determined by the interplay between brain resistance and the pressure from the pathology. Joseph et al.[18] in their study 'Mild traumatic brain injury defined by Glasgow coma Scale: is it really mild?' had mortality of 8.2%. The study included GCS 13-15 patients with factures or intracranial lesions on the initial CT scan, but excluded those with no CT findings. The outcomes measured were increase in volume of initial lesion or appearance of new lesion, and the need for neurosurgical intervention. The repeat CT was done within 6 hours of the initial one. They found progression in 13.1% and neurosurgical intervention in 5.4% of the patients. They did not document the GCS of the patients when they progressed or prior to surgery to know whether they progressed to moderate or severe category. The repeat CT time was too close to the initial one, hence could not have captured some diffuse axonal injuries or extra-axial hematomas. In the factors that determined progression, SDH and EDH ≥10mm were included. Ordinarily SDH and EDH of 10mm in adult is an indication for surgical intervention. So these patients could have had surgery without waiting for progression. They started with GCS but they left this clinically important component and concentrated on the radiological component. Their exclusion of patients without radiological findings influenced the high mortality percentage seen in the study. Ibańez et al.[24] found mortality of 0.4% in their study. However they chose GCS 14-15 as mild traumatic brain injury leaving out GCS 13 and used CT positive as primary outcome. Thus GCS 13 patients might have affected their mortality percentage as outcome was seen in our study to have significant relationship to GCS.

We noted that many studies on mild traumatic brain injury focused on radiological progression of mild traumatic brain injuries [19, 40, 41] without much consideration to continuous clinical assessment of the patients and the use of GCS to follow the progression of the pathology. As noted by Joseph et al.[18] the GCS was devised as a scale to assess the neurological conditions of patient at any given point in time, and the true value is in the repeated assessment of patients over time to assess any potential change, particularly deterioration. This was observed in the management of our patients. Focusing on repeat CT progression only, may lead to unnecessary operations. The GCS of the patients should dictate the need for surgery with CT finding as an adjunct. Most patients who deteriorated were from progression of the pathology which had been seen by many authors as a process rather than static event.[42,43] Questions such as 'how mild is 'mild traumatic brain injury?' was probably borne out of florid radiological findings in mild traumatic brain injury. The classification was based on clinical events. The word 'mild' is a comparative adjective, comparing mild to moderate and severe traumatic brain injuries. Comparing the radiological findings and treatment outcomes in the three groups will give perfect answers to some of the posed questions. We have to be careful not to sacrifice the clinical skills on the altar of neuroimaging with the attendant consequences, especially in developing countries like ours.

The mean hospital length of stay (LOS) for our patients was 11.92 days. Joseph et al.[18] had 3.6 ±4.6days mean LOS in their study. Ashraf et al. [40] in their study had 5±3 days as mean LOS. The difference was due to our keeping some of our patients longer, allowing symptoms to resolve since many of them did not do CT scan of the brain.

Conclusion

Male gender and age group 20-40 years were the main groups that had mild traumatic brain injuries. Road traffic accident was the most common etiology. The etiology significantly related to care provided. The favorable outcome in our study was very good. The knowledge of pathologic progression with frequent assessment of patients using GCS and other physical signs, coupled with appropriate surgical intervention to stop progression of the pathologies, helped us to assign appropriate GCS at the time of reversal of the pathologic progression.

Recommendations

1 The Glasgow Coma Scale score after resuscitation should be repeated every two hours until it stabilizes and start to reverse upwards or till surgery is about to begin to arrest the progression of the pathology. The actual score should be at time of reversal or just before induction of anesthesia.

2 Cranial computed tomography scan should be obtained as soon as the patient can afford it, for treatment and prognostication. Repeat scan is needed if there is clinical evidence of progression of the pathology.

3 Routine repeat CT scan without corresponding clinical examinations should be discouraged as it may lead to treating 'the CT scan' instead of 'the patient'.

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