ORIGINAL RESEARCH

Epidemiology and Outcome of Diffuse Axonal Injury- A Study in a Tertiary Centre in Eastern India

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ABSTRACT

Background:Trauma to the head is an increasing cause of mortality and morbidity in today's modern world with increasing number of road traffic accidents being the most common cause of head injuries. Among the various types of head injury Diffuse Axonal Injury (DAI) is the type which is often associated with prolonged hospitalisation andhas a high rate of morbidity and mortality.Moreover those who survive are often dependent on others for daily activities.

Materials and Methods: The study was a prospective cohortstudy carried out at Calcutta National Medical College Kolkata on patients admitted with head injury through the emergency department over a period from 1stJanuary 2015 to 31st December 2020.The patients were followed up at monthly intervals following discharge for a period of six months.

Results: Thestudy found that the most common causes of Diffuse Axonal Injury were Road Traffic Accidents, followed by falls and assaults. Out of 168 patients admitted with Diffuse Axonal Injury who were included in the study 8 patientsdied during hospitalisationwhile10 patientswere discharged fully recovered whilethe remaining150 patientswere discharged either in a vegetative condition or with varying degrees of dependence for daily activities.

Conclusion: Diffuse Axonal Injury is a type of brain injury causing significant morbidity and mortality especially affecting the younger people and hence causing huge economic burden on society as a whole and increased preventive measures seems to be the best way to prevent this type of injury.

Keywords: Diffuse Axonal Injury(DAI), Traumatic Brain Injury(TBI), Glasgow Coma Scale(GCS),ExtendedGlasgow Outcome Score (GOS-E).

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INTRODUCTION

Head injuries are increasing due to increased number of vehicles along with increasing violence in society. Head injury is any sort of injury to the brain, scalp or skull. The incidence of head injuries in India is about 1.5 to 2 million per year.[1]

Traumatic brain injury (TBI) is a common health problem in both developed and developing nations and causes a heavy disease burden in all age groups.[2] According to CDC Traumatic Brain Injuries are responsible for nearly 2.5 million emergency visits in a year out of which nearly 282000 require admission and there are around 56000 deaths.[3]The estimated economic burden of TBI is estimated to be about 4.4 trillion USD in GDP for the period 2015to 2030in developing countries.[4]

Diffuse axonal injury is a type of injury which is quite unique as most of these patients do not have any findings on CT scans or very minimal signs, however most patients are found to

have poor GCS on admission and often remain so for prolonged periods of time. In Diffuse Axonal Injury there is microscopic damage tothe axons in the neural tracts, corpus callosum and brain stem. There is vascular injury at a capillary level which can be seen as isolated or multiple haemorrhages at the junction of white and grey matter.[5]

Diffuse Axonal Injury is clinically defined by coma lasting more than 6 hours after traumatic brain injury excluding cases ofbrain swelling or ischaemic lesions.[6] It is the most common cause for post traumatic coma, disability and persistent neurovegetative stage. It causes long term cognitive, physical and behavioural changeswhich in turn affects their return to work and activities ofdaily living and hence decreases the quality of life.[7] However as the brain tissue is usually functionally impaired rather than being totally destroyed recovery is seen in some and the brain plasticity helps to remodel the brain and restore function in many patients.

CT scan remains the first imaging test performed in all head injuries, however it has a low sensitivity for detecting DAI.In CT scans DAI is suggested by presence of small non expansive haemorrhages at the grey white matter junctions, intraventricular haemorrhage and generalised brain oedema.MRI remains the investigation of choice in DAI and is able to detect to Intraparenchymalabnormalities in 75% of patients with normal CT scans.[8]

The exact incidence of Diffuse Axonal Injuries is not known. It is estimated that around 10% of Traumatic Brain Injuries (TBI) have Diffuse Axonal Injury and among these patients nearly 25% succumb.[9]

Genarelli's clinical classification is used to classify DAI severity into three grades. Coma lasting for six to twenty-four hours in patients are classified as mild DAI, while those with coma lasting beyondtwenty-four hours but without abnormal posturing are classified as moderate DAI. In severe DAI coma lasts more than twenty-four hours along with signs of brainstem impairment. Patients were considered to be out of coma when they had a best motor response of six.

Adams classification is commonly used to grade DAI radiologically.Grade 1 ismild diffuse axonal injury with microscopic white matter changes in the cerebral cortex, corpus callosum and brainstem while in Grade 2 which is moderate DAIthere aregross focal lesionsin the corpus callosum and lastly in Grade 3 which is severe DAI findings in Grade 2 along with additional lesions in the brainstem are found on MRI.

The Glasgow outcome scale was initially used to assess outcome which was later expanded into the Extended Glasgow Outcome Scale (GOS-E)which is used to categorise functional outcome of patients into Eight categories.

GOS	GOSE	Interpretation
1 = Dead	1 = Dead	Dead
2 = Vegetative state	2 = Vegetative state	Absence of awareness of self and environment
3 = Severe disability	3 = Lower severe disability	Needs full assistance in ADL
	4 = Upper severe disability	Needs partial assistance in ADL
4 = Moderate disability	5 = Lower moderate disability	Independent, but cannot resume work/school or all previous social activities
	6 = Upper moderate disability	Some disability exists, but can partly resume work or previous activities
5 = Good recovery	7 = Lower good recovery	Minor physical or mental deficits that affects daily life
	8 = Upper good recovery	Full recovery or minor symptoms that do not affect daily life

ADL = activities of daily living.

Patients alive at six months of follow up were grouped into independent comprising those with upper good recovery, lower good recovery, upper moderate disability and lower

moderate disabilitywhile those with upper severe disability, lower severe disability and persistent vegetative stage were classified as dependent.

MATERIALS & METHODS

It was a prospective cohort study carried out by compiling and analysing data from patients admitted with TBI through the Emergency Department in our hospital for a period of ten years from January 2011 to 2021.

Eligible patients were those who had a Glasgow Coma Scale (GCS) of 8 or less with either a normal CT scan or with a CT scan with signs of DAI.

DAI was confirmed by an MRI in all cases.

Patients with previous history of psychiatric treatmentor physical disabilities and those with other types of head, thoracic, abdominal or long bone fractures were excluded from the study group.

The following data wasrecorded at the time of admission.

Socioeconomic characteristics- age, sex, marital and occupational status.

How the injury occurred, the type of pre hospital care, whether there is any history of alcohol consumption.

Data related to time of admission after injury, respiratory rate,bradycardia /tachycardia, hypotension,convulsion, hypoxia, hyperglycaemia, hypoglycaemia pupillary size and GCS at time of admission were also recorded.

Data was noted on a daily basis on the above parameters and also on duration of stay in ICU, blood parameters like sodium, potassium, CRP, total count and arterial blood gas for patients on ventilation.

CT Scan findings on admission were noted and all suspected cases of DAIunderwent MRI for confirmation and grading.

Early DAI signs in CT Scan in the first 24 hours included those with intraventricular haemorrhage, subarachnoid haemorrhage, gliding contusion or diffuse brainswelling with effacement of basal cisterns and sulci(indirect signs of brain injury).

The ExtendedGlasgow Outcome Scale (GOS-E) was noted at the time of discharge and subsequently during followup to a period of six months after discharge at one monthly intervals.

Stastical Analysis

The data collected during the study was analysed using the Epi Infosoftware. The required sample size was also calculated using the same software.

RESULTS

246 patients were admitted during the period of study with initial diagnosis of DAI. Out of these 78 patients were excluded due to presence of other injuries like spinal, abdominal,thoracic or long bone injuries which could have a confounding effect on recovery of the patients. 8 patients diedduring hospitalisationwhich left us witha total of 160 patientswho were included in the study.

Table 1: Socio Economic Characteristics ofthe Dai Patients

Socio economic characteristic	No. Of patients	Percentage
Male patients	126/160	78.75%
Female patients	34/160	21.25%
Married	108/160	67.5%
Employed	110/160	68.75%
Unemployed	8/160	5%
Students	20/160	12.5%
Housewife’s	22/160	13.75%

Table 2: Causes of Head Injury

Cause of head injury	Number of patients	Percentage of patients
Road traffic accidents	140/160	87.5%
Fall from heights	4/160	2. 5%
Assault	15/160	9.375%
Sports injuries	1/160	0.625%

Table 3: Classification of Dai patients according to Genarellis clinical classification at time of admission

Genarellis classification	No. Of patients at admission	Percentage of patients
Mild	10	6.25%
Moderate	56	35%
Severe	94	58.75%

Table 4: Classification of patients according to Adams radiological classification

Adams classification	No. Of patients	Percentage of patients
Grade 1	18	11.25%
Grade 2	60	37.5%
Grade 3	82	51.25%

Table 5: extended Glasgow coma scale (Gos-e) scores at time of discharge and at six months after follow up

Gos-e	No. Of patients at discharge	No. Of patients at six months of follow up
Upper good recovery	10	24
Lower good recovery	15	27
Upper moderate disability	26	12
Lower moderate disability	13	17
Upper severe disability	38	22
Lower severe disability	33	21
Persistent vegetative state	25	5
Dead		32

DISCUSSION

Diffuse axonal injury is a microscopic injury associated with significant morbidity and mortality and is often responsible for prolonged hospitalisation and also prolonged post discharge recovery period which in turn places a huge economic burden on affected families and society along with a loss of man hours.

In our study we found that male patients (78.75 %) constituted a majority of the patients of DAI as compared to females(21.25%) which can be attributed to the social trend of our country of males largely driving vehicles and going to work. Road traffic accidents(87.5%)account for the majority of the patients with the rest being due to fall(2.5 %)and assaults(9.375 %). Only one case was due to sport injury. Most of those admitted were employed(68.75%), while of the remaining patients 13.75% were housewives, 12.5% were students and only 5% were unemployed.

Out of the 160 patients included in the studyaccording to Genarelli's clinical classification at the time of admission10patients(6.25%)were found to have mild DAI,56(35%)patients were found to have moderate DAIand 94(58.75%)patients were found to have severe DAI.

Adam'sRadiological classification of DAI was done by doingMRIwhich showed that18 patients(11.25%) had grade 1 DAI, 60 patients(37.5%) hadGrade 2 DAI and82 patients(58.75%) had Grade 3 DAI.

At the time of discharge 10 patients(6.25%) were found to be having upper good recovery, 15 patients (9.4%)were found to be havinglower good recovery,26 patients(16.25%) were found

to have upper moderate disability, 13patients (8.13%)were found to have lower moderate disability, 38patients(23.75%) were found to have severe upper disability,33 patients (20.63%)were found to have lower severe disability and lastly 25patients(15.63%) were found to be in a persistent vegetative stage.

In the six months of followup another32 patients(20%) died due to various complications . The rest of the patients were found to have some progression with24 patients(15%) having GOS-E of upper good recovery,27patients(16.875) with lower good recovery,12 patients(7.5%) with upper moderate disability, 17patients(10.62%) with lower moderate disability, 22patients(13.75%) with upper severe disability,21 patients(13.12%) with lower severe disability and 5 patients(3.13%) were still in persistent vegetative stage.

CONCLUSION

Among the patients of our study 80 patients (50%) were found to be independent, thatis in the upper four categories of the GOS-E Scale. 32 patients (25%) died during follow upmainly those in the vegetative and lower severe disability category. Similar studies on prognosis have reported a higher percentage of patients reachingthe independent stages. A study shows nearly 88 % of the surviving patients reaching the independent stage at six months of followup.[9]

The failure of our patients to improve as much as western studies can be attributed to thepoor socioeconomic background of the patients which limits their access to good nursing, physiotherapy, nutrition and rehabilitation.

As can be seen in the study DAI results in significant mortality and morbidity. Many patients are unable to lead a productive life and this places a heavy burden on the families and society as a whole. Prevention is still the best measure and can be done byplacing speed limits on vehicular speed, enforcing motorcyclists to wear helmets and making airbags compulsory for all cars, wearing safety equipment while working at heights and use protective head gear during contact sports.

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