

Clinico: Pathological Study of Diffuse Axonal Injury and Outcome Analysis

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Abstract

Background: DAI is considered the most important factor in determining morbidity and mortality in victims of TBI and is the most common cause of posttraumatic coma, disability, and a persistent neurovegetative state.

Aim: To predict the outcome with GCS at admission and CT Scan and MRI findings.

Materials and methods: It was a prospective cohort study in a group of 59 patients with head injury cases with GCS < 12. All the head injury cases with normal CT scan and > 6 hrs were taken in study. Mode of injury, incidence among various age groups, sex distribution, post resuscitative Glasgow Coma Scale were noted in patients. Mortality and morbidity analysed with respect to GCS and CT & MRI Scan findings.

Results: DAI constitutes 1.72% of total head injury admissions & 20.06% in severe head injury. MRI is more sensitive compared to CT. Mortality in our series is 32.20%. Most of DAI are due to road traffic accidents. Second and third decade populations are more in DAI. Neurological deficits improved almost completely (over the 1½ years to 2 years) and early recovery seen in younger age groups compared to elder age groups. In 27.5% of cases recovery is good as per GCS.

Conclusion: In Patients with diffuse axonal injury the help of GCS, CT Scan and MRI findings one can know which patients can be salvaged.

Keywords: Diffuse Axonal Injury (DAI).

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Introduction

Diffuse axonal injury (DAI) is one of the most common and important pathologic features of traumatic brain injury [1,2]. The definitive diagnosis

of DAI, especially in its early stage, is difficult. In addition, most therapeutic agents for patients with DAI are non-specific. The CT scan is widely used to identify signs of DAI. Although its sensitivity is limited to moderate to severe DAI, [1,2]. It remains a useful first-line imaging tool that may also identify co-morbid injuries such as intracerebral haemorrhage. Recently, investigations have sought to apply advanced imaging techniques and laboratory techniques to detect DAI. Meanwhile, some potential specific treatments that may protect injured axons or stimulate axonal regeneration have been developed.

Classically DAI has been considered the pathological substrate of those cases rendered unconscious at the moment of impact and in which the CT scan does not show mass lesions [1,2]

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Diffuse axonal damage is almost always related to mechanisms of injury in which the rotational acceleration produces shear and tensile strains of high magnitude.

In fact, DAI represents approximately one half of all intra-axial traumatic lesions. This lesion is the most significant cause of morbidity in patients with traumatic brain injuries, which most commonly result from high-speed motor vehicle accidents. Any patient with a closed head injury who experiences extensive loss of consciousness and neurological deficits warrants neuroimaging. DAI typically consists of several focal white-matter lesions measuring 1-15 mm in a characteristic distribution [1,2]. Most of the cases of DAI are due to high velocity injuries because of road traffic accidents or fall from height. With increase in urbanization and rapid method of transportations incidence of high velocity road traffic accidents are increasing in India. India accounting for 6% road traffic accidents and has highest accident rate in the world with fatality rate of 55 deaths per 10,000 vehicles. Brain dysfunction without any gross structural damage observed in 40% severe head injury and 1/3 of deaths in severe head Injuries are due to DAI [4].

Aims and Objectives

1. To study the incidence of Diffuse Axonal Injury in head injuries.
2. To analyse the morbidity and mortality in DAI.
3. Predicting the outcome with respect to Glasgow Coma Scale, CT and MRI findings.

Materials and Methods

This is a prospective study consisting of 59 cases of DAI studied over a period from October 2011-October 2013 in the Department of Neurosurgery, Osmania General Hospital, Hyderabad.

All the patients were admitted in acute neurosurgical care unit, and a variety of clinical/imaging data were collected and analysed with respect to

1. Mode of injury.
2. Incidence among various age groups.
3. Sex distribution.
4. Post resuscitative Glasgow Coma Scale.
5. Findings on CT Scan / MRI.

6. Outcome of the patient at discharge & follow up.

The mortality and morbidity analysed with respect to GCS and CT & MRI Scan findings.

Inclusion Criteria

All the head injury cases with GCS < 12.

All the head injury cases with normal CT scan and > 6 hrs loc.

All the head injury cases with the age > 5 yrs, because children are not cooperative for MRI scanning.

Exclusion Criteria

All the cases with significant focal lesions on CT scan (eg: EDH, SDH, contusion) are excluded.

All other causes of prolonged unconsciousness (eg: abdominal injuries, unstable vitals, metabolic causes) are excluded.

All the cases with significant extracranial injuries like multiple long bone fractures, chest injury, abdominal injury and cervical spine injury are excluded from the study.

All the cases with unstable vitals are excluded.

All the cases with GCS >13 are excluded.

All the cases with < 6 hours LOC or no post traumatic amnesia.

All routine investigations are done and also X-Ray Cervical spine, Chest X-Ray, CT Scan Brain and MRI Brain

Glasgow outcome scale (Jennett & Bond) [5]:

5- Good recovery

4-Moderate disability

3-Severe disability

2-persistent vegetative state

1- Death

GOS 4, 5 were classified as favourable outcome.

GOS 2,3,1 were classified as unfavourable outcome.

Results

During the period of study total number of admissions were 3424 in Acute Neurosurgical Care unit. Severe head injuries i.e. GCS ≤ 8 were 294, comprising 27.55% of total head injury admissions. Total number of cases with diffuse axonal injury

were 59 constituting 1.72% of total admissions, and 20.06% in severe head injuries.

Table 1: Mode of injury and age of patients in study

Mode of injury	No of cases	Percentage
RTA	52	88.13%
Fall from height	06	10.16%
Assault	01	1.69%
Age in years		
6-10	03	5.08%
11-20	09	15.25%
21-30	21	35.59%
31-40	19	32.20%
41-50	04	6.77%
>50	03	5.08%
Sex		
Males	53	89.83%
Females	06	10.17%

In this study, most common mode of injury was Road Traffic Accident constituting 88.13%. In our study, most of the patients were in productive age group. In this study, majority of patients were between 21-40 (67.79%) The youngest patient was 6 years old and oldest was 60 yrs. In this study 89.83% were male (Table 1).

Table 2: Clinical Examination and Focal Neurological Deficits in study

Clinical Examination:	No. of cases	Percentage
GCS		
3-4	12	20.33
5-6	19	32.20
7-8	22	37.28
9-10	06	10.16
Focal Neurological Deficits		
Present		
Rt Hemiparesis	18	30.50
Lt Hemiparesis	08	13.55
Rt UL Monoparesis	23	38.98
Lt UL Monoparesis	04	6.77
Total	53	89.8
Absent	06	10.16%

In our study, patients with GCS 7-8 were 22 (37.28%). 53 (89.83%) patients had focal neurological deficits within 24hrs (Table 2).

Table 3: CT scan findings in study

Grade on CT Scan	Pathology	No. of cases	percentage
I	No abnormally	34	57.62%
II	Cisternal space normal <5mm midline shift	04	6.77%

III	Cisternal space obliterated <5mm midline shift	11	18.64%
IV	>5mm midline shift	10	16.94%

In our study, CT scan diagnosed DAI in out 25 of 59 patients (42.37%)

In our study, patients of diffuse axonal injury with CT scan findings in III to IV grade were 21, constituting 35.58% of total cases (Table 3).

Table 4: MRI Grading

Grade	Areas affected	No. of cases	Percentage
I	Parasagittal regions of the frontal lobes periventricular temporal lobes	09	15.25%
II	Internal and external capsules Stage I areas + corpus callosum	18	30.50%
III	Stage I + Stage II areas + rostral brain stem	07	11.86%

In our study, patient of diffuse axonal injury with MRI of brain II and III grade were 25, constituting 42.36% of total cases. In this study most of patients classified as grade II 18 patients (30.50%) (Table 4).

Table 5: Mortality in study with respect to GCS, CT findings and MRI findings

Mortality	No. of cases	No of deaths	Percentage
Mortality with respect to GCS			
3-4	12	5	41.66%
5-6	19	6	36.57%
7-8	22	7	31.81%
9-10	06	1	16.66%
Mortality with respect to radiological CT grade injury:			
II	04	0	0%
III	11	3	27.27%
IV	10	6	60%
Mortality with respect to radiological MRI grade injury:			
I	09	1	11.11%
II	18	3	16.66%
III	07	6	85.71%
Total deaths in study			
	59	19	32.2%

All the survived patients were followed up every 2 months for a period of 6 months and every 6 months for 2 years (Table 5).

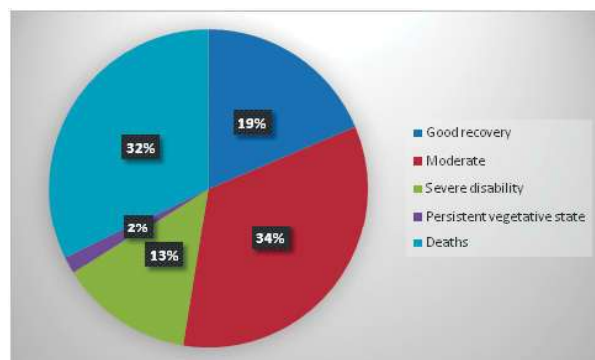
In this study upto 2% of patients with TBI remaining in persistent vegetative state after 2 years.

No. of cases in follow up after 6 months: 36

No. of cases in follow up after 1 year: 19

No. of cases in follow up after 1 ½ year–2 years: 9

Fig. 1: Outcome analysed by Glasgow Outcome Scale.



Discussion

Outcome prediction after severe head injury continues to be an area of intense interest as increasing attention is paid to resource allocation in all societies. Our ability or inability to predict outcome accurately becomes very important for utilization of scarce resources. Relatively accurate predictions of likely outcome allow specific populations who are failing our present therapeutic regimens to be identified, so that new experimental therapies can be targeted to them.

It is generally accepted that the patient's neurological status and age are the two most important factors in outcome predictions. There is increasing evidence that to these two classic variables should be added the pattern of structural brain injury as visualized by CT and MRI. Mortality rate between 20- 80% has been reported in literature in diffuse axonal injury. Many prognostic factors were identified in predicting the outcome analysis in DAI. Our study aimed in predicting the outcome with GCS at admission and CT Scan and MRI findings.

Present study analysed 59 cases of DAI in Osmania General Hospital for duration of 2 yrs. This study showed an overall mortality of 32.20% i.e., 19 died out of 59 patients. The present study was conducted in Osmania General Hospital, Hyderabad which is a Tertiary Referral centre to where all the severe head injuries are referred, that is the reason in this study the incidence of severe head injury is more and the DAI, that contributing significant number of severe head injury. For this reason our study is designed to assess the prognosis of the patient using the CT Scan and MRI which is available in our hospital. Several studies have been

done to prognosticate the diffuse axonal injury with number of lesions & location of lesions in MRI brain and several, modifications of MRI techniques like diffusion weighted images, gradients, echo images etc.

Our study is conducted in OGH from October 2011 to October 2013. During this period, 3424 cases were admitted in neurosurgical care unit. Out of these cases, severe head injury cases were 294, comprising 27.51% of total admissions. DAI cases were diagnosed clinically on the basis of mode of injury, clinical & radiological findings. DAI patients will be unconscious since the time of admission. (no lucid interval), and have poor GCS.

In our study, the most common etiology is RTA 52 cases (88.13%), followed by fall from height 6 cases (10.16%). Overall diffuse axonal injuries are due to high velocity injuries. Majority of DAI were in younger or middle age.

More than half of the cases were in 21-40 years. This age group is more vulnerable to RTA due to various socioeconomic reasons. In our study, 53 patients out of 59 were male. The incidence in male is more because they are involved in most of the road traffic accidents. All the patients are admitted in acute neurosurgical care unit and GCS noted after resuscitation and subjected to appropriate radiological and biochemical investigations. CT Scan was taken for all patients, CT scan diagnosed as a diffuse axonal injury in 25 cases (42.37%). In another study conducted by Chelly et al 6 sensitivity was 25%. MRI was done within 7 days \pm 4 days for patient with Grade I CT scan lesions (unconscious patient with normal CT scan of brain), as per MRI findings grade I 19 cases, Grade II 17 cases, Grade III – 8 cases.

MRI is more sensitive compared with CT as proved by Paterakishk et al 7. Out of 59 patients 53 had focal neurological deficits in the form of Right Hemiparesis (18 patients), Left Hemiparesis (08 patients), Right ULMonoparesis (23 patients) and Left UL Monoparesis (04 patients). All the patients were managed conservatively with standard protocols like protection of airway by endotracheal tube/tracheostomy when required, maintaining oxygen saturation, blood pressure etc., preventing secondary brain injury, correcting electrolyte disturbances.

In our study, we segregated the patients with respect to CT Scan and MRI findings and Glasgow Coma Scale, followed the cases in each subgroup and analysed the mortality in each subgroup and outcome after 6 months.

In our study, we tried to find whether with GCS and CT Scan and MRI finding it is able to prognosticate the patients with DAI. Out of 59 cases, 19 cases expired in the hospital. Mortality rate is 32.20%. Mortality in DAI is ranging from 5-80% in various series [2,8,9,10]. Mortality in our series is high because more number of patients are in very poor GCS.

Total numbers of cases are divided with respect to CT Scan findings into 4 groups, MRI into 3 groups and mortality in each group and number of cases are tabulated.

Mortality rate with respect to radiological degree of injury:

As on CT Scan, grade III, grade IV patients have very high mortality.

As on MRI of brain, grade II & III patients have very high mortality.

GCS 3-4, 5-6 patients have high mortality.

Hence, we can prognosticate the cases of DAI with the help of GCS, CT Scan and MRI findings, so that we can know which patients can be salvaged.

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Table 6: Global outcome after severe closed head injury

Author	No of patients	Meanage	Glasgow outcome scale (%)				
			Good recovery	Moderate disability	Severe disability	Vegetative	Death
Pecker et al. [11]	160	27	36	24	08	2	30
Bowers marshall [12]	200	27	42	10	8	4	36
Miller et al. [13]	158	31		47.5		12	405
Gennarelli et al. [1]	1107	NR	26	16	13	4	41
Lobato et al. [14]	277	33	26	16	13	4	41
Alberico et al. [15]	330	NR	32	20		10	38
Marshall et al. [16]	746	29	27	16	16	5	36
Present Day	59	31	11	20	8	1	19

Conclusions

DAI constitutes 1.72% of total head injury admissions & 20.06% in severe head injury. MRI is more sensitive compared to CT. Mortality in our series is 32.20%. Most of DAI are due to road traffic accidents. Second and third decade populations are more in DAI. Neurological deficits improved almost completely (over the 1½ years to 2 years) and early recovery seen in younger age groups compared to elder age groups. In 27.5% of cases recovery is good as per GCS. The prognosis, morbidity, mortality in DAI can be predicted with GCS and CT Scan and MRI findings.

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