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Original Research Article

Clinicoradiological Study and Analysis of Diffuse Axonal Injury and its Outcome – An Institutional Experience

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Abstract:

Background: Diffuse axonal injury is also known as traumatic axonal injury, a severe form of traumatic brain injury and known for its severe consequences. The definitive diagnosis of DAI, especially in its early stage, is difficult. DAI represents approximately one-half of all intra axial traumatic lesions. The 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 will experience extensive loss of consciousness and neurological deficits warrants neuro imaging. DAI typically consists of several focal white matter lesions measuring 1 – 15 mm in a characteristic distribution.

Aim: Aimof the study is to study the incidence of Diffuse Axonal Injury in Head Injuries; analyze the morbidity and mortality in DAI; predict the outcome concerning Glasgow Scale, CT, and MRI findings**.**

Methodology: This is a prospective study consisting of 69 cases of DAI studied over a period from October 2021 to December 2023 in the Department of Neurosurgery, Guntur Medical College / Government General Hospital, Guntur. All the patients were admitted to the acute neurosurgical care unit and a variety of clinical / imaging data were collected and analyzed concerning Mode of injury, Incidence among various age groups, Sex distribution, Post resuscitative Glasgow Coma Scale (After optimization of SBP, SPO2, GRBs.), Findings on CT Scan, MRI grading, The outcome of the patient at discharge and follow up by Glasgow Outcome Scale. The mortality and morbidity were analyzed concerning GCS and CT & MRI. Scan findings.

Results and Conclusion: DAI constitutes 2.98% of total head injury admissions and 27.70%in severe head injury. MRI is more sensitive compared to CT. Mortality in our series is 40.58%. Most of DAI are due to Road Traffic Accidents. Second and third decade populations are more in DAI (62.32%). Most of them sustained RTA under alcohol influence (77.41% i.e., 48 out of 62 patients). Neurological deficits improved almost completely (over the 1 ½ year 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.

Keywords: Head Injury, Diffuse Axonal Injury, Glasgow scale, Neurosurgery, CT, MRI.

Introduction

Diffuse axonal injury is also known as traumatic axonal injury, a severe form of traumatic brain injury and known for its severe consequences. DAI was clinically defined by loss of consciousness lasting 6 hrs or more after TBI, excluding swelling hematomas or ischemic brain lesions [1,2,3]. The definitive diagnosis of DAI, especially in its early stage, is difficult. Besides, 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, it remains a useful first-line imaging tool that may also identify co-morbid injuries such as intra cerebral hemorrhage. 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 [4,5].Classically DAI was considered the

pathological substrate of those cases rendered unconscious at the moment of impact and in which the CT scan does not show any mass lesion. Diffuse axonal injury is almost always related to mechanisms of injury in which the rotational acceleration produces shear and tensile strains of high magnitude.

DAI represents approximately one-half of all intra axial traumatic lesions. The lesion is the most significant cause of morbidity in patients with traumatic brain injuries6, which most commonly result from high-speed motor vehicle accidents [7], Any patient with a closed head injury who will experience extensive loss of consciousness and neurological deficits warrants neuro imaging. DAI typically consists of several focal white matter lesions measuring 1 – 15 mm in a characteristic distribution [8].

Aims and objectives

- To study the incidence of Diffuse Axonal Injury in Head Injuries.
- To analyze the morbidity and mortality in DAI.
- To predict the outcome concerning Glasgow Scale, CT, and MRI findings

Materials and methods

This is a prospective study consisting of 69 cases of DAI studied over a period from October 2021 to December 2023 in the Department of Neurosurgery, Guntur Medical College and General Hospital, Guntur.

All the patients were admitted to the acute neurosurgical care unit and a variety of clinical / imaging data were collected and analyzed concerning Mode of injury, Incidence among various age groups, Sex distribution, Post resuscitative Glasgow Coma Scale (After optimization of SBP, SPO2, GRBs.), Findings on CT Scan, MRI grading, The outcome of the patient at discharge and follow up by Glasgow Outcome Scale. The mortality and morbidity were analyzed concerning GCS and CT & MRI. Scan findings.

Inclusion criteria: All the head injury with GCS< 12, with normal CT scan and >6hours LOC, with age> 5yrs.

Exclusion criteria: All the cases with significant focal lesions on the CT scan (e.g., EDH, SDH contusion); other causes of prolonged unconsciousness (e.g., abdominal injuries, unstable vitals, metabolic causes); cases with significant extra cranial injuries like multiple long bone fractures, chest injury, abdominal injury, cervical spine injury were excluded from the study; with unstable vital; cases with GCS>13; the cases with <6 hours LOC or no Anti grade/ Retrograde posttraumatic amnesia were excluded.

Investigations: CBP, RBS, Blood Urea, S. Creatinine, Blood Grouping & Typing, BT, CT, HIV, HBsAg, HCV, S. Electrolytes, X-ray cervical spine, Chest X-ray, ECG, CT scan Brain, M.R.I. Brain.

Observations and results

During the period of study, total admissions in Acute Neurosurgical Care Unit were 2314. Severe head injuries, i.e., GCS < 8, were 641, comprising 27.70% of total injury admissions.

The total number of cases with isolated diffuse axonal injury was 69 constituting 2.98% of total admissions and 10.76% in severe head injuries. In another study conducted in Moscow state University by oigav, Senyukova et al. [6] 50% of DAI occur in severe TBI.

Table 1: Mode of Injury

Mode of injury	No. of cases	Percentage
RTA.	62	89.86%
Fall from Height	05	7.24%
Assault	02	2.90%

Table 2: Age Distribution

Age in years	No. of patients	Percentage
6-10	01	1.45%
11-20	06	8.70 %
21-30	15	21.74%
31-40	28	40.58%
41-50	9	13.04%
>50	10	14.49%

Table 3: Sex Distribution

Sex	No. of patients	Percentage
Male	62	89.86%
Female	07	10.14%

Table 4: Clinical Examination

GCS	No. of patients	Percentage
3-4	14	20.33%
5-6	22	32.20%
7-8	26	37.28%
9-10	07	10.16%

Table 5: Focal Neurological Deficits

Deficits		No. of patients	Percentage
Present		53	76.82%
Rt Hemiparesis	18		
Lt Hemiparesis	8		
Rt UL Monoparesis	23		
Lt UL Monoparesis	4		
Absent		06	8.69%
It could not be assessed.		10	14.49%

Table 6: Grade on CT scan

Grade	Pathology	No. of cases	Percentage
I	No Abnormality	40	57.98%
II	Cisternal space normal 0-5mm midline shift	04	5.79%
III	Cisternal space obliterate <5mm midline shift	13	18.84%
IV	>5mm midline shift	12	17.39%

Table 7: Grade on MRI Scan

Grade	Areas affected	No. of cases	Percentage
I	Parasagittal regions of the frontal lobe Periventricular temporal lobes Internal and external capsules	10	14.49%
II	Stage I areas + corpus callosum	21	30.44%
III	Stage I + Stage II areas + rostral brain stem	09	13.04%

Table 8: Mortality Concening GCS, CT Grade, MRI Grade

GCS	No. of cases	No. of deaths	Percentage
3-4	15	15	100%
5-6	21	7	33.33%
7-8	26	5	19.23%
9-10	07	1	14.28%
CT Grade	**No. of cases**	**No. of deaths**	**Percentage**
II	04	01	25%
III	13	05	38.46%
IV	12	08	66.66%
MRI GRADE	**No. of cases**	**No. of deaths**	**Percentage**
I	10	1	10%
II	21	5	23.8%
III	09	8	88.88%
Overall mortality	69	28	40.58%

Follow up study: All the patients who survived were followed up every two months for six months and every six months for two years. The outcome was analyzed by the Glasgow Outcome scale. Glasgow outcome scale (Jennett and Bond); 5 - Good Recovery; 4 - Moderate disability; 3 - Severity disability; 2 - Persistent vegetative state; 1 – Death. GOS 4, 5 were classified as favorable outcomes GOS 2, 3, 1 were classified as an unfavorable outcome.

Table 9: Outcome on Follow up As per Glasgow Outcome Scale

No of patients	Good recovery	Moderate	Severe Disability	Persistent vegetative state	Deaths
69	11	20	8	2	28

No. of cases in follow up after six months: 36 No. of patients in follow up after one year: 19. No. of cases in follow up after 1 ½ year: 2 years: 9

Table 10: Glasgow Outcome Scale in the Study Group

GOS.	5	4	3	2	1	
Total	41	11	20	8	2	28

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 scare 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 analyzed 69 cases of DAI in Government General Hospital, Guntur for duration of 2 years. This study showed an overall mortality of 40.58% i.e., 28 died out of 69 patients.

The present study was conducted in Government General Hospital, Guntur, which is a Tertiary Referral center 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 a significant number of severe head injury. For this reason, our research was 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 lesions and location of lesions in MRI brain and several modifications of MRI technique like diffusion-weighted images, gradient, echo images, etc.,

During the period, 2314 cases were admitted to the Neurosurgical care unit. Out of these cases, severe head injury cases were 641, comprising 27.70% of total admissions. DAI cases were diagnosed clinically based on mode of injury, clinical and radiological findings. Since the time of admission (no lucid interval), DAI patients will be unconscious and have poor GCS.The total number of cases with isolated diffuse axonal injury was 69 constituting 2.98% of total admissions and 10.76% in severe head injuries. In another study conducted in Moscow state University by oigav, Senyukova et al. [6], 50% of DAI occur in severe TBI.In our study, the most common etiology is RTA 62 cases (85.50%), followed by falls from height 5patients (7.24%) and assault 2 patients (2.89%). Overall diffuse axonal injuries are due to high-velocity injuries. The majority of DAI were in younger or middle age. More than half the cases were in 21-40 years. The mean age was 36 years. In another study conducted by King JT Jr et al. [9], it was 30 years. This age group is more vulnerable to RTA due to various socio-economic reasons.

In this study, 89.83% were male. Male patients commonly sustained a severe head injury due to RTA because they were more involved in outdoor activities and vehicle driving than females. In another study conducted by King JT Jr et al. [9], it was 77%.

All the patients are admitted to the acute Neurological care unit, and GCS was noted after resuscitation and subjected to appropriate radiological and biochemical investigations. Took CT scan for all the patients. CT scan diagnosed diffuse axonal injury in 29 cases (42.02%). In another study conducted by Chelly et al. [10], CT sensitivity was 25%.

MRI was done within 7 days + 4 days for patients with Grade I CT Scan lesions (unconscious patient with normal CT scan of brain), as per MRI findings grade I - 11 cases, Grade II - 21 cases, Grade III – 8 cases. MRI is more sensitive compared with CT, as proved by Paterakis HK et al. [11]

Out of 69 patients, 53 had focal neurological deficits in the form of Right Hemi paresis (18 patients), Left Hemi paresis (8 patients), Right UL Mono Paresis (23 patients), Left UL Mono Paresis (04 patients), and in 10 patients, focal deficits could not be assessed because of poor GCS. All the patients were managed conservatively with standard protocols like protecting the airway by endotracheal tube / tracheostomy when required, maintaining oxygen saturation, blood pressure, etc., preventing secondary brain injury, correcting electrolytes disturbances, and cerebrolysin infusions.

Our study segregated the patients concerning CT scan and MRI findings and Glasgow Coma Scale, followed the scale in each subgroup, and analyzed the mortality in each subset and outcome after 6 months at discharge. All the patients have been prescribed Amantadine.

Our study tried to find whether it can prognosticate the patients with DAI with GCS and CT scan and

MRI findings. Out of 69 cases, 28 cases expired in the hospital. The mortality rate is 40.58%. Mortality in cases of DAI ranges from 5-80% in various series. Mortality in our series is high because more patients are in very poor GCS. The total number of cases is divided concerning CT scan findings into four groups, MRI into 3 groups, and mortality in each group and the number of cases is tabulated. 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.

Table 11: Global Outcome after Severe Closed Head Injury

Author	No. of patients	Mean age	Glasgow outcome scale (%)				
			Good Recovery	Moderate disability	Severe disability	Vegetative	Death
Jennett et al (1979) [12]	1000	34	22	17	10	2	49
Bowers Marshall (1980) [13]	200	27	42	10	8	4	36
Miller et al (1981) [14]	158	31	47.5		12		405
Gennarell et al(1982) [15]	1107	NR	26	16	13	4	41
Present Study	69	36	11	20	8	2	28

Conclusion

DAI constitutes 2.98% of total head injury admissions and 27.70%in severe head injury. MRI is more sensitive compared to CT. Mortality in our series is 40.58%. Most of DAI are due to Road Traffic Accidents. Second- and third-decade populations are more in DAI (62.32%).

Most of them sustained RTA under alcohol influence (77.41% i.e., 48 out of 62 patients). Neurological deficits improved almost completely (over the 1 ½ year 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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