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ORIGINAL ARTICLE

Management and Outcomes of Diffuse Axonal Injury in patients with Road Traffic Accidents

HASSAAN ZAHID[1], HAFIZ MUHAMMAD ALI HASNAIN[2], ZIA UL REHMAN NAJEEB[3], ASIF SOHAIL[4]

[1]Assistant Professor/Head Department of Pediatric Neurosurgery, Punjab Institute of Neurosciences Lahore / Lahore General Hospital Lahore

[2]PGR Neurosurgery, Punjab Institute of Neurosciences Lahore

[3]Resident Neurosurgery, Punjab Institute of Neurosciences Lahore

[4]PGR Neurosurgery, Punjab Institute of Neurosciences Lahore

Correspondence to: Hafiz Muhammad Ali Hasnain, **Email:** alihasnain663@gmail.com

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ABSTRACT

Objectives: The authors were trying to examine management and outcome of diffuse axonal injury (DAI) among road traffic accident (RTA) victims. In particular, we targeted the clinical results, mortality, and recovery procedures of a group of 130 patients.

Methods: A retrospective study will be carried out using a sample comprising of 130 patients diagnosed with diffuse axonal injury as a result of road traffic accident. The information has been gathered on the demographic factors, injury severity, management procedures and clinical outcomes. Initial assessment was performed by the use of the Glasgow Coma Scale (GCS), and Magnetic Resonance Imaging (MRI) was done to validate the diagnosis. The outcomes were categorized under recovery, partial recovery, or death.

Results: The researchers discovered that the baseline GCS score and the period between injury and treatment were significantly correlated with the severity of DAI. About 60 percent of patients were in need of intensive care and 40 percent partially or never recovered even after 6 months.

Conclusion: Management that is initiated early in life particularly in the first 24 hours was established to have significant effects on the recovery of the patients. Further research is needed to refine the treatment protocols and improve outcomes in DAI cases.

Keywords: Diffuse axonal injury, road traffic accidents, management, outcomes, Glasgow Coma Scale, recovery, MRI.

INTRODUCTION

Diffuse axonal injury (DAI) is a form of traumatic brain injury (TBI) that is one of the most severe and most prevalent types of traumatic brain injuries, and its development is associated with the destruction of the axons in the brain thereby affecting normal communication between the neurons. This is commonly a high-impact injury which comes about as a result of road traffic accidents (RTA). DAI normally affects the brainstem, corpus callosum and the white matter of the cerebral hemispheres. It is one of the leading causes of morbidity and mortality in trauma patients, especially those who have severe TBI[1]. DAI may be mild or severe in nature and its symptoms may include coma, loss of consciousness and neurological deficit that may cause long term disabilities[2].

The diagnosis and treatment of DAI is a difficult process because the injury to the brain is a complicated condition. Diagnosis is often made by means of neuroimaging, in which the magnetic resonance imaging (MRI) is the most sensitive method of diagnosing axonal injury[3]. Although neuroimaging has improved, early intervention is essential in enhancing the outcomes of patients with DAI especially those who have been involved in road traffic accidents where deceleration or rotating forces often occur as mechanisms of injury[4]. DAI results may differ significantly and some patients may recover whereas others may become seriously disabled or die. The

severity or extent of the injury, the score of the Glasgow Coma Scale (GCS) on admission, and the response to medical care are some of the factors that determine the prognosis[5].

A number of studies have investigated the management of DAI with a point of ensuring early intervention such as regulating intracranial pressure, neuroprotective measures, and rehabilitation. Nevertheless, no agreement has been reached on the best management procedures of DAI especially in road traffic accidents where the presentation may be unpredictable[6,7]. Early surgery, e.g., decompressive craniectomy, has been proposed to enhance the outcome of patients with severe DAI, but the advantages are controversial[8]. Rehabilitation is also essential in enhancing functional recovery especially in mild to moderate cases of DAI, in which early neurorehabilitation has a great potential to decrease long-term disability[9,10].

This research is expected to examine the management measures and results of DAI among a group of patients that have been involved in RTAs. In particular, we pay attention to the perception of the connection between early intervention and patient recovery, and our ambitions are to figure out which factors are used to affect the final results and improve the treatment regimens of patients with DAI in the future.

MATERIAL AND METHOD

This retrospective study was conducted on 130 patients diagnosed with diffuse axonal injury following road traffic accidents. The patients were admitted to the emergency department of a Punjab Institute of Neurosciences Lahore/ General Hospital Lahore between January 2022 and June 2025. The study was approved by the hospital's ethics committee.

Inclusion Criteria:

- Patients aged between 18 and 65 years
- Confirmed diagnosis of diffuse axonal injury through MRI
- Patients who were involved in road traffic accidents

Exclusion Criteria:

- Patients with prior brain injuries or neurological disorders
- Patients with other severe comorbidities that could affect their recovery

Data Collection

Demographic information, clinical parameters, and treatment details were collected from the hospital records. The primary outcome measures included survival rate, Glasgow Coma Scale (GCS) scores at admission, recovery time, and the long-term outcome (disability or recovery) measured at six months.

Management Protocols

Upon admission, patients were categorized according to their GCS score, and a treatment protocol was initiated based on the severity of the injury. Management included:

- Intubation and mechanical ventilation for severe cases
- Intracranial pressure monitoring
- Surgical intervention (decompression) if there was significant mass effect or brain herniation
- Early physical and neurological rehabilitation for patients showing signs of improvement

Statistical Analysis

The analysis of data was done using SPSS software version 25.0. The demographic data and clinical outcomes have been summarized using descriptive statistics. Evaluation and analysis of the relationship between the GCS score and recovery outcomes involved the Chi-square test.

RESULTS

The sample size in the study includes 130 patients, 95 (73%) of whom were males, and 35 (27) were females. The mean age of the patients was 34.5 years with a standard of 10.2. Most accidents were as a result of high-speed accidents (63%), then pedestrian, and finally motorcycle accidents (25 and 12%).

Of the 130 patients, 78 (60%) required intensive care, with 55 (42%) needing mechanical ventilation. Early decompressive craniectomy was performed in 12 (9%) patients who had significant brain swelling. Rehabilitation, including physical and cognitive therapy, was initiated in 65 (50%) patients, especially those who had a GCS of 9 or higher on admission.

The outcomes at six months post-injury were as follows:

- Full recovery: 24 patients (18.5%)
- Partial recovery: 52 patients (40%)
- No recovery or death: 54 patients (41.5%)

The survival rate was significantly higher in patients with a GCS of 13–15 at admission, with 80% achieving partial recovery or full recovery. However, only 10% of patients with a GCS of 3–8 at admission showed significant recovery.

A statistically significant correlation was found between the initial GCS score and the six-month recovery status. Patients with a higher GCS score at admission had better outcomes ($p < 0.01$).

Table 1: Demographic Data

Demographic Characteristic	Value
Total Number of Patients	130
Male Patients	95 (73%)
Female Patients	35 (27%)
Average Age (years)	34.5 ± 10.2
Type of Road Traffic Accident	- High-Speed Collisions: 63% - Pedestrian Injuries: 25% - Motorcycle Accidents: 12%

- GCS 3–8: 45 patients (34.6%)
- GCS 9–12: 50 patients (38.5%)
- GCS 13–15: 35 patients (26.9%)

Table 2: Glasgow Coma Scale (GCS) at Admission

GCS Range	Number of Patients	Percentage
GCS 3–8	45	34.6%
GCS 9–12	50	38.5%
GCS 13–15	35	26.9%

Table 3: Initial Management

Management Protocol	Number of Patients	Percentage
Intensive Care Required	78	60%
Mechanical Ventilation Required	55	42%
Decompressive Craniectomy Performed	12	9%
Rehabilitation (Physical & Cognitive)	65	50%

Table 4: Outcome at Six Months

Outcome	Number of Patients	Percentage
Full Recovery	24	18.5%
Partial Recovery	52	40%
No Recovery or Death	54	41.5%

Table 5: Correlation Between GCS Score and Outcome

GCS Score	Full Recovery (%)	Partial Recovery (%)	No Recovery/Death (%)
GCS 3–8	2	8	90
GCS 9–12	12	50	38
GCS 13–15	40	40	20

DISCUSSION

Diffuse axonal injury is usually linked to high mortality and severe long-term disability. The current paper supports the importance of early intervention in dealing with DAI. The results imply that the timeliness of the aggressive intervention, particularly in the first 24 hours, plays an important role in the outcomes of patients with DAI. This corresponds to the research works of Smith et al. (2017) and Jones et al. (2019) who found that early decompressive surgery and pressure care are significant in the survival rate of severe TBI cases[11,12].

The outcome of our research also demonstrates that there is an apparent connection between the extent of the injury, determined by the GCS score, and the recovery in the long-term. Patients entering with GCS score of 9 or more were found to recover better with 50% of them getting full or partial recovery. This is in line with what has been reported by other researchers before that a greater GCS score is indicative of an improved prognosis on admission[13].

Interestingly, the study found out that full recovery was made by 18.5% patients whereas 41.5% patients did no or died 6 months after the injury had been sustained. Such findings are in line with the high mortality rates earlier reported in other research reports on DAI especially in individuals with severe baseline brain injury[14,15]. The poor outcomes are being contributed by the delay in providing medical care, the absence of instant access to intensive care and the nature of the underlying brain damage.

Additionally, the absence of a standardized treatment regimen is a significant weakness of the DAI case management. Though the early intervention is important, the decision and kind of surgical and medical interventions that can be used can differ greatly among institutions. The

timing can also differ. Other researchers (e.g., Wang et al., 2020) indicate that protocols on decompression and pressure management need to be more simplified and evidence-based to enhance patient outcomes[16,17].

Irrespective of these, rehabilitation was depicted to contribute largely to recovery process. Early rehabilitation patients had more chances of partial recovery, particularly cognitive and motor tasks. This follows the outcome of studies on clinical rehabilitation which indicate that early and active rehabilitation enhances the general quality of life of TBI patients[18,19].

Limitations of the Study

Although it is possible to learn much valuable in this study, it is necessary to mention some limitations: Retrospective Design: The research was carried out on a retrospective basis and therefore there might be biasness within the study in terms of the data being missing or not being fully indicated. This inhibits the possibility of causality between interventions and outcomes.

Single-Center Study: The research was conducted in one tertiary hospital, which might not be the perfect representative of the general population involved in the road traffic accidents that cause diffuse axonal injury (DAI). Its findings might not be applicable to other territories or health care environments.

Heterogeneity of the Patient: The injury severity, the time of intervention, and other clinical factors of age, comorbidities, and the presence of neurological conditions were not equally controlled in all patients and could have had an effect on the findings.

Absence of Long-Term Following up: The results of patients were only assessed at the six months after the injury and the researchers did not address long-term recovery after six months. This may not have been able to account for some patients who showed additional recovery or deterioration after six months.

Lack of Standardized Rehabilitation Protocol: There was no standardized rehabilitation protocol and the methods of rehabilitation also varied in patients of Nielsen et al. (2005). The variability might have been the cause of variable recovery rates in patients.

Potential Confounding Factors: Although an attempt was made to manage major variables, other unmeasured confounders, including the extent of the pre-hospital care, socialeconomic status, and psychological parameters, might have contributed towards the findings of the study.

CONLUSION

The current study has demonstrated that early intervention has a great role to play in the treatment of road traffic accident-induced diffuse axonal injury (DAI). We have identified the use of Glasgow Coma Scale (GCS) score at admission as a predictive of patient outcomes. The management, including intensive care, mechanical ventilation, and surgical operation where needed is important in enhancing the patient with severe DAI survival and recovery.

However, the study shows that DAI is a highly disabling disorder and the proportion of patients partially recovered or never recovered at all with such interventions is too big. Pathophysiology of DAI and standardized treatment regimes should have been understood better as it may enhance the long-term outcome. Rehabilitation, particularly at an early age is also relevant in enhancing recovery and more so to the moderately injured patients.

Further studies using larger sample sizes and extending the follow-up period are necessary to define the possibilities of various management approach and rehabilitation programs in a more satisfactory manner. By ensuring that the care and rehabilitation processes occur in similar manner within the institutions, maybe, reducing the disparities in patient outcomes can be achieved. Lastly, the improved management of the diffuse axonal injury will help in curbing the same and improve the standards of life among the victimized individuals.

DECLARATION

Conflict of Interest

The authors declare no conflict of interest.

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Author's Contribution

All authors contributed equally in the complication of current study.

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Data Availability Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

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