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Original Research Article

Early rehabilitation intervention is associated with significant positive functional outcomes in traumatic brain injury: a retrospective analysis

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ABSTRACT

Background: Traumatic brain injury (TBI) is a global public health problem affecting adversely health care system. While acute trauma care has been documented to improve outcomes, the impact of early rehabilitation on outcome is not well documented especially in the developing world like ours. Predicting functional outcome from admission variables helps in intervention development, and appropriate fund allocation for TBI treatment. Therefore, we accepted a challenge to do a retrospective study on TBI patients admitted in our newly established and resource limited trauma center. The aim of the study was to assess the effect of early rehabilitation on TBI patients on functional improvement and to prognosticate the improvement from early admission variables.
Methods: Study was conducted at Apex Trauma Center, SGPGIMS, Lucknow analysis of prospectively maintained data. Retrospective analysis of records of patients, admitted within 48 hrs of moderate to severe injury, was done after Institute Ethic Committee approval. Statistical analysis used was regression analysis and multivariate analysis was done between possible risk factors and FIM gain.
Results: There was significant FIM score improvement from admission to discharge ($p<0.001$). Factors associated with a higher FIM gain were admission FIM motor and cognitive scores, GCS score on admission and length of hospital stay.
Conclusions: Our study strongly suggests that a dedicated rehabilitation programme, designed according to the functional needs of TBI patient, helps in improved functional outcome and recovery.

Keywords: Traumatic brain injury, Neurological rehabilitation, Functional outcome, Developing countries

INTRODUCTION

Traumatic brain injury (TBI) is a global public health problem which is fast becoming a health priority.[1] These injuries not only are associated with health loss and disability for individual and their families but also represents a burden to health care.[2] The high health care cost and loss of productivity have significant impact on global health care system particularly in developing economies like ours.[2]

Estimated worldwide incidence of TBIs is approximately 69 million individuals yearly.[3] From the year 2020 it has displaced other diseases as a major cause of morbidity and

mortality.[4] WHO reports Road traffic accidents (RTA) are most common cause of TBI in developing countries, with 56% of such RTA associated TBI cases in Africa and Southeast Asia alone.[3] Unfortunately, 85% of the world population stays in this region where unsafe driving behaviours, not using safety precautions are prevalent.[5] Similar trends are seen in India with estimated incidence of approximately 1.5-2 million TBI injuries and one million deaths annually.[6,7]

The recent advances in pre-hospital care and management of the TBIs have led to increased survival rates, but also increased survivor disabilities. There is strong evidence that early rehabilitation intervention improves functional outcome compared with late intervention.[8] Early introduction of rehabilitation also leads to improved levels of cognitive functioning and shorter lengths of stay.[9] The primary goals of specialized inpatient rehabilitation is to overcome impairment, prevent complications, promote functional independence, restore social participation and to ease distress of the patient as well as of the caregivers. Despite post-injury rehabilitation services and care is still in infancy in trauma centres across the country. Predicting outcome of TBI has been an active subject of research for several decades. Commonly used predictors are age, mechanism of injury, Glasgow come scale, pupillary reactivity, brain stem reflexes, CT findings as well as LOS during hospitalization etc.[10-15] Predicting outcome helps in intervention development, cost estimation, and appropriate fund allocation for TBI treatment specially when there are challenges in resource availability.[16]

The Functional independence measure (FIM) is one of the many tools available to measure outcome and is currently being utilized widely during rehabilitation programs.[17] There are not many studies available on the role of early rehabilitation on functional outcome in trauma centres in India. Therefore, the present study was planned.

The study, alongside, also evaluates several early variables that are readily available to the clinician such as age, etiology of injury, initial GCS scores, CT findings, associated skeletal trauma, length of hospitalization to determine their relationship to admission and discharge motor and cognitive FIM score.

METHODS

It was an observational study with retrospective analysis of records of patients with moderate to severe new TBI, between January 2019-January 2020, after Institute Ethic Committee approval. The procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation and with the Helsinki Declaration of 1975.

Inclusion criteria

Patients with moderate to severe head injury and aged >18 years were included.

Exclusion criteria

Patients with prior history of stroke, spinal cord injury, previous head injury or psychiatric disorders; mild TBI, injury duration >48 hrs were excluded from the analysis.

Based on admission Glasgow coms scale and Loss of consciousness (LOC), patients were divided into (a) mild category- GCS 13-15, loss of consciousness (LOC) up to 30 min; (b) moderate category- GCS 9-12, LoC >30 min but <6 hrs; and (c) severe category- GCS 3-8, LoC >6 hrs as suggested by ACRM.[16,18]

Rehabilitation protocol

Patients were diagnosed for TBI based on history, abnormal clinical and radiological findings. All TBI patients were assessed within 24 hrs of admission by the physiatry team including a physiatrist, nurse, physiotherapists, dietician and medical social worker. After definitive acute management and becoming clinically stable, they were then started on rehabilitation programme. The aim of the study was to initiate early rehabilitation programme within 48 hrs of injury. All patients received rehabilitation therapy given by a specialized rehabilitation team. Depending upon the individual needs, patients were treated for spasticity, bladder training, early mobilization, ROM exercises, muscle strength and endurance training, gait and balance training, oromotor dysfunction training, management of cognitive defects and neuro-behavioural problems. Patients were trained particularly for activities of daily living. Individualised therapies for various TBI associated motor and cognitive issues were given to each individual patient on daily basis for duration of up to 3 hrs in divided sessions. For study purpose early rehabilitation was defined as initiation of rehabilitation therapy within 48 hrs of injury. Time of discharge was mutually agreed by the treating neurosurgeon and physiatrist, once the desirable functional goals were achieved.

Data collection

Baseline demographic data like age, gender, education, occupation, mechanism of injury, injury duration, Loss of consciousness (LOC), GCS on admission, extremity fracture(s), CT findings, FIM score at admission, FIM score at discharge and Length of stay (LOS) were noted from the patient records.

Outcome variable

FIM was utilized to assess functional outcome because of its proven validity and reliability, and its ability to measure functional capacity as it relates to the burden of care.[19,20] FIM is an 18-item rating scale assessing self-care, bowel and bladder management, mobility, communication, cognition and psychosocial adjustment.[15] Each item is scaled from 1 (complete dependence) to 7 (complete independence). The FIM consists of two subsets, FIM

Motor (FIM-M) and FIM cognitive (FIM-COG). FIM-M consists of 13 items with score range 13-91, and FIM-COG has 5 items regarding processing of information, interaction with others or behaviour and communication with score range 5-35. Total FIM score is of the range 18-126. A total FIM score of <108 indicates limitation in activities and need for assistance. While scores of 109-126 indicates functional independence. It was calculated once at admission and then before discharge. FIM gain which is the difference between FIM discharge and FIM admission was calculated.

Statistical analysis

Statistical analysis was performed using the SPSS version 16.0 (SPSS INC., Chicago, IL, USA). Continuous variables were put across as mean or median and standard deviation. The dependent variable in regression analysis was FIM at discharge. Admission motor and cognitive FIM scores were used in regression analysis of discharge motor and cognitive FIM score and FIM gain.

Independent variables included GCS score, CT findings, and LOS. Bivariate analysis was done between possible risk factors and FIM gain. For the variables with $p<0.1$, (age, admission GCS score, admission FIM motor and cognitive score and LOS) multiple linear regression analysis was done to quantify their predictive impact on FIM gain and to control for possible confounding effects among independent variable. P value<0.05 was considered statistically significant with 95% confidence interval.

RESULTS

Analysis of data from 71 patients which met our criteria was done (Table 1). Fifty-six patients (78.8%) were male and 15 female patients. Mean age of patients was 35.17±16.20 years (range 19-76 years). There were 42 patients with severe injury out of 76.6% were males. 29 patients had moderate injury with 82% males. The mean age of patients in severe category was 26.12±18.2 years, and moderate category was 37.23±14 years. Regarding the etiology of injury, RTA was found to be the most common cause, accounted for 43% of injuries. RTA accounted for 3 times more severe injuries than moderate injuries. Most common intracranial pathology was contusion (48%), followed by SAH (20%). Out of 71 patients we took, 12 had extremity fracture(s). Out of these 8 belonged to severe injury category and 4 to moderate injury category. Mean LOS in hospital for severe category patients was 42±19 days and for moderate injury patients 25±12 days.

The FIM total mean score for admission was 82±23, which improved to 104±28 on discharge (Table 2). When patients were compared for their GCS score with FIM scores, it was found that severely injured group had lower FIM scores both motor and cognitive for admission. There was significant FIM score improvement from admission to discharge in both the groups ($p<0.001$). However total FIM score improved more from admission to discharge in severe (+20) than the moderate group (+16), ($p<0.001$). FIM motor score improved significantly in both the groups, by 15 points in severe and by 10 points in moderate group, ($p<0.001$). FIM cognitive score improved by 6 points in moderate and by 5 points in severe injured group.

LOS was longer in the severely impaired group as compared to moderate injured group with difference significant even after applying regression analysis. Longer stay was however associated with higher increase in both FIM-M and FIM-COG scores ($p<0.001$). Most of the effect was explained by admission FIM-M score ($p<0.001$), GCS score and length of hospital stay ($p<0.001$). Factors associated with a higher FIM gain were admission FIM motor and cognitive scores, GCS score on admission and length of hospital stay (Table 3). It explained 75% of the variance of FIM score at discharge. Largest influence was by FIM-M score at admission (3.43), followed by GCS score at admission (2.97) and LOS (1.39).

Table 1: Demographics and clinical features of the patients.

Demographics variables	N/mean	Percentage (%)
Total patients	71	100
Gender		
Male	56	78.8
Female	15	21.2
Age		
Mean age at the time of injury	35.17±16.20 years	
Range	19-74 years	
Education		
Primary	39	54.9
Secondary	14	19.8
Highschool	11	15.5
Graduate and above	7	9.8
Marital status		
Single	26	36.6
Married	45	63.4

Continued.

Demographics variables	N/mean	Percentage (%)
Etiology		
RTA	31	43
Falls	27	39
Sports injuries and other violence	13	18
CT finding		
Contusion	34	48
SAH	14	20
SDH	09	12
ICH	07	10
DAI	07	10
Extremity fractures	12	16.9
Mean GCS at admission	8±4	
LOS (days)	29±16	
Severe injured	42±19	
Moderate injured	25±12	

Table 2: FIM score distribution and FIM gain.

Distribution		Admission FIM	Discharge FIM	P value
Mean		82	104	0.003
Severe injured (N=42)	Total	76	96	<0.001
	Motor	56	71	<0.001
	Cognitive	20	25	<0.001
Moderate injured (N=29)	Total	96	112	<0.001
	Motor	72	82	<0.001
	Cognitive	24	30	<0.001

Table 3: Multiple linear regression analysis of functional independence measure gain (B= standardized coefficient, adjusted R^2=0.76).

Risk factors	B coefficient (95% CI)	P value
Admission FIM-M	3.43	0.023
Admission FIM-COG	1.22	0.002
GCS score	2.97	<0.01
LOS	1.39	<0.01
Age	-0.29	<0.01

DISCUSSION

TBI, a significant public health problem, is a leading cause of disability and mortality in all regions of the globe despite advancement in prevention and treatments.[21] Traumatic brain injuries often result in disabilities, which are a burden for any society. TBI causes death, disabilities and distress in all age groups. It is more in young and productive persons and is higher in males than females.[22] Rehabilitation has been proven time and again to be of immense help in functional improvement in TBI patients. After the acute management, once patient is physiologically and neurologically stable, the physiatrist does assessment of impairments, initiates early rehabilitation and plans to prevent complications that may hinder recovery.[23] In addition, a physiatrist is also actively involved in more specialized treatment including evaluating and treating disorders of consciousness, arousal, attention, memory, executive function, and agitation.[23,24] Unfortunately, in the tertiary care hospitals across the country most surgeons are unaware about the concept of rehabilitation, especially related to TBI.

While acute trauma care has been documented to improve outcomes and early rehabilitation in the acute care setting is strongly encouraged, the impact of rehabilitation on outcome is not well documented in the developing world. Our trauma centre has been recently established, with a physical medicine and rehabilitation unit which has limited manpower, equipment and resources. We accepted a challenge to do a retrospective study on TBI patients admitted in our trauma centre to assess the effect of early rehabilitation on TBI patients on functional improvement and to prognosticate the improvement from early admission variables. In the study we took 71 patients with moderate and severe TBI injuries, classified on the basis of initial GCS scores. The male: female ratio was 4:1, which was comparable to Indian studies.[25,26] Mean age of

patients in this study was 35.17±16.20 years (range 19-76 years). The mean age of patient was more in moderate category (37.23±14 years) as compared to the severe category (26.12±18.2 years). Severe TBI affects more the younger age group, which is similar to what other studies found.[2,16,23] However some of the studies from western countries found that TBI affected higher age group.[15,23,27] Because the developed nations have aging populations, fall was suggested as commonest cause of TBI, however we found that RTA was commonest cause of TBI.[27] Total mean FIM score, 96, was more in the moderate injury group and they had milder motor and cognitive impairment in comparison to the sever injured group.

The study results proved that our comprehensive rehabilitation treatment programme was effective for the TBI patients. Our results are in tandem with a large body of work proving rehabilitation as an effective treatment to improve functions in a TBI patient.[15,16,20,23,27-30] There was marked functional improvement, more in the severe injured group than moderate injured group. In a study by Wagner et al they proposed that early rehabilitation consultation for patients with lower FIM scores and longer hospitalization result in improved FIM motor level and shorter stay.[31]

In addition, regression analysis revealed that FIM scores at the time of admission, GCS score at admission and total LOS of the patient is significantly associated with FIM gain. The FIM is an attempt to refine outcome measurement and is currently being utilized in inpatient rehabilitation programs with patients having varied medical problems, including TBI.[17] In our study we used this instrument to assess the level of motor and cognitive disability which in turn measures the burden of care.[16] The study showed marked FIM gain from the time of admission till the time of discharge, The FIM total mean score for admission was 82±23, which improved to 104±28 on discharge. Overall functional recovery was more in the severe age group where total FIM gain was 20 points and 16 points in the moderate age group. This was similar to findings of study by Sandhaug.[15]

Outcome prediction after TBI is a subject of research for last several decades. An accurate prediction can modify the treatment protocol and reduce patient and caregiver's distress. In the study several multiple linear regression analysis were done to identify association of admission variables with functional outcome, in form of FIM gain. It showed positive association with the initial GCS score, FIM- Motor and cognitive scores at the time of admission and the total duration of stay in the hospital. Sandhaug et al reported similar result which found predictors of functional level at the time of discharge from rehabilitation were GCS score, FIM total score at the time of admission, LOS in the rehabilitation unit and length of post traumatic amnesia.[15] Guise et al also indicated that FIM, the Extended glasgow outcome scale, and Neurobehavioral rating scale-revised scores at the time of discharge were important predictors of functional outcome.[32] In another study, McLafferty et al found that normo-tension at the time of admission and LOS in the rehabilitation unit were associated with a response to inpatient rehabilitation.[33] We did not had adequate blood pressure data in our study to assess its role. An important confounding factor associated with longer stay in hospital is spontaneous recovery with time. Age and other demographic variables were not found to be significant predictors of functional recovery.

As with any study there are some limitations in our study. There was not adequate sample size, which prevents generalization of the results. Lack of control group which would have provided an unbiased comparison of the results, amounts to another limitation. We could not do a randomised controlled trial because it seemed unethical to deny a TBI patient rehabilitation benefit. Our study could not assess the impact of commonly prescribed medications after TBI on rehabilitation outcomes. Also, the role of surgical interventions on neurological recovery could not be established separately.

CONCLUSION

In the end, our study strongly suggests that a dedicated rehabilitation programme, designed according to the functional needs of the patient, who sustain moderate to severe TBI, helps in improved functional outcome and recovery. The initial GCS score, FIM- motor and cognitive scores at the time of admission and the total duration of stay in the hospital are strong predictors for recovery. These results may be helpful when resources are limited and help in treatment plan and discharge planning.

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