Original Article

Functional outcome following rehabilitation in chronic severe traumatic brain injury patients: A prospective study

Anupam Gupta, Arun B. Taly

Neurological Rehabilitation Division, Department of Psychiatric and Neurological Rehabilitation, National Institute of Mental Health and Neuro Sciences, Bangalore, India

Abstract

Objective: The objective was to assess functional outcome of rehabilitation in chronic severe traumatic brain injury (TBI) in-patients. **Setting:** The study was performed at university tertiary research hospital. **Study Design:** A prospective cross-sectional study **Materials and Methods:** Forty patients (34 men) with mean age of 30.1 years (range 6--60, SD 10.8), severe TBI (Glasgow coma scale 3--8, duration of coma > 6 hours, post-traumatic amnesia> 1 day postinjury) were admitted in rehabilitation unit minimum 3 months (mean 7.7±4.6 months, range 3--22 months) following injury falling in Glasgow outcome scale (GOS) of 3. Functional recovery was assessed using the Barthel Index (BI) score and disability rating scores (DRS). **Data Analysis:** Paired Student's t-test was used for the assessment of functional recovery using mean BI scores at admission and discharge. The Wilcoxon nonparametric test was used for the assessment of functional recovery by comparing admission and discharge DRS scores. **Results:** Mean duration of stay was 30.8 days (range 18--91, SD15.6). Significant functional recovery observed in patients comparing BI and DRS scores at admission and discharge (mean BI admission 50.5±25.4, range 0--85 vs. mean discharge BI score 61.1±25.3, range 0--95, $P<0.001$, mean DRS admission score 7.57±4.1, range 2.5--21.0 vs. mean discharge DRS score 6.36±4.3, range 1.0-21.0, $P<0.001$). **Conclusion:** Patients with severe TBI continue to show functional recovery even in chronic phase with rehabilitation. They are left with significant residual physical and cognitive deficits and would require long-term care and assistance from care givers for the daily activities, as suggested by the mean DRS score at discharge.

Key Words

Functional outcome, inpatient rehabilitation, severe traumatic brain injury

For correspondence:

Dr. Anupam Gupta, Neurological Rehabilitation Division, Department of Psychiatric and Neurological Rehabilitation, National Institute of Mental Health and Neuro Sciences, Bangalore, India. E-mail: drgupta159@yahoo.co.in

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Introduction

Severe traumatic brain injury (TBI) is often associated with polytrauma, fractures, spinal cord injuries, peripheral nerve injuries, and limb amputations.[1] After surviving acute stage and coming out of comatose/vegetative stage, the treating team faces the challenge of rehabilitating such patients, left with significant disabilities.

Most recent estimates in the USA indicate that each year 235,000 patients are hospitalized for nonfatal TBI, 1.1 million treated in emergency departments, and 50,000 die, with estimated 43.3% having residual disability 1 year after hospitalization with TBI. The prevalence of U.S. civilian residents living with disability following hospitalization with TBI is 3.2 million.[2] In Europe the incidence rate, reporting hospitalized patients and patients who die before reaching hospital, is approximately 243 per 100,000 per year.[3-5]

In India an estimated 1.6 million persons sustain head injury each year with 200,000 deaths and 1 million requiring rehabilitation services at any point of time. The prevalence of patients with TBI in India is estimated to be 9.7 million. Out of total TBI cases approximately 16% sustain severe TBI.[6]

As patients with severe TBI are left with physical, cognitive, behavioral and speech impairments, multidisciplinary rehabilitation is the need of the hour to address these issues. A number of studies have been done in the past few years to assess functional outcome following TBI which carries great importance as these patients are left with significant residual

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deficits across different domains and functional recovery make them at least partially independent.[7-20]

The present study was conducted on patients who sustained severe TBI with significant residual deficits across multiple domains requiring inpatient neurological rehabilitation. The objective was to assess functional recovery in these patients and observe to what extent these patients become independent for day-to-day activities at home with rehabilitation.

Materials and Methods

This prospective cross-sectional study was conducted in the neurological rehabilitation department of the tertiary research hospital. Forty patients (34 men) fulfilling the criteria of severe TBI (Glasgow coma scale 3–8, duration of coma > 6 hours, post-traumatic amnesia> 1 day postinjury) were recruited in the study. The study was conducted over a period of 22 months (May 2009 to March 2011). Minimum duration of injury at admission was 3 months. Consent was taken from patients (or family members in case patients were not in a position to give consent) to participate in the study. Only patients with severe TBI, medically stable, having Glasgow outcome scale (GOS) of 3 (severe disability) were included in the study. Patients with mild to moderate TBI, vegetative state, global aphasia and age > 60 years were excluded.

Patients were admitted from the out-patient services of the neurological rehabilitation department. A detailed clinical and neurological examination was done on admission to identify deficits across various domains. Initial screening for cognitive deficits was done using Folstein's MMSE scale[21] and later all patients underwent detailed neuropsychological assessment using NIMHANS neuropsychology assessment battery[22] to identify cognitive impairments. Functional disabilities were assessed using Barthel Index (BI) scores and Disability Rating Scale (DRS) – most commonly used scale for assessment of TBI patients.

Their ambulatory abilities were assessed using the Functional Ambulatory Category (FAC) scale. It is a 6-point scale (0-5) used to assess functional ambulation status of the patients undergoing rehabilitation training. Category 0: patients who cannot walk, or need help from two or more persons, 1: patients who need firm continuous support from one person who helps carrying weight and with balance, 2: patients who need continuous or intermittent support of one person to help with balance and coordination. 3: patients who require verbal supervision or stand-by help from one person without physical contact. 4: patients who can walk independently on level ground, but requires help on stairs, slopes or uneven surfaces, and 5: patient who can walk independently anywhere.

All scales were used both at the time of admission and discharge to assess the change in their functional status during stay in rehabilitation unit.

Neurorehabilitation program

It included medical treatment, physical therapy, occupational therapy, and orthotic management. Treatment was supervised by physiatrist and neurologist and included taking care of all medical issues and complications seen in the patients along with coordination, supervision, and guidance to other team members. Physical therapy consisted of range of motion exercises, strengthening exercises for limbs and trunk, gait training in the form of conventional gait training, and body weight support treadmill training (as and when indicated), balance assessment and training (Biodex Balance Master) and electrotherapy. Occupational therapy included Activity of Daily Living (ADL) training, functional ability training, fine motor hand skills training, coordination exercises, sensory and proprioceptive reeducation. Assistive adaptive devices, barrier-free environment at home and working place, and modification orientation training were provided to the patients. Orthotic management included providing patients with limb orthoses. Majority required short lower limb orthoses (ankle foot orthoses). Knee gaiter, wrist cock-up splints, resting splints, and tenodesis splints were also provided to patients for prevention/correction of limb deformities.

Cognitive rehabilitation services were under the supervision of consultant clinical psychologist. Patients had significant cognitive deficits and were assessed using NIMHANS neuropsychological test battery. Once cognitive assessment was completed, training was imparted to all patients. Details of cognitive rehabilitation are outside the purview of this article. Psychological issues like mood and affective disorders, psychosis and anger outburst were observed in many patients and were managed by psychologist, social workers, and psychiatrists. Patients with speech and language disorders and dysphagia were managed by speech pathologists.

Data analysis

Analysis was done using SPSS 15.0 version. Descriptive statistics included frequency, means and standard deviation for quantitative variables such as age, duration of illness, duration of stay, and Barthel Index scores.

Paired Student's t-test was used for the assessment of functional recovery using mean BI scores at admission and discharge. The Wilcoxon nonparametric test was used for the assessment of functional recovery by comparing admission and discharge DRS scores. Same test was used to assess change in Functional Ambulation Category (FAC) while comparing admission and discharge scores.

Results

Forty patients (34 men) met the criteria and were included in the study. Mean age was 30.1 years (range 6--60 years, SD 10.8). Mean duration of stay in unit was 30.8 days (range 18–91, SD15.6). Patients were included minimum 3 months after the episode. The mean duration since injury was 7.7 months (range 3–22 months, SD 4.6). All patients had an initial GCS score between 3 and 8, duration of coma of more than 6 hours, and PTA of more than 1 day. Patients had MRI/CT scan of brain done during initial admission.

Cause of injury was predominantly road traffic accident – 36 (90%) patients. Three patients had history of assault and 1 patient sustained injury as a result of fall. Eleven patients (27.5%) were operated after trauma and others were managed

conservatively. Patients were screened for cognitive deficits on admission using Folsteins' MMSE scale (0-30). Eleven patients (27.5%) showed no cognitive deficits (27–30) while 9 patients (22.5%) had mild cognitive impairment (20–26), 15 patients (37.5%) had moderate to severe cognitive impairment (20–26) and 5 patients (12.5%) had severe cognitive impairments (<10). Detailed neuropsychological assessment was carried out by the psychologist/s and all of them (including 11 patients with no cognitive deficits on MMSE) were found to have significant cognitive impairment with diffuse lobar involvement. Cognitive retraining was imparted accordingly.

Neurological examination at admission revealed 12 patients had right or left hemiplegia/ hemiparesis, 7 patients had quadriparesis, 6 patients had cerebellar features, 15 patients had extra-pyramidal features with 5 had dystonias and 10 had parkinsonian features. A number of these patients had combination of pyramidal, extra-pyramidal and cerebellar features together. Thirty-one patients (77.5%) had facial palsy/ weakness either alone or in combination with occulomotor nerve involvement (3 patients) and abducent nerve (3 patients). Five patients (12.5%) had bulbar weakness with lower cranial nerve involvement and 5 patients had no cranial nerve involvement. Limb spasticity was present in 36 (90%) patients. Nine patients (22.5%) were started on antidepressants and 2 patients were started on antipsychotics.

Four patients (10%) had neurogenic bladder (not due to cognitive impairment) and urodynamic study was performed, which suggested overactive detrusor with sphincter dyssynergy. They were started on antimuscarinic medications along with behavioral and supporting management.

Other than these no complications were observed during inpatient rehabilitation of these patients and the program was uninterrupted. No patient was required to be shifted out of rehabilitation ward for attention of other medical issues.

Most commonly required orthosis in the study was Ankle-Foot Orthosis (AFO), which was provided to 24 patients (60%) and 13 patients (32.5%) were given wrist hand/wrist cock-up splint and AFO's. One patient was given only wrist cock-up splints. Five patients (12.5%) were given Knee Gaiters for locomotion.

Assistive devices required for locomotion are mentioned in [Table 1].

DRS scores of patients during admission and discharge have been shown in [Table 2].

As can be seen from Table 3, patients showed significant functional recovery after inpatient rehabilitation according to both BI and DRS scores. Same trend was observed with FAC scores indicating significant improvement in locomotion [Table 3].

Table 1: Assistive device for locomotion

Assistive device	No. of patients	%
Walker	10	25
Hemiwalker	1	2.5
Elbow or axillary crutches	4	10
Cane	8	20
Wheel chair	5	12.5
Not required	12	30

Discussion

Patients were included minimum 3 months after the episode for 2 reasons: to ensure patients are medically stable so that the rehabilitation can go uninterrupted without having to shift patient/s to other units; the second reason was to see the impact of rehabilitation in chronic phase of injury. Another inclusion criterion; patients with Glagow outcome scale of 3 only were selected because we wanted to observe patients who have had severe disability but conscious and responding to environment stimuli. Patients with GOS scores of 2 (vegetative state) and 4 (disabled but independent) were excluded. All patients had Glasgow Coma Scale scores between 3 and 8 posttrauma. Previous studies have established that there is no correlation between low GCS scores alone and functional outcomes in such

Table 2: Disability rating scale scores in patients

DRS scores	Disability	No. of patients admission	No. of patients discharge
0	None	0	0
1	Mild	0	1
2–3	Partial	3	9
4–6	Moderate	19	17
7–11	Moderately severe	13	9
12–16	Severe	3	2
17–21	Extremely severe	2	2
22–24	Vegetative state	0	0
25–29	Extreme veg. state	0	0

Table 3: Functional outcome and locomotion of the participants

	Admission	Discharge	*P* value
Mean Barthel Index Score	50.5 ± 25.4 (0-85)	61.1 ± 25.3 (0-100)	<0.001
Mean Disability Rating Scale Score	7.8 ± 4.1 (2.5-21.0)	6.4 ± 4.2 (1.0-21.0)	<0.001
Functional Ambulation Category Score	1.9 ± 1.3 (0-4)	2.8 ± 1.3 (0-4)	<0.001

patients.[19,23] Factor like age has to be taken into consideration while making such predictions.[24] Mean age (30 years) suggests young patients with road traffic accident (36/40 patients -- 90%) as the most common cause of injury in the study. A lot of studies in the past have observed similar trend with 10% of all mortality occur due to road traffic accidents.[25,26] In India the mortality is estimated to be 13--18% with 50% mortality in patients sustaining severe TBI.[27] With recent advances in technology and improved skills in managing patients, more and more patients with severe TBI are saved causing reduced mortality but an increase in morbidity. Patients surviving the acute injury face significant residual deficits and disabilities and secondary complications.

It is well known that the disabilities as a result of severe TBI are multidimensional. It is almost impossible for one discipline or specialty to address all problem areas and issues faced by these patients. The need of multidisciplinary rehabilitation right from intensive care unit management to long-term care has been well established. There is also high-quality evidence available suggesting rehabilitation following TBI is not only effective but also cost-effective.[28] A Cochrane review on the role of multidisciplinary rehabilitation following acquired brain injuries concluded that the problems following injuries vary widely, so different interventions and combinations of interventions are required to suit the needs of patients with different problems. TBI patients presenting acutely to hospital with moderate to severe brain injury should be routinely followed up to assess their needs for rehabilitation because intensive rehabilitation intervention leads to earlier gains.[29]

This is one of the few prospective studies in the country with severe chronic head injury patients who were admitted and received comprehensive multi-disciplinary inpatient rehabilitation in a specialized neurological rehabilitation unit. Although there were no controls, the study highlights the need of such a rehabilitation program for better functional outcome following severe head injury.

The mean length of stay (LOS) in the rehabilitation unit in our study was 30 days, which corresponds well with mean LOS in our unit irrespective of diagnosis of neurological illness. Patients stayed in the unit for up to 3 months. Longer stay following severe TBI does not necessarily mean better gains. In fact the trend is reverse with patients responding poorly to rehabilitation inputs tend to stay longer. A similar trend has been observed in the earlier study also.[19]

Disability Rating Scale (DRS) was used to assess functional abilities of the patients in this study. This is probably the most comprehensive scale used following TBI. It covers all the stages from coma (through GCS components) to patients' physical and cognitive abilities along with employability. The scale can be used when the patient is in intensive care unit up to when the patient is availing treatment in rehabilitation unit and can assess vocational component of rehabilitation by indicating employability of the patients. Significant improvement (P<0.001) in the functional abilities was observed using this scale comparing the discharge mean score (6.4) with admission mean score (7.8) in the study. The mean DRS score although suggests significant recovery with inpatient rehabilitation but patients still left with significant disability at the time of discharge. Majority of the patients required supervision/ assistance of care givers for their activities of daily living at the time of discharge and were not in a position to resume their jobs/studies. In fact only 6 patients could be tagged as "community ambulator" at discharge in the study. Our findings are similar to some of studies done earlier using the DRS scale showing significant functional recovery in the patients.[11,15,16,19] Similar trends were seen with significant recovery (P<0.001) using the Barthel Index score when comparing mean discharge score with admission scores.

Functional Ambulation Category (FAC) scale was used in this study to assess the impact of the rehabilitation on patients' locomotion. Patients had significant improvement in locomotion according to this scale. Five patients at the time of discharge were wheel chair bound and remaining patients were at least "independent ambulator" using lower limb orthoses and assistive devices.

Cognitive and psychosocial rehabilitation constitute integral part of multidisciplinary rehabilitation. The significance of detailed assessment of cognitive impairment can be highlighted by going through the MMSE scores in this study. Eleven patients (27.5%) scored in the normal range but on detailed cognitive assessment all patients including these were found to have significant cognitive deficits with diffuse lobar involvement. So, detailed assessment of cognitive impairment is essential for comprehensive rehabilitation. Affective disorders, anger outburst, impulsivity, and psychosis were observed in the patients. Cicerone *et al*. in their Cochrane review emphasized on the significance of cognitive and psychosocial rehabilitation and observed that patients show functional gain in the community as long as 1--2 year after TBI with these services.[30,31]

Future direction

Focus has to be on multidisciplinary or preferably inter/trans-disciplinary model of rehabilitation of patients with severe TBI. Use of recent technologies like robotic rehabilitation, neuroprostheses and advanced software for cognitive assessment and retraining will help in improving patients' physical, functional, and cognitive status and make them productive members of the society.

Conclusions

Patients with severe TBI continue to show functional recovery even in chronic phase with neurological rehabilitation. In spite of intensive program they are left with significant residual physical, cognitive, and functional deficits and would require long-term care and would be dependent on care givers, as suggested by a mean DRS score at discharge in the present study.

Limitations of the study

Lack of follow-up of the patients, which would have provided more information in terms of their ability to perform activities of daily living at home and barriers (both environmental and due to disability and handicap) they deemed, needs to be overcome/ modified. Another limitation was the small sample size of the patients in the study. A case--control study should

have been better in terms of highlighting the significance of inpatient rehabilitation for these patients and the impact of such a program in the eventual neurological and functional outcome compared to the TBI patients not availing/enrolled for the in-patient rehabilitation program in the specialized rehabilitation unit.

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