

# Home based neuropsychological rehabilitation in severe traumatic brain injury: a case report

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## ABSTRACT

Traumatic Brain Injury (TBI) is the most common cause of death and disability in young people. The patients with TBI often suffer impairments in psycho motor speed, memory, attention, speed of information processing, executive functioning, fluid intelligence, language and visuo-spatial skills. These impairments need to be addressed as these have a significant impact on their social and occupational functioning. Neuropsychological rehabilitation has been found to be useful in improving cognitive and day to day functioning. It focuses on the improvement of basic abilities which in turn enhance cognitive functioning. The aim of the present study was to develop a home based neuropsychological rehabilitation programme and examine its usefulness in severe TBI. A single case study method was adopted. A detailed assessment was done at 1½ months (pre-assessment) and 9 months (post-intervention) to evaluate the changes. Post-intervention improvement was observed in her cognitive functions and day to day functioning. She had resumed her previous job also. Home based neuropsychological rehabilitation emerged to be useful in brain damaged patients.

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## Introduction

Traumatic Brain Injury (TBI) is the most common cause of death and disability in young people.<sup>1</sup> 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 which approximately 16% sustain severe TBI.<sup>2</sup> The patients with severe TBI often suffer impairments in psycho motor speed, memory, attention, speed of information processing, executive functioning, fluid intelligence, language and visuo-spatial skills.<sup>3</sup> These impairments have a significant impact on their social and occupational functioning.

The natural or spontaneous recovery initiates the process of restoration of functions. The pace of natural recovery is fast up to 3 months and gradually slows down, but usually lasts for a year. Neuropsychological rehabilitation facilitates the recovery in the early stages and mediates recovery in the later and chronic stages.<sup>4</sup> Neuropsychological rehabilitation is based on the concept of neuronal plasticity, involving the principles of re-establishment and re-organization of the lost functions of the brain.<sup>5</sup> It uses systematically organized procedures (manual or computerized) that focus on specific core processing abilities which in turn enhance cognitive competency of the affected patients. It involves assessment of cognitive functions, goal setting and applying appropriate cognitive exercise to improve the cognitive function.<sup>6</sup>

Long term outcome and restoration of cognitive functions in various conditions have been always an area of concern in neuropsychology.<sup>7-9</sup> Efficacy studies have recommended direct attention training and meta-cognitive training during post acute rehabilitation, cognitive-linguistic therapies during acute and post-acute rehabilitation, cognitive interventions for specific language impairments such as reading comprehension

and memory strategy training for mild memory impairments including the use of internalized strategies (eg, visual imagery) and external memory compensations (eg, notebooks).<sup>10</sup> Studies have shown neuropsychological rehabilitation to be useful in improving the cognitive functions and day to day functioning.<sup>11,12</sup>

Despite its utility, the cognitive retraining is not in the reach of many affected in India. The reasons could be the lack of trained manpower to cater to the increasing rehabilitative needs and the high cost of treatment combined with hassles of frequent hospital visits which make treatment adherence difficult. Hence there is a need to develop a cognitive retraining programme which is easy to implement, inexpensive and can be carried out by caregivers. A home based cognitive retraining programme is the need of the hour and also has been reported to be useful in brain damaged patients.<sup>13,14</sup>

In the present study an attempt has been made to develop a home based cognitive retraining programme and to explore its usefulness in improving cognitive and day to day functioning in a patient with severe TBI.

## Case Report

A 24 year old female, an engineering graduate, previously working in a private firm was admitted to Advanced Trauma Centre of Postgraduate Institute of Medical Education and Research, Chandigarh following a road traffic accident. She presented with a history of loss of consciousness and vomiting. Her Glasgow Coma Scale score was 8 (E2 V2 M4), classified as severe TBI. She was diagnosed to have left parieto-occipital EDH and left temporal pole EDH. She had to undergo two surgical procedures: i) left parieto-occipital craniotomy, posterior fossa craniotomy and evacuation of EDH and ii) left temporal craniotomy and evacuation of EDH. She had no past history of any medical or psychiatric illness. She had no associated physical or neurological

deficits. At the time of discharge her Glassgow Outcome score was 4 indicating a good outcome. She was referred for neuropsychological assessment and rehabilitation at 1½ months post injury with complaints of forgetfulness, inattention, difficulty naming objects, inability to read, increased irritability and anxiety.

**Tools**

With the consent of the patient and family a detailed assessment was carried out at 1½ months (pre-intervention) and 9 months (post-intervention) using following tools:

1. PGI Battery of Brain Dysfunction<sup>15</sup>: It is a measure of cognitive impairment consisting of following subtests:
  - Verbal Adult Intelligence Scale
  - Revised Bhatia's Short Battery of Performance Tests of Intelligence
  - PGI Memory Scale
  - Nahor and Benson Test: a measure of perceptuo-motor functions
  - Bender Visuo-Motor Gestalt Test: a measure of perceptuo-motor functions
2. Selected tests from NIMHANS Neuropsychological Battery<sup>16</sup>
  - Digit Symbol Substitution Test : a measure of information processing speed
  - Digit Vigilance Test : a measure of sustained attention
  - Controlled Oral Word Association Test : a measure of phonemic fluency
  - Animal Names Test : a measure of category fluency

3. Dysfunctional Analysis Questionnaire<sup>17</sup>: measures dysfunction in the area of social, vocational, personal, familial and cognitive functioning.

**Procedure**

Based on the obtained profile (pre-assessment) a home based neuropsychological remediation plan was developed. Patient's father, 65 years old, educated up to higher secondary and retired air force official was incorporated as co-therapist. The training programme developed for the present study included tasks that could be performed by the patient in the home setting under the supervision of the caregiver. The tasks were presented in a graded fashion. The method of saturating cueing was followed. The difficulty level and the complexity of the tasks were gradually increased and provision for scoring for error and time is provided.<sup>18</sup> The cognitive retraining tasks used in the present study have been found to be useful by many Indian researchers. These included tasks of enhancing attention<sup>11</sup>, temporal encoding tasks to enhance verbal learning and memory,<sup>12</sup> tasks to improve verbal fluency<sup>12</sup> and naming and describing things to improve expressive speech. For restoring reading skills both sight word approach and phonetic approach were used. Supervised reading practice with error and time monitoring was done. A brief description of the cognitive training tasks and domains targeted has been given in the Table 1.

Prior to cognitive retraining the family and the patient were psycho-educated regarding the nature of difficulties, their impact on daily living, the possible outcome and the principles of

**Table 1: A brief description of the home based cognitive retraining programme**

Cognitive domain	Retraining task	Task description
Verbal memory	Temporal encoding	4 lists of 12 words each with increasing level of difficulty (immediate recall and delayed recall)
Expressive speech	Naming and describing things (cueing and semantic analysis)	Subject is asked to name given objects (initially cues were provided). Subject is asked to describe a thing or a picture)
Verbal fluency	Word generation	Similar to Controlled Oral Word Association Test (COWAT) and Animal Names Test (ANT). Subject is asked to generate words from a given letter and words belonging to category viz. round objects, things made of wood, etc. within a stipulated time. The letters used in COWAT and animal names were not used
Attention	Sorting colours and objects	Subject was asked to sort particular objects or colours. The difficulty level was gradually increased by combining the objects and colours.
	Letter and digit cancellation	Subject was asked to cancel two digits or letters in a given array of randomly arranged letters/digits on a sheet. Increase in the difficulty level was achieved by increasing the number of rows and columns and decreasing the font size. To minimize the practice effect the numbers used in Digit Vigilance Test were never used.
Information processing speed	Letter symbol substitution	Similar to Digit Symbol Substitution Test. The task involved substituting designated symbols corresponding to letters. Increase in difficulty level was achieved by increasing the number of target symbols and number of letters to which corresponding symbols had to be inserted.
Reading ability	Sight word approach	The subject was made to read aloud selected words from a paragraph written on the flash cards and after mastering made to read the paragraph and errors and time was noted down.
	Phonetics approach	Reading aloud a list of words belonging to particular phonetic family.

therapy. The goals were set as per the patients need. At the onset of each session the tasks selected for a particular week were first demonstrated and then rehearsed by the co-therapist in the hospital setting. Subsequently the exercises were given to be carried out at home under the supervision. The co-therapist was asked to monitor without being punitive. The number of tasks to be carried out each day was also designated. In the following sessions the performance was reviewed and the tasks for next week were advised only if previous goal was accomplished. Counseling sessions were also held to take care of anxiety and realistic expectation setting. The review was done once a week during the first 2 months, once in fortnight during the next 2 months and then once a month for the next 6 months. Total number of sessions was 18. At the end of the programme (9 months) post assessment (post-intervention) was done to review the improvement.

### Results

The cognitive profile of the patient was compared with normative data. The pre-assessment revealed severe impairment on the tests of information processing speed, sustained attention (visual), phonemic fluency, category fluency, delayed recall, dissimilar pairs (new learning) and visual recognition. Moderate impairment was observed on the tests of perceptuo-motor functions, remote memory, mental balance (working memory), delayed recall and immediate recall (Table 2,3). Though her mean IQ was average i.e. 102 (Verbal IQ = 99 and Performance IQ = 104) but there was significant scatter across various sub-tests (Table 1). Informal assessment of reading showed significant impairment in her reading skills (Table 3). Dysfunctional Analysis Questionnaire showed significant dysfunction in all the areas of functioning i.e. social, vocational, personal, familial and cognitive (Table 4). Clinical interview revealed features of anxiety. She was over concerned with her looks after the surgery and impairment in expressive language and reading skills that made her to avoid social interactions.

After the intervention marked improvement was observed in her performance on the tests of remote memory, mental balance

**Table 2: Comparison of Pre and Post Performance on Intelligence Tests**

Sub-Tests	Pre-assessment	Post-assessment
<b>Verbal Adult Intelligence Scale</b>		
Information	71*	93
Arithmetic	89	120
Comprehension	97	110
Digit span	139	139
Verbal IQ	99	116
<b>Revised Bhatia's Short Scale of Performance Tests</b>		
Koh's Block design	105	158
Alexander's Pass along	104	120
Performance IQ	105	139
Mean IQ	102	128

\*Impairment present

**Table 3: Comparison of Pre and Post Performance on PGI Memory Scale**

Sub-Tests	Pre-assessment	Post-assessment
Remote memory	30 <sup>th</sup> *	50 <sup>th</sup>
Recent memory	50 <sup>th</sup>	50 <sup>th</sup>
Mental Balance	30 <sup>th</sup> *	50 <sup>th</sup>
Attention & concentration	90 <sup>th</sup>	90 <sup>th</sup>
Delayed recall	30 <sup>th</sup> *	70 <sup>th</sup>
Immediate recall	30 <sup>th</sup> *	30 <sup>th</sup> *
Similar pairs	50 <sup>th</sup>	50 <sup>th</sup>
Dissimilar pairs	10 <sup>th</sup> **	30 <sup>th</sup> *
Visual retention	90 <sup>th</sup>	70 <sup>th</sup>
Visual Recognition	10 <sup>th</sup> **	50 <sup>th</sup>

\*moderate impairment

\*\*severe impairment

**Table 4: Comparison of pre and post assessment on measures of perceptuo-motor functions, verbal fluency, sustained attention, information processing speed and reading skills**

Sub-Tests	Pre-assessment	Post-assessment
Bender Visuo-Motor Gestalt Test	5 errors*	No error
Nahor & Benson Test	1 error	1 error
Controlled Oral Word Association Test	6 average words**	9 average words
Animals Name Test	6/minute**	9/minute*
Digit Symbol Substitution Test	291 secs**	245 secs**
Digit Vigilance Test	2040 secs**	1210 secs**
Reading Test	Grade 2**	Grade 5**

\*moderate impairment

\*\*severe impairment

(working memory), delayed recall, visual recognition, perceptuo-motor functions and phonemic fluency. Though improvement was also observed in her performance on measures of dissimilar pairs (new learning), sustained attention (visual), information processing speed, category fluency and reading skills but have not yet reached the normal level of functioning (Table 2-3). Her mean IQ also improved from average to superior intelligence i.e. 128 (Verbal IQ = 116 and Performance IQ = 139) (Table 1). The scores on Dysfunctional analysis Questionnaire (Table 4) revealed normal level of functioning in the vocational, personal and familial areas of functioning but mild dysfunction still persists in the areas of social and cognitive functioning. Parents reported significant improvement in her anxiety and social interactions. She had also resumed her previous work.

**Table 5: Comparison of Pre and Post Performance on Dysfunctional Analysis Questionnaire**

Area	Pre-assessment	Post-assessment
Raw score (Dysfunction)		
Social	96 (profound)	46 (mild)
Vocational	90 (profound)	34 (no dysfunction)
Personal	60 (mild)	34 (no dysfunction)
Familial	62 (moderate)	36 (no dysfunction)
Cognitive	64 (moderate)	48 (mild)

### Discussion

The aim of the present study was to develop a home based cognitive retraining programme and to explore its usefulness in improving cognitive and day to day functioning in a patient with severe TBI. Initially the memory and expressive language (naming difficulty) deficits were targeted as these were the most distressing for the patient and also have been recommended in the acute phase of recovery. Once some improvement was reported in recall and naming ability, the training focused on reading impairment and verbal fluency after 2 months of initiation of remediation programme. The impairments in attention and information processing speed were targeted in the 5<sup>th</sup> month i.e. 6 months post injury. The duration of the sessions were gradually increased as more tasks were incorporated. The sessions were limited to twice a day with average duration of 45 minutes to 1 hour.

In the present study the direct training of cognitive processes was adopted involving repetitive stimulation of distinct components of damaged cognitive functions with an expectation of improvement in processing.<sup>19</sup> The mechanism of recovery of cognitive functions after TBI is explained in terms of neural plasticity. Neuronal plasticity refers to the brain's capacity to change and alter its structure and functions are particularly relevant to cognitive rehabilitation.<sup>20</sup> Cognitive retraining utilizes this mechanism, thereby allowing the brain to restore or compensate for the impaired cognitive functions that are lost due to trauma.

In the present study maximum gains were observed in memory and expressive language. The compensatory mechanism of cognitive retraining has been demonstrated by studies using temporal encoding tasks to improve recall performance.<sup>21,22</sup> Evidence also exists in the literature in support of the use of cueing techniques and semantic analysis in improving naming ability.<sup>23,24</sup>

The repeated stimulation of attention systems via graded attention exercises is hypothesized to facilitate changes in attention functioning.<sup>20,25</sup> The normal level of functioning was not attained in the domains of sustained attention and information processing speed but the impairment level changed from marked to moderate. A few studies have reported improvement in attention using the same methods.<sup>11,14</sup> This could also be attributed to the decreased contact with the patient at later part of the therapy when attention enhancing tasks were introduced. At times the patient deviated from the defined methodology and indulged in attempting difficult tasks being overwhelmed with success. This resulted in alleviation of her

anxiety and increased irritability. Thus there is a need to have more frequent contacts with the patient and family to monitor the process.

Though a significant improvement in cognitive functioning was observed only in few domains yet there was a marked improvement in the dysfunction level of the patient. The parents also reported improvement in her day to day activities like going out, social interactions etc. The patient has also resumed her previous occupation. Evidence shows that even mild changes in ability to attend, recall and act upon information can have significant affect on the basic everyday tasks.<sup>20</sup> Clinically, there is consensus that cognitive rehabilitation should not be focused exclusively on the remediation of impairments, but should reduce disability and help restore social role functioning.<sup>26</sup> But whether the gains obtained are maintained and generalized to other situations, are yet to be seen.

Another limitation of the present study was the difficulty in ascertaining whether the improvement in the patient's cognitive performance was due to the natural or spontaneous recovery or the remediation programme as it involves only a single case. But it has been advocated that rehabilitation should begin at the earliest as it facilitates the recovery in the early stages and mediates recovery in the later and chronic stages.<sup>4</sup>

Despite several limitations home based neuropsychological rehabilitation seems to be useful in improving cognitive functions and is cost effective but its efficacy needs to be assessed in a larger population.

### Conclusions

The present study emphasizes the role of care givers in the neuropsychological rehabilitation of brain damaged patients.

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