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Cognitive assessment during neuro-rehabilitation in severe brain injury patient – a single-subject case study

Running title: Neuro-rehabilitation in severe TBI

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ABSTRACT

This study examined the importance of neuro-rehabilitation on a severe brain injury patient. We studied on a 9-years old girl who had severe brain injury following a motor vehicle accident (MVA). According to her mother, after accident patient had poor attention and memory and behavioural changes. Subsequent to three months the patient was undergone with neuropsychological assessments. Wechsler Intelligence Scale for Children (WISC-IV), Benton Visual Retention Test (BVRT) and Rey Auditory Verbal Learning Test (RAVLT) were done. All the scores were poor. Then neuro-rehabilitation was started to improve the patient's attention and memory. Rehabilitation was done once for every two weeks. Up to now reassessment was done twice, 6 weeks and one year after first assessment (baseline). Results showed improvement of all scores gradually in first and second assessments. These results provide us the importance for the clinical use of neuro-rehabilitation regularly to improve cognitive function for quality of life in severe brain injury patients.

INTRODUCTION

To update, motor vehicle accident (MVA) is the leading cause of traumatic brain injury (TBI) in developing countries [1]. TBI causes of death and disability due to damage to the brain which causes impairment and disability mainly for dramatic loss of power, independence, productivity and income potentials [2]. Though MVA is the most common cause of TBI among adults, but MVA is the third common cause of TBI among children [3]. Like adult, paediatric TBI also classified into mild, moderate and severe categories [4] by grading Glasgow Coma Scale (GCS), duration of post-traumatic amnesia (PTA) and duration of loss of consciousness (LOC) [5, 6, 7, 8]. When GCS is ≤ 8, PTA is >7 days and LOC is >24 hours then severe TBI is diagnosed [5, 6, 7, 8]. Complications can arise as a result of TBI depends on type, duration, location of brain involved. Despite the complications in acute condition of TBI, patients have long term physical, cognitive, emotional and behavioral complications also. Externalizing behaviour like ADHD [9, 10], anxiety disorder [11, 12 13], memory [14], aggressive behaviour and destructiveness [15, 16], personality changes [17, 18. 19] etc. are the long term complications of TBI.

Among all those complications, memory is the most common in severe TBI in children. After severe TBI, memory impairment mainly in difficulties in recalling or recognizing information after an interval is common among TBI patients [14] which make the children difficulties for good school performance by obstacles of cognitive function and intellengence score (IQ) [20, 21, 22]. Visual memory [23] and verbal memory [24] are being the facilitator of executive functions (EFs) and important for developing good school performance [20, 22]. Overall EF is the largest practical support for both adult and school going children for the academic and school achievements [25, 26]. Executive dysfunction was observed in case of learning disabilities in both mathematics and reading [20, 22]. That's why we need to assess and improve visual and verbal memory for the sake of improvement of EFs after severe TBI.

Neuro-rehabilitation practices are the fruitful area for the improvement of sensory and cognitive function for the patients of attention deficit/hyperactivity disorder (ADHD), concussion and even spinal cord injury. The brain functions that are

impaired due to vehicle accident (brain injury) are difficult to rehabilitate. We need to regenerate the neural pathway through rehabilitation which is damaged most. During the period of rehabilitation neuropsychologist usually target cognitive functions like attention, memory, and executive functions depends on individuals problems after baseline assessment [27, 28]. In this study we assessed the improvement of visual, verbal memory and IQ after rehabilitation in one school going child who had severe TBI.

CASE HISTORY

A 9-years old girl was transferred in emergency due to severe motor vehicle accident (MVA). In emergency her Glasgow Coma Score (GCS) was 8/15 in which the subcomponents score were: Eye response 1, Verbal response 2 and Motor response 5. Her Blood pressure (BP) was 105/67 and heart rate (HR) was 123 bpm. Emergency CT scan was done (Figure 1). Brain CT scan revealed (1) right frontal and left parietal region contusion (2) Skull fractures at right frontal, parietal and left temporal bone (3) left orbital and zygomatic bone fracture. The patient was diagnosed as severe traumatic brain injury (sTBI). The patient was undergone with neurosurgery to repair the skull fracture and treated with antiepileptic, antibiotic and analgesics with intravenous fluid. She had no other injuries in her body. The patient was recovered slowly and five days after she had GCS 15. She was discharged 12 days after accident. Three months after accident patient was assessed for the neuropsychology tests by a neuropsychologist where

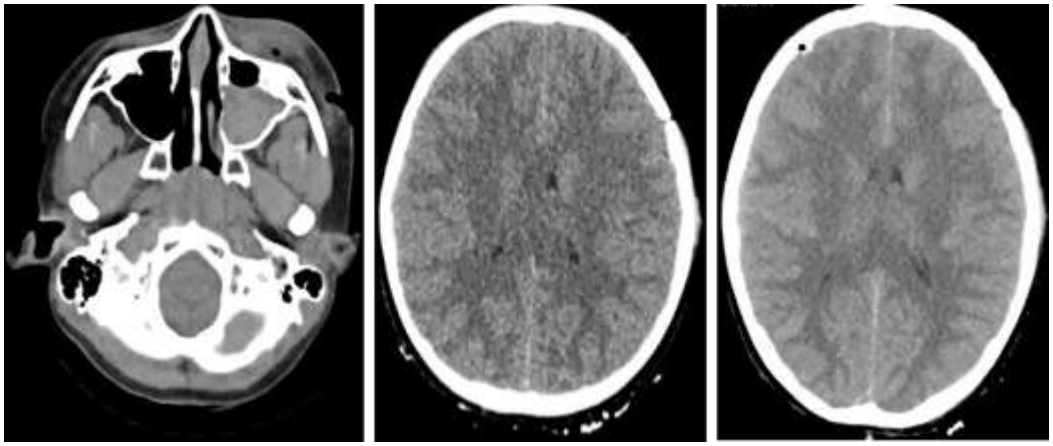

Figure 1: CT scan of the patient

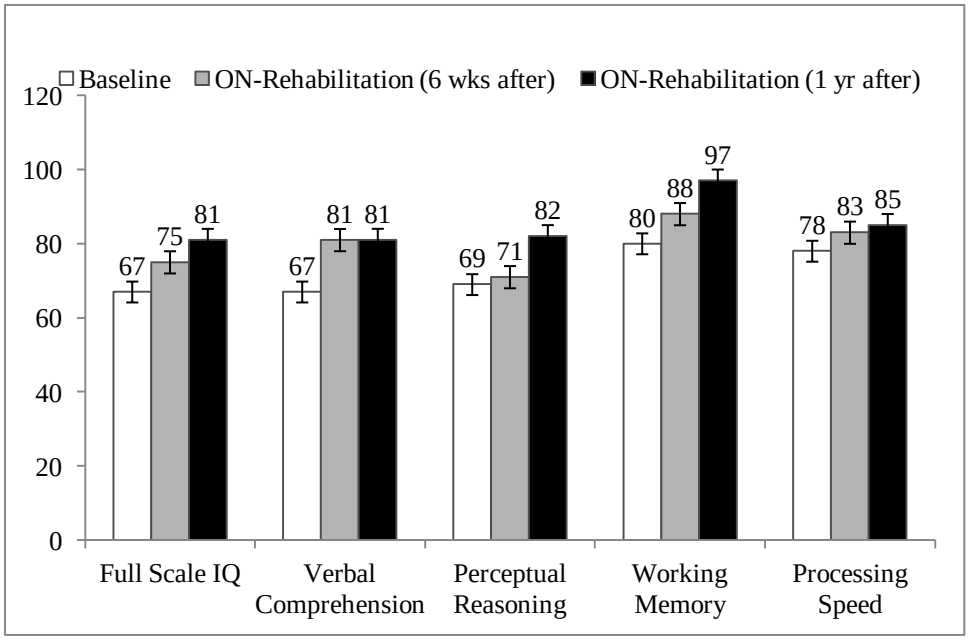

Figure 2: Bar graph shows IQ assessment after rehabilitation in different times after accident for the patient. I-symbol indicated error bars with standard error.

intelligence score was poor (Figure 2), visual memory (Figure 3) and verbal memory (Figure 4) were impaired. Then neuro-rehabilitation was started by "Parrot Software" to improve the attention and memory of the patient. Patient came for rehabilitation once in every week during 1st year and once in every 2 weeks for the next year. Up to now she received two other assessments

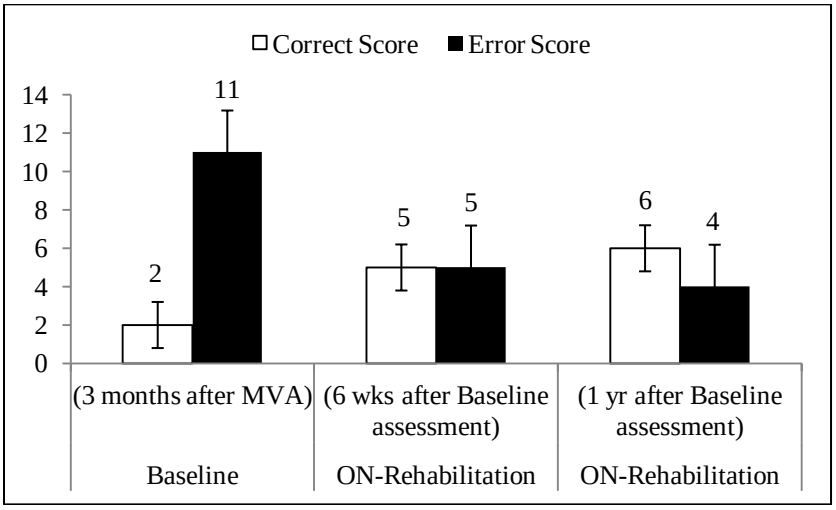

Figure 3: Bar graph shows Benton Visual Retention Test (BVRT) after rehabilitation in different times after accident to observe improvement of visual memory. I-symbol indicated error bars with standard error.

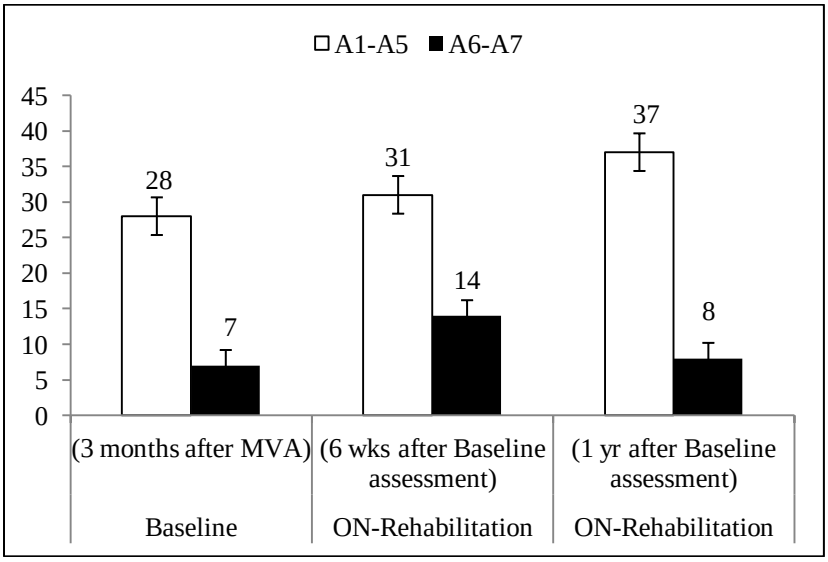

Figure 4: Bar graph shows scores of Rey auditory Verbal Learning Test (RAVLT) after rehabilitation in different times to observe improvement of verbal memory. I-symbol indicated error bars with standard error.

after first baseline assessment during her period of rehabilitation. The last assessment shows improvement in the scores of all IQ domains, and in the visual and verbal memory (fig 2, Fig 3 and fig 4), but the patient still has poor performance in school in comparison to performance of before accident. According to her mother, though the patient showed little improvement in memory, but her changed behaviour resembling get angry easily was not improved.

Neuropsychology tests:

Wechsler Intelligence Scale for Children (WISC-IV):

General intelligence (IQ) was assessed with Wechsler Intelligence Scale for Children (WISC-IV) [29]

Benton Visual Retention Test (BVRT):

BVRT was used to assess visual perception and visual memory [30]. Patient drew images from memory after looking to it for 10 sec. There are total 10 images. Scores were assessed on the basis of the number of mistakes by patient.

Rey Auditory Verbal Learning Test (RAVLT):

RAVLT was done to assess auditory memory [31]. It has two different lists of 15 words. Participants heard one word per second. There are five recall learning trial which made 'List A'. List B is the interference trial which had different set of 15 words. After interference trial retention based on List A and 20-30 min after recall trial were made.

DISCUSSION AND CONCLUSION:

In this study we described a school going patient with severe TBI who had poor memory after accident. This outcome was assessed by neuropsychology tests in three months after accident. It was the baseline assessment. Neurorehabilitation was performed after baseline assessment. During neurorehabilitation, neuropsychological assessments were done at 6 weeks and at 1 year time point. The later results compare to baseline showed improvement in her IQ (Figure 2), in the visual attention and visual memory (Figure 3), and also in her auditory memory (Figure 4).

In a study, it is found that total 86% surviving severe TBI patients are usually admitted for rehabilitation and other 16% are not admitted for rehabilitation [32]. This percentage depends on some factors. Odgaard (2015) find out that female, pre injury no working condition, unemployed, home workers, sick and older people usually are not interested for rehabilitation. The people who have works and studying are admitted for rehabilitation to improve their quality [32]. They studied on over 15 years old patients. Till now we have no record about rehabilitation of below 15 years old that are going to school. Our studying patient was nine years old school going severe TBI patient who received rehabilitation and got improved in memory. We assume that our study will encourage for rehabilitation to school going children to improve their school performance where visual and verbal memory are important for school performance [20, 22].

Rehabilitation and care after TBI is highly acceptable over 20 years [33]. In a large population of TBI patient study proved that prognosis after rehabilitation is effective [34, 35]. Patients have many new limitations after TBI where rehabilitation on neurological level can assist them to develop coping strategies for their daily life. Expressions of trophic factors increase during rehabilitation in ideal environment which may repair the injured neurons and at the same time there are also provident that stress and poor diet can decrease this trophic factors production [36, 37]. This is clear that special rehabilitation environments and methods can help for recovery [38] with improvement of learning through positive reinforcement and extinction paradigms which facilitate the creation of new neurological structures and cortical reorganization [39-41].

We concluded that rehabilitation should be encouraged among school going children after TBI mainly severe TBI to keep performance in their school and for their quality of life.

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