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Cognitive rehabilitation effectiveness for severe to moderate traumatic brain injury: Case Series

Ahlam Ibrahim Hamami[1]*

1 Dept of Psychiatry, College of Medicine, University of Dammam, Dammam, Saudi Arabia

*** Corresponding Author:** Ahlam Ibrahim Hamami **E-mail:** halomahemo@gmail.com

ABSTRACT

Objective: This case series study aimed to investigate the effectiveness of a holistic approach of a computer-assisted and traditional neuropsychological rehabilitation program in improving some cognitive functions in patients who sustained a traumatic brain injury (TBI).

Methods: The case series study followed a single-case design, with an A-B-A-B design and was conducted in the rehabilitation center at King Fahad Medical City-Saudi Arabia between Aug 2015 and March 2016. Participants comprised 5 males with moderate-to-severe TBI and persistent cognitive impairments. The computerized model included known software programs for cognitive rehabilitation to improve this rehabilitation process. The program period was six weeks for each case, all focusing on executive functions, memory, and attention.

Results: three out of the five cases improved remarkably in their attentional, executive, and related memory functions; with one showing moderate improvement and the five-case showing little improvement.

Conclusion: The holistic approach of the neuropsychological rehabilitation program is effective for some TBI cases in improving their cognitive and psychosocial functioning, alongside vocational outcomes, as reported in the follow-up interviews of the patients and their families. More research is required to contribute to the current literature and for the study's findings to be further analyzed for these interventions.

Keywords: Cognitive Rehabilitation, Traumatic Brain Injury, Case Series, neuropsychological.

INTRODUCTION

For many, traumatic brain injury (TBI) exceeds other diseases as a major cause of death and disability, with an estimated 10 million individuals affected annually by it. Saudi Arabia is no exception, especially with the Kingdom's rapid urbanization and huge development in construction, transportation, communication, and changing lifestyles (1). This has led to different types of health problems and huge losses, among which TBI is eminent on the list; yet, it remains largely unmeasured due to being considered the main cause of death and disability in Saudi Arabia. One of the several treatment modalities used to improve cognitive functions in patients with TBI is neuropsychological or cognitive rehabilitation. Therefore, it would be extremely valuable and helpful to examine this aspect in Saudi Arabia. The relationship between clinical severity measures and various types of outcome measures, such as neuropsychological, functional disability, and levels of handicap, have been well established (1, 2).

Researchers have analyzed cognitive rehabilitation to enhance the recovery of brain-injury survivors. They developed a range of therapies for patients with non-traumatic brain injuries, such as a stroke, that causes language (aphasia) or visuospatial skill impairments. Cognitive remediation therapy (CRT) is explained based on the preferred result of the treatment, such as improved memory or attention tasks or by the method or provider giving the treatment. CRT is like occupational therapy, speech-language pathology, and physical treatment. All these treatments are used to reduce or compensate for an underlying cognitive disorder (3).

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TBI severity is generally graded from mild to moderate or severe. There are multiple ways to classify severity, and each measure has a different predictive utility, including determining injury, death, or long-term functional outcomes. The degree of severity is often based on the acute effects of the injury, such as an individual's stimulation level or duration of amnesia (**3-6**).

The current study aimed to evaluate the effectiveness of a mixed holistic neuropsychological program which was computer-assisted and combined with the traditional cognitive training program to (i) improve attentional function in cases of TBI and (ii) examine whether this improvement, if any, would be generalized to related executive functions, as measured by neuropsychological tests.

MATERIAL and METHODS

Research Design

The present study is case series study performance at rehabilitation center at King Fahad Medical City-Saudi Arabia, between Aug 2015 and March 2016, that used single-case design (SCD).

Sample Population

Five participants were selected from the rehabilitation center in KFMC in Riyadh, Saudi Arabia, with severe to moderate TBIs, and cognitive disabilities for 3-12 months post-injury.

Brief Background on the 5 Cases

Case (1): SA is a 16-year-old male who showed paroxysmal asthma until 4 months prior to admission due to a road traffic accident (RTA) in June 2015. The accident caused severe TBI, and the initial Glasgow Coma Scale score (GCS) admission was August 15.

Case (2): AA is an 18-year-old male student, he was involved in an RTA, causing a fractured skull, intracranial hemorrhage, and clavicle fracture, where he was admitted on December 10, 2015.

Case (3): MH is a 22-year-old male, he experienced an RTA in October 2015, which resulted in a TBI with subarachnoid hemorrhage, left clavicular fracture, and a left acetabular fracture. MH was admitted to the rehabilitation hospital on March 6, 2016.

Case (4): BA is a 24-year-old male patient who experienced an RTA on November 23, 2015. With the GCS score of 15/15, the patient was eventually intubated in the ICU.

Case (5): AS a 22-years-old male patient, who have fractured skull, intracranial hemorrhage, and clavicle fracture due to a road traffic accident (RTA) in Aug. 2015, he stayed in the ICU for 10 weeks, then he transferred to KFMC rehabilitation hospital, where he was admitted on Nov. 2015.

Research Procedures

The consecutive duration of treatment was 6-weeks. Subjects were evaluated thrice (during the course of treatment) i.e. prior to the start (baseline), after 3-weeks (midway), and until the end of the 6th week.

Materials and Instruments

Cognitive Training Tools: The program was tailored to each participant's cognitive status while maintaining a systematic approach to attention and executive functions by following the treatment manual. Cognitive training was conducted through 3 therapeutic sessions per week at the rehabilitation center. Each session lasted approximately 120 minutes.

The concentration Attention and Mental Speed Rehabilitation Task (CAMSART) program combines structured tasks with performance measurement. (**7, 8**).

RESULTS

Case Study (1): SA. The Therapeutic Procedure and Results

SA showed significant impairment in selective and sustained attention, immediate and delayed verbal memory, and executive functions during week 1 of the baseline assessment (**Table 1**). In the same week, we started the Cognitive Rehabilitation Program as a multicomponent cognitive training program, targeted largely at attention-related executive functions training including worksheet exercises and CAMSART.

Case Study (2): AA. The Therapeutic Procedure and Results

Compared to the baseline, AA did not achieve any notable improvement after week 3 and week 6 (**Table 2**), in any of the computerized training tasks. He demonstrated little improvement in his cognitive flexibility, attention control, and orientation to place. It was obvious that he had difficulties with attention, concentration, poor motivation, and delaying the acquisition.

Case Study (3): MH. The Therapeutic Results and Discussion

MH received intensive therapy by the rehabilitation team, including physical, occupational, speech, and psychological therapies. When cognitive rehabilitation started, MH was still suffering from attention and concentration difficulties, alongside forgetfulness. He forgets the date and time and suffers from low confidence (**Table 3**). During week 1 of CRT, his concentration was raised to the level of awareness, and his weak points now included poor attention and his ability to perform the required tasks and remember instructions.

Case Study (4): BA. The Therapeutic Procedure and Discussion

In week 1, BA was not able to remember the time, date, or days due to the difficulty in maintaining recording words for more than a minute. We started training with a computer and paper-based cognitive rehabilitation program to improve his attention, concentration, and orientation to time, date, and days (**Table 4**). However, he did not show a sufficient degree of cooperation for his cognitive functions to improve due to quick dispersion, monotony, and much laughter. There was minor improvement in attention, concentration, and orientation to time and memory.

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Case Study (5): A.S the Therapeutic Procedure and Discussion

The results of pre- and post-treatment scores on computerized training tasks for case 5 are shown in **Table 5** as raw scores. Compared to the baseline, As did not achieve any notable improvement after week 3 and week 6, in any of the computerized training tasks.

Although we showed a little improvement in his cognitive flexibility and attention control. In addition to, he required more time to achieve daily tasks. It was obvious that he had difficulties with attention, concentration, and delaying the acquisition. The later assessment showed clear impairment in his executive functioning, which also might have affected his cognitive flexibility and level of motivation.

Table 1: Changes in Performance during the Training Program for Case 1

Trained TBI Patients							
CAMSART Training	**Days/ Sessions**	**Weeks**					
		1	**2**	**3**	**4**	**5**	**6**
Task (1): A symbols Response	**Day (1)**	25	+28	+35	+39	+40	+41
	Day (2)	-24	+28	+38	+39	+40	+41
	Day (3)	+26	+30	+38	+41	-40	+43
Task (2): A word Response	**Day (1)**	25	-15	+30	+30	+33	+38
	Day (2)	+26	-22	+32	+32	+35	+38
	Day (3)	+29	-26	+35	+38	-37	+39
Task (3): Color and word combination	**Day (1)**	23	+35	+36	+36	+39	+41
	Day (2)	+24	+38	-33	+35	+39	+40
	Day (3)	+27	+29	+38	+39	+40	+40
Task (4): Same word ignoring words' color	**Day (1)**	23	+25	+30	+30	+34	+40
	Day (2)	+25	+28	+29	+29	+35	+39
	Day (3)	+29	-26	+33	+33	+37	+41
Task (5): Color description	**Day (1)**	7	+17	+29	+30	+36	+36
	Day (2)	+17	+20	+28	+29	+36	+38
	Day (3)	+18	+22	+29	+33	+34	+39
Task (6): The color in the word	**Day (1)**	27	+32	+33	+35	+38	+38
	Day (2)	+32	+33	+35	-33	+34	+40
	Day (3)	+35	+36	-35	+35	+35	+39

Table 2: Changes in Performance during the Training Program for Case 2

Trained TBI Patients							
CAMSART Training	**Days/ Sessions**	**Weeks**					
		1	2	3	4	5	6
Task 1: A symbols Response	**Day (1)**	22	+23	+24	-23	+28	+29
	Day (2)	+23	+25	+25	+26	+29	+29
	Day (3)	+25	-24	+26	+28	+28	-27
Task 2: A word Response	**Day (1)**	15	+23	+23	+24	+29	+30
	Day (2)	+21	+24	+25	+26	+27	+33
	Day (3)	+23	+26	+28	+29	+31	-30
Task 3: Color and word combination	**Day (1)**	23	+30	+31	-30	+33	+34
	Day (2)	+25	+28	+32	-30	+30	+31
	Day (3)	+28	+30	+30	-29	+32	+35
Task 4: Same word; ignoring words' color	**Day (1)**	12	+22	+30	+32	+33	+39
	Day (2)	+17	+20	+28	+30	-29	+35
	Day (3)	+22	+23	+27	+30	+31	+38

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Table 3: Changes in Performance during the Training Program for Case 3

Trained TBI Patients							
CAMSART Training	**Days/ Sessions**	**Weeks**					
		1	**2**	**3**	**4**	**5**	**6**
Task 1: A symbols Response	**Day (1)**	28	+ 36	-35	+36	+39	+42
	Day (2)	+29	+30	+30	+32	+36	+38
	Day (3)	+33	+32	+36	-32	+38	+40
Task 2: A word Response	**Day (1)**	37	+41	+39	+39	+39	+40
	Day (2)	+38	+41	-39	+40	+41	+41
	Day (3)	+39	+40	+40	-38	+39	+40
Task 3: Color and word combination	**Day (1)**	34	+40	+40	-38	+40	+40
	Day (2)	+35	+45	+42	+40	+40	+42
	Day (3)	+37	+47	+45	+42	-39	+43
Task 4: Same word; ignoring words' color	**Day (1)**	30	+34	+40	-38	+39	+40
	Day (2)	30	+35	-39	-30	-38	+41
	Day (3)	+33	+33	+39	+41	-40	+44
Task 5: Color description	**Day (1)**	26	+25	+30	+33	+37	+39
	Day (2)	26	+28	+30	+31	+32	+35
	Day (3)	+29	+33	+33	-30	+33	+40
Task 6: The Color in the word	**Day (1)**	18	+25	+33	+36	+36	+39
	Day (2)	+25	+30	+35	+35	+37	+40
	Day (3)	+24	+32	+37	+37	+37	+38

Table 4: Changes in Performance during the Training Program for Case 4

Trained TBI Patients							
CAMSART Training	**Days/ Sessions**	**Weeks**					
		1	**2**	**3**	**4**	**5**	**6**
Task 1: A symbols Response	**Day (1)**	8	+9	+12	+18	+21	+23
	Day (2)	-6	-8	+10	+11	+20	+21
	Day (3)	-5	8	+10	+12	+22	+24
Task 2: A word Response	**Day (1)**	8	-7	+9	+10	+18	+20
	Day (2)	+9	9	+9	+10	+15	+22
	Day (3)	-7	-5	+7	+9	+13	+19
Task 3: Color and word combination	**Day (1)**	9	+10	+12	+14	+20	+23
	Day (2)	9	9	+10	+10	+14	+18
	Day (3)	-8	+11	-9	+13	+17	+20
Task 4: Same word; ignoring words' color	**Day (1)**	4	4	+7	+7	+11	+15
	Day (2)	+6	6	+6	+9	+13	+18
	Day (3)	-5	-4	+7	+8	+12	+19

Table 5: Changes in Performance during the Training Program for Case 5

Trained TBI Patients							
CAMSART Training	**Days/ Sessions**	**Weeks**					
		1	**2**	**3**	**4**	**5**	**6**
Task 1: A symbols Response	**Day (1)**	21	+22	+24	-25	+28	+27
	Day (2)	+21	+23	+25	+28	+28	+28
	Day (3)	+24	-23	+25	+29	+28	-25
Task 2: A word Response	**Day (1)**	15	+22	+22	+23	+29	+29
	Day (2)	+20	+24	+25	+25	+26	+32
	Day (3)	+22	+26	+27	+29	+31	-29
Task 3: Color and word combination	**Day (1)**	24	+30	+30	-31	+32	+34
	Day (2)	+26	+29	+31	-31	+30	+30
	Day (3)	+27	+30	+31	-28	+31	+34
Task 4: Same word; ignoring words' color	**Day (1)**	15	+20	+30	+31	+32	+37
	Day (2)	+19	+22	+29	+32	-29	+36
	Day (3)	+23	+24	+29	+31	+32	+39

DISCUSSION

The main objective of this study was to explore the effectiveness of a combined CACR and paper and pencil cognitive rehabilitation program, in improving the impairment of cognitive functions following TBI. The results of this study partially support the objective that individuals with TBI may improve functional and impairment level measures following direct attention training. Specifically, the findings demonstrated that the two cases with moderate TBI, (Cases 1 and 3) showed remarkable improvement in their attentional, executive, and verbal memory functions, which is supported by other studies (**9, 10**). This is shown in both the scored computerized training tasks and the objective neuropsychological measures of these functions. The holistic cognitive rehabilitation program, which implements the combined approach of attention exercises, executive functions, and memory training strategy, can be effective in remediating attention deficits and executive dysfunctions following TBI. For both SA and MH cases, areas of weakness were determined at the baseline through formal testing and their report of deficits. Thus, the SAC, the SDMT, and the CTT part (A) identified attention as the main problems of these two cases. In addition, the CTT, the VD and DF, and verbal memory indicated that these two patients were functioning at a deficient level at the first baseline assessment. For the other three cases (cases 2, 4 and 5), the recorded improvement in both the computerized training tasks and the neuropsychological measure was not as expected. Case 2 and 5 is described as moderate and limited only to some tests, while case 4 is described as slow and small. Two main reasons could explain this result. The first was related to the duration of stay in the ICU following a TBI for each patient. Compared to Case 1 and 3, who showed better improvements, Cases 2, 4 and 5 had a relatively longer stay in the ICU.

Thus, Case 2 and 5 spent nearly 3 months, Case 4 stayed for more than 6 weeks, while the other two cases needed less than 3 weeks in the ICU. This interpretation is consistent with many other studies, which reported that patients with severe TBI and a mass lesion on admission in their head CT, were found to have a prolonged ICU stay independent of the indicators of injury severity and intracranial pressure course. These studies also reported that the length of stay is a predictor of severity and diffuseness of the injury alongside being a strong predictor of the outcome (**11, 12**). Thus, the length of stay could be considered as an indicator of the diffuseness of the injury, which has consequently caused the slow progress of Cases 2, 4 and 5 in this study.

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REFERENCES

1. Aboabat A. Traumatic Brain Injury Continuum of Care: The Saudi Arabia Perspective. Brain Injury. The official publication of the North American Brain Injury Society. 2015; Vol 11(2).

2. Wade D. Rehabilitation–a new approach. Overview and Part One: the problems. Clinical Rehabilitation. 2015; 29(11), 1041-1050.

3. Bonavita S, Sacco R, Corte M, Esposito S, Sparaco M, d'Ambrosio A, et al. Analysis of BTI aging of level shifters. Conference: 22nd IEEE International Symposium on On-Line Testing and Robust System Design; 2016.10. DOI: 10.1109/IOLTS.2016.7604662.

4. Manolov R, Moeyaert M. How Can Single-Case Data Be Analyzed? Software Resources, Tutorial, and Reflections on Analysis. Behavior Modification; 2017. 41(2). Pp., 179-228. Available from https://doi.org/10.1177/0145445516664307.

5. Cirillo S, Gallo A, Esposito F, Tedeschi G. Computer-aided cognitive rehabilitation improves cognitive performances and induces brain functional connectivity changes in relapsing remitting multiple sclerosis patients: An exploratory study. Journal of neurology. 2016;262. 10.1007/s00415-014-7528-z.

6. Krasny-Pacini A, Evans J. Single-case experimental designs to assess intervention effectiveness in rehabilitation: A practical guide. Annals of Physical and Rehabilitation Medicine; 2017. 61(3). Doi: 10.1016/j.rehab, 2017.12.002.

7. Klein OA, Drummond A, Mhizha-Murira JR, Mansford L, dasNair R. Effectiveness of cognitive rehabilitation for people with multiple sclerosis: a meta-synthesis of patient perspectives. Neuropsychol Rehabil; 2017.29(4). Pp., 491-512. Doi: 10.1080/09602011.2017. 1309323. Epub. PMID: 28457198.

8. Harand C, Daniel F, Mondou A, Chevanne D, Creveuil C, Defer G Neuropsychological management of multiple sclerosis: evaluation of a supervised and customized cognitive rehabilitation program for self-used at home (SEPIA): protocol for a randomized controlled trial. Trials 20; 2019.614. Available from DOI: https://doi.org/10.1186/s13063-019-3715-7

9. Matchett K. Cognitive Rehabilitation Therapy for Traumatic Brain Injury: Model Study Protocols and Frameworks to Advance the State of the Science: Workshop Summary. National Academies Press.2015;14:2. DC.

10. Lazaridis C, Yang M, Desantis SM, Luo ST, Robertson CS. Predictors of intensive care unit length of stay and intracranial pressure in severe traumatic brain injury. Journal of Critical Care; 2015.30(6), 1258-1262.

11. Kiely KM, Butterworth P, Watson N, Wooden M. The Symbol Digit Modalities Test: Normative Data from a Large Nationally Representative Sample of Australians. Archives of Clinical Neuropsychology; 2016.29(8).767-775. Doi:10.1093/arclin/acu055.

12. Mukhtar F. Causes and patterns of spine trauma in children and adolescents in Saudi Arabia: implications for injury prevention. Annals of Saudi Medicine; 2017. 34(1), 31–37. Available from https://doi.org/10.5144/0256-4947.2014.31.