REVIEW ON CLINICAL EVIDENCES OF COGNITIVE IMPAIRMENTS AND REHABILITATION THERAPY OF TRAUMATIC BRAIN INJURY PATIENTS

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ABSTRACT

Background: Traumatic brain injury (TBI) is also major cause of morbidity and mortality in world. It is well documented that about 1.6 million persons carry on TBI in which 2 lakhs die annually in India, whereas around more than 60 % due to road traffic accidents India.

Objective : Present review is an attempt to summarize to suitable cognitive rehabilitation strategies for recovery of cognitive functions of TBI Patients.

Methods: Through the search engine "Scopus and pubmed", literature on recent advances on clinical evidences of cognitive impairments and rehabilitation therapy of traumatic brain injury patients includes approximately all cognitive rehabilitation methods to improve cognitive functions such as attention, memory, language, cognition, communication, and executive, problem solving and reasoning have been collected.

Results: The comprehensive clinical studies have been conducted by various researchers assert cogitative functions are impaired due traumatic brain injury and it can be significantly recovered by utilize of various cognitive rehabilitation methods.

Conclusion: On behalf of clinical evidences, it has been revealed that we have various cognitive rehabilitation methods to improve functions.

KEYWORD

Traumatic brain injury, Cognitive impairment, rehabilitation.

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INTRODUCTION

Traumatic brain injury (TBI) is a form of nondegenerative acquired brain injury, resulting from an external physical force to the head by fall, accident or other mechanisms of displacement of the brain within the skull (e.g., blast injuries). Consistent with the diagnostic criteria detailed in the Diagnostic and Statistical Manual of Mental Disorders which is associated with one or more characteristics: Changes in levels of consciousness, Memory disturbances, Confusion associated with deficits in orientation and Neurological signs such as brain injury observable on neuroimaging, new onset or worsening of seizure disorder, visual field deficits, hemiparesis, etc [1]. Traumatic Brain Injury (TBI) affects the daily lives of populations, their families and relatives [2]. Traumatic brain injury (TBI) is a steadily rising a significant causes of morbidity and mortality in India [3]. Around 10 million people sustain TBI worldwide annually [4]. The sign and symptoms of TBI are physical Effects, visual effects, auditory and vestibular effects, neurobehavioral effects, cognitive-communication effects and dysphasia. The significantly effect on cognitive, behavioral, psychosocial, physical factors, and vocational issues of survive TBI Persons [5].

On basis of severity of TBI, it is divided various types like mild, moderate, and severe based on the extent and nature of injury, duration of loss of consciousness, post-traumatic amnesia (PAT), and the severity of confusion [6]

Various previous studies have been reported that mild traumatic brain injury is determined by their severity of injury, loss of consciousness should not be exceed than 30 minutes, Glasgow Coma Scale (GCS) of 13-15 after 30 minutes of onset of injury, and memory loss not greater than 24 hours (7). Cognition appears to be markedly impaired around 1-month postinjurya in moderate to severe TBI, [8] or shortly after resolution of PTA. [9,10] when cognitive impairments retaining even after 3 months which is found to be associated with higher frequency disability. [11]

It has been reported that cognitive recovery of TBI moderate to severe patients does not return to baseline even after 2 years of injury however the cognitive recovery of mild TBI tends to be rapid recovery almost to "normal baseline functioning" within 3 months. [12, 13].

Previous studies have been reported that effective techquines can be used as cognitive rehabilitation interventions in post TBI patients that can help a significant recovery and minimize the functional disability. On the basis of present study, it was observed that there were not have accurate guideline for the cognitive rehabilitation of traumatic brain injured persons with multiple cognitive impairments.

METHODS:

On behalf exhaustive literature survey using Palmed, Medline and Scopus databases is collected of TBI cases and their cognitive rehabilitation methods to improve cognitive functions such as attention, memory, language, cognition, communication, executive, problem solving and reasoning.

DIAGNOSIS OF TBI PERSON

The diagnosis of TBI is performed using a MDCT Scanner and MRI Imaging. CT head data sets are performed in the supine position for adequate Multi planar reconstruction, scanning performs to cover the area from orbito-meatal line to the vertex of head. Where MPR images are obtained in axial, coronal and saggital planes whenever need. 3D technique including shaded surface display (SSD), volume rendering technique (VRT) are used to obtained three dimensional image according to the findings from the original image. All TBI patients diagnose was observed various type injury such as skull fractures, Extra Dural hematoma, Sub Dural hematoma, Sub archnoid hemorrhages, Intra cerebral hematoma, brain contusions and diffuse cerebral edema (14,15.16.17,18)

COMMON COGNITIVE IMPAIRMENTS

. Arciniegas et al. (2002) has been reported that TBI can cause an embarrassment of cognitive impairments [19] they have following type common Cognitive Impairments in TBI.

- Ÿ Impaired attention
- Ÿ Decreased concentration
- Ÿ Easy distractibility
- Ÿ Impaired visual spatial conceptualization
- Ÿ Slow verbal/visual information processing
- Ÿ Impaired memory
- Ÿ Communication disorder
- Ÿ Poor judgment
- Ÿ Poor executive function

COGNITIVE ASSESSMENT

Assessment and management of cognitive deficits includes neuropsychologists, occupational therapists, and other members of the interdisciplinary team, as well as Speech-language pathologists (SLPs). In neuropsychology assessment is determine to residual cognitive ability and inability of TBI person. It should be assessed before starting cognitive rehabilitation. Neuropsychological assessments should run at a regular interval to evaluate the effectiveness of ongoing treatment.

Assessment for functional outcome measurement tools Functional independence measure [FIM] and Disability Rating Scale [DRS] to live independently and to return to work, should be considered when attempting to plan appropriate cognitive rehabilitation programs for survivors of TBI. It is evident from literature [20-22] that the neuropsychological test results, as measures of cognitive ability, have found to correlate significantly with functional outcome measures (e.g., FIM and DRS). Hanks et al. [22] reported that cognitive performances, measured on neuropsychological

Attention-visual and auditory attention

TBI patients, auditory and visual attention cognitive functions can be affected. They can be assessed by various parameters like Orientation, concentration, vigilance, mental speed and attention, distractibility, working memory and multitasking by using many standard scale like Visual attention - CCPT-II, symbol digit modalities test (written and oral), Auditory Attention - PASAT, WAIS-III [23]

Conjunctive Continuous Performance Task (CCPT)

This test is used to determine quantitative information about Visual attention over time. It is widely used for research and clinical practices for neurodevelopment disorders which includes changes in the reaction time for different inter stimulus intervals (ISIs) and measurements based on signal detection theory. Signal detection theory measures to distinguish between several determinants of the subjects' performance in a vigilance task and sustained attention task is to determine by arise fundamental questions whether subjects are attention impairment due to a loss of perceptual sensitivity to detect the signal or due to changes in the response decision criteria CCPT provides 15 measurements that potentially reflect different dimensions of attention (24).

Symbol digit modalities test (written and oral)

Smith (1968) has been reported that 'The Symbol Digit Modalities Test (SDMT)' which identifies individuals with neurological impairment (25) The SDMT assesses key neurocognitive functions that measures many substitution tasks, including attention, visual scanning, and motor speed. The SDMT requires individuals to identify nine different symbols corresponding to the numbers 1 through 9, and to practice writing the correct number under the corresponding symbol. Then they manually fill the blank space under each symbol with the corresponding number. A second oral administration is then completed. The participant is given a blank copy of the test and asked to state the correct number for each corresponding symbol. The participant is given 90 s to complete each of these administrations. A written and oral score is calculated by totaling the number of correct answers for each section. Oral and written administrations provide two different indices of functioning, which assess attention, scanning abilities, and motor skills (26).

Paced Auditory Serial Addition Test (PASAT)

The Paced Auditory Serial Addition Test (PASAT) is frequently used by neuropsychologists to assess attention processing (27). This is a popular serial addition task develops as an experimental tool to examine the role of immediate memory and attention where the stimuli are present visually rather than aurally. Early PASAT is used in TBI research; current utilization has a much broader scope. PASAT composes a series of single digit numbers where the two most recent digits must be summed. For example, if the digits '3', '6' and '2' were presented, the participant would respond with the correct sums, which are '9' and then '8'. The participant must respond prior to the presentation of the next digit for a response to be scored as correct. Gronwall and Sampson (1974) reported that manipulated speed of information processing by presenting the same sequence of digits at different rates (28). Originally five rates of presentation are used (2.4 s, 2.0 s, 1.6 s, 1.2 s and 0.8 s), but the 0.8 s rate is discontinued in subsequent research because of unacceptably low numbers of correct responses. The duration of each digit was approximately 4 second. Typically, a series of practice trials is used prior to beginning the first trial (29).

Wechsler Test of Adult Reading (WTAR)

It is commonly used "hold" tests, which has observed words pronunciations capacity of TBI patients. It is neuropsychological test that determines abilities of thought to be unaffected by cognitive decline associated with neurological damage. Patients are use as premorbid IQ estimates in a variety of cognitively impaired populations (30-33). The WTAR consists of 50 words with irregular pronunciations that participants read aloud within approximately 10 minutes. Patients are promoting for single word pronunciation with presenting the first word card by examiner. It is proceeds through all 50 word cards and is discontinued if the patient provides 12 consecutive incorrect pronunciations. The raw score transforms to an age-adjusted standard score, which is used together with the participants' demographic information (age, gender, race, education) to predict IQ (M = 100; SD = 15). The WTAR was conformed to the Wechsler Adult Intelligence Scale, Third Edition (WAIS-III), and has been validated even in populations exhibiting questionable effort (34,35).

Wechsler Adult Intelligence Scale (WAIS)

The Wechsler Adult Intelligence Scale (WAIS) is an IQ test designed to measure intelligence and cognitive ability in adults and older adolescents. [36] The original WAIS (Form I) was published in February 1955 by David Wechsler, as a revision of the Wechsler–Bellevue Intelligence Scale, released in 1939 [37] . It is currently in its fourth edition (WAIS-IV) released in 2008 by Pearson, and is the most widely used IQ test, for both adults and older adolescents, in the world. Data collection for the next version (WAIS 5) began in 2016 and is projected to be complete in 2019.

Originally, the WISC (1950) was a downward extension of the Wechsler-Belleview test to children. A revision, the WISC-R, was published in 1974. The WISC-III was published in 1992. Most of the scales in the WISC-III are similar to those in the WAIS-R. Like the WAIS-III, administration alternates a Verbal scale and a Performance scale. Also, whereas Digit Span is always given in the WAIS-R, it is an optional test in the WISC-R (it may be substituted for any one of the other Verbal scales, if the other scale cannot be administered due to an examinee's handicap or because administration of a scale was disrupted). Also, a Mazes subtest may be substituted for the Coding test on the Performance scale. Order of administration of the tests is as follows:

1. Picture Completion;
2. Information;
3. Coding;
4. Similarities;
5. Picture Arrangement;
6. Arithmetic;
7. Block Design;
8. Vocabulary;
9. Object Assembly;
10. Comprehension;
11. Symbol Search (Optional);
12. Digit Span (Optional);
13. Mazes (Optional).

Learning and memory

Memory can categories many types likes Explicit (fully and clearly express) /implicit (understood though) and verbal memory, visual memory and working memory. There are measured by as follow [11,23].

- Visual learning and memory – CVMT,
- Verbal learning and memory – CVLT,
- Working memory - Digit span backward, letter number sequencing from WAIS-III.

Visual learning and memory (CVMT)

The CVMT used to eliminate the motor component associated with drawing tasks and reduce the verbal labeling that may occur on tests that utilize simplistic geometric designs. Moreover CVMT composes a 30-minute delay recall trial and a visual discrimination task that distinguishes visual memory problems from visual discrimination deficits. The construct validity of the CVMT demonstrates in normal adults (38) and in a patient sample (39). The clinical utility of the test demonstrates in persons with unilateral cerebral vascular disease, closed head injury, amnestic syndrome, and dementia of the Alzheimer's type (40).

Verbal learning and memory (CVLT)

The California Verbal Learning Test (CVLT) is a common used in clinical and research test that helps to measure key develop in cognitive psychology behaviors such as repetition learning, serial position effects, semantic organization, intrusions, and proactive interference. CVLT results are reviewed and it makes for clinical utility. It concludes that CVLT are recognized to make a useful contribution to the clinical assessment of verbal learning and memory (41).

Language

Language can assess by patients capacity to language comprehension and understanding naming, receptive vocabulary and verbal fluency. It can measure by multilingual aphasia examination Token Test, Boston Naming Test, Peabody Picture Vocabulary Test, Controlled Oral Word Association Test.

Multilingual Aphasia Examination

It develops to evaluate the presence and nature of aphasic disorders. The measure consists of seven subtests as follows: (41)

- Visual Naming (VN): Ten lines drawings require 30 naming responses are used to evaluate the subject's capability to apply semantically proper labels to visually presented stimuli, independently of impaired appreciation or expression. Satisfactory responses are developed by consulting dictionaries and by interviewing individuals in the different ethnic subgroups.
- Sentence Repetition (SR): subject is read fourteen sentences of gradually increasing length at a time and is required to repeat each sentence exactly as presented. Items of the English Multilingual Aphasia Examination (MAE) are modified in order to maintain similar sentence length and grammatical complexity.
- Controlled Oral Word Association (COWA): The subject makes links to three letters of the alphabet by saying all the words and can think of that start with the specified letter during a 60-second interval. Letters of the English MAE are replaced in order to maintain similar frequencies in the respective languages.
- Token Test (TT): subject Twenty large and small circles and squares in five colors are use to assess the subject's ability to follow auditory commands. Items from the English MAE were modified to maintain similar command length and complexity.
- Aural Comprehension of Words and Phrases (AC): Six pages with four line drawings are used to assess the aural comprehension of words and phrases in a multiple choice format. When indicated, the terminology of the English MAE was modified with culturally appropriate stimuli.
- Written Comprehension of Words and Phrases (WC): This is the written version of the AC subtest. The subject is required to write a word or phrase and point to the drawing that best represents it. The terminology of English MAE was modified when indicated.
- Rating of Articulation: A 9-point, subjective rating scale with five descriptors is used to evaluate the subject's speech articulation. Judgment is based on total speech output (conversation plus performance on tests requiring verbal output).

Executive function [23]

Executive function TBI patients can determine their ability to make planning, goal setting, monitoring performance and flexibility. There are measured by Wisconsin Card Sorting Test, Stroop test, backwards spatial and digit span test.

Wisconsin Card Sorting Test (WCST)

WCST is clinical neuropsychological instrument. It develops to assess abstract reasoning task and the ability to shift cognitive strategies in response to changing environ-mental conditions. It is also used to assess frontal lobe function in a variety of clinical and research contexts. Moreover WCST fails to discriminate frontal patients from those with lesions in other brain regions or from normal. Event-related potentials (ERP) from frontal, fronto-temporal, temporal, parietal and occipital areas records during the performance of a computerized version of the WCST in order to explore frontal versus non-frontal ERP indexes (42)

Stroop effect

Stroop effect has been discovered by John Ridley Stroop in 1935. The effect had previously been published in Germany in 1929 [43, 44]. It is a demonstration of interference in the reaction time of a task. In which name of colour like Blue, Green, or red is written in difference colure link example red printed in blue ink instead of red ink.

Stimuli in Stroop paradigms can be divided into 3 groups: Neutral, Congruent and Incongruent.

- Neutral stimuli which are provided by only the text or color are displayed. [45]
- Congruent stimuli which are ink color and the word refer to the same color (eg. word "pink" written in pink).
- Incongruent stimuli which are ink color and word differ. Three experimental findings are recurrently found in Stroop experiments. [45]

Psychomotor function

The psychomotor function assess on behalf of motor function of patients. It is determined by using Grooved pegboard, Purdue pegboard, finger tapping test.

The Grooved Pegboard Test (GPT) is conceived as a test of manual dexterity, upper-limb motor speed, and hand–eye coordination. Manipulative dexterity, including finger speed is assessed. The test requires more complete visual motor coordination than most pegboard, because the pegs must be rotated before they can be inserted. Assessment is used for prevocational and vocational testing but also been found sensitive to general slowing due to medication or disease progression [46]

COGNITIVE REHABILITATION

The ambition of cognitive rehabilitation improves cognitive functions of TBI patients. Silver et al. [47] has been reported that cognitive rehabilitation is a best intervention process which is well-motivated mild and moderate cognitive impairments.

Cognitive rehabilitation composes of various interventions that have to be adapted on behalf literature and individual needs. Previous finding of cognitive rehabilitation have divided into two components: Restorative and compensatory approach [6].

Restorative approach:

The purpose of restoration approach to reinforcing, strengthening, or restoring the impaired skills. It consists the frequent exercise of standardized cognitive tests of increasing trouble, targeting specific cognitive domains (e.g., selective attention, memory for new information).

Compensatory approach

TBI patients teach ways of bypassing or compensating for the impaired function. Previous studies have reported the effective use of assistive technologies (AT), calendars, electronic memory devices, alarms, or reminders as compensatory techniques [48].

Pharmacotherapy is also good help to improve cognitive function. It is based on two principles like catecholaminergic and cholinergic amplification which is useful as adjunct in cognitive rehabilitation.

Attention, memory, awareness and, executive functions are individually exercising in Cognitive rehabilitation therapy and its carry out by many areas of health care staffs.

Attention and memory

Cicerone el al. (2005) and Tsaousides et al (2009) reported that Attention is defined as an ability of an individual receives and begins to process internal and external stimuli. Attention deficits are more commonly in severe TBI persons. They difficulties to make concentration, sustained attention and delayed reaction time, distractibility, decreased processing speed and impaired dual or multitasking.

It can be developed by direct attention training program which is intended to be restorative and it has been planned to pick up visual and auditory attention. Attention training program targets five components of attention: Focused attention, sustained attention, selective attention, alternating attention, and divided attention. The training program consists of tasks with a hierarchical progression of increasing attention demands, graduating from simple to complex distracters. Barman et al (2016) have been reported that traumatic brain injured persons are undergoing APT, performed better in the Paced Auditory Serial Addition Test, Stroop (50). Westerberg et al.[2007] also reported that a significantly improve in attention in TBI patients whose are undergone to direct attention training, an automated, and computerized training program (computer software) for 5 weeks. Thus various data of attention has been indicated that sever TBI patients may not make of suitable attention. It can be developed by APT for 5 week. However, Wilson et al [2009] assemble numerous data which show that cognitive memory therapy may result in positive effects by three types of method: 1) cognitive training; 2) behavioural training; 3) mnemonic training (52).

Visuospatial perception

Visuospatial perception changes such as unilateral neglect, impairments of body scheme, and constructional skills are common in severe TBI persons [47]. Agnosia and apraxia are not uncommon. When such deficits combine with cognitive impairments, they have a significant impact in rehabilitation participation and ADL along with posing as a safety concern.

Using visuospatial cues to direct attention to the areas of residual vision, in vision restoration therapy (VRT), some improvement in vision in persons with visual field defect has been documented. It has the potential to enhance neural plasticity and ultimately increase conscious visual perception.[48] Similarly, Mueller et al.[49,50] showed that VRT improves visual functions in persons with central nervous system disorders. Pizzamiglio et al.[51] used spatial scanning with optokinetic stimulation in patients with the hemineglect disorder, but it failed to show any additional benefit in their performance. A study by Cicerone et al. [25] has found visual scanning training, isolated microcomputer exercises, and electronic technologies to be useful. Likewise, prism adaptation has also been found to be useful in gaze abnormalities.[52] Nonconfrontive, behavioral therapy approaches have been reportedly beneficial in anosognosia.

Language communication

Communication is very difficult and also complex after brain injury. It is actually two types like verbal and nonverbal information. In the TBI patients, this disorder can be divided into four main groups:

Apraxia: it is a motor disorder developed due to damage to the brain of the posterior parietal cortex resulting patient has difficulty make planning to perform tasks or movements. They are delivered proper response by their communication but they tried to response by symbolic. The nature of the brain damage determines the severity, and the absence of sensory loss or paralysis helps to explain the level of difficulty [53]. It various types like Ideomotor apraxia [54,55] Ideational/ conceptual apraxia, Buccofacial or orofacial apraxia, Constructional apraxia, Gait apraxia [56], Limb-kinetic apraxia, Oculomotor apraxia, and Apraxia of speech [57].

Aphasia: On the basis of location of the brain injury, three type of speech and language impairment aphasia such as Broca's aphasia (26.49%) is the most common type, than anomic aphasia (19.6%), and transcortical motor aphasia (15.6%) [58]

Dysarthria: It is characterized by poor articulation of phonemes in which problems effectively occur with the muscles which help us produce speech, frequently making it very difficult to pronounce words. In which swallowing deficits has been reported and also affecting respiration, phonation, resonance, articulation, and prosody [59].

Cognitive communication disorder: It may be impaired social interacting and reintegrating which can eventually lead to provoking or awkward experiences.[60] after TBI person suffered with delayed word recall to reduced emotion whereas communicating with others. They can find obscurity in particular word finding [61] and language dispensation [62].

Cognitive status of persons is significantly directed to language functions and their communication which can be significantly affected due to brain injured [63] Speech and language therapy, including constraint-induced aphasia therapy (CIAT),[64,65,66] computer-assisted therapy,[67,68,69,70] melodic intonation therapy,[71,72,73] can be used for treatment of cognitive communication disorder.

Executive functions

Executive function is a set of mental skills that help in pay attention, switch focus, plan and organize, remember details, avoid saying or doing the wrong thing etc. These skills are controlled by frontal lobe of the brain. Executive function can be divided into two groups: Organization: assemble information and structuring it for evaluation. Regulation: delightful stock setting and changing behavior in their response.

Goverover et al. (2007) and Cheng et al. (2006) have reported that metacognitive strategy training directed at improving self-control and self-monitoring more effective than to conventional rehabilitation in humanizing TBI executive dysfunction [74,75]. Metacognitive strategy training helps to assess individual's performance and reduces or prevents errors by structured and encouraging repeated assessment and self-monitoring. Cicerone et al [2008] has also reported that metacognitive strategy training facilitates the supervision of language deficits, attention, memory and social skills [76].

Drugs used of Improves Executive functions

Executive functions can be improved by using of many drugs like bromocriptine and amantadine. McDowell et al.(1998) cognitive function be improve by using bromocriptine can it is significantly diminished apathy after TBI. Persons who are taking a low dose of bromocriptine (2.5 mg/OD) performed better on tests of executive functioning. amantadine (400 mg/OD) gives positive response in executive functions. It is also an N-methyl D-aspartate glutamate receptor antagonist caused by protect neural cells against excitotoxicity (78)

Noninvasive brain stimulation

It includes transcranial magnetic stimulation (NBS) and tDCS hold promise of diagnostic and therapeutic helpfulness to facilitate functional reestablishment in TBI. it is well documented that NBS may be boasted constructive changes in mood, visuospatial functions, language and working memory, and executive functions (79). Villamar et al. (2012) reported some evidence from preclinical and clinical studies that revealed prospective advantage of NBS in attractive genuine changes to smooth the progress of learning and improvement of function (80)

Comprehensive holistic rehabilitation program

This program helps to greater improvements in society execution compared to conventional rehabilitation. Its combination of therapeutic services which is included individual with group therapies, psychotherapy, psychoeducation, and family therapy. It is facilitated skill convey and simplification, behavioral and emotional directive, and society integration [81,82].

CONCLUSION

Traumatic brain injury is most leading cause of cognitive functions deficits which is frequent and too significant induces disability and morbidity in person. On behalf of clinical evidences, it has been revealed that present review have various cognitive rehabilitation novel techniques to significantly recovers cognitive functions deficits in TBI persons.

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