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OPTIMIZING HAND FUNCTION WITH SIMULTANEOUS APPLICATION OF BIHEMISPHERIC TRANSCRANIAL DIRECT CURRENT STIMULATION (TDCS) AND THERAPIST ASSISTED SENSORYMOTOR TASK SPECIFIC TRAINING (TASTT) IN SUBACUTE STROKE SURVIVORS -SINGLE CASE REPORT

Neurology

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ABSTRACT

BACKGROUND: Individuals across every age, race or socioeconomic background are affected with stroke which is more prevalent in women than men.[1] Stroke is the third leading cause of mortality worldwide and can cause significant disability, such as paralysis, speech difficulties, and emotional problems.[2] A great percentile o stroke survivors land up into severe consequences as a result of persistent disability, who require more effective therapeutic strategies. The role of a physiotherapist is very crucial with respect to the rehabilitation point of view especially in the initial months in which there is maximum potential for recovery. However after which, this potential declines.[3]

A fully Functioned hand is vitally important for quality of everyday life. The acquisition of hand motor skills following stroke depends upon the cortical synchrony and the integrity of iplsilesional and contralesional motor circuits in the cerebral hemispheres.[4]

Stroke survivors can partially recover their motor function control from rehabilitation that involves task-specific and repetitive motor exercises. [3]

Advances in brain-computer interface (BCI) technology have enabled stroke survivors to interact with the environment using their brain signals. Since, Brain is an electrical organ and expends considerable energy maintaining a specific cellular resting potential. Not surprisingly therefore electrical intervention have potential to modify brain function to improve outcomes after stroke [5]

Hand repertoire exercises as the part of neurorehabilitation leads to partial recovery. Cortical motor map reorganization as a result of skilled arm and hand training suggests that neuroplasticity mechanisms are involved in motor learning. The challenge for improving stroke recovery is to understand how to optimally engage and modify surviving neuronal networks, to provide new response strategies that compensate for the loss due to injury in the brain. In general best recoveries are associated with greatest return towards normal state of brain functional organization, reorganization of central nervous system.

Thus Enhancing stroke recovery by facilitating brain plasticity with the direct application of a physical modality to the cerebral cortex was the key motive for conducting the present study.

KEYWORDS

CASE DESCRIPTION

The present case involves description about a 60 years old hypertensive female, with no previous history of cerebrovascular accident. She lives in a house with her daughter and is resident of Patiala, Punjab. In the month of December, 2018, On the day of stroke , All of sudden, she started feeling weakness in her right arm with the apparent loss of speech followed by which she fell on the floor but remained conscious. Fortunately she got immediate medical attention when she was admitted to a nearby hospital. Medical evaluation indicated left middle cerebral artery infarct. After ensuring her stability on medical ground, she was discharged within 4-5 days.

Post CVA her initial symptoms were paresis in the right arm and leg with the partial loss of motor control in upper and lower limbs. Upper limb was affected more severely than the lower limb. Simultaneously she also had cognitive impairments with short term memory loss and difficulty in speaking and impaired gait. Her blood pressure was labile. Initial medical treatment included Medications for regulation of blood pressure, speech therapy for regaining control over speech and physical therapy for initial 3 months. Post Three months of speech therapy sessions, her speech was improved she was able to articulate and make sentences but her memory loss retained with no significant improvement as more evident with anomia and agraphia. She also gained some control in her upper limb activities and some improvement in the gait. Despite her motor and cognitive impairments she also developed periodic depressive episodes and anxiety attacks specifically when she was not able to use her hand.

As reported in her medical review records, she was stabilized neurologically and there was some improvement in her upper limb and lower limb activities post 3 months of speech and physiotherapy treatment sessions. Her speech was improved but was still hesitant along with the persistent anomia.

At the onset of neurophysiotherapy patient came with the complaint of difficulty in picking up things, eating , writing, ease of forgetfulness, lack of balance and coordination, periodic depressive symptoms and anxiety attacks as reported by the patient's family members.

CLINICAL EXAMINATION

Patient underwent thorough clinical examination and assessment. Patient was cognitively stable but had mild cognitive impairment with MMSE Score of 27. Patient's handedness was determined with the help of Edinberg handedness inventory. It was observed that patient had difficulty in shoulder, elbow and hand movements. Her Deep tendon reflexes were exaggerated but there was no significant increase in the muscle tone. She had decreased muscle strength in her shoulder girdle muscles with the grade of 2/5 for shoulder abductors and flexors, 2/5 for elbow extensors, 3/5 in knee flexors & Extensors, 3/5 in Hip musculature. From the initial assessment, it was analyzed that the patient does have reduced mobility and was not at her baseline level of function. Now she has reduced independence with transfers and requires assistance for sit to stand from a chair and for transfers from bed to chair.

Functional examination of lower extremity revealed that she required mild to moderate assistance for her transfer and ambulatory activities. She was advised to walk with the support of a walker by keeping walker close to her body. She displayed swinging of her affected foot out while walking. She was walking with the short strides

RESULTS

Patient's Handedness was determined by short term- Edinberg handedness Inventory to find out the handedness of the Patient.[6]The ability to perform coordinated movements of arm, hand and finger with accurate precision and speed is termed as Manual Dexterity. In the present case objective assessment tool used for Manual dexterity was Nine hole peg Test, which is a is a timed test of finger dexterity and fine motor coordination[7]. In a study on arm function in stroke, investigators found the nine-hole peg test to be suitable for rating the dexterity of patients recovering from acute strokes[8]. Hand Function assessment was done in terms of Grip strength and pinch strength . Hand Dynamometer was used to find out the grip strength, Pinch strength measurement was done by executing the pinches on a pinch guage for measuring key pinch, lateral pinch and tip to tip pinch strength.[9](Figure 1, 2, 3)

Fig:1 Pinch Gauge

Fig:2 Nine Hole Peg Board

Fig:3 Hand Dynamometer

Treatment approach chosen comprised of application of (tDCS), TASTT i.e Therapist assisted sensory motor training and conventional physiotherapy treatment session. Total treatment was given for the period of 4 weeks, 5 days/week. (TASTT) approach was designed by integrating the principles of learned non-use phenomenon, mirror neurons, neuroplasticity and somatosensory input. In which Investigator fastened her hands including finger and thumb with patient hand with the help of micropore in a way that therapist's ventral aspect of hand overlied dorsal aspect of patient hand. So that all the movements of DIP, PIP, MCP Joints of all the fingers and Thumb were directed by the therapist. Along with the TASTT, Simultaneous Bihemispheric Direct Current was administered via a pair of (16.3 sq.cm) sponge electrodes moistened with tapwater or NaCl solution for 15 minutes with intensity ranging from 1.0-2.0 mA direct current with electrodes placed on C3 C4 area of international 10-20 EEG electrode system. The anode was placed on the lesioned motor cortex and cathode on the contralesional cortex.[10] Conventional Physiotherapy treatment protocol; for upper extremity and hand function rehabilitation included Passive/Active Range of Motion Exercises, Weight Bearing and Supportive reaction Training, Reaching Activities, Grasping, holding and release activities and Upper Extremity ADL activities[11].

Objective assessment of Complete UE function was done at Baseline (Day 0) i.e Pre intervention and Day 15 and Day 30 i.e Post Intervention**.** Changes Observed within the time frame of 20 sessions of Treatment are described in the (Table 1)

Tools Used	Parameters	Day 0	Day 15	Day30
Hand Dynamometer	Grip Strength	10 Kg	15 Kg	20 Kg
Pinch Gauge	Chuck Pinch	10 Kg	15 Kg	15 Kg
	Lateral Pinch	10 Kg	12 Kg	18 Kg
	Tip to Tip Pinch	5Kg	5Kg	7 Kg
	Pulp Pinch	7 Kg	9 Kg	9Kg
Nine Peg Hole Test	Manual Dexterity	180 Seconds	100 Seconds	90 Seconds

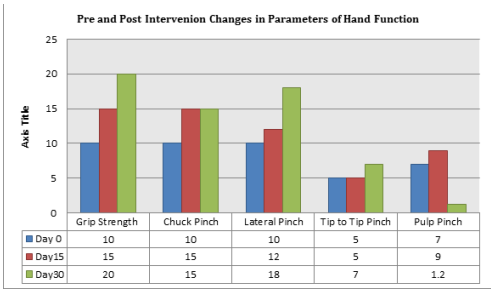

Fig:1

DISCUSSION

The present work is a part of a project funded by Science education and research Board, Government of India, in which the effect of simultaneous application of (tDCS) and TASTT is observed along with the conventional physiotherapy treatment on upper extremity Hand Function in stroke. In the present case significant change were observed in terms of the post intervention scores of FMA and Grip Strength, whereas minimal changes were observed in terms of Pinch Strength and Hand Dexterity.

Human Hand Function Comprises two complimentary aspects: *Strength* and *Control of Finger Movements*. The Most Common Observation of stroke is that both are impaired *Weakness i.e* Difficulty in voluntary opening of hand , extending the wrist and fingers *And Loss of Finger control:* manifests as inability to either move a single finger while keeping other fingers immobile.[12]

When strength may recover following stroke, control often remains impaired causing lasting disability. With the episode of stroke, loss of input to the motor neuron follows, that leads to weakness, spasticity, altered pattern of movement and loss of motor control in the fingers as a consequence to it. As a result of neuronal hyperactivity and loss of reciprocal inhibition unwanted coactivation of Finger Flexors and extensors occur that cause difficulty in individual movement of the Fingers. Even when substantial strength recovers, a deficit of relatively independent finger movements that impairs tasks requiring fine manipulation typically persists, substantially[13]

Loss and difficulty in regaining Individuation can also be justified by the physiological basis of neural control of Hand. Motor cortex is equally capable of controlling single digits and constructing multiple digit synergies.. The distributed cortical organization suggest that it is artificial to draw a destruction between moving a single digit and moving several digits in a particular way , a distinction that items from misleading intuition that each finger should have a separate island of Representation for any part.[14]

Along with the minimal changes in the scores of hand dexterity parameters, significant changes were seen in the scores of FMA and Grip strength. Difficulty in Individuation of hand digits are also evidenced in the study conducted by Sunderlans et al in which they showed better return of Grip strength compared to dexterity as measured by 9 peg Hole test. They concluded that it is a common observation to see a patient able to perform power grip with all the fingers but unable to flex single digit while keeping others still.[15] Results of present study are supported by the study conducted by Heller et al in which they showed that Grip Strength recovered earlier than other aspects of hand function such as ability to manipulate objects.[8]

CONCLUSION

In the Present Study Grip Strength Recovered But difficulty in individuation of digits was persistent. Clinically, patient's Grip strength improved more significantly than the pinch strength. Despite the ease in applicability and no side effects of (tDCS,) Single participant case study provided us with the evidence that Bilateral transcranial direct current stimulation can be used concomitantly with the conventional treatment protocol but there is strong need of larger trial to establish the quality evidence.

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