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Case Report *Medical research*

To study effect of modified constraint induced movement therapy on hand function in patients with chronic stroke- case report

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ABSTRACT

Background and aims

The following study was conducted to study the effect of modified constraint induced movement therapy on hand function in patients with chronic stroke. Hand function is affected due to weakness, sensory loss, abnormal tone, unilateral neglect. Modified constraint induced movement therapy is known to induce neural plasticity which helps improve functional ability.

Methods

A descriptive case study was carried out on 2 patients screened from the community and selected through purposive sampling. They were given mCIMT for a duration of 2hrs/ 5 days a week for 3 weeks along with conventional upper limb exs. The unaffected hand was constrained and the affected hand was engaged in functional activities. The patients were also instructed to wear the restraint for 3 hours unsupervised and maintain a log of the activities. MAL and JTHFT were used as pre and post outcome measures.

Results

For JTHFT, the one-tailed p-value for grip is 0.02 for subject 1 and $p<0.006$ for subject 2 which is statistically significant at 5% level of significance. The p-value for writing is $p<0.03$ for subject 1 and $p<0.02$ for subject 2 which is statistically significant. The p-value for the other components for all subjects is $p>0.1$ and hence it is not statistically significant. For MAL, The one-tailed p-value calculated for each subject for Motor Activity Log of the Amount scale and Quality of Movement scale is $p<0.001$ which is very significant.

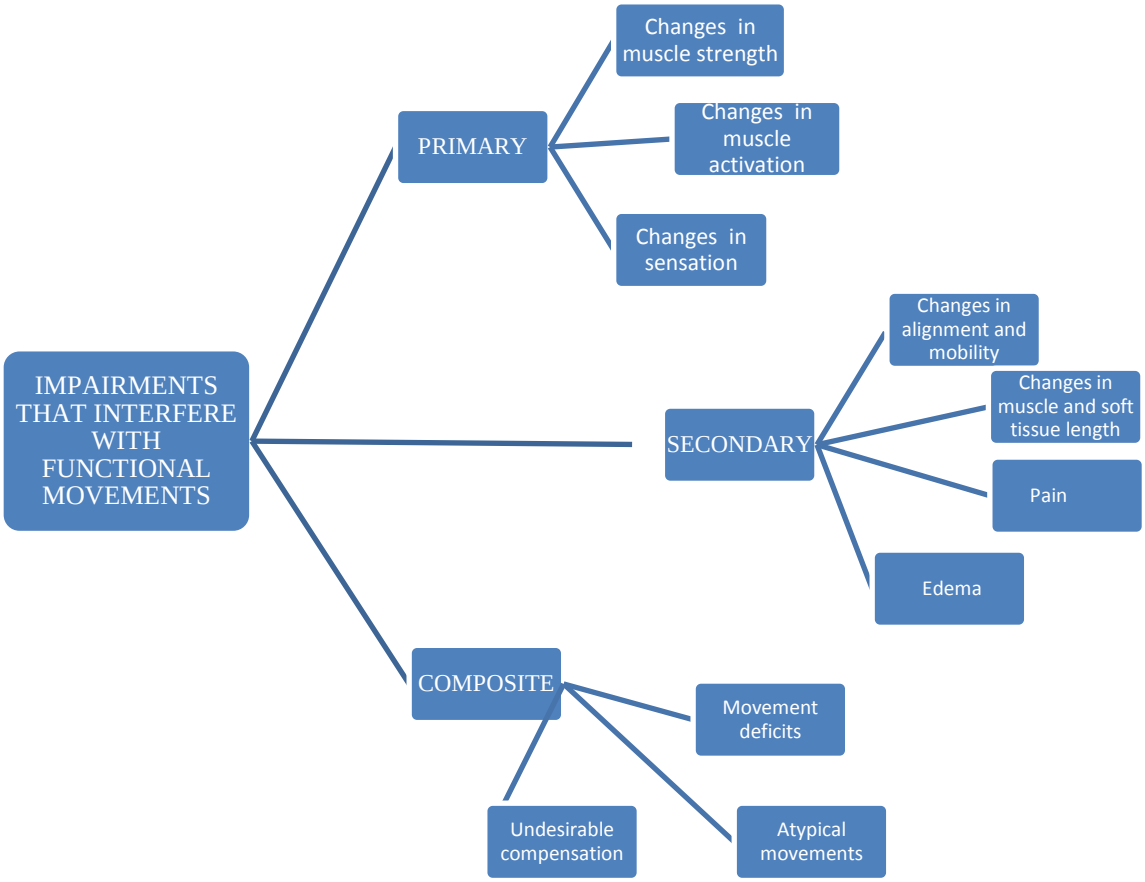
Keywords: mCIMT, hand function

INTRODUCTION

A stroke, or Cerebrovascular accident, results in sudden, specific neurological deficit and occurs when a brain blood vessel is either occluded by a clot or bursts[1]. It is the suddenness of the deficit- occurring over seconds, minutes, hours or a few days- that characterizes the disorder as vascular. [1]

CVAs can be classified according to pathological type- thrombosis, embolism or hemorrhage- or according to temporal factors, such as completed stroke, stroke-in-evolution or transient ischemic attacks (TIAs). [1]

Hemiplegia, a paralysis of one side of the body, is the classic sign of neurovascular disease of the brain. [1]



The weakness caused due to paralysis, inappropriate initiation of a movement due to imbalance in the motor unit firing between agonists and antagonists that also leads to abnormal sequencing of the movement pattern. Affection of sensory system i.e lack of awareness or localization of stimulus, proprioception are some of the primary causes of movement deficits.

Abnormal tone that is observed after stroke is due to corticospinal tract affection. This leads to development of synergy in movement patterns as well as a typical attitude for the affected extremity. The most commonly observed attitude of the affected limb is shoulder elevation, adduction, internal rotation, elbow flexion, pronation, wrist and finger flexion. Since no physical therapy is usually taken in the initial acute phase, either due to ignorance or inability to understand its importance, the muscles and surrounding soft tissue structures undergo shortening or disuse atrophy. This ultimately leads to further weakness or contributes to atypical movement patterns due to changes in muscle length and body alignment. Pain is another factor restricting mobility.

UNILATERAL NEGLECT

Unilateral neglect is a phenomenon observed in stroke patients where there is lack of awareness of a part of the body or the external environment. It limits movement and use of more involved

extremity. The patient typically does not react to sensory stimuli presented on the more involved side.

Modified Constraint Induced Movement Therapy (MCIMT)

Constraint-Induced Movement Therapy (CIMT) consists of a set of rehabilitation techniques designed to reduce functional problems in the most affected upper extremity of clients with stroke [14]. This therapy involves constraining movements of the less-affected arm, usually with a sling or mitt for 90% of waking hours, while intensively inducing the use of the more-affected arm[14]. Concentrated, repetitive training of the more-affected limb is usually performed for six hours a day for a two to three week period [14]. Compliance of the patient for the rigorous restraint and training schedule, as well as the required intensity of therapy provided by therapists in a clinical setting, are important issues to consider. [14]

Modified CIMT (mCIMT) is a less intense treatment that involves the same principles as CIMT (i.e. restraint of the less-affected upper extremity and practice of functional activities of the more-affected extremity), but with less intensity than traditional CIMT (i.e. less time). The common therapeutic factor in all CIMT techniques includes concentrated, repetitive tasks with the more-affected arm. [14]

Functional benefits appear to be largely confined to those individuals with some active wrist and hand movement. Studies have explored the efficacy of this intervention for improving functional outcomes post-stroke. [14]

A number of neuro-imaging and transcranial magnetic stimulation studies have shown that CIMT can produce a massive use-dependent cortical reorganization that increases the area of cortex involved in the innervation of movement of the more-affected limb (Taub et al., 1999). [14]

NEUROPLASTICITY

Plasticity is a general term describing the ability to show modification. Plasticity, or neural modifiability, may be seen as a continuum from short term changes in the efficiency or strength of synaptic connections, to long term structural changes in the organization and numbers of connections among neurons. [3]

Neuroplasticity occurs in the brain:

- At the beginning of life: when the immature brain organizes itself
- In case of brain injury: to compensate for lost functions or maximize remaining functions.
- Through adulthood: whenever something new is learned and memorized.

For plasticity to occur in the brain, stimulus must be of specific intensity and quality, and challenging. Repetition, specificity, intensity, feedback and shaping are important for the effects of neural plasticity over a longer period.

Subjects 1

Presents with C/O weakness in left upper limb and decreased use of left hand since 8 months. Subject is a 55 yr old female who suffered from rt. MCA territory infarct on 20th March 2017. On 20th March, when subject was washing clothes, she felt giddiness and black out. Her relatives helped her to the bed. After 10-15 mins she started vomiting, sweating profusely then lost consciousness. She was then taken to a hospital within 30 mins where she was administered oxygen and an injection was given. After about an hour she was shifted to another hospital where she was admitted in the ICU and was given oxygen. She regained consciousness on 21st March around 11 a.m. Left side was paralysed, mouth deviated to the left, slurred speech and drooling of saliva was present. MDCT angiography of neck and intracranial vessels reveals mild luminal irregularity and multifocal narrowing in right MCA.

Subject was admitted in the hospital for 9 days. Physiotherapy was started from 4th of April 2017 and continued since then. She was taught transfers and functional rehabilitation was started.

Functional abilities at present: Subject is unable to comb hair, wash utensils, drape a saree or carry grocery bags in left hand. She can cook and clean house by herself. No specific attitude is adopted for the left upper extremity. Arm swing absent during gait.

Subject was evaluated and included in the study after assessment. The subject was (1) 8 months post stroke (2) grade 5 according to Brunnstrom stage of recovery for upper limb (3) grade 5 according to Brunnstrom stage of recovery for hand (4) used

spectacles for vision (5) MMSE is 28 (6) no tightness in biceps or wrist flexors.

Subject 2

Presents with decreased use of right hand and numbness since 3 to 4 years. Subject is a 82 year old male who suffered a stroke on 27th October 2010. While sitting, he suddenly experienced heaviness in the right arm and subsequently lost consciousness. He was then driven to a nearby hospital by his son where medications were given. An MRI was performed on 28th October which revealed patchy acute infarcts in left PCA territory. He was admitted in the hospital for 11 days. Medications were administered. No physical therapy was taken during this period. After discharge, subject regained ambulation within a month and gradually started use of upper limb. He could wear clothes, have a bath, hold a glass, eat with right hand within 3 to 4 months sometimes requiring minimal assistance. He still continued experiencing some weakness in right arm but did not give history of disuse. Since the past 3 to 4 years, subject started experiencing increased weakness and reduced grip strength in the right hand because of which he has reduced use of right hand. Patient now uses left hand for self-grooming activities, minimal use of right hand for wearing a shirt, eats with left hand. No Physical therapy was taken by the subject.

Subject was (1) 8 years post stroke (2) grade 5 according to brunnstrom stage of recovery for upper limb (3) grade 5 according to Brunnstrom stage of recovery for hand (4) uses spectacles for vision (5) MMSE is 28

METHODOLOGY

- Study design: Descriptive study
- Sampling technique: Purposive sampling with chits
- Sample size: 6
- Sampling population: Stroke patients having UE involvement in chronic stage in Talegaon
- Materials**:**

1. Peg Board
2. Towel
3. Grocery
4. Jebsen Taylor Scale, MAL scale, MMSE scale
5. Ball
6. Cups
7. Book
8. Laptop
9. Racquets
10. Functional boards
11. Cardboard and crepe bandage

CRITERIA OF STUDY

Inclusion

- Patients with chronic stroke i.e. 6 months and beyond
- Brunnstrom stage of recovery - grade 3 and above for arm (i.e. spasticity increasing; synergy pattern or some of their components can be performed voluntarily) [8]
- Brunnstrom stage of recovery – grade 4 and above for hand (i.e. gross grasp present; lateral prehension developing; small amount of finger extension and some thumb movement possible) [8]
- Patients having active wrist extension and active finger extension.
- MMS> 24
- Intact vision
- Both sexes.

Exclusion

- Other neurological deficit
- Musculoskeletal affection in the affected limb causing functional limitations (dislocated shoulder or any soft tissue condition, prior trauma limiting use of affected extremity).
- Flaccid stroke

PROTOCOL

The following exercises were given under conventional treatment

- Stretching for wrist and finger flexors, supinators, biceps 3 times each with 30 sec hold (contract-relax method)
- Active movements of the wrist, elbow, radio-ulnar and shoulder joints (10 repetitions each)
- Scapula setting exercises: for rhomboids, trapezius-upper, middle, lower, serratus anterior.
- Patients undergoing physiotherapy may continue to do so; they are to refrain from practicing any upper extremity functional activities for the duration of the study.

Modified CIMT was given for 2 hours per day, 5 days a week for a total of 3 weeks. [3] The patients' unaffected extremity will be restrained using a cardboard splint or a crepe bandage wrapped around the hand for 2 hours a day during which the patient will be engaged in circuit training performing activities with the affected extremity.

Apart from the time spent in therapy, patient will be asked to continue wearing the restraint for at least 3 hours after therapy and carry on his routine activities. The restraint may be removed while eating or using the bathroom.

The patient is asked to maintain a log of the home program where he must record the days of compliance, duration of restraint, activities done and number of times the restraint was removed during the duration.

mCIMT protocol

Badminton [15]

The subject is to rally with the therapist.

Feedback parameters

- Number of hits in certain amount of time
- Number of successful hits without dropping

Writing [15]

This is applicable only if dominant hand affected. The subject is asked to copy down an article given.

Turning pages of a book [15]

Place reading material on table.
The subject turns the pages while concentrating on turning the pages by either pronating or supinating

Shaping Progressions

- The position of the reading material Left/centre/right
- The number of pages to turn

Feedback parameters

Number of pages turned in a set amount of time

Cups/Containers [15]

A subject can use cups (or other containers) to lift, move and stack them. lifting/moving/stacking.

Shaping progressions

- Distance away from subject the cups are placed
- Flipping upside down when stacking or moving

Feedback parameters

- Amount of time to move a certain number of cups
- The number of cups that can be moved in a certain amount of time

Grocery packing [15]

While sitting or standing, participants lift items (eg. cans, vegetables etc.) from grocery bags and place them on a table/shelf. Items can be repacked from the table/shelf into the grocery bags.

Shaping progressions

- Mixed items
- Feedback parameters:
- Number of items moved in given time period
- Successful movements and separation of items with different weights and sizes.

Keyboard [15]

Place keyboard on the table. Have the subject place hand on table and ask him to depress a key repeatedly with one finger at a time. Subject is instructed to isolate the individual finger movements by keeping their hand as flat as possible on the table.

Shaping progressions

- Move keyboard farther away from subject
- Have subject alternate fingers over trials and within a trial

Feedback parameters

- The number of depressions accomplished in a set period of time

Pegboard (vertical) [15]

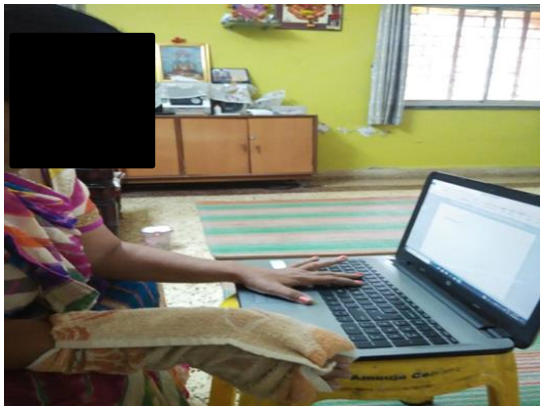
Participants lift wooden pegs and place them into holes on a pegboard.

Shaping progressions

- Pegboard distance from participant
- Pegboard location on table (to the right or left of participant)
- Location of peg placements on board (left or right side)

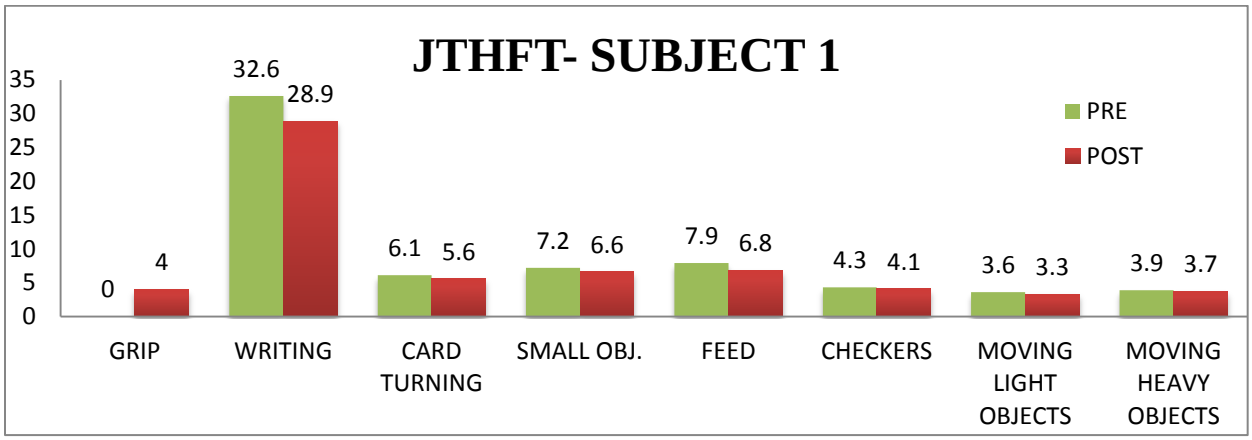
Feedback conditions

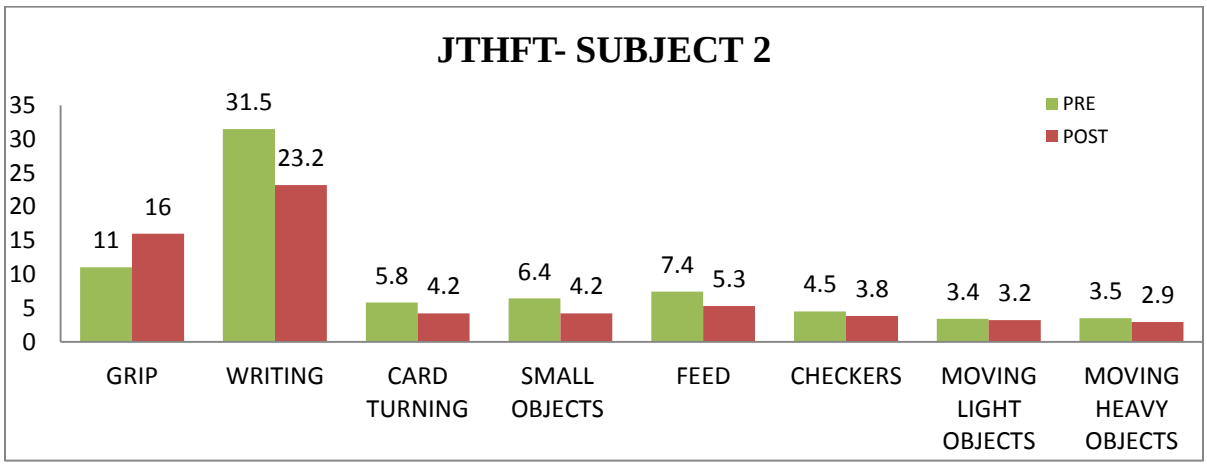
- Amount of time to place certain number of pegs
- Number of pegs placed over given period of time



RESULTS AND ANALYSIS

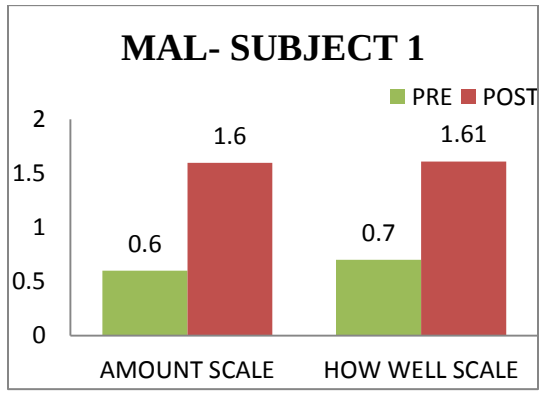
Jebsen taylor hand function test

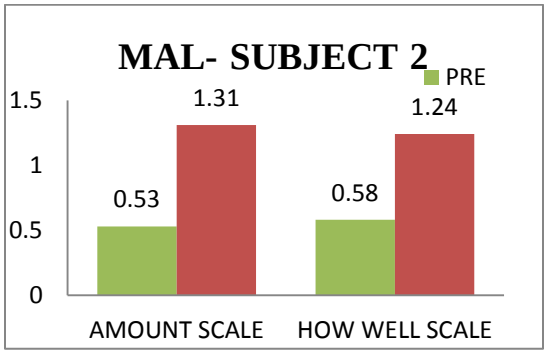




- As observed from the above graphs, grip strength and the writing component of the scale show much better improvements than the other components. The one-tailed p-value for grip is 0.02 for subject 1 and $p<0.006$ for subject 2 which is statistically significant at 5% level of significance. The p-value for writing is $p<0.03$ for subject 1 and $p<0.02$ for subject 2 which is statistically significant. The p-value for the other components for all subjects is $p>0.1$ and hence it is not statistically significant. Also, no normative data for reference ranges are available for the above scale.

Motor activity log





- The one-tailed p-value calculated for each subject for Motor Activity Log of the Amount scale and Quality of Movement scale is $p<0.001$ which is very significant.
- Also, as observed from the graphs, the quality of movement and amount scale show similar improvement in Subject 1 while amount scale shows slightly better improvement than the quality of movement in Subject 2.

DISCUSSION

The study was conducted for a duration of 3 weeks on 5 subjects with upper arm affection in patients with chronic stroke and similar grade of motor recovery of upper extremity. During rehabilitation, it has been observed that learned non-use phenomenon and incorrect movement patterns are significant problems that the therapists and patients need to overcome for proper rehabilitation and maintaining functional independence. The more that the patients make use of the unaffected hand, the more they lose their functional independence [17]. Hence, it may be assumed that increased use of the hemiplegic hand will help improve the habitual performance of functional tasks.

It has been observed that short term bilateral training has resulted in reduced intracortical inhibition and increased intracortical facilitation to both hemispheres, while unilateral training produced increased intracortical facilitation and reduced intracortical inhibition in only the contralateral hemisphere.

Modified CIMT includes forced use of the affected hand by restraining the unaffected hand which has been shown to increase the size of contrast-enhanced bilateral sensorimotor cortex on T1 weighted MRI scans. [17] In addition, previous studies have shown that there is a significant proportional correlation between the size of contrast-enhanced bilateral sensorimotor cortex and degree of functional recovery of hemiplegic upper extremity. [17]

In the case series performed, the activities used for mCIMT require patients to perform habitual activities while also emphasizing correct and isolated movements at shoulder while playing badminton, isolated elbow flexion and extension for peg boards, pronation-supination for turning pages and so on. It is a known fact that the brain recognizes and learns the movement patterns and not the activity and this phenomenon is targeted in mCIMT.

Neural plasticity requires a stimulus which is of a sufficient intensity, quality and duration. In mCIMT the intensity and duration of performing the activities are reinforced as well as quality of the movement is emphasized. Since the activities are performed repetitively, corticomotor activity in the brain increases and this leads to improved use of the affected hand as noted in a study conducted by **Jin A Yoon, Bon Il Koo, Myung Jun Shin *et al*. in Korea.**

This may be one of the reasons for improvement noted significantly in following functional activities for subject 1 in Group B: open drawer, remove clothing from drawer, get out of car, wash hands, pull chair away from table, pick up glass, carry an object.

The following show improvement in subject 2 for Group B: turn on a light switch, wash hands, get up from chair, pull chair away, pull chair toward table, pickup a glass, brush your teeth, write on paper, carry an object. We observe that subject 2 shows more activity improvement in terms of unilateral arm use compared to subject 1. This may be because that subject 2 had dominant hand affected while subject 1 had non dominant hand affected as observed in a review conducted by **Sandy McCombe Waller and Jill Whitall, University of Maryland, USA.**

Subject 1 complied with the unsupervised hour for first 6 days but only for the duration of one hour. As the subject was right handed dominant and left extremity was affected, the subject complained of inability to carry out right handed ADL's and hence did not agree to wear the restraint for unsupervised hours. Subject 2 complied with unsupervised hours of treatment for 2 hours for 11 days of the treatment. The subject was right hand dominant and hence did not face similar problems as subject 1 for ADLs. Thus from the 2 cases we see that the subject with dominant affection is more likely to wear the restraint to improve hand use.

We, as therapists, lack in planning of a more targeted and functional approach during rehabilitation focusing more on regaining the general movements which leads to a delay in regaining hand use. mCIMT is not an intervention used commonly for rehabilitation because of its intensity. It requires patience from both the patient as well as the therapist. This study shows us that it is the responsibility of the therapist to explain to the patient the importance and effectiveness of the intervention and to include them in regular rehabilitation protocols.

CONCLUSION AND SUGGESTIONS

From the study conducted and the results obtained, we may conclude that modified constraint induced movement therapy show significant improvement in the Motor Activity Log scale.

SUGGESTIONS

We may further conclude that dominant hand usually does not require assistance for all activities, while the non-dominant hand acts as the support and usually provides assistance to dominant hand. Hence, modified constraint induced movement therapy may be much more useful if the dominant hand is affected.

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