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Study On The Effectiveness Of Constraint Induced Movement Therapy Used As An Adjunct To Rehabilitation Of Hemiplegia

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INTRODUCTION

Hemiplegia is paralysis that affects only one side of your body. This symptom is often a key indicator of severe or life-threatening conditions like a stroke, but can also happen with conditions and circumstances that aren't as dangerous.

Hemiplegia is paralysis of the muscles of the lower face, arm, and leg on one side of the body. In addition to motor problems other losses may occur eg.sensation, memory, cognition. The most common cause of hemiplegia is stroke, which damages the corticospinal tracts in one hemisphere of the brain. Other causes of hemiplegia include trauma eg. spinal cord injury; brain tumours; and brain infections.

Hemiplegia is treated by addressing the underlying cause and by various forms of therapy to recover motor function. In particular, motor function in a hemiparetic limb may be improved with physical therapy and with mirror therapy. [1]

Hemiplegia is often used interchangeably with hemiparesis as both produce similar symptoms. An individual living with hemiparesis experiences a weak paralysis on one side of the body, while hemiplegia may cause the person to experience full paralysis on one side of their body, as well as difficulty breathing or speaking.[2]

Etiology

- Vascular - Cerebral hemorrhage , Stroke , Diabetic Neuropathy.
- Infective - Encephalitis , Meningitis , Brain abscess.
- Neoplastic - Glioma - meningioma
- Traumatic - Cerebral lacerations , Subdural Hematoma . Rare cause of hemiplegia is due to local anaesthesia injections given intra arterially rapidly , instead of given in a nerve branch .
- Congenital- Cerebral palsy

- Disseminated - Multiple Sclerosis
- Psychological - Parasomnia (Nocturnal hemiplegia).[3]

Signs and Symptoms of Hemiplegia

Symptoms of hemiplegia range from one person to another and are dependent on the severity of the condition. Symptoms of hemiplegia include:

- Impaired motor skills
- Difficulty grasping or holding on to objects
- Weakness of muscles or stiffness on one side of the body
- Permanently contracted muscles or muscle spasticity
- Poor balance
- Difficulty walking[2]
- Treatment

People living with hemiplegia usually undergo a combination of rehabilitation therapy, which typically involves physical therapists, mental health professionals, and rehabilitation therapists.[2]

Constraint induced movement therapy is a rehabilitation approach that is designed to reduce in capitating motor deficits of the upper limbs in patient after neurological injury and increase their functional independence.

Types of Hemiplegia

One of the most common causes of hemiplegia is stroke. When a stroke occurs, the supply of blood in the brain is compromised and causes damage to nerve cells in a specific region of the brain(Andrea Reinkensmeyer,2024).

Other neurological conditions that can cause hemiplegia are brain injury, spinal cord injury, and cerebral palsy. Hemiplegia in individuals with cerebral palsy is congenital, meaning that it is caused by damage to the brain before, during, or shortly after birth.

Listed below are the possible types of hemiplegia:

Contralateral hemiplegia

The brain is divided into two hemispheres. The right hemisphere controls movement on the left side of the body, and the left hemisphere controls movement on the right side of the body. Contralateral hemiplegia refers to paralysis on the side of the body that’s opposite (contralateral) to the side where the brain damage occurred.

Right hemiplegia refers to paralyzed muscles on the right side of the body following injury to the left hemisphere of the brain. Left hemiplegia refers to paralyzed muscles on the left side of the body after right hemisphere injury.

Spinal hemiplegia (ipsilateral)

Unlike the brain, the spinal cord controls movement to the same side (ipsilateral) of the body. After spinal cord injury, right hemiplegia describes paralysis on the right side of the body after injury to the right side of the spinal cord, whereas left hemiplegia reflects paralysis on the left side of the body after injury to the left side of the spinal cord. Brown-Sequard syndrome is another term referring to this relatively rare condition.

Spastic hemiplegia

Spastic hemiplegia refers to a type of hemiplegia that is common with cerebral palsy. Weakness or paralysis on the side of the body opposite to the hemisphere of the brain injured before, during, or shortly after birth is called spastic hemiplegia. It is the most common type of cerebral palsy, where the arm is usually more affected than the leg. (Andrea Reinkensmeyer,2024).

The term 'spastic' refers to spasticity experienced by the person with cerebral palsy. Spasticity includes stiff, involuntarily-contracted muscles. Individuals with spastic hemiplegia display stiff movements while individuals with flaccid hemiplegia experience loose, floppy muscles on their affected side.

Facial hemiplegia

Facial hemiplegia is paralyzed or weak muscles on one side of the face. It can be the only symptom of nerve damage or occur in conjunction with hemiplegia elsewhere in the body.

One of the hallmark signs of a stroke is facial drooping on one side of the face. Facial hemiplegia can be temporary and go away once the stroke has been treated and normal blood flow in the brain is restored.

Hemiplegia Symptoms and Signs

Because hemiplegia is a neurologic condition, the symptoms vary based on the characteristics of the injury, its location, and size. For example, a spinal cord injury only impairs movement below the level of injury, while a brain injury can impair movement anywhere on the affected side, ranging from the face to the arm to the leg.

Every neurologic injury is unique, and therefore, every individual experiences hemiplegia slightly differently. Some common signs and symptoms include:

Paralysis of the arm, leg, and/or lower face on the affected side

Difficulty with walking and balance

Loose, floppy muscles (flaccidity) on the affected side

Stiff, rigid muscles (spasticity) on the affected side

Delay in developmental milestones for children with spastic hemiplegia

Hemiplegia is a secondary effect of a primary neurologic injury. Individuals with a primary injury involving the brain may also experience other secondary symptoms such as:

Sensory loss (numbness, “pins and needle” sensations)

Visual disturbances

Difficulty with speech

Seizures

Neglect and learned nonuse of the affected side

Hemiplegia does not cause these additional symptoms. They are complications of the primary neurologic injury.

Hemiplegia Treatment

Treatment for hemiplegia occurs in two phases. First, the primary neurologic injury is treated, if possible. For example, when a stroke occurs, initial treatment focuses on stopping the stroke and restoring normal blood flow in the brain. This can include administration of anti-coagulants or even stroke surgery.

The second phase of hemiplegia treatment involves stimulating the nervous system to rewire itself. The brain or spinal cord can strengthen and reorganize neural pathways through neuroplasticity.

After one area of the brain is damaged, neuroplasticity causes unaffected parts of the brain to grow and develop control of the muscles originally controlled by the damaged parts of the brain. For spinal cord injuries, neuroplasticity reorganizes neural pathways in the spine. This “rewiring” is possible when the spinal cord is not completely severed. See our article on complete spinal cord injury for more details.

Neuroplasticity is enhanced by experience and repetition. When movement is practiced, the nervous system is stimulated to create and strengthen new neural pathways for that movement. Through experience and repetition, individuals with hemiplegia are able to regain movement on the paralyzed side. This is why exercise is essential for hemiplegia treatment (more on this later).

Not all individuals can regain functional movement, but all can stimulate their nervous system. Regardless of an individual’s prognosis, every neurologic injury is unique, so even when the odds are unfavorable, stimulating the nervous system with movement (passive or active) is worthwhile. No one can predict the true outcome of any single neurologic injury. Therefore, the only way to know how much movement a person can

recover is to pursue rehabilitation and see what happens. (Andrea Reinkensmeyer,2024).

Rehabilitation Methods for Hemiplegia

What rehabilitation methods help improve hemiplegia? Each rehabilitation method described below will stimulate neuroplasticity, potentially improving hemiplegia.

Rehabilitation exercise

Rehabilitation exercises are designed to help rewire the brain through repetition. When therapeutic movements are practiced with good form, it stimulates neuroplasticity and encourages better movement patterns.

Passive exercise

Individuals with hemiplegia may be unable to move their limb through its full range of motion. With help from another individual, your limb can be moved through its full range of motion passively. Your joint moves even though your targeted muscle group has not actively contracted to cause that movement. This is called passive exercise.

Even though your muscles are not contracting to generate this movement, passive movement stimulates the brain and sparks neuroplasticity, particularly when attention is paid to the movement. For example, if an individual performs passive exercise while watching television, it won't have as much of the desired effect. In addition, passive exercise provides gentle stretching to the affected limbs, which helps restore the use of those muscles.

Physical therapy

Physical therapists specialize in restoring movement in the body. Individuals with hemiplegia benefit from working with a physical therapist to practice rehabilitation exercises tailored to their unique needs.

Occupational therapy

Occupational therapists help you find meaningful or fun ways to engage with movements that will lead to neuroplasticity. Because your brain requires many repetitions of movements to rewire itself, making an exercise engaging is the key to recovery. When an activity is meaningful or fun, it will be repeated.

Often OTs use activities of daily living to stimulate neuroplasticity and improve a person's function. Occupational therapists can teach individuals how to use adaptive devices to accomplish daily activities. (Andrea Reinkensmeyer,2024).

Assistive devices

Individuals with hemiplegia are at a greater risk of falling, particularly if leg function and balance are impaired. It's always a good idea to consult with a physical and/or occupational therapist to get recommendations when using assistive devices for walking or activities of daily living. There is a wide range of devices for enhancing mobility or increasing independence with activities of daily living. So, be sure to ask a therapist if there is equipment you can use to make your life easier.

Mental practice

Mental practice, or mental imagery, involves visualizing yourself practicing a movement that you want to improve. Studies have shown that visualizing movement sparks changes in the parts of the brain that control movement such as the motor and premotor areas in the cortex of the brain.

Mental practice can be done anytime and anywhere, even from your bed. The accessibility of this therapy makes it a great fit for individuals with hemiplegia. For best results, individuals can mentally rehearse their rehabilitation exercises before actually performing them. Studies have found that combining mental practice with physical practice leads to better results than physical practice alone.

Electrical stimulation

When hemiplegia makes voluntary movement difficult, electrical stimulation can cause contractions in the affected muscles. Electricity is applied to the affected muscles through pads affixed to the skin. Never attempt to do electrical stimulation by yourself without first consulting with a therapist and receiving training.

Muscle contractions from electrical stimulation cause a contraction of the affected muscles, reminding those tissues how to respond to neuronal inputs. As with all hemiplegia treatments, use this therapy in conjunction with rehabilitation exercises for the best results.

Electrical acupuncture

Acupuncture is an alternative treatment that involves inserting thin needles into specific "acupoints" on the body. Sometimes electrical stimulation can be applied to these needles after they are inserted; and sometimes electrical stimulation pads can be affixed to the specific acupoint instead of a needle. (Andrea Reinkensmeyer,2024).

One study found that electrical acupuncture helped improve hemiplegia when using the latter technique (applying e-stim through pads affixed to specific acupoints) combined with traditional rehabilitation exercises.

Sensory retraining

After a stroke, some individuals with hemiplegia experience sensory changes like numbness or "pins-and-needles" sensations. Sensory nerve fibers provide the brain with important information and can help the brain reorganize. There are many sensory receptors in the nervous system, and a rehabilitation technique called sensory retraining offers ways to stimulate all these sensory receptors, which stimulate the brain. This therapy improves the brain's ability to process sensation while stimulating neuroplasticity.

One important sensory receptor in the body is our receptor for joint position. Proprioception is the body's ability to determine where its joints are in space without visual cues. Studies indicate stimulating proprioception improves rehabilitation from stroke.

Modified constraint-induced movement therapy

Modified constraint-induced movement therapy (mCIMT) involves restraining the non-affected limb to encourage use of the affected side. For example, an oven mitt can be placed on the non-affected hand to encourage use of the affected hand.

mCIMT is potentially frustrating to a person with hemiplegia. Therefore, it's important to do this therapy to the point of challenge, but not frustration. (Andrea Reinkensmeyer,2024).

One study found that mCIMT led to better results than traditional therapy alone. It's worth noting that each individual participated in nearly 6 hours of therapy per day, which is twice the amount of therapy given during inpatient rehabilitation. These results affirm the common understanding that the amount (or dose) of exercise increases one's rehabilitation potential.

Exercises for Hemiplegia

As you can see, every treatment for hemiplegia involves some form of exercise because it's the key to improving movement after neurologic injury. Here are some types of hemiplegia exercises your therapist may recommend:

Passive exercises

Passive exercises can be accomplished in a variety of ways. For hand exercises, individuals can use their non-affected hand to assist their affected hand through the exercise. However, heavier limbs like the leg require help from a therapist or caregiver to passively perform these exercises.

hand palm-down on a table for passive hemiplegia exercise

hand flipped over for passive hemiplegia exercise

One example of a passive exercise for the hand is “palm up and down.” During this exercise, you place your affected hand on a table and then use your non-affected hand to turn your palm up and down. Pay close attention to the movement to maximize neuroplasticity.

See more hand therapy exercises »

Strengthening exercises

Individuals with hemiplegia are at greater risk of muscle atrophy (when the muscles shrink and waste away) due to nonuse. Therefore, it’s helpful to perform weight-bearing exercises that strengthen the muscles on the affected side.

OT in starting position for cane lean stretch

OT leaning to the left with the cane

One example is the “cane lean” exercise. Start by placing your affected hand on a cane and then place your non-affected hand on top for stability. Then, gently and safely lean into the affected side. This weight bearing helps stimulate the affected side.

Stretching exercises

Individuals with hemiplegia need to perform stretching exercises to prevent tightening of their joints, especially when spasticity is involved. For the upper arm, include a forearm stretch and wrist stretch.

occupational therapist demonstrating forearm stretch

During the forearm stretch, place your hands in your lap and then interlace your fingers. Then bend your wrist to stretch your affected arm palm-side up.

occupational therapist demonstrating wrist stretch for hemiplegia

For the wrist stretch, keep your fingers interlaced and then gently bend your affected wrist. It’s ok to feel a gentle pulling sensation, but never stretch to the point of sharp pain.

If you’re looking for suitable exercises for hemiplegia, your therapist is a great resource. They know how to choose suitable exercises that target your unique needs.

You can also browse through our library of rehabilitation exercises and adapt them for hemiplegia by practicing them passively. It's a good idea to have a therapist assign you some exercises and then practice those specific exercises daily at home. Remember that repetition is required for neuroplasticity.

Improving Movement with Hemiplegia

Hemiplegia involves paralysis on one side of the body, often after injury to the brain or spinal cord. Treatment includes rewiring the brain through repetitive exercises.

While exercise is one of the best rehabilitation methods, you can enhance your results by combining traditional therapy with other modalities such as electrical stimulation and mental practice.

Every neurologic injury is unique, which means that every individual can benefit from a unique therapy plan. Work closely with your therapists and try to be as consistent as possible with your exercises. This will help maximize the chances of regaining movement with hemiplegia.

AIM OF THE STUDY

The aim of the study is to know whether the constraint induced movement therapy is effective in improving upper limb function on patients with hemiplegia. An effective measure for the rehabilitation of stroke patients will certainly help both the patients and rehabilitation team. Thus, if this study is proved to be effective this can be used as an adjunct in the rehabilitation of hemiplegia

METHODOLOGY

RESEARCH DESIGN

The study was quasi experimental in nature.

Day 1 8^{th} week

Constraint induced movement therapy

8Weeks

Pretest Post test

Pretest measurements of upper limb function was measured using Fugl - meyer scale.

CRITERIA FOR SELECTION

Inclusion Criteria

- Age 40-60 years
- Both sex
- Chronic stroke patients
- MCA involvement only
- Side - both side

Exclusion Criteria

- Shoulder dislocation
- Recent fractures
- Traumatic brain injury
- Cognitive impairment
- Cervical myelopathy
- Brachial plexus injury

POPULATION

All the patients who fulfilled the selection criteria were taken as the population of the study.

SAMPLE SIZE AND METHOD OF SELECTION

10 samples were selected from the population using simple random sampling method.

VARIABLES

Independent variable

- Constraint induced movement therapy

Dependent Variable

- Upper limb function

VALIDITY AND RELIABILITY OF THE TOOL USED

Fugl-meyer scale is a valid and reliable tool to measure upper limb function.

SETTING

The study was conducted at the department of Post graduate studies of Vinayaka Missions College of physiotherapy, Salem and the patients were selected from VMKV medical college hospital, Salem.

METHODOLOGY

A pilot study was conducted prior to the main study with subjects to observe the feasibility of study.

After this, samples of subjects were selected using simple random sampling method from the population. All the participants were explained about the purpose and procedure of study and written consent was obtained from them before being included in the study. Pretest measurement of upper limb function was done using Fugl- meyer scale.

PROCEDURE

CONSTRAINT INDUCED MOVEMENT THERAPY (CIMT)

Principles of CIMT

- Constraining the unaffected limb
- Forced use of the affected limb
- Massive practice

This approach has been used most frequently with persons recovering from stroke and the main aim is to retain the brain by constraining the unaffected arm and forcing the use of the weakened arm.

The patient were engaged in daily repetitive task and behavioral shaping sessions, which included training in tasks such as,

- Opening a lock
- Turning a door knob
- Pouring a drink
- Eating lunch
- Throwing a ball
- Playing dominoes

The post test measurements of upper limb function where collected at the end of 8^{th} weeks in a similar manner as that of pretest measurement.

OBSERVATION AND ANALYSIS

The collected data were analyzed using paired "t" test

Table 1.1 : Constraint Induced Movement Therapy

Variable	**"t" cal value**	**"t" table value**
Upper limb function	18.48*	2.262

- "t" calculated value > "t" table value Significant at 5% level.

RESULTS AND DISCUSSIONS

RESULTS

The data was subjected to statistical analysis and the following results were obtained.

Constraint induced movement therapy is significantly effective in improving upper limb function on patients with Hemiplegia .

DISCUSSION

The aim of the study was to know the effect of Constraint induced movement therapy in improving upper limb function on patient with Hemiplegia . The results obtained from the study showed a significant improvement in upper limb function after the application of Constraint induced movement therapy as a treatment technique.

The results obtained from the study showed that Constraint induced movement therapy is significantly more effective in improving upper limb function on patients with Hemiplegia .

The improving upper limb function following constraint induced movement therapy may be due Induces long term structural changes in the organization and number of connection among neurons. Parallel and hierarchical processing with in CNS markedly increased which results in peak amplitude and size of cortical output to the muscles were significantly larger and shorter reaction times. Practice (CIMT) makes the maps of cortiical output to the muscles continued to enlarge until the subjects explicit knowledge of the sequence. Repeated practice of motor skill results in improved synaptic efficiency between the sensory and motor cortext, increases the efficiency of the thalamocortical pathways that are co activated during learning

process.

Recovery of arm function was associated with ventral extension of upper limb areas of the cortex (functionally related area). Strengthen of the shift in the hierarchical organization of the cortex, with supplementary motor cortex, premotor cortex descending pathways taking over for the primary corticomotor pathways.

Increased alteration of motor cortex by hard prospected training programme. Co – Activation of many muscles simultaneously present at initial level, of with continuous, hard practice those less efficient contractions are eliminated and only the necessary muscles contact. Extension of upper limb presentation in cortex and pre motor supplementary motor cortex descending pathways taking over the primary corticomotor pathway. The study results conclude with, **Nilsson L., et.al., (1998)** showed that, constraint induced movement was significantly effective in improving the upper limb function on patients with Hemiplegia . **Ann Charistin Eliasson. et. al., (2004)** concluded that the constraint include movement therapy shows greater improvement in upper limb function on patients with Hemiplegia.

CONCLUSION

From this study it was concluded that constraint include movement therapy can be used as an effective adjunct in improving upper limb function on patients with Hemiplegia.

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APPENDIX – I

Fugl – Meyer Assessment scale

	Score		
1. Shoulder / elbow / forearm			
1.1. Reflex activity	0	1	2
Flexors (biceps and finger flexors)	0	1	2
Extensors (triceps)			
1.2. Flexors synergy – volitional movement within synergy			
Shoulder retraction	0	1	2
Shoulder elevation	0	1	2
Shoulder abduction	0	1	2
Shoulder external rotation	0	1	2
Elbow flexion	0	1	2
Forearm supination	0	1	2
1.3. Extensor synergy – volitional movement within synergy			
Shoulder adduction / internal rotation	0	1	2
Elbow extension	0	1	2
Forearm pronation	0	1	2
1.4. Volitional movement mixing the dynamic flexor and extensor strategies			
Hand on lumbar spine	0	1	2
Shoulder flexion	0	1	2
Forearm pronation / supination	0	1	2

1.5. Volitional movements are performance with little or no synergy dependence	0	1	2
Shoulder abduction Shoulder flexion	0	1	2
Forearm pronation / supination	0	1	2
2. Wrist			
2.1. Wrist stability – elbow 90^0	0	1	2
2.2. Wrist flexion / extension – elbow 90^0	0	1	2
2.3. Wrist stability - elbow 0^0	0	1	2
2.4. Wrist flexion / extension – elbow 0^0	0	1	2
2.5. Circumduction	0	1	2
3. Hand			
Mass flexion	0	1	2
mass extension	0	1	2
Grasp A – distal finger grasp	0	1	2
Grasp B – thumb adduction grasp	0	1	2
Grasp C – thumb to index finger grasp	0	1	2
Grasp D – Cylinder grasp	0	1	2
Grasp E – spherical grasp	0	1	2
4. Co-ordination / speed			
Tremor	0	1	2
Dysmetria	0	1	2
Speed	0	1	2
Upper limb Score			

0 – Unable to perform

1 – Able to perform in part

2 – Able to perform

APPENDIX - II

MASTER CHART

(Constraint include movement therapy)

S.No	Fugl – Meyer Scale	
	Pre test	**Post test**
1	11	29
2	9	27
3	8	32
4	14	45
5	9	42
6	11	49
7	13	43
8	9	47
9	8	36
10	14	37