EFFECT OF VISUAL FEEDBACK ASSISTED ARM CYCLING TRAINING IN IMPROVING THE UPPER EXTREMITY FUNCTION AMONG THE INDIVIDUALS WITH ACUTE STROKE.

AN EXPERIMENTAL STUDY

Dissertation submitted to the TamilnaduDr. M.G.R. Medical University towards partial fulfilment of the requirements of **MASTER OF PHYSIOTHERAPY (Advanced PT in Neurology)** Degree Programme.

KMCH COLLEGE OF PHYSIOTHERAPY

(A unit of Kovai Medical Centre Research and Educational Trust)

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CERTIFICATE

This is to certify that the research work entitled "**EFFECT OF VISUAL FEEDBACK ASSISTED ARM CYCLING TRAINING IN IMPROVING THE UPPER EXTREMITY FUNCTION AMONG THE INDIVIDUALS WITH ACUTE STROKE – An Experimental Study"** was carried out by the candidate bearing the **Register No: 27101609**, KMCH College of Physiotherapy, towards partial fulfilment of the requirements of the **Master of Physiotherapy (Advanced PT in Neurology)** of the Tamil Nadu Dr. M. G. R. Medical University, Chennai - 32.

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Acknowledgement

THIS PROJECT WORK IS DEDICATED TO MY BELOVED PARENTS AND FAMILY MEMBERS

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Abstract

ABSTRACT

OBJECTIVE: Impaired upper limb function is the most common consequences of middle cerebral artery stroke, which limits the performance of activities of daily living. The motor recovery of the upper limb in hemiplegic stroke patients can be improved significantly by repetitive arm training at the initial phase of rehabilitation. The aim of this study is to determine the effect of visual feedback assisted arm cycling training in improving upper limb function among the individuals with acute stroke. **STUDY DESIGN:** Two groups Pre test – Post test experimental study design. **PARTICIPANTS:** Twenty middle cerebral artery acute stroke patients of both sexes between 40-65 years who meet the inclusion criteria were selected and randomly assigned into two groups, conventional physiotherapy group and arm cycling group. Each group contained 10 subjects. **INTERVENTION:** Both the groups were treated with conventional physiotherapy training for an 45 to 60 minutes a day, with arm cycling group received additional 30 minutes of arm cycling training. **OUTCOME MEASURES:** Upper limb function was assessed by Fugl-Meyer scale – upper limb component and Stream scale – upper limb component before the commencement and 3weeks after the training. **RESULTS:** At baseline subjects in both groups were closely similar. After the intervention both groups showed statistically significant differences on Fugl-Meyer and Stream scale. By comparing the mean value of improvement in both groups, arm cycling group showed more significant improvement than the conventional group in both outcome measurements. **CONCLUSION:** This study revealedthat there is significant improvement of arm cycling training in improving the upper limb function among the individuals with acute stroke.

Introduction

1. INTRODUCTION

Human brain is the most complex and unique part of the human body that depends upon the continuous supply of oxygen and other nutrients from the blood. When blood supply is disturbed even for few minutes, areas of brain may be damaged and a person may suddenly lose some of the functions controlled by that region of brain. This sudden loss of functions is referred to as stroke.[1]

Stroke etiology is divided into ischemic (90%) and haemorrhagic (10%). Of ischemic stroke, the thrombotic type is the most common, followed by embolic and lacunar types, respectively.Stroke is defined as "rapidly developing clinical signs of focal (or global) disturbance of cerebral function, with symptoms lasting 24 hours or longer or leading to death, with no apparent cause other than of vascular origin" – WHO.

A study by the World Health Organization (WHO), which released in 2009 June, says that the incidence of stroke in India is around 130 per 100,000 people every year. Stroke is the most common cause of disability with more than 70 % of stroke survivors remaining vocationally impaired and more than 30 % requiring assistance with activity of daily living.[66]

The middle cerebral artery is the artery most often occluded in stroke.[58]The features of middle cerebral artery stroke are contralateral hemiparesis (worse in the arm and face than in the leg), dysarthria, hemianesthesia, contralateral homonymous hemianopia, aphasia or apraxia and sensory neglect depends upon the involvement of dominant hemisphere.[39]

Hemiparesis is the most common consequences after stroke, affecting greater than 80% of the subjects acutely and 20% chronically.[42] The paretic upper limb is a common undesirable consequences of which limits performance in daily activities and consequently increases the activity limitation.[11,15] A leading cause of disability after stroke is hemiparesis, with poor control of arm, hand and finger movements.[17]Upper limb impairments following stroke can include weakness, pain, sensory loss, impaired dexterity and incoordination. Weakness in the upper limb muscles could impair stabilization of proximal arm segments, limit reaching ability, confine hand usage and affect upper limb control and coordination.[23]The upper limb makes a significant contribution to most activities of daily living and impairments can compromise participation in many of these essential and meaningful tasks.[11,47]

Jill Whitall et al., reported that upper extremity hemiparesis impairs performance of many daily activities such as eating, dressing, bathing, self-care, and writing, thus reducing functional independence of the individual, only 5% of adults regain full arm function after stroke, and 20% regain no functional use.[28]

A lack of recovery reflected by performance on measures of activity limitation may cause therapists and patients to switch too quickly to the teaching of compensatory techniques using the unaffected upper limb and not working on improving the motor function in the affected upper limb. This, in turn, may lead to "learned non-use," in which failed attempts to use the affected arm can lead to negative reinforcement in the use of that arm. Poor outcomes in the rehabilitation of the upper limb have been noted to be due to the missense of independence gained by the use of compensatory techniques.[59]

Stroke induces not only a region of cell death and scar formation, but regions of neural repair and reorganisation.[60]Cortical reorganization of involved hemisphere plays a major role of motor recovery of stroke.[13,40] Functional imaging in humans suggest that recovery of functions is associated with extensive reorganization of the cortical motor system, presumably to maximize control of remaining motor output.[64,65] Reorganization takes place in unaffected hemisphere through interhemispheric connections of premotor areas in the brain, so that premotor areas in undamaged hemisphere play a role in the recovery of functions after stroke.[10,30]

The rate of recovery in an arm paralysed after an acute stroke is usually greatest in the initialweeks, with little change occurring after one year. Good recovery is not expected if no movement is seen by one month.[3]Commonly available treatment for upper limb rehabilitation are **Repetitive task training,Neuro developmental training, Sensory motor training, Mental practice, Hand splinting, Robotic devices for movement therapy, Virtual reality technology, Constraint induced movement thereapy.**

Patient very soon after general stabilization undergo rehabilitation treatment to improve affected upper limb function after stroke. Optimal restoration upper limb motor function is essential in permitting stroke patients to independently perform the activities of daily living. Upper limb functions are needed to be emphasized while aiming to rehabilitate a stroke patient to the fullest extent.[17]

Bilateral arm training like arm cycling, a rehabilitation therapy based on the concept that bilateral movement permits interhemispheric facilitation of the limbs.Bilateral repetitive upper extremity rehabilitation therapy appears to induce reorganization in bilateral, but mainly in contralesional hemisphere networks and in cerebellum.[2]

K. Diserensad et al., have done study with arm cycling in chronic stroke patients and he stated that repetitive arm cycling training leads to significant improvement in motor function among chronic stroke patients and cycling on an arm cycling is a useful tool for rehabilitation.[38] MH Rabadi et al., have done a pilot study of activity-based therapy in the arm motor recovery post acute stroke, he proved that arm cycling is a better therapy in decreasing impairment and improving disability in the paretic arm of severely affected stroke patients in the subacute phase.[43]

In this study we are using Reckmotomed arm cycling device to improve upper limb function, this device which offers the visual feedback to the patient about their symmetry of limb usage, and it also have motorised cycle that enables users with very limited muscle strength to cycle actively (with the support of the motor). So Patients can start early in the rehabilitation process to apply and strengthen even the weakest muscle, This cycling is also offer active training which it is carried out with own muscle strength, against resistance. The resistance level can be adjusted in finely graduated gears. The display gives feedback about the active performance.

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Need for the Study

1.1 NEED FOR THE STUDY

Upper limb functional recovery following middle cerebral artery stroke is not having satisfactory result as lower limb functional recovery, following studies are supporting this concept.

Nakayama H et al., proposed thatarm weakness occurs in 70–80% of post stroke patients, and it is persistent in 40% of patients. Nakayama and associates looked at the recovery of upper limb function from the first week of poststroke to until patients were discharged from acute care or died. They found that only 18% of the patients with severe upper limb paresis achieved full upper limb function.[45]

Approximately two thirds of stroke survivors have residual neurological deficits that persistently impair their function. Specifically, dysfunction from upper extremity hemiparesis impairs performance of many daily activities such as eating, dressing, bathing, self-care, and writing, thus reducing functional independence. In fact, only 5% of adults regain full arm function after stroke, and 20% regain no functional use.[28] Buchkremer-Ratzmann et al., suggested from their studies that in stroke recovery period, the critical period was defined as the early hyper excitability that occurs in tissues ipsilateral and contrlateral to the ischemic infarct, which subsequently dissipates over several weeks.[7]Schallert et al., pointed out that this increased excitability coincides with the period during which commencement of early rehabilitation produces greatest recovery.[33]

Bilateral arm training like arm cycling, a rehabilitation therapy based on the concept that bilateral movement permits interhemispheric facilitation of the limbs. Specific bilateral repetitive upper extremity rehabilitation therapy appears to induce reorganization in bilateral, but mainly in contralesional hemisphere networks and in cerebellum, and may operate by recruiting these brain areas to provide functional benefits.[2,48]

Muscle weakness rather than spasticity plays a dominant role in impairment of active voluntary movements. Effective therapy is based on the repetitive stimulation of muscle activity in the arm. Active repetitive motor training of hand and fingers has proven to be directed at recruitment of muscle activity. The important therapeutic implication is that interventions should be directed at recruitment of muscle activity will produce early recovery. In addition, it might be crucial to apply this type of intervention as soon as possible to prevent learned nonuse of the hemiplegic arm.[26]

Rhythmic training, like arm cycling induces phasic flexor and extensor movements involving rhythmic muscle and tendon stretching, gamma activation, and sensory input on the spinal level. The repetitive character could entrain supraspinal spasticity control through long-term potentiation.[24]

K. Diserensad et al., have done study with arm cycling in chronic stroke patients and he stated that Repetitive arm cycling training leads to significant improvement in motor function among chronic stroke patients and arm cycling is a useful tool for rehabilitation. Repetitive movements seem to be particularly effective in rehabilitation and motor learning; the major mechanisms are attributed to synaptic plasticity and synaptic efficacy in existing neural circuits.[38]

MH Rabadi et al., have done a pilot study of activity-based therapy in the arm motor recovery post acute stroke, he proved that arm cycling is a better therapy in decreasing impairment and improving disability in the paretic arm of severely affected stroke patients in the subacute phase. And he stated that arm cycling training helps decrease intracortical inhibition and helps to increase bilateral recruitment of corticospinal, reticulospinal and rubrospinal pathways in each supplementary motor area.[43]

E. Paul Zehr et al., stated that the modulation of cutaneous reflexes during rhythmic arm movement arises from the activity of a human locomotor central pattern generator and this could explain phase- and task-dependency of reflexes via pre-motoneuronal gating of afferent feedback and rhythmic arm movements are regulated by Central Pattern Generators just as posited for the leg.[19]Higgins et al: have done research in acute stroke(with in 5 weeks of post stroke) and he suggest that the improvement occurring during the first 5 weeks post stroke in the affected arm is clinically meaningful and may actually translate into greater use of the affected limb in "realworld situations."[25]

Biernaskie, Garry Chernenko also pointed out that initiating rehabilitative therapy as early after the stroke provided significant functional gains and enhanced structural plasticity relative to the same treatment delayed by one month.[4]

So this study mainly focused on the effect of visual feedback assisted arm cycling training in improving the upper extremity function among the individuals with acute stroke.

Review of Literature

2. REVIEW OF LITERATURE

2.1. INCIDENCE OF STROKE

Stroke incidence rises rapidly between the age group of 45 – 65 years with similar gender variability and increases rapidly after 65 years with increasing variability found in males than female with ratio of 3:1.[51]

2.2. STROKE AND ARTERY

On the basis of pathology it can be classified as

- Thrombotic
- Embolic
- Haemorrhagic

Approximately 83% of strokes are due to ischaemic cerebral infarction and 17% due to brain haemorrhage.[16]

In majority of stroke patients the upper limb is more severely involved than the lower limb, as most infarction occurs in the territory of the middle cerebral artery.[29]

2.3. MIDDLE CEREBRAL ARTERY STROKE

The middle cerebral artery is the largest branch of the internal carotid. The artery supplies a portion of the frontal lobe and the lateral surface of the temporal and parietal lobes, including the primary motor and sensory areas of the face, throat, hand and arm and in the dominant hemisphere, the areas for speech. The middle cerebral artery is the artery most often occluded in stroke.[58]

The features of middle cerebral artery stroke are contralateral hemiparesis (worse in the arm and face than in the leg), dysarthria, hemianesthesia, contralateral homonymous hemianopia, aphasia (if the dominant hemisphere is affected) or apraxia and sensory neglect (if the nondominant hemisphere is affected)[39]

Tom Skyhoj Olsen have done study and he stated that following middle cerebral arterystroke upper extremity functional improvement was recorded in 52% of the patients and in lower extremity function in 89%.[62]

Justin A et al.,suggested that 80% of patients experiencing acute paresis of the upper extremity after stroke, only approximately 1/3 achieve full functional recovery, Predicting functional recovery for these patients is highly important in order to provide focused, cost effective rehabilitation.[36]

Longitudinal studies of recovery after stroke suggest that only 50% of patients with significant arm paresis recover useful function.[63]

2.4. ARM RECOVERY AFTER STROKE

Klein et al., concluded that in early phase following stroke, there is prompt initial improvement in function as pathologic process associated with penumbra – ischaemic metabolic injury, edema, haemorrhage and blood pressure resolve. The later ongoing improvement involved is termed as reorganization that represent neuroplasticity. It is recognized that repeated participation by patients in active physical therapeutic programs probably provides direct influence on the process of functional reorganization in the brain and enhances the neurological recovery.

Shelton et al., suggested that neuronal dysfunction due to ischemic penumbrasurrounding an area of infarction magnifies the apparent clinical severity of the stroke. Neuronal recovery in ischemic penumbra explains the rapid improvement of neurological impairment over the first several days of post stroke.[21]

Peurunnen et al.,suggested that early after stroke, the homeostatic environment around an area of infarction is enriched in growth factors, altered transmitter receptors and other trophic process. This could support the formation of synapses or enhancement of dendritic arborisation and it is possible that these processes occurring early may play a disproportionate role in recovery.[50]

Susan B. O'Sullivan stated that following middle cerebral artery stroke upper extremity is more affected than lower extremity, about 20% individuals with middle cerebral artery strokes fail to regain any functional use of the affected upper extremity.[54]

Harris et al.,suggested that upper limb impairments following stroke can include weakness, pain, sensory loss, impaired dexterity and incoordination. Weakness in the upper limb muscles could impair stabilization of proximal arm segments, limit reaching ability, confine hand usage and affect upper limb control and coordination.[23]

Nancy et al., done a study with the purpose to describe the disabilities experienced by person with stroke during first year and explore the evaluation of impairment, disability, handicap, and health related quality of life. They suggest that much of improvement in impairment and disability occurs during the first month and then reaches a plateau. Handicap and quality of life continue to be issue later.

Johanne Higgins et al., suggested that significant improvement in upper limb function occurs in the first 5 weeks poststroke and the extent of upper limb deficits assessed in the first week following a stroke with the use of a measure of activity limitation is a good prognostic indicator of upper limb function at 5 weeks poststroke and should be used for the planning of treatment strategies.[31]

Broeks JG, et al., done study to investigate the recovery of arm function after stroke over a period of 4 years and he stated that it is encouraging to note that even after 16 weeks improvement still occurred in some patients. However, considerable long-term loss of arm function, associated disability and perceived problems were found. There is an obvious need to develop effective treatment methods for hemiplegic arm function.[6]

Jill whitall et al., suggested that approximately two thirds of stroke survivors have residual neurological deficits that persistently impair function. Specifically, dysfunction from upper extremity hemiparesis impairs performance of many daily activities such as dressing, bathing, self-care, and writing, thus reducing functional independence. In fact, only 5% of adults regain full arm function after stroke, and 20% regain no functional use.[28]

Bard and Hirschberg., suggested that any patient without observable movement or recordable finger grip by 28 days is unlikely to recover any useful function and this information might be used to make a relatively early decision with regard to further therapy, either towards more intensive treatment or towards acceptance of the lack of function, with adaptive training to using the unaffected arm.[3]

Hilde M. Feys suggested that muscle weakness rather than spasticity plays a dominant role in impairment of active voluntary movements. Efficacy of the therapy could be attributed mainly to the repetitive stimulation of muscle activity in the arm. Active repetitive motor training of hand and fingers has proven to be directed at recruitment of muscle activity. The important therapeutic implication is that interventions should be directed at recruitment of muscle activity will produce early recovery. Our results support this philosophy. In addition, it might be crucial to apply this type of intervention as soon as possible to prevent learned nonuse of the hemiplegic arm.[26]

2.5. BILATERAL ARM TRAINING

Julie Duque et al., have done research in trancallosal inhibition in chronic stroke patients and he suggested that deeper premovementinterhemispheric inhibition with paretic than non-paretic hand movements of patients with chronic stroke is a possible mechanism for underlying deficits in motor control.[34]

Parlow SE et al., suggested that Bilateral arm training a rehabilitation therapy based on the concept that bilateral movement permits interhemispheric facilitation of the limbs.[48]

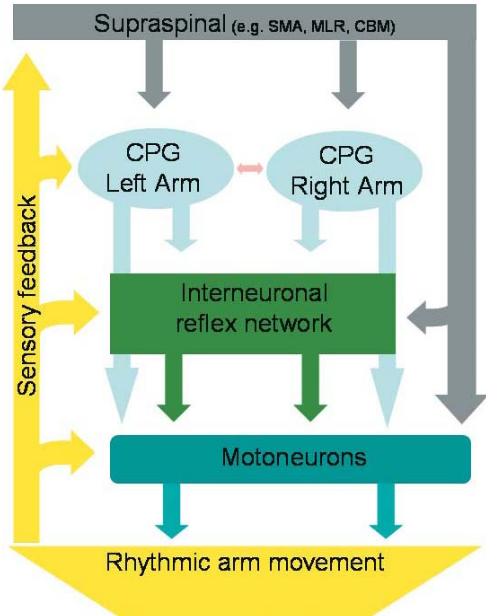
Andreas R et al., suggested that In patients with chronic motor impairment after stroke, specific bilateral repetitive upper extremity rehabilitation therapy appears to induce reorganization in bilateral, but mainly in contralesional, hemisphere networks and in cerebellum, and may operate by recruiting these brain areas to provide functional benefits. This association supports the hypothesis that bilateral arm training improves arm function by inducing reorganization of contralesional motor cortex networks.[2]

Jill Whitall,et al., suggested that the bilateral arm training regimen based on motor learning principles leads to significant and potentially durable functional gains in the paretic upper extremity of chronic hemiparetic patients.[28]

Goldberg G. Stated that bilateral arm training helps decrease intracortical inhibition and helps to increase bilateral recruitment of corticospinal, reticulospinal and rubrospinal pathways in each supplementary motor area.

S. Hesse et al., have done the study on 4 to 8 weeks after stroke and he suggested that 30- 20 minute sessions of robotic bilateral training improved upper limb motor control and muscle strength compared with electrical stimulation of the paretic wrist extensors in subacute stroke patients with severe upper limb paresis.[24]

2.6. ARM CYCLING



E. Paul Zehr et al., stated that the modulation of cutaneous reflexes during rhythmic arm movement has been suggested to arise due to activity of a human locomotor Central Pattern Generator and this could explain phase- and task-dependency of reflexes via pre motoneuronal gating of afferent feedback and rhythmic arm movements are to some extent regulated by Central Pattern Generators just as posited for the leg.[19]

K Diserensad et al., suggested that Repetitive arm cycling training leads to significant improvement in motor function among chronic stroke patients and cycling on an arm ergometer is a useful tool for rehabilitation.[38]

E. Paul Zehret al., from his study on neural control of rhythmic human arm movement: phase dependence and task modulation of hoffmann reflexes in forearm muscles suggested that in the lower limb, the patterns of cutaneous and H-reflex modulation are suggestive of activity in central-pattern–generating networks associated with leg movement. Extensive phase and task dependency of cutaneous reflexes during arm cycling suggests that there is also a central pattern generator controlling rhythmic arm movement. The presently observed patterns of modulation of the forearm H-reflex suggest that central pattern generators associated with arm movement control separately each limb as might be predicted based on recent distributed segment models of central pattern generator networks.[18]

The inhibition of H-reflex amplitude during bilateral and ipsilateral arm cycling compared with static contraction suggests that feedback from the moving arms and central mechanisms (possibly originating from a central pattern generator resident in the cervical spinal cord) both interact to modify peripheral feedback during arm movements.[19]

MH Rabadi et al., have done a pilot study of activity-based therapy in the arm motor recovery post acute stroke, he compared arm cycling training with occupational therapy programme and robotic training programme and he has proved that arm cycling training have the same effect as Ocupational therapy and robotic training group therapy in decreasing impairment and improving disability in the paretic arm of severely affected stroke patients in the subacute phase.[43]

K. Diserensad et al., have done study on the effect of repetitive arm cycling on post stroke spasticity and motor control, in this study he used 30 minutes of arm cycling training consist of 15 minutes forward pedalling followed by 5 minutes rest period than again 15 minutes of backward pedalling and he stated that it is a effective protocol to provide improvement.[38]

E. Paul Zehr et al., have done study on possible contributions of central pattern generator activity to the control of rhythmic human arm movement and he suggested that central pattern generator activity contributes to the neural control of rhythmic arm movement.[19]

Christensen lod, johannsen et al., have proposed position emission tomography study during cyclic movement showed that active cycling significantly activated areas bilaterally in the primary sensory cortex, primary motor cortex and supplementary motor cortex and also in the anterior part of cerebellum.[9]

Braun &kautz et al., have told that person with hemiplegia increase force output by their plegic limb when pedalling against higher workloads without exacerbation of impaired motor control therefore exerctionalpedalling exercise is beneficial intervention for achieving gains in muscular force output without worsening motor control impairment.[5]

2.7. VISUAL FEEDBACK ON STROKE

Magill RA et al., Feedback along with practice is considered to be a potent variable affecting motor skill learning. When one performs a task, there are 2 general types of performance-related information or feedback available. One type of feedback is called inherent feedback, which is the sensory perceptual information that is a natural part of performing a skill. For example, a person sees that he has missed picking up a cup with his hands. The second type of feedback is called "augmented" feedback. Although various terms have been used to identify this type of feedback (information, extrinsic or artificial feedback) Augmented refers to adding to or enhancing task-intrinsic feedback with an external source, the external source may be a therapist or a device such as a biofeedback system or a timer.[41]

Sandeep K. Subramanian et al., had done review on extrinsic feedback result in improved motor learning in the upper limb poststroke and he stated that that people with stroke may be capable of using extrinsic feedback for implicit motor learning and improving upper limb motor recovery.[52]

M. C. Cirstea, suggest that there is a considerable potential for enhancing the effectiveness and efficiency of upper limb motor rehabilitation by providing feedback at the motor impairment level.[44]

2.8. CONVENTIONAL PHYSIOTHERAPY

Joel stein, defined conventional therapy as a standard approach which essentially involves providing physical assistance and encouragement for stroke patients during functional or prefunctional tasks and then gradually withdrawing this support as the individuals ability to perform desired activity improves. The therapeutic program typically incorporates instruction in compensatory technique to improve functional abilities.[29]

Chae et al., suggested that surface neuromuscular stimulation enhances the upper extremity motor recovery of acute stroke survivors and the effect is maintained for up to three months after completion of treatment.[8]

Gereon et al.,concluded that passive movements in hemiplegic patients produce mainly proprioceptive input to motor pathways that elicited some of the brain activation patterns by functional organization.Increasing regional blood flow in bilateral inferior parietal cortex and sensorimotor cortex of hemiplegic patients during passive movements measured by functional imaging suggested that these may play an important role in the reorganization of sensory and motor system for preceding restoration of neurological function.[22]

Peter et al., suggested that repetitive active or passive practice of movements may enhance motor learning and recovery in stroke patients.[49]

Susan Ryerson suggested that hemiplegic side, sustained stretching or elongation through weight bearing in conjunction with the retraining of motor control is more effective in preventing future loss of joint range.[57]

Schmitz suggested that the more the patient can be made to use the affected side, the greater the chance of increased sensory awareness and function. Treatment should therefore involve the patient using hemiplegic side in volitional motor task. The presentation of repeated sensory stimuli will maximize the use of residual functions and central nervous system reorganization.[54]

2.9. OUTCOME MEASURES

Julie Sanford et al., have assessed the reliability of fugl - meyer scale with three experienced physical therapist on 12 patients in a rehabilitation population and he stated that It is a relatively simple assessment to administer and requires minimal training. The overall reliability for this instrument was high (ICC = .96).[35]

David J et al., suggested that The Fugl - Meyer scale is a much-needed instrument for monitoring the course of recovery from hemiplegic stroke. Its design, content, and measurement properties strongly favour the use of the 100-point motor domain to evaluate changes in motor impairment following stroke. Excellent intrarater and interrater reliability have been demonstrated for the entire scale and each of its subsections.[14]

Thomas Platz et al., have done the study to assess the Reliability and validity of arm function assessment with standardized guidelines for the FugI-Meyer Test, Action Research Arm Test and Box and Block Test and he stated that fugl - meyer is the valid measure to assess the upperlimb function of post stroke patients.[61]

Gladstone DJ, have done the review on the fugl-meyer assessment of motor recovery after stroke and he stated that fugl-meyer score at 30 days predicted 86% of the variance in recovery of motor function.[14]

John W. Krakauer,reported from his review on arm function after stroke: from physiologyto recovery that The difference between impairment and disability highlights the critical distinction between true recovery or restoration of function, as opposed to compensation a patient with right arm paresis who learns to perform activities of daily living with her left arm has compensated but has not recovered. Measurements of impairment are more likely than measurements of activities of daily living or handicap to distinguish true recovery from compensation. Second, the Fugl - Meyer score at 5 days was a better predictor of recovery.[32]

Kathy Daley et al., have done the study on Reliability of Scores on the Stroke Rehabilitation Assessment of Movement Measure and he stated that The reliability of scores obtained with the Stream measure as determined under the conditions of this study is excellent, both within and between raters and The internal consistency of the Stream scores is also excellent, with Cronbach alphas of greater than .98 on the subscales.[37]

Chun-Hou Wang et al., have done the study on inter-rater reliability and validity of the stroke Rehabilitation assessment of movement (stream) instrument and he stated that Theintraclass correlation coefficient for the total score was 0.96 indicating very high inter-rater reliability and The total Stream score was moderately to highly associated with the score of the Barthel Index and Fugl-Meyer motor assessment scale, rho = 0.67, and 0.95.[12]

Sara Ahmed et al., have done the study onStroke Rehabilitation Assessmentof Movement. A Comparison With other Measures used to evaluate effects of stroke and rehabilitation and he suggested that Stream showed a moderate to high correlation with the other measures used in this study.[53]

I-Ping Hsueh et al., have done the study on Psychometric Comparisons of 2 Versions of the Fugl-Meyer Motor Scale and 2 Versions of the Stroke Rehabilitation Assessment of Movement and he stated that the motor scales showed acceptable levels of reliability, validity, and responsiveness in stroke patients. The Stream is recommended because it is short, responsive to change, and able to discriminate patients with severe or mild stroke.[27]

Nancy mayo stated that this Stream sub score of a, b, c is not used for statistical inferences but only for the therapist to plan treatment and change the quality of movement. For all statistical calculations the sub scores , 1a, 1b, 1c shall be put as 1 only.

Aim & Objectives

3. AIM AND OBJECTIVES

3.1. AIM

To find The Effect Of Visual Feedback Assisted Arm cycling Training In Improving The Upper Extremity Function Among The Individuals With Acute Stroke.

3.2. OBJECTIVES

- To initiate arm motor recovery earlier in acute stroke patients to maximize their functional ability.
- To evaluate the effect of visual feedback assisted arm cycling in improving the upper extremity Function among the individuals with acute stroke.
- To determine the effect of conventional physiotherapy training in improving the upper extremity Function among the individuals with acute stroke.
- To study the difference between the effect of visual feedback assisted arm cycling training and conventional physiotherapy training with conventional physiotherapy training in improving the upper extremity function among the individuals with acute stroke.

Materials & Methodology

4. MATERIALS AND METHODOLOGY

4.1. STUDY DESIGN

Pre test-Post test experimental study design

4.2. SAMPLING TECHNIQUE

Simple random sampling.

4.3. SAMPLE SIZE

20 subjects, satisfying the inclusion criteria with 10 subjects in each group.

Group A – 10 subjects

Group B – 10 subjects

4.4. STUDY SETTING

Department of physiotherapy,

Kovai Medical Centre and Hospital, Coimbatore.

4.5. CRITERIA FOR SELECTION

4.5.1. INCLUSION CRITERIA

- ≤1 weeks of dominant hemisphere middle cerebral artery stroke with hemiparesis.
- Age between 40 to 65 years.
- Able to sit in chair with back support.
- First time stroke.
- Both thrombotic and haemorrhagic stroke with haemodynamically stable patient.
- Patients with stable vital signs as confirmed by neurologist.
- Both genders
- Good visual field and acuity.

- Able to initiate shoulder flexion, extension and abduction, elbow flexion and extension movement. (Brunnstromvoluntary motor grade2)
- Fuglmeyer upper extremity motor score between 15 to 20
- Both Inpatient and outpatient rehabilitation care.

4.5.2. EXCLUSION CRITERIA

- Sensory impairment
- Inferior subluxation or impingement syndrome of the affected side shoulder.
- Shoulder pain during active and passive 60 degree of forward flexion.
- Significant oedema in forearm and hand.
- Massive haemorrhagic stroke.
- Recurrent stroke.
- Non – dominant hemisphere stroke.
- Presence of biceps bursitis or tendinitis.
- Recent cardiac events.
- Recent unstable angina and cardiac dysrhythmia.
- Patients with associated or with a history of any other neurological disorder.
- Pre existing musculoskeletal deformities and contractures of wrist and hand.
- Posterior cerebral artery & Anterior cerebral artery stroke
- Perceptual & Cognitive disorder

4.6. HYPOTHESIS

4.6.1. NULL HYPOTHESIS

H_{01} - There is no significant effect of visual feedback assisted arm cycling training in improving the upper extremity function among the individuals with acute stroke.

H_{02} - There is no significant effect of conventional physiotherapy training in improving the upper extremity function among the individuals with acute stroke.

H_{02} - There is no significant difference between the visual feedback assisted arm cycling training and conventional physiotherapy training with conventional physiotherapy training in improving the upper extremity function among the individuals with acute stroke.

4.6.2. ALTERNATE HYPOTHESIS

H_{A1} - There is significant effect of visual feedback assisted arm cycling training in improving the upper extremity function among the individuals with acute stroke.

H_{A2} - There is significant effect of conventional physiotherapy training in improving the upper extremity function among the individuals with acute stroke.

H_{A2} - There is significant difference between the visual feedback assisted arm cycling training and conventional physiotherapy training with conventional physiotherapy training in improving the upper extremity function among the individuals with acute stroke.

4.7. STUDY METHOD

4.7.1. TREATMENT PROCEDURE

Totally 20 patients who come under inclusion criteria were selected, out of these 20 patients 10 patients were allocated as arm cycling group and other 10 patients as conventional physiotherapy group by simple randomisation technique.

For both groups upper limb motor function were measured before and after the treatment programme by using the fuglmeyer assessment scale for upper limb motor function and Stroke Rehabilitation Assessment of Movement instrument, For the both group A & group B conventional physical therapy techniques are given for 45 to 60 minutes including.

4.7.2. TREATMENT DURATION

5 sessions a week for 3 weeks.

- Group A receives 45 to 60 minutes a day of conventional physiotherapy training alone with adequate rest periods when patient needs.
- Group B receives 45 to 60 minutes a day of conventional physiotherapy training with adequate rest periods followed by 30 minutes of arm cycling training consist of 15minutes forward and 15minutes backward pedalling.

4.7.3. CONVENTIONAL PHYSIOTHERAPY

Deep Diaphragmatic breathing exercise

Repetition – 10 times

Electrical stimulation

- Electrical stimulation was given to wrist, finger extensor, quadriceps and dorsi flexor muscle groups.
- Type of current - Faradic current
- Waveform - symmetrical biphasic
- Pulse duration - 1ms
- Pulse frequency - 50H_Z
- Pulse amplitude - Sufficient enough to achieve desire strength of Contraction.
- Number of contraction based on the response of the muscle in order to avoid fatigue.

Passive ROM exercise

Passive range of motion exercises to wrist, fingers and lower extremity were given.

Repetition – 10 times

Self assisted ROM exercise

Self assisted range of motion exercises to shoulder, elbow, wrist and finger flexion & extension and lower extremity movements were given.

Repetition – 10 times

Active assisted ROM exercise

Active assisted range of motion exercises to shoulder, elbow, wrist and finger flexion & Extension and lower extremity movements were given.

Repetition – 10 times

Active ROM Exercise

Active range of motion exercises of the upper extremity was given.

- Sitting and arm raising movement in three planes.
- Pronation - supination exercise in elbow at 90 of flexion.
- Forward reaching
- Hands to lumbar spine in sitting
- Wrist circling
- Flexion-extension of wrist
- Flexion-extension of the elbow in all forearm positions (pronation, mid position, supination)
- Elevation-depression of shoulder girdle
- Shoulder flexion-extension (up to 90°)
- Shoulder abduction-adduction with elbow flexed (up to 90°)
- Lateral-Medial rotation of shoulder with elbow flexed end forearm resting on table
- Pour sand from hand onto table
- Manipulating a doorknob
- Knock the table

Repetition – 10 times

Facilitatory Techniques

- Quick stretching to muscles in the upper extremity and lower extremity.
- Cryotherapy(fast icing with ice cubs for 10 to 15 minutes) to wrist and finger muscle groups.
- Local facilitation techniques like muscle tapping over the muscle belly in the upper extremity muscles.
- Weight bearing activities to upper extremity like long sitting, quadruped, prone on hand and prone on elbow with block transferring by unaffected hand.
- Facilitate associate reactions (grasp reactions) along with Tapping over belly of the flexor digitorumprofundus and superficialis tendon – for 5 mins continuously 5 repitions.
- Contractual hand – orientating response training.
- Grasp and release training with peg-board.

For group-A

Conventional physiotherapy training alone will be given 45 to 60minutes a daywith adequate rest periods when ever patient needs

For group B

Conventional physiotherapy training with adequate rest periods when ever patient needsfollowed by 30 minutes of arm cycling trainingwill be given.

4.7.4. ARM CYCLING TRAINING

The paretic arm will be supported by a wrist strap, and then placed on the arm cycle pedal to prevent wrist injury during exercise and wrist status was assessed before and after each treatment session to prevent injury.

The patient will be advised to use the affected extremity for pedalling. Symmetry of limb usage will be displayed in the monitor, it will give the visual feedback to the patient to perform efficiently, and the exercise was stopped if the patient reported fatigue or discomfort in the affected arm. Pulse rate and Blood pressure measurements will be intermittently monitored for adverse cardiovascular reaction during the exercise period.

Arm cycling training consist of 2sets of exercising in each session, the duration of each set is 15minutes with intermittent rest periods of 5minutes in each set.

Set 1: forward pedalling alone with 0 resistance and gradual increase in resistance based on patients ability.

Set 2: Backward pedalling alone with 0 resistance and gradual increase in resistance based on patients ability.

Each session consist of 30 minutes, totally 15 sessions will be given.

ARM CYCLE UNIT

VISUAL FEEDBACK

ARM CYCLING TRAINING

4.8. OUTCOME MEASURES

- The upper extremity section of the Fugl-Meyer assessment of motor recovery after stroke.
- The upper extremity section Stroke Rehabilitation Assessment of Movement instrument (STREAM).

4.9. STATISTICAL ANALYSIS

The changes within the experimental and control group were analysed using paired'‘t’ test and independent ‘t’ test.

INDEPENDENT `t’ TEST (between groups)

$$t = \frac{\overline{X1} - \overline{X2}}{S}\sqrt{\frac{n_1 n_2}{(n_1 + n_2)}}$$

Where, $$S = \sqrt{\frac{\sum d_1^2 + \sum d_2^2}{n_1 + n_2 - 2}}$$

PAIRED `t’ TEST (within groups)

$$t = \frac{\bar{d}\sqrt{n}}{S}$$

Where, **S** = $$\sqrt{\frac{\sum d^2 - \left[\bar{d}\right]^2 \times n}{n - 1}}$$

S=combined standard deviation

$d_1 \& d_2$ =difference between initial & final readings in group A &group B

respectively.

n_1 & n_2=number of patients in group A & group B respectively

$\overline{X}_1 \& \overline{X}_2$ =Mean of group A & group B respectively

Data Presentation

5. DATA PRESENTATION

5.1. TABULAR PRESENTATION

PAIRED 'T' TEST:

FUGL-MEYER SCALE – UPPER LIMB COMPONENT

GROUP I – CONVENTIONAL PHYSIOTHERAPY GROUP

	MEAN	't' VALUE		LEVEL OF SIGNIFICANCE
		CALCULATED 't' VALUE	TABLE 't' VALUE	
PRE-TEST	16.2	14.95	2.262	At 5% Significant
POST-TEST	24.6			

GROUP II – ARM CYCLING GROUP

	MEAN	't' VALUE		LEVEL OF SIGNIFICANCE
		CALCULATED 't' VALUE	TABLE 't' VALUE	
PRE-TEST	16.3	24.55	2.262	At 5% Significant
POST-TEST	34.4			

STREAM SCALE – UPPER LIMB COMPONENT

GROUP I – CONVENTIONAL PHYSIOTHERAPY GROUP

	MEAN	't' VALUE		LEVEL OF SIGNIFICANCE
		CALCULATED 't' VALUE	TABLE 't' VALUE	
PRE-TEST	6.0	14.33	2.262	At 5% Significant
POST-TEST	10.30			

GROUP II – ARM CYCLING GROUP

	MEAN	't' VALUE		LEVEL OF SIGNIFICANCE
		CALCULATED 't' VALUE	TABLE 't' VALUE	
PRE-TEST	6.0	27.11	2.262	At 5% Significant
POST-TEST	13.0			

INDEPENDENT 'T' TEST

PRE TEST:

FUGL-MEYER SCALE – UPPER LIMB COMPONENT

GROUP	MEAN VALUE	't' VALUE		LEVEL OF SIGNIFICANCE
		CALCULATED 't' VALUE	TABLE 't' VALUE	
CONVENTIONAL GROUP	16.20	0.1802	2.101	At 5% Not significant
ARM CYCLING GROUP	16.30			

STREAM SCALE – UPPER LIMB COMPONENT

GROUP	MEAN VALUE	't' VALUE		LEVEL OF SIGNIFICANCE
		CALCULATED 't' VALUE	TABLE 't' VALUE	
CONVENTIONAL GROUP	6.0	0.0	2.101	At 5% Not significant
ARM CYCLING GROUP	6.5			

POST TEST:

FUGL-MEYER SCALE – UPPER LIMB COMPONENT

GROUP	MEAN VALUE	't' VALUE		LEVEL OF SIGNIFICANCE
		CALCULATED 't' VALUE	TABLE 't' VALUE	
CONVENTIONAL GROUP	24.6	11.21	2.101	At 5% Significant
ARM CYCLING GROUP	34.4			

STREAM SCALE – UPPER LIMB COMPONENT

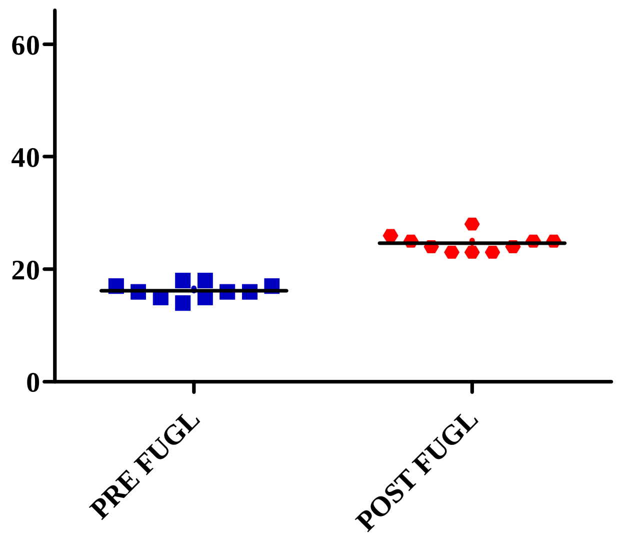
GROUP	MEAN VALUE	't' VALUE		LEVEL OF SIGNIFICANCE
		CALCULATED 't' VALUE	TABLE 't' VALUE	
CONVENTIONAL GROUP	10.3	6.02	2.101	At 5% Significant
ARM CYCLING GROUP	13.0			

5.2. GRAPHICAL PRESENTATION

FUGL – MEYER SCALE VALUES

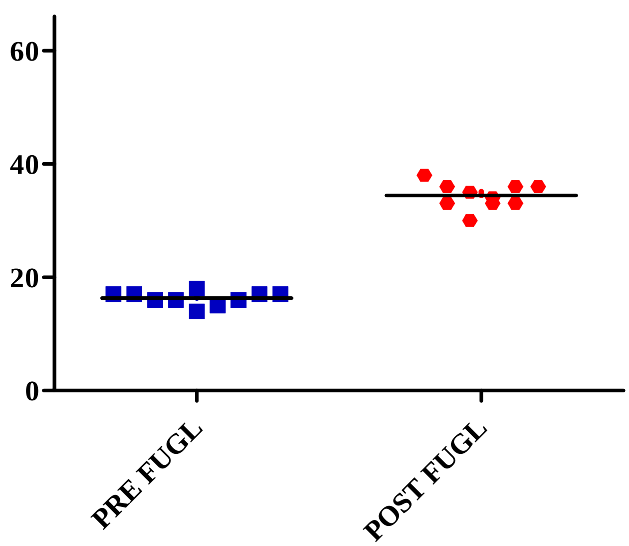
GROUP I – CONVENTIONAL PHYSIOTHERAPY GROUP

PAIRED 't' TEST



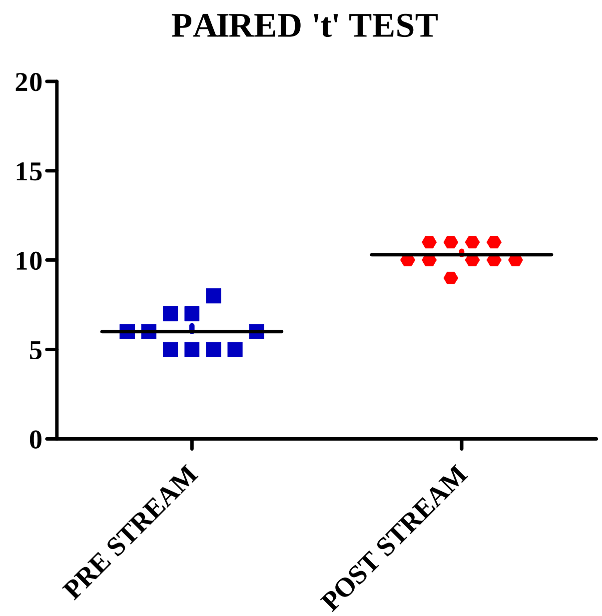
GROUP II – ARM CYCLING GROUP

PAIRED 't' TEST

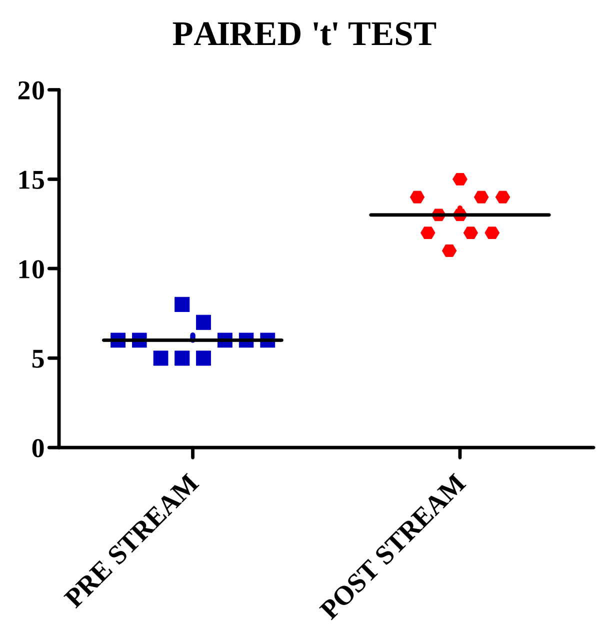


STREAM SCALE VALUES

GROUP I – CONVENTIONAL PHYSIOTHERAPY GROUP



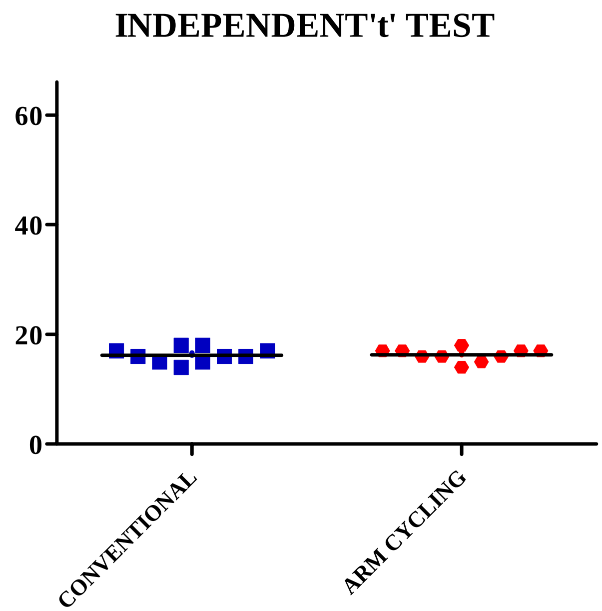
GROUP II – ARM CYCLING GROUP



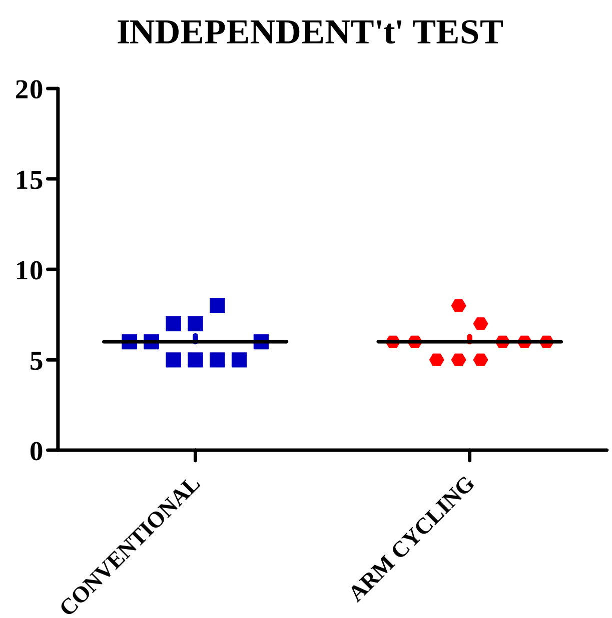
INDEPENDENT'‘t’ TEST

PRE TEST VALUES

FUGL – MEYER SCALE VALUES

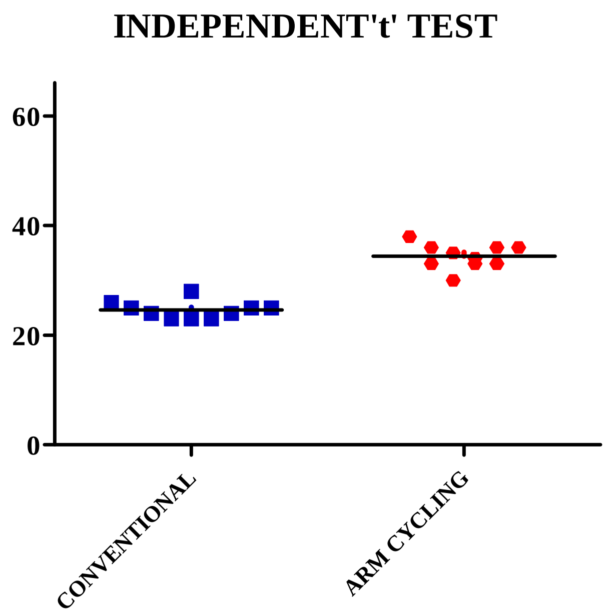


STREAM SCALE VALUES

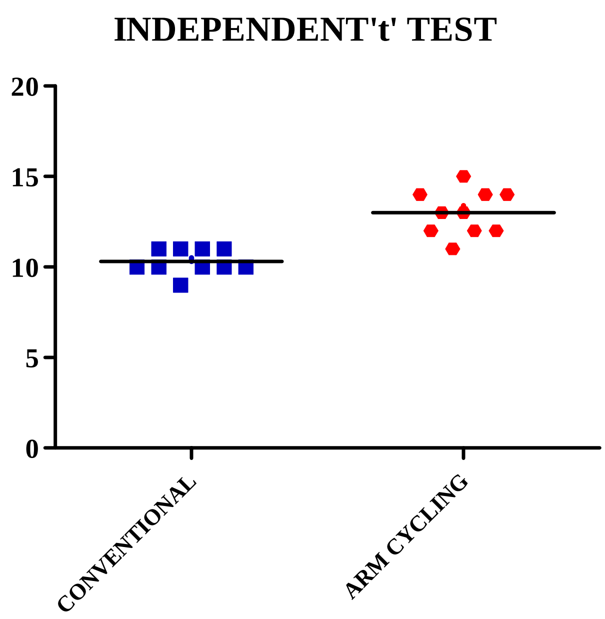


POST TEST VALUES

FUGL – MEYER SCALE VALUES



STREAM SCALE VALUES



Data Analysis

&

Results

6. DATA ANALYSIS AND RESULTS

PAIRED ‘t’ TEST

GROUP I – CONVENTIONAL PHYSIOTHERAPY GROUP

FUGL – MEYER SCALE – UPPER LIMB COMPONENT

The pre test and post test values of Fugl – Meyer scale – upper limb component was analysed using paired ‘t’ test. For 9 degrees of freedom and at 5% level of significance, the table ‘t’ value is 2.262 and the calculated ‘t’ value was 14.95. As the calculated ‘t’ value was greater than the table ‘t’ value, null hypothesis was rejected . Hence there was significant effect of conventional physiotherapy in improving upper limb function of acute stroke patients.

STREAM SCALE – UPPER LIMB COMPONENT

The pre test and post test values of Stream scale – upper limb component was analysed using paired ‘t’ test. For 9 degrees of freedom and at 5% level of significance, the table ‘t’ value is 2.262 and the calculated ‘t’ value was14.33 . As the calculated ‘t’ value was greater than the table ‘t’ value, null hypothesis was rejected . Hence there was significant effect of conventional physiotherapy in improving upper limb function of acute stroke patients.

GROUP II – ARM CYCLING GROUP

FUGL – MEYER SCALE – UPPER LIMB COMPONENT

The pre test and post test values of Fugl – Meyer scale – upper limb component was analysed using paired ‘t’ test. For 9 degrees of freedom and at 5% level of significance, the table ‘t’ value is 2.262 and the calculated ‘t’ value was 24.55. As the calculated ‘t’ value was greater than the table ‘t’ value, null hypothesis was rejected . Hence there was significant effect of conventional physiotherapy in improving upper limb function of acute stroke patients.

STREAM SCALE – UPPER LIMB COMPONENT

The pre test and post test values of Stream scale – upper limb component was analysed using paired ‘t’ test. For 9 degrees of freedom and at 5% level of significance, the table ‘t’ value is 2.262 and the calculated ‘t’ value was27.11 . As the calculated ‘t’ value was greater than the table ‘t’ value, null hypothesis was rejected . Hence there was significant effect of conventional physiotherapy in improving upper limb function of acute stroke patients.

INDEPENDENT ‘t’ TEST

PRE TEST VALUES

FUGL – MEYER SCALE – UPPER LIMB COMPONENT

The pre test values of both the groups were analysedusing independent‘t’ test. For 18 degrees of freedom and 5% level of significance, the table‘t’ value 2.101 and the calculated ‘t’ value is 0.1802. As the calculated ‘t’ value was lesser than the table ‘t’ value, there was no significant difference between the pre test values of both groups. Hence there was homogeneity between both the groups before the experiment.

STREAM SCALE – UPPER LIMB COMPONENT

The pre test values of both the groups were analysed using independent ‘t’ test. For 18 degrees of freedom and 5% level of significance, the table ‘t’ value 2.101 and the calculated ‘t’ value is 0.0. As the calculated ‘t’ value was lesser than the table ‘t’ value, there was no significant difference between the pre test values of both groups. Hence there was homogeneity between both the groups before the experiment.

POST TEST VALUES

FUGL – MEYER SCALE – UPPER LIMB COMPONENT

The post test values of both the groups were analysed using independent 't' test. For 18 degrees of freedom and 5% level of significance, the table 't' value 2.101 and the calculated 't' value is 11.21. As the calculated 't' value was greater than the table 't' value, null hypothesis rejected. Hence there was significant difference between the effectiveness of arm cycling and conventional physiotherapy when compared with conventional physiotherapy in improving upper limb function of acute stroke patients.

STREAM SCALE – UPPER LIMB COMPONENT

The post test values of both the groups were analysed using independent't' test. For 18 degrees of freedom and 5% level of significance, the table 't' value 2.101 and the calculated 't' value is 6.02. As the calculated 't' value was greater than the table 't' value, null hypothesis rejected. Hence there was significant difference between the effectiveness of arm cycling and conventional physiotherapy when compared with conventional physiotherapy in improving upper limb function of acute stroke patients.

Discussion

7. DISCUSSION

Stroke leaves many of its survivors with mental and physical disabilities. Impaired upper limb function is one of the primary reason of admission for inpatient rehabilitation after stroke. Aim of stroke rehabilitation is to reduce the disabilities and enable the patient to return to community and make the person functionally independent as much as possible. So there is a need of properly designed rehabilitation programme to achieve the efficient recovery.

Repetitive arm training is required for accurate motor recovery and for effective motor learning. In patients with middle cerebral artery stroke, muscle weakness rather than spasticity plays a dominant role in impairment of active voluntary movements. Efficacy of the therapy could be attributed mainly to the repetitive stimulation of muscle activity in the arm. Active repetitive motor training of hand and fingers has proven to be directed at recruitment of muscle activity. The important therapeutic implication is that interventions should be directed at recruitment of muscle activity will produce early recovery.[26]The purpose of this study was to identify the effect of visual feedback assisted arm cycling training in improving the upper extremity Function among the individuals with acute stroke.

This study was conducted on twenty acute middle cerebral artery stroke patients in which 10 patients were administered with 45 to 60minutes per day of conventional physiotherapy training only and another 10 patients were given 45 to 60minutes per day of conventional physiotherapy training followed by 30 minutes of arm cycling training for every day for 3 weeks. The upper limb functions were assessed by Fugl-Meyer scale – upper limb component, Stream scale- upper limb component before and after the treatment schedule. The data analysis was carried out with ‘t’ test.

The pre test and post test values of both conventional physiotherapy and arm cycling group showed significant improvement of upper limb function in acute stroke patients on Fugl-Meyer scale upper limb component and Stream scale upper limb component. But arm cycling training group showed more significant improvement than the conventional physiotherapy training group.

The conventional physiotherapy includes a gold standard approach which essentially involves providing physical assistance and encouragement for stroke patients during functional or prefunctional tasks and then gradually withdrawing this support as the individuals ability to perform desired activity improves. Hence these techniques are effective in showing improvement.[29]

The reason with arm cycling training could be thatarm cycling induces phasic flexor and extensor movements involving rhythmic muscle and tendon stretching, gamma activation, and sensory input on the spinal level. These repetitive character could entrain supraspinal spasticity control through long-term potentiation.[24] This was supported by K. Diserensad et al., he suggested that arm cycling training leads to significant improvement in motor function among stroke patients and it is an effective therapy in rehabilitation and motor learning, the major mechanisms are attributed to synaptic plasticity and synaptic efficacy in existing neural circuits.[38]

Another study by MH Rabadi et al., arm cycling training helps decrease intracorticalinhibition and helps to increase bilateral recruitment of corticospinal, reticulospinal and rubrospinal pathways in each supplementary motor area.[43]Johansen- Berg H et al., suggested that Reorganization takes place in unaffected hemisphere through interhemispheric connections of premotor areas in the brain, so that premotor areas in undamaged hemisphere play a role in the recovery of functions after stroke.[30]

The technique behind visual feed-back assisted arm cycling training allows patient to alter motor unit activity based on the visual feed-back information. Visual feed-back gives continuous input about the symmetry of limb usage, it gives more motivation to the patient to use the affected upper limb instead of using the unaffected upper limb. But in patients with neurological deficits, this processing is confounded by disruption of supraspinal neural influences upon peripheral motor activity. So these patient initially rely on the visual feed-back and Central Pattern Generator in the cervical spinal segment. E. Paul Zehr et al., stated that the modulation of cutaneous reflexes during rhythmic arm movement arises from the activity of a human locomotor Central Pattern Generator and this could explain phase- and task-dependency of reflexes via pre-motoneuronal gating of afferent feedback and rhythmic arm movements are regulated by Central Pattern Generators.[19]

The findings from this study shows that proximal segment of the upper limb showed good recovery followed arm cycling training but distal segment like hand and fingers didn't show same recovery as like the proximal segments, because arm cycling training includes more range of repetitive movements in the proximal segments like shoulder and elbow. But it produces less repetitive range of movements to the hand and fingers, this could be the reason why proximal segments showed good improvement than distal segments.

Hence the results of the present study indicate that upper limb functional recovery in acute stroke patients can be improved significantly by additional Arm cycling training.

The small size sample and duration of the treatment might have mitigated against the detection of treatment effect. The implication of the findings in this study are important and should be confirmed in large sample size.

Summary & Conclusion

8. SUMMARY AND CONCLUSION

Despite improvement in their general physical mobility, many stroke survivors continue to experience great difficulty in regaining functional use of their affected upper limb. This study was to find out the effect of visual feedback assisted arm cycling training in improving the upper limb function among the individuals with acute stroke. Twenty acute middle cerebral artery stroke patients were selected by simple random sampling method and ten of them were administered conventional physiotherapy techniques only and another group of ten patients were treated with arm cycling training along with conventional physiotherapy training and the study duration was about three weeks. The upper limb function was assessed using Fugl-Meyer scale upper limb component and Stream scale upper limb component. The data was analysed using‘t’ test. Results showed that both groups had significant improvement in upper limb function but arm cycling group showed more significant improvement in upper limb function than the conventional physiotherapy group. Hence it is concluded that arm cycling training can be supplemented to regular rehabilitation programme in order to improve the upper limb function.

Limitations

&

Suggestions

9. LIMITATIONS AND SUGGESTIONS

9.1. LIMITATIONS

- Optimal sample size was not identified.
- Experiment was done during the spontaneous recovery period that might have influenced the results.
- Follow up assessment was not done.
- Activities of daily living were not analysed.
- There was no control group with no treatment

9.2. SUGGESTIONS

- Optimal sample size has to be identified.
- Control group should be added in further studies.
- The follow up has to be done to identify the effect of therapy on long term.
- Further studies should consider about the Activities of daily living also.
- Motor threshold using mapping studies should be performed to determine the response of arm cycling training.
- This intervention can be tested in the treatment of other neurological disorders.

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Appendices

APPENDIX - I

BRUNNSTROM VOLUNTARY MOTOR GRADING FOR ARM

RECOVERY STAGE 1

No voluntary movement of the affected limb can be initiated. In this stage the limbs feel heavy when moved passively, and little or no muscular resistance to movement can be detected.

RECOVERY STAGE 2

The basic limb synergies or some of their component now make their appearance either as weak associated reaction or minimal voluntary movement responses may be present. The extend of movement does not necessarily result in joint movement, spasticity is developing but may not be very marked.

RECOVERY STAGE 3

The basic limb synergies or some of their components are performed voluntarily and are sufficiently developed to show definite joint movements. Spasticity has increased, and during this stage it may become marked.

RECOVERY STAGE 4

Spasticity begins to decrease, and some movement combinations that deviate from basic limb synergies become available.

RECOVERY STAGE 5

A relative independence of the basic limb synergies characterizes this stage, and spasticity waning. More difficult movement combinations can be performed and certain individual joint movements may succeed. Easier movement combinations are performed in a more effortless manner.

RECOVERY STAGE 6

Isolated movements are now freely performed, as well on the affected as on the unaffected side. In general movements are well coordinated and appear normal or near normal. The basic movement synergies no longer interfere with the performance of a variety of movement combinations, but under close examination some awkwardness may be observed.

APPENDIX - II

FUGL – MEYER SCALE – UPPER LIMB COMPONENT

Area	Test	Scoring Criteria	Maximum Possible Score	Attained Score	
				Pre	Post
UPPER EXTREMITY (sitting)	**I. Reflexes** a. biceps b. triceps	0 - No reflex activity can be elicited. 2 – Reflex activity can be elicited.	4		
	II. Flexor Synergy Elevation Shoulder retraction Abduction (at least 90°) External rotation Elbow flexion Forearm supination	0 – Cannot be performed at all. 1 – Performed partly. 2 – Performed faultlessly.	12		
	III. Extensor Synergy Shoulder adduction/internal rotation Elbow extension Forearm pronation	0 – Cannot be performed at all. 1 – Performed partly. 2 – Performed faultlessly.	6		
	IV. Movement Combining Synergies a. Hand to lumbar spine b. Shoulder flexion to 90° elbow at 0° c. Pronation/supination of forearm with elbow at 90° and shoulder at 0°	a.0 – No specific action performed. 1 – Hand must pass anterior superior iliac spine. 2 – Action is performed faultlessly. b. 0 – Arm is immediately abducted or elbow flexes at start of motion. 1 – Abduction or elbow flexion occurs in later phase of motion. 2 – Faultless motion. c.0 – Correct position of shoulder and elbow cannot be attained and/or pronation or supination cannot be performed at all. 1 – Active pronation or supination can be performed even within limited range of motion, and at the same time the shoulder and elbow are correctly positioned. 2 – Complete pronation and supination with correct position at elbow and shoulder.	6		

Area	Test	Scoring Criteria	Maximum Possible Score	Attained Score	
				Pre	Post
UPPER EXTREMITY	**V. Movement Out of Synergy** a. Shoulder abduction to 90° elbow at 0° and forearm pronated b. Shoulder flexion, 90-180° elbow at 0° and forearm in mid position c. Pronation/supination of forearm elbow at 0° and shoulder between 30-90° of flexion	a.0 – Initial elbow flexion occurs or any deviation from pronated forearm occurs. 1 – Motion can be performed partly, or if during motion, elbow is flexed or forearm cannot be kept in pronation. 2 - Faultless motion. b. 0 – Initial flexion of elbow or shoulder abduction occurs. 1 – Elbow flexion or shoulder abduction, occurs during shoulder flexion. 2 - Faultless motion. c.0 – Supination and pronation cannot be performed at all or elbow and shoulder positions cannot be attained. 1 – Elbow and shoulder properly positioned and pronation and supination performed in a limited range. 2 - Faultless motion.	6		
	VI. Normal Reflex Activity Biceps and/or finger flexor and triceps	0 – At least 2 of the 3 phasic reflexes are markedly hyperactive. 1 – One reflex markedly hyperactive or at least 2 reflexes are lively. 2 – No more than one reflex is lively and none are hyperactive.	2		

Area	Test	Scoring Criteria	Maximum Score	Attained Score	
				Pre	Post
UPPER EXTREMITY	**VII.** a. Stability, elbow at 90°, shoulder at 0° b. Flexion/extension, elbow at 90°, shoulder at 0° c. Stability, elbow at 0°, shoulder at 30° d. Flexion/extension, elbow at 90°, shoulder at 30° e. Circumduction	a. 0 – Patient cannot dorsiflex wrist to require 15°. 1 – Dorsiflexion is accomplished, but no resistance is taken. 2 – Position can be maintained with some (slight) resistance. b. 0 – Volitional movements does not occur. 1 – Patient cannot actively move the wrist joint throughout the total ROM. 2 – Faultless, smooth movement.	10		
HAND	VIII. a. Finger Mass Flexion b. Finger Mass Extension c. Grasp #1 MP joint extended and PIPS & DIPS are flexed. Grasp istested against resistance. d. Grasp #2 Patient is instructed to adduct thumb, 1st carpometacarpophalangeal &interphalangeal joint at 0°. e. Grasp #3 Patient opposes the thumb pad against the pad of index finger. A pencil is interposed f. Grasp #4 The patient should grasp a cylinder shaped object (small can), the volar surface of the 1st and 2nd finger against each other. g. Grasp #5 A spherical grasp.	a. 0 – No flexion occurs. 1 – Some flexion, but not full motion. 2 – Complete active flexion (compared with unaffected hand). b. 0 – No extension occurs. 1 – Patient can release active mass flexion grasp. 2 – Full active extension. c.0 – Required position cannot be acquired. 1 – Grasp is weak. 2 – Grasp can be maintained against relatively great resistance. d.0 – Function cannot be performed. 1 – Scrap of paper interposed between thumb and index finger can be kept in place, but not against a slight tug. 2 – Paper is held firmly against a tug. e. Scoring procedure are same as for Grasp #2. f. Scoring procedure are same as for Grasp #2 and #3. g. Scoring procedure are same as for Grasp #2, 3, and #4.	14		

Area	Test	Scoring Criteria	Maximum Score	Attained Score	
				Pre	Post
HAND	IX. Coordination/Speed – Finger – to-nose (five repetitions in rapid succession). a. Tremor b. Dysmetria c. Speed	a. 0 – Marked tremor. 1 – Slight tremor. 2 – No tremor. b. 0 – Pronounced or unsystematic dysmetria. 1 – Slight or systematic dysmetria. 2 – No dysmetria. c.0 – Activity is more than 6 seconds longer than unaffected hand. 1 – 2 to 5 seconds longer than unaffected hand. 2 – Less than 2 seconds difference.	6		
	TOTAL MAXIMUM UPPER EXTREMITY SCORE		66		

APPENDIX – III

STREAM SCALE – UPPER LIMB COMPONENT

STROKE REHABILITATION ASSESSMENT OF MOVEMENT (STREAM)

STROKE REHABILITATION ASSESSMENT OF MOVEMENT (STREAM)

Assessment Date: ______________________________

Patient Name: ______________________________

Date of CVA: ______________________________ Sex: M F Age: ______

Comorbid Conditions: ______________________________

Type of aid(s) used: ______________________________

Physiotherapist: ______________________________

General Commands: ______________________________

STREAM SCORING

VOLUNTARY MOVEMENT OF LIMBS

0 – unable to perform the test movement through any appreciable range (includes flicker or slight movement)
1 a - able to perform only part of movement and with marked deviation from normal pattern
b – able to perform only part of movement but in a manner that is comparable to the unaffected side
c – able to complete the movement but only with marked deviation from normal pattern
2 - able to complete the movement in a manner that is comparable to the unaffected side

SCORE

2	1c	1b	1a	0	SUPINE
					PROTRACTS SCAPULA IN SUPINE “Lift your shoulder blade so that your hand moves towards ceiling” Note: therapist stabilizes arm with shoulder 90° flexed and elbow extended.
					EXTENDS ELBOW IN SUPINE (starting with elbow fully flexed) “Lift your hand towards ceiling, straightening your elbow as much as you can” Note: therapist stabilizes arm with shoulder 90° flexed; strong associated shoulder extension and or abduction – marked elevation (score 1a or 1c)
					SITTING (feet supported; hands resting on a pillow on lap) SHRUGS SHOULDERS (SCAPULAR ELEVATION) “Shrug your shoulders as high as you can” Note: Both shoulders are shrugged simultaneously.
					RAISE HAND TO TOUCH TOP OF HEAD “Raise your hand to touch the top of your head”
					PLACES HAND ON SACRUM “Reach behind your back and as far across toward the other side as you can”
					RAISES ARM OVERHEAD TO FULLEST ELEVATION “Reach your hand as high as you can towards the ceiling”
					SUPINATES AND PRONATES FOREARM (Elbow flexed at 90°) “Keeping your elbow bent and close to your side, turn your forearm over so that your plan faces up, then turn your forearm over so that your palm faces down” Note: movement in one direction only – partial movement (score 1a or 1b)
					CLOSES HAND FROM FULLY OPENED POSITION “make a fist, keeping your thumb on the outside” Note: must extend wrist slightly (ie, wrist cocked) to obtain full marks; full fist with lack of wrist extension – partial movement (score 1a or 1b)
					OPENS HAND FROM FULLY CLOSED POSITION “Now open your hand all the way”
					OPPOSES THUMB TO INDEX FINGER (tip to tip) “make a circle with your thumb and index finger”

APPENDIX – IV

ASSESSMENT FORM

Name:

Age: Sex:

Occupation:

Date of admission:

Date of assessment:

IP/OP Number:

Address:

Selection criteria

Voluntary motor control grade:

Fugl – meyer scale score :

Outcome measures

SCALES	PRE TEST	POST TEST
FUGL-MEYER ASSESSMENT SCORE		
STREAM ASSESSMENT SCORE		

APPENDIX – V

CONSENT TO PARTICIPATE IN A RESEARCH STUDY

I voluntarily consent to participate in the research study named **"EFFECT OF VISUAL FEEDBACK ASSISTED ARM CYCLING TRAINING IN IMPROVING THE UPPER EXTREMITY FUNCTION AMONG THE INDIVIDUALS WITH ACUTE STROKE" – AN EXPERIMENTAL STUDY**

The researcher has explained to me the exercise approach in brief, risk of the participation and has answered the questions related to the research to my satisfaction.

Participant Signature:

Signature of Witness:

Signature of Researcher: