



Original Research Article

Effect of Repetitive Unilateral and Bilateral Arm Training Using Students Designed Manual Reach Equipment (MRE) in Improving Motor Function of the Hemiplegic Subjects

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ABSTRACT

Background and purpose: Stroke has found to assume the position of primary importance because of its high morbidity and mortality rate. Recent trends in rehabilitation seem to contradict the traditional practice of training either the affected or unaffected side, the focuses are nowadays on bilateral training approach on training motor function in the upper limb.

Objective: To determine the efficacy of bilateral repetitive arm training with manual reach equipment in improving upper extremity function in patients with stroke.

Study design: Randomised, single blind study

Outcome measure: a) Fugl -meyer upper extremity motor performance scale b) Wolf motor function test.

Subjects: A total of 30 patients with middle cerebral artery involved stroke subjects participated in the study; they were randomly allocated into 2 groups, 15 in each group.

Intervention: Repetitive bilateral arm training for group A and Repetitive unilateral arm training for group B using manual reach equipments for 6 weeks.

Methods: We determined the effects of 6 weeks of training using MRE, assessments were performed by a blinded investigator before and after 6 weeks training using Fugl -meyer upper extremity motor performance scale & Wolf motor function test. The treatment consist of daily sessions of 30 mins for 4 days/week for 6weeks of repetitive to and fro movement in MRE for both group A i.e. bilateral training and group B unilateral training.

Results: Paired and Unpaired t-test was used to analyze the data, the level of $p < 0.05$ was considered significant. The statistical analysis showed that the mean total of Fugl meyer scale

and wolf motor function test of both the groups showed difference between pre score and post scores within i.e. group A:(FMA pre 14.93, post 20.06, WMFT pre 49.93 sec, post 35.86 sec), group B: :(FMA pre 15.06, post 16.46, WMFT pre 52 sec, post 48.80 sec) and among each other (FMA 20.06, 16.46, WMFT 35.86 sec, 44.80 sec). there is a significant difference between bilateral arm training and uni lateral arm training groups ($p < 0.01$) with Fugl meyer scale scores and even more significant (performance time measure, $p < 0.001$) with scores of wolf motor function.

Conclusion: Six weeks of training with MRE improved functional motor performance in stroke in both unilateral and bilateral arm training groups, but substantial improvement is observed in bilateral repetitive arm training stroke subjects.

Key words: Cerebral stroke, Sensori motor function, Fugl -meyer upper extremity motor performance scale, Wolf motor function test.

INTRODUCTION

Stroke is not only one of the leading causes of death but also identified by WHO as a major cause of disability affecting a large proportion of people globally. Although with advancement of health care system, early diagnosis and intervention in the last decade the incidence of mortality rate due to stroke has began to drop considerably, we should not forget that it is also leaving an increasing number of patient requiring rehabilitation. [1] Approximately two third of stroke survivors suffer from neurological deficits that results in persistent impairment of motor and sensory functions. Especially the recovery of upper extremity sensory and motor function as for a long time had been a challenging task in stroke rehabilitation, statistical evidences suggest that only a proportion of 3 % of adult stroke subject regain more than 70 % of their hand functions. [2] Therefore it is important that close to complete recovery must be attempted in upper extremities because higher percentage disability in this zone can seriously dent the quality of life thus reducing functional independence. In the past conventional and traditional methods of neurological rehabilitation have offered us many strategies towards stroke management, restoration of upper extremity motor functions have always been a challenge. Recovering after a stroke may feel like a

daunting task. Among other things, your brain must relearn skills it lost when it was damaged by the stroke. Recent researches though show that the brain is amazingly resilient and capable of adapting after a stroke. This means that recovery is more possible than previously thought. [3] Recovering use of your arm does bring special challenges, though different than those experienced with the legs.

Hence, alternative strategies are needed to reduce the long term disability and functional impairment in upper extremity of stroke patients because reducing the degree of permanent disability remains the primary goal of post stroke neuro-rehabilitation program and invention of new approaches/tools for impairment reduction through managing motor experience may contribute further to altering disability. Many studies have previously proved that there is an increasing degree of preference shown by neurological patients in rehabilitation centre towards usage of task oriented equipment in training program. [3, 11] In the present study our students have designed wooden and steel based reach equipment with a repetitive arm training protocol, specifically designed to suit stroke subjects. we hypothesized that use of non paretic arm along with paretic arm using manual reach equipment(MRE) could

produce more improvement in motor function in adult stroke subjects in comparison with training with affected arm alone.

MATERIAL AND METHODS

Patients

The patients discharged with diagnosis of middle cerebral artery stroke from various hospitals in Chennai were approached and considered for inclusion; details of their medical history were obtained from medical records. Inclusion criteria included age 40-65 years, at least 4 months post stroke, arm paresis, both side right and left side middle cerebral artery stroke, intact sensory function. Exclusion criteria included communication difficulties, history of other neurological disorders. In a total of 43 subjects with the criteria's only subjects responded favourably to our invitation. They were randomly allocated into group A (bilateral training) and group B (unilateral training) with 15 subjects each. Written informed consent is obtained from for each subjects and the study was carried out in accordance with approval of local institutional ethical committee.

Measurements

Assessment included the initial base line to decide inclusion. The Fugl-Meyer

Upper Extremity Motor Performance test [4] was selected because it assesses impairments in sensorimotor function. This test has been shown to be valid and reliable and it correlates well with inter joint upper extremity and Wolf motor function tests [5] was selected because it reliably evaluates functional ability in a variety of activities and is sensitive than other tools, the timed items assess speed of performance. All patients were measured 3 times over an initial baseline period prior to training of 6 weeks and after 6 weeks training programme. The patients were also requested to report on changes in quality of activities of daily life after the training. Both pre and post assessment of subjects were done by an investigator who was not informed about patients treatment and group.

Manual reach equipment (MRE):

The equipment is a portable, table top device constructed with wood and steel. it consist of two tracks of steel rods on with a wooden handle which moves to and fro i.e. forwards and backwards with least friction. Adjuncts like handle straps and trunk constrain belt can be used in subjects with poor grasp. If proven effective the equipment will be a great training tool in stroke clinics and can be used as home therapy device.



Fig- 1. Bilateral arm training with Manual reach equipment



Fig- 2. Unilateral arm training with Manual reach equipment

Training procedure

Training of the subjects of both group consisted of 30 minutes of active training period in a complete session of 45 minutes a day of bilateral (group A) and unilateral (group B) repetitive arm movements using MRE equipment for 4 times a week for 6 weeks [6] as shown in fig. 1 and 2. Participants were seated with the trunk stabilized with a strap to prevent trunk flexion substitution during arm movement

and they were to hold 1 or 2 separate bar handles that moves in transverse plane. In subjects with poor grasping, the hand were strapped and the subjects pushed the handles i.e. bilateral in group A and unilateral affected arm in group B away from them and then pulled it back. Frequency remained constant for the whole 6 weeks and at the end of the training all base line tests were repeated to obtain the post scores.

STATISTICAL ANALYSIS AND RESULT

The data derived from the experiment is subjected to analyses using SPSS software. For comparison of the variables, we implied paired and unpaired t-test. The significance level was chosen at $p < 0.05$. Table 1 clearly exhibits that both group A and group B shows some sort of improvement in their mean value i.e. group A (pre test-FMA: 14.93, WMFT: 49.93 sec.

post test-FMA: 20.06, WMFT: 35.86), group B (pre test-FMA: 15.06, WMFT: 52 sec. post test-FMA: 16.46, WMFT: 44.80). The unpaired t-test was used to test the post test scores between the groups. The FMA scores between groups showed significant improvement ($p < 0.01$), WMFT scores for timed performance proves to be much more significant ($p < 0.001$).

Table: 1 Paired t-test analysis of Pre & Post-test scores of Fugl Meyer Assessment scale (FMA) and Wolf Motor Function Test (WMFT) for Group A and Group B

Parameter	Dependant Variables	Pre test		Post test		't' test	P value
		Mean	S.D	Mean	S.D		
Group A Bilateral training	FMA	14.93	2.49	20.06	3.80	13.64	< 0.001***
	WMFT	49.93	3.32	35.86	3.24	91.77	< 0.001***
Group B Unilateral training	FMA	15.06	2.76	16.46	2.99	8.57	< 0.001***
	WMFT	52	2.36	44.80	2.90	13.42	<0.001***

*** Indicates significance $P < 0.05$

Table: 2 Unpaired t-test analysis of Post test scores of Fugl Meyer assessment scale (FMA) and Wolf Motor Function Test (WMFT) between Group A and Group B

Dependant Variables	Group A		Group B		't' test	P value
	Mean	S.D	Mean	S.D		
FMA	20.06	3.80	16.46	2.99	2.87	< 0.01**
WMFT	35.86	3.24	44.80	2.90	7.93	< 0.001***

Fig 3: Fugl Meyer Assessment scale (FMA)

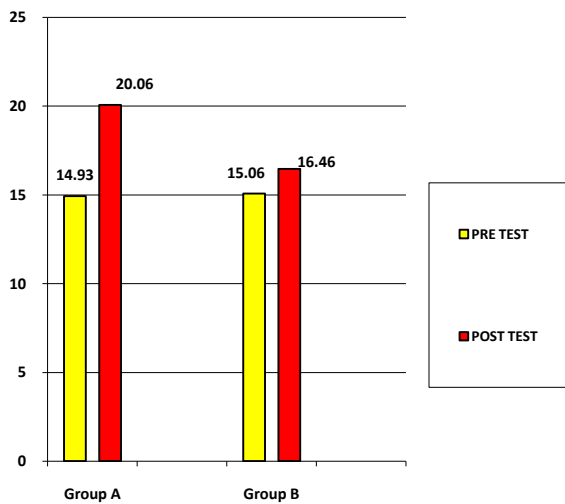
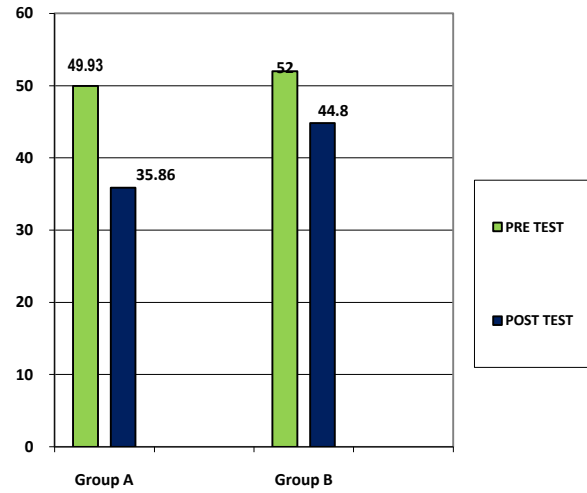


Fig 4: Wolf Motor Function Test (WMFT)



DISCUSSION

In this experimental study 6 weeks of upper extremity bilateral repetitive training with the manual reach equipment can improve several key measures of Sensori-motor function of upper extremities and improves coordination in the affected side of stroke subjects. Practicing bilateral movements in synchrony and in alternation may result in a facilitation effect from the non paretic arm to therapeutic arm. [7] Bimanual movements are initiated simultaneously, the arms act as a unit that supersedes individual arm action, indicating that both arms are strongly linked as a coordinated unit in the brain. [8] In addition, it is well known that even if one arm or hand is activated with moderate force, this can produce motor overflow in the other such that both arms are engaged in the same or opposite muscle contractions although at different levels of force, Furthermore, studies have shown that learning a novel motor skill with one arm will result in a subsequent bilateral transfer skill to the other arm. Taken together, these experiments suggest a

strong neurophysiologic linkage in the central nervous system that explains how bilateral (simultaneous and perhaps alternating) movements may benefit motor learning and an another advantage of this sort of training program is it's a "time on task" which is an important motor learning principle, goal setting is also known to promote motor learning. According to Rice and Newell reported that in bilateral arm training the non paretic arm was limited by the paretic arms ability to move, suggesting that the non-paretic hand is strongly coupled to the paretic hand. Therefore, inconsistencies of the non paretic hand seen may be due to coupling effect. During isolated voluntary movement of paretic arm, the contralesional motor cortex imposes an abnormally high inhibitory drive onto the ipsilesional cortex, which may contribute to motor impairment. [9] The Fugl-Meyer test assesses the ability to isolate movements at each joint and the influence of unwanted synergies on movement and the WMAT measures functional ability. The Wolf time is the mean time required to perform 14 functional tasks with the paretic

arm and hand. Maximum Wolf time is 120 seconds; moderate and severe impairment results in times above 80 and 120 seconds, respectively (S.M.-W., S. Harding, J.W., 2004). The possible concerns or limitations of the study could be having studied only middle cerebral artery lesion stroke subjects, limited training sessions and non individualized rehabilitation protocols. Based on the analysis of data, this study suggests that there appears to be enhanced arm motor function with unilateral and bilateral practice with synchronous and alternative protocol, but the improvement is significantly high when comparing group A and group B which supports the findings of Taub et al and Classen et al. ^[10]

CLINICAL IMPLICATIONS

Bimanual coordination does not arise from unimanual trainings; instead they must be trained as specific synergies and not as sum of two single limbs. MRE proves to restore and exploit bimanual coupling and symmetry breaking phenomena. Usage of different type of task oriented equipment had shown to draw extensive amount of interest and participation of stroke subjects which could prove very beneficial in neuro rehabilitation

CONCLUSION

This study suggests that six weeks of training with manual reach equipment in stroke subjects had benefits like subjects showing high preference to tool based training. Bilateral repetitive arm training with MRE produced sustainable and durable enhancement of motor function of upper extremities in stroke subjects. Thus there exists a significant difference between two groups in their measure of motor function of upper extremities. So if optimally conducted bilateral trainings could prove be an efficient

approach towards significantly reducing impairments and accelerate recovery of upper limb function in stroke.

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