Effect of Manual Therapy with Task Oriented Training on Hand Function in Stroke Patients: A Randomized Controlled Study

Mona Adel Abd Eltwab[1], Abeer Abo Bakr Elwishy[2], Hanan Helmy Mohamed[3].

[1, 2] Department of Neuromuscular Disorder and Its Surgeries, Faculty of Physical Therapy, Cairo University.

[3] Department of Neurology, Faculty of Medicine, Cairo University.

Abstract

Background

Proper hand function is a must for everyday life activities. However, post stroke, muscle contracture and joint stiffness develop as a common consequence of immobility in hemiplegic hand.This study aimed to investigate the effect of adding mobilization to task oriented training to help stroke patients in reaching a satisfactory level of recovery for their hand function.

Methods

Thirty stroke patients were participated in this study and randomly divided into two equal groups; group A, which received mobilization followed by task oriented training and group B, which received task oriented training only. Both groups received treatment three times per week for a period of six weeks. All patients were evaluated before and after therapy for hand function, active and passive wrist extension range of motion, and grip strength.

Results

The results of this study showed that post treatment; there was a statistically significant difference ($P<0.05$) between both groups regarding all outcome measures in favor to the study group (A).

Conclusion

The present study revealed that mobilization is effective intervention in improving hand function post stroke and the combination between mobilization and task oriented training is more effective in improving hand function post stroke than task oriented training alone.

Keywords: Hand function, Mobilization, Stroke, Task oriented training.

Introduction

Stroke is classically characterized as a neurological deficit attributed to an acute focal injury of the central nervous system (CNS) by a vascular cause, including cerebral infarction, intracerebral hemorrhage (ICH), and subarachnoid hemorrhage (SAH) **(1).** Hemiparesis is the most common motor impairment after a stroke and frequently leads to persistent hand dysfunction **(2).**

The hand is a complex system and its usage is even more complex. It can be used in a vast variety of tasks. Such as grasping, pushing, holding objects and expressing emotions **(3).** As a result, hand motor dysfunction contributes considerably to disability and adecreased quality of life **(4).**

The severity of hand impairment in stroke survivors can range widely, from a flaccid paralysis to trouble with finger individuation. A typical presentation has the wrist and fingers flexed with weakness of extension. The deficits arise from a variety of sources, including somatosensory loss, flexor hypertonicity, reduced muscle activation, and loss of individuation. The resulting loss of motor control can have a profound impact on self-care, employment, and leisure activities. Hand impairment can even impact mobility in individuals with combined lower and upper extremity deficits by reducing the ability to use mobility aids **(5).**

Carr and Shepherd suggested task-oriented training as a treatment method to help improve deteriorated motor skills of stroke patients and their capacity to perform daily activities, and diverse functional activities **(6).** In recent years, task-oriented therapy has been widely used for the rehabilitation of patients in the acute or chronic stage after stroke **(7-10).** It has a significant effect in improving hand functions and activities of daily living in stroke patients **(11).** There also is a growing interest in the phenomenon of neuroplasticityfollowing central nervous system injury and its critical link to task-oriented training **(12).**

Joint mobilizations are used as an intervention for improving range of motion (ROM), decreasing pain and ultimately improving function in patients with a wide variety of upper extremity diagnoses **(13).** The joint mobilization technique proposed by Maitland is based on a graded system **(14).** Grades I and II of Maitland mobilization techniques are primarily used to decrease joint pain, Whereas Grades III and IV are primarily used as stretching manoeuvres that increase joint ROM. Appropriate selection of mobilization technique for treatment can only take place after a thorough assessment and examination **(15).**

After stroke Joint contractures and reduced range of motion at joints can result from a number of factors including reduced muscle length, and increased stiffness of muscle and connective tissue. This loss of range may be reduced by moving the joints through a full range of motion with pressure at the end of range; such motion can be delivered by manual therapy **(16).**

A study conducted to determine the effects of wrist mobilization in the rehabilitation of the chronic hemiplegichand after stroke found that mobilization has a significant effect in improving wrist ROM, hand function, grip strength and spasticity **(17).** Another study found that combining mobilization with taping have a significant effect in improving the range of motion, grip strength, and spasticity in stroke patients, whereas no significant difference was found with just taping **(18).** So, this study aimed to investigate the effect of adding mobilization to task oriented training on hand function in chronic stroke patients.

Material and methods:

Study design

This study was designed as a randomized controlled study.

Participants

Thirty patients (13 females and 17males) diagnosed with stroke confirmed clinically and radiologicaly were included in this study. Patients were selected from the Outpatient Clinic of The Faculty of Physical Therapy, Cairo University; the Outpatient Clinic of Kasr Al Aini, Teaching Hospital, Cairo University and from The Physical Therapy Department at El Mataria Teaching Hospital. Patients were assigned randomly into two equal groups, the study group (A) who received mobilization followed by task oriented training for 6 weeks and the control group (B) who received task oriented training for 6 weeks.

Patients were included if they had the following criteria: More than six months should have passed after clinical diagnosis of ischemic or hemorrhagic hemiparetic stroke and confirmed by magnetic resonance imaging or computed axial tomography scan. Patient's age ranging from 45-60 years, and spasticity grade 1 and +1. Patients were excluded if they had the onset of the stroke less than six months old, dysfunction caused by other pathologic disorders unrelated to stroke (eg, musculoskeletal disorders), treatment for spasticity for up to six months with botulinum toxin or baclofen injections, and concurrent participation in other hand training.

The study was carried out in the Faculty of Physical Therapy, Cairo University Outpatient Clinic and the Physical Therapy Department at El Mataria Teaching Hospital; during period from March 2017 to December 2018. Patients in both groups (A&B) signed Informed consent form before starting the study. This study was approved by Ethical committee of faculty of Physical Therapy, Cairo University (No: P.T.REC/012/001491).

Measurement procedures:

Initially Patient gender, age, weight, height, time after stroke, grade of spasticity and hemiplegic side were recorded before starting the study then the following evaluations were done in the two groups.

- Hand function:

The Jebsen Taylor Hand Function test (JTT) was used to evaluate hand function.It is avalid, reliable and easily performed test. It was used to assess gross and fine motor functional hand ability and consists of seven subtests, which reflect activities of daily living **(19).** We included in this study six of the seven JTT subtests: turning over cards, picking up small objects and placing them in a can, picking up small objects with a teaspoon and placing them in a can, stacking checkers, moving large light cans, and moving heavy cans. Since some patients were unable to perform writing tasks (the seventh JTT subtest) with their paretic hand, we excluded this particular subtest from the study. The time to complete each subtest was measured with a stopwatch and recorded for analysis.

- Range of motion:

ROM for active wrist extension and passive wrist extension was measured by using a standard goniometer.The reliability of a goniometer is shown with an intraclass correlation coefficient (ICC) of 0.95 by Khamwong and colleagues **(20).** The patient was positioned sitting in a chair. The forearm was positioned on the table or on the arm support of the chair with the elbow in 90 degree flexion and in full pronation with the hand over the edge of the table or arm support. The center of the goniometer was placed at the center of axis of the wrist joint (triquetrum bone), with one arm of the goniometer placed parallel to the lateral midline of the

ulna, and a moveable arm of the goniometer placed to the lateral midline of the fifth metacarpal bone.

- Grip strength:

A JAMAR Adjustable Hand Dynamometer (serial number: 30402340) was used to measure the paretic hand grip strength **(21).** The patient was asked to squeeze as hard as he or she can and after three seconds of continuous compression the subject was asked to relax. The highest force exerted was automatically recorded by the peak hold needle. The scores of three successive trials were recorded and the mean of them was calculated and reported.

TreatmentProcedures:

The treatment program was given to the 2 groups (A&B) three sessions per week for successive six weeks. The study group (A) received 20 minutes of joints mobilization followed by 40 minutes of task oriented training, while the control group (B) received only 40 minutes of task oriented training.

Mobilization grade III and IV was done for the study group (A) as described originally by Maitland and updated by Hengeveld and Banks **(22);** and consisted of: supination, wrist extension, wrist radial deviation, radiocarpal extension, radiocarpal supination, metacarpophalangeal extension, and first carpometacarpal joint extension.

Task oriented training rehabilitation program was done following the guide lines of Carr and Shepherd **(23).**The therapist used the principles of task-oriented approach to grade the functional tasks into tasks with various difficulty levels and promoted learning by progressively increasing the complexity of a functional task over time according to each patient's ability. The therapist also encouraged the patient to use the affected upper limb to execute tasks and provided feedback to facilitate successful performance.

Statistical analysis:

Descriptive statistics and t-test was conducted for comparison of the subject characteristics between both groups. Chi squared test were conducted for comparison of affected hand, sex and spasticity grades distribution between both groups. Mixed MANOVA was conducted to compare the effect of time (pre versus post) and the effect of treatment (between groups), as well as the interaction between time and treatment on mean values of JTT, active and passive wrist extension and grip strength. The level of significance for all statistical tests was set at $p < 0.05$. Statistical analysis was performed through the statistical package for social studies (SPSS) version 22 for windows.

Results

Table 1 showed that comparing the general characteristics of the subjects of both groups revealed that there was no significance difference between both groups in mean ± SD age, weight, height and duration of illness ($p > 0.05$).Table 2 showed that There was also no significant difference between both groups in sex distribution ($p = 0.71$), the distribution of the affected hand ($p = 0.43$), and the distribution of spasticity grades ($p = 0.45$).

Table 1. Descriptive statistics and t-test for comparing the mean age, weight, height and duration of illness of the study and control groups.

	Study group	Control group	MD	t- value	p-value	Sign
	$\overline{X}$ ±SD	$\overline{X}$ ±SD				
Age (years)	55.53 ± 4.73	54.66 ± 5.19	0.87	0.47	0.63	**NS**
Weight (kg)	86.13 ± 5.64	84.86 ± 9.84	1.27	0.43	0.66	**NS**
Height (cm)	173.2 ± 8.1	171.4 ± 8.65	1.8	0.58	0.56	**NS**
Duration of illness (month)	27 ± 6.52	28.06 ± 7.5	-1.06	-0.41	0.68	**NS**

$\overline{X}$: mean **SD: Standard deviation** **MD: mean difference**
t value: Unpaired t value **p value: Probability value** **NS: Non significant**

Table 2. The frequency distribution and chi squared test for comparison of sex distribution, the affected hand and grade of spasticity distribution between study and control groups.

	Study group	Control group	χ^2 value	p-value	Sig
Females	6 (40%)	7 (47%)	0.13	0.71	**NS**
Males	9 (60%)	8 (53%)			
Right hand	4 (27%)	6 (40%)	0.6	0.43	**NS**
Left hand	11 (73%)	9 (60%)			
Grade I	8 (53%)	10 (67%)	0.55	0.45	**NS**
Grade I+	7 (47%)	5 (33%)			

χ^2 : Chi squared value p value: Probability value NS: Non significant

Jebsen Taylot Hand Function Test (JTT):

Table 3 demonstrated the mean ± SD total JTT time pre and post treatment of the study and control groups. In group A, There was a significant decrease in total JTT time in the study group post treatment compared with that pre treatment (p = 0.0001).The mean difference was 50.09 sec and the percent of change was 45.43%. In group B, There was a significant decrease in total JTT time in the control group post treatment compared with that pre treatment (p = 0.0001). The mean difference was 20.27 sec and the percent of change was 20.1%.Comparison between both groups (A&B), showed that there was a significant decrease in the mean values of the total JTT time of the study group post treatment compared with that of control group (p = 0.0001).

Active wrist extension ROM:

Table 4 demonstrated the mean ± SD active extension ROM pre and post treatment of the study and control groups. In group A, There was a significant increase in active extension ROM in the study group post treatment compared with that pre treatment (p = 0.0001). The mean difference was -20.54 degrees and the percent of change was 59.07%. In group B, There was a

significant increase in active extension ROM in the control group post treatment compared with that pre treatment (p = 0.004). The mean difference was -8.04 degrees and the percent of change was 23.69%. Comparison between both groups (A&B), showed that there was a significant increase in the mean values of the active extension ROM of the study group post treatment compared with that of control group (p = 0.0001).

Passive wrist extension ROM:

Table 5 demonstrated the mean ± SD passive extension ROM pre and post treatment of the study and control groups. In group A, There was a significant increase in passive extension ROM in the study group post treatment compared with that pre treatment (p = 0.0001). The mean difference was -22.44 degrees and the percent of change was 38.09%. In group B, There was a significant increase in passive extension ROM in the control group post treatment compared with that pre treatment (p = 0.004). The mean difference was -5.53 degrees and the percent of change was 9.76%. Comparison between both groups (A&B), showed that there was a significant increase in the mean values of the passive extension ROM of the study group post treatment compared with that of control group (p = 0.0001).

Hand grip strength:

Table 6 demonstrated the mean ± SD hand grip strength pre and treatment of the study and control groups. In group A, There was a significant increase in hand grip strength in the study group post treatment compared with that pre treatment (p = 0.0001). The mean difference was -9.09 kg and the percent of change was 75.24%. In group B, There was a significant increase in hand grip strength in the control group post treatment compared with that pre treatment (p = 0.001). The mean difference was -3.13 kg and the percent of change was 26.93%. Comparison between both groups (A&B), showed that there was a significant increase in the mean values of

the hand grip strength of the study group post treatment compared with that of control group (p = 0.001).

Table 3. Mean total JTT time pre and post treatment of the study and control groups.

Total JTT time (sec)	Pre	Post	MD	% of change	P-value	Sig
	$\overline{X}$ ±SD	$\overline{X}$ ±SD				
Study group	110.24 ± 16.41	60.15 ± 8.7	50.09	45.43	0.0001	S
Control group	100.8± 22.27	80.53 ± 10.54	20.27	20.1	0.0001	**S**
MD	9.44	-20.38				
P-value	0.19	0.0001				
Sig	**NS**	**S**				

$\overline{X}$: Mean **SD: Standard deviation** **MD: Mean difference**
p value: Probability value **S: Significant** **NS: Non significant**

Table 4. Mean active extension ROM pre and post treatment of the study and control groups.

Active extension ROM (degrees)	Pre	Post	MD	% of change	P-value	Sig
	$\overline{X}$ ±SD	$\overline{X}$ ±SD				
Study group	34.77 ± 10	55.31 ± 4.28	-20.54	59.07	0.0001	S
Control group	33.93± 7.17	41.97 ± 9.8	-8.04	23.69	0.004	**S**
MD	0.84	13.34				
P-value	0.79	0.0001				
Sig	**NS**	**S**				

$\overline{X}$: Mean **SD: Standard deviation** **MD: Mean difference**
p value: Probability value **S: Significant** **NS: Non significant**

Table 5. Mean passive extension ROM pre and post treatment of the study and control groups.

Passive extension ROM (degrees)	Pre	Post	MD	% of change	P-value	Sig
	$\overline{X}$ ±SD	$\overline{X}$ ±SD				
Study group	58.91 ± 9.64	81.35 ± 5.29	-22.44	38.09	0.0001	S

Control group	56.64± 7.31	62.17 ± 4.28	-5.53	9.76	0.004	**S**
MD	2.27	19.18				
P-value	0.47	0.0001				
Sig	**NS**	**S**				

$\overline{X}$ **: Mean** **SD: Standard deviation** **MD: Mean difference**
p value: Probability value **S: Significant** **NS: Non significant**

Table 6. Mean hand grip strength pre and post treatment of the study and control groups.

Hand grip strength (kg)	**Pre**	**Post**	**MD**	**% of change**	**P-value**	**Sig**
	$\overline{X}$ **±SD**	$\overline{X}$ **±SD**				
Study group	12.08 ± 5.32	21.17± 5.87	-9.09	75.24	0.0001	**S**
Control group	11.62± 2.33	14.75 ± 2.63	-3.13	26.93	0.001	**S**
MD	0.46	6.42				
P-value	0.75	0.001				
Sig	**NS**	**S**				

$\overline{X}$ **: Mean** **SD: Standard deviation** **MD: Mean difference**
p value: Probability value **S: Significant** **NS: Non significant**

Discussion

This study was conducted to investigate the effect of adding mobilization to task-oriented training on hand function in chronic stroke patients.

The results of this study showed that post treatment; there was a significant improvement in The Jebsen-Taylor Hand Function Test, active and passive wrist extension range of motion and hand grip strength in both groups, However there was a significant difference between both groups regarding these improvements in favor to the study group (A).

Our results come in agreement with **Smedes et al., (17)** who investigated the effects of manual mobilization of the wrist in the rehabilitation of the chronic hemiplegic hand after stroke. The primary outcome measures were range of motion expressed in active and passive wrist extension and activity limitation that was measured with the Frenchay Arm Test. The secondary

outcome measures were spasticity, grip strength, and pain. The results showed that Manual mobilization of the wrist has a significant beneficial influence on the recovery of the mobility of the wrist, activity limitation, and the grip strength in patients with a chronic hemiplegic hand post-stroke.

The results also agree with **An and Jo, (24)** who examined the effects of talocrural mobilization on ankle strength, dorsiflexion passive ROM, and weight-bearing ability on the paretic limb during standing or gait in chronic stroke patients with limited ankle mobility. They found a significant improvement in plantarflexor strength, dorsiflexion passive ROM, and forward–paretic direction limit of stability for the study group following intervention compared to the control group. In addition, the single limb support phase and the double limb support phase, respectively, were significantly increased and decreased within the study group during gait.

The results also come in agreement with **Jang and Bang, (25)** who investigated the effect of Thoracic and cervical mobilization in increasing trunk mobility and improving respiratory function in stroke patients. Both groups were simultaneously given physiotherapy treatments consisting of 30 min of exercise, 15 min of rehabilitation ergometer training, and 15 min of functional electrical stimulation. Additionally, members of the experimental group had 30 min of thoracic and cervical joint mobilization. The control group showed no significant changes in all outcome measures, while the experimental group showed a statistically significant improvement in thoracic movement, resulting in a significant improvement in pulmonary and cough function.

The results in our study can be explained by, the positive relationship that was demonstrated between the improvement in range of motion and the improvement in hand function in chronic stroke patients **(17).** It was reported that post stroke patients experience

stiffness, which represents a major challenge to perform tasks and makes attempts at using the affected arm extremely difficult **(2).**

Joint mobilization techniques have specialty increasing ROM **(26).** Maitland mobilization improves ROM by producing mechanical effects that involve a permanent or temporary change in the length of connective tissue structures such as joint capsule ligaments and muscle **(27).** Applying joint mobilization techniques to limited motion joint in stroke patients were found to be effective in improving ROM **(28, 29).** Thus, the increase in available motion could result in improved efficiency of movement and decrease time to perform the task **(29-31).**

It is also possible that the improvement in joint flexibility would allow the muscles to increase their action **(32).** In addition, Mobilization appears to be an appropriate and effective therapy intervention that potentially will kick start the process of activating muscle after stroke by providing significant proprioceptive information to the brain, facilitating direct activation of the primary motor cortex and the corticospinal system to increase motor activity **(33).**

The results of our study contradict with **Park and Kim, (34)** who evaluated the immediate effects on balance ability after anterior-to-posterior (A-P) talocrural joint mobilization combined with elastic taping in chronic stroke patients. The experiment group underwent joint mobilization and elastic taping and the control group underwent taping alone. After 30 minutes of intervention balance was measured by using a BioRescue system (AP1153, SyCoMORe, France). The results showed that there was no significant difference between the results of the experimental and control groups in this study. This could be explained by that the intervention period was immediate; this may be insufficient duration to produce significant change. In addition, the study did not investigate whether the BioRescue system was effective in showing an improvement in balance ability.

Conclusion:

From this study it was concluded that the combination between mobilization and task oriented training had highly significant effect in improving hand function post stroke than task oriented training alone.

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