Effect of Core Muscle Training on Upper Limb Function in Hemiparetic Patients: A Randomized Controlled Study

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Abstract:

Background: Upper limb paresisis a common problem in patients with stroke. Although it is known that trunk control is an integral part of shoulder stability, the effect of core muscle training program on upper limb function is not well established till now so our Purpose to determine the effect of core muscle training on upper limb function in hemiparetic patients.**Methods:**30 patients with hemiparesis, with mean age 56.9±7.24years with mean duration of illness2.66±1.34years.They assigned into two equal groups method of allocation was concealed in sequentially numbered, sealed envelopes, the control group GA: 15patients received only conventional physical therapy program (stretching for shoulder muscles, active resisted exercises for shoulder and trunk control exercises),the study group GB: 15patients received conventional physical therapy program and additional core muscle training. Patients received 18 sessions for 6 weeks, three sessions/week.The upper limb function was assessed using Wolf motor function test with subscales (function ability scale, time and grip strength), the range of motion of shoulder flexion and abduction was measured by using goniometer.**Results:** There was no statistical significant difference between two groups in pretreatment assessment using wolf motor function test and shoulder range of motion. In post treatment assessment there was no statistical significant difference between group GA and GB in all the outcome measures.**Conclusion**:Core muscle training is similar to conventional physical therapy program in improving upper limb function in hemiparetic patients.
Key words: Hemiparesis - Upper Limb Function- Core Muscle Training

Introduction:

Stroke is a common nervous system disorder that occurs due to abnormal blood circulation in the brain with a completely developed nervous system. According to the American Stroke Association, about 87% of strokes are ischemic, and the remaining 13% are hemorrhagic **[1].**

Upper limb dysfunction is the most common problem in stroke patient. Their affection due to many causes one of them is due to lack of activation of the trunk that affecting the efficacy of the limb to move freely in relation to the other, as well as to move away from the trunk**[2].**

In stroke patient muscle weakness arise primarily from the lesion of the pyramidal tract and secondary from lack of activity and mobility, after six months the decrease in force production due to reduce in the muscle cross sectional area and decrease in motor units due to**[3].**

Core stability has a high established reliability concerning improving the trunk muscle performance **[4**] as core muscles supporting the lumbo-pelvic-hip complex researchers have reported that core stability training could improve not only trunk function but also balance and mobility **[5].**

Exercise for core-stability serve as treatment for simultaneously activating the abdominal and multifidus muscle in order to stabilize the body and head during the beginning of limb movement and during the course of these movements **[6].**

Core stability exercises have been reported to improve the rehabilitation effect in stroke patients, the mean trunk impairment scale score and muscle activity of the lower trunk increased in the experiment group significantly [**6**].

However, few studies on the relationship between core muscle training and upper limb function in hemiparetic patient have been reported[**7**] Therefore, the purpose of this study was to examine the effect of core muscle training on upper limb function and trunk balance in hemiparetic patients.

As Core stability is defined as the foundation of trunk dynamic control that allows the production, transfer and control of force and motion to the terminal segments like upper extremities **[8].**

KO et al., 2016 **[9]** has shown that core muscle strengthening is a beneficial therapeutic technique for the improvement of trunk balance in patients with acute, subacute or chronic hemiparetic stroke.

The result of the current study may inform the physical therapist about whether the core muscle training will improve the upper limb function and trunk balance in patients with hemiparesis and to enable physical therapist to conduct and develop effective program to improve upper limb function in these patients.

Statement of the Problem:

Is there effect of adding core muscle training to the conventional physical therapy on upper limb function in hemiparetic patients?

Purpose of the study:

To determine the effect of adding core muscle training to the conventional treatment program on upper limb function in hemiparetic patients.

Materials and methods:

<u>Design of the study: Randomized controlled trial</u>

Study participants were randomly allocated to either control group (GA) or study group (GB). The randomization was managed by an external person uninvolved in the study. The method of allocation was concealed in sequentially numbered, sealed envelopes. The data were collected from 40 stroke patients. Unfortunately, four patients, two from the control group and two from the study group, withdrew from the study during the first three weeks of the treatment program because of changes in their personal circumstances. Another three patients dropped out shortly from the control group because of a health problem. In addition, the communication was lost with three patients during the 4th week of the treatment. Consequently, complete data records were obtained from thirty patients who successfully completed the training protocol for six successive weeks.

Participants:

Thirty male patients suffered from hemiparesis due to cerebrovascular stroke were selected from the outpatient clinic, Faculty of Physical Therapy, Cairo University. All the patients were matched for age, duration of stroke and degree of motor impairment.

- **Inclusion Criteria:**

1. Male or female patients aged from 45-60years.
2. Patients were given their written consent form to participate in the training.
3. Duration of illness should be between 6months and 3years.
4. Patients with spasticity on the Modified Ashworth Scale MAS between grade (+1and 2)**[10].**
5. The affected upper limb had a moderate motor impairment. The scores of upper limb motor performance ranged from (19-40) according to Fugl-Meyer scale for the section of upper limb and hand**[11].**

- **Exclusion Criteria:**

1. Patients with balance disturbance due to neurological disorders other than stroke (e.g. Parkinson’s disease, inner ear, vestibular or cerebellar dysfunctions).
2. Musculoskeletal disorders such frozen shoulder or degenerative diseases affecting the posture and motor performance as ankylosing spondylitis
3. Patients with communication problems.
4. Patients with a history of previous stroke or other neurologic diseases or disorders.
5. Patients with pain, limited motion, or weakness in the non-paretic lower extremity that affect performance of daily activities.
6. Patients with uncontrolled hypertension or symptomatic cardiac failure or unstable angina.
7. Respiratory disorders or conditions that may influence the posture of the skeletal system of the back (e.g. asthma).

Measurement procedures:

1- The functional ability of the upper limb was assessed by wolf motor function test (WMFT). One valid and commonly used assessment tool of upper extremity functional ability is the Wolf Motor Function Test (WMFT) **[12]**.The WMFT tests a broad range of upper extremity function through two strength measurements and a series of 15 functional tasks that progress from simple movements in proximal joint areas to complex movements in distal joint areas. **Table 1**.

Each of the 15 tasks is timed to completion, up to a maximum of 120 seconds. Functional ability sub-scores represent the quality of the movement during the performance of these functional tasks. **figure 1**, **figure 2**

Table 1: List of tasks of the Wolf motor function test WMFT

Task	Time	Functional ability	Comment
1. Forearm to table (side)		0 1 2 3 4 5	
2. Forearm to box (side)		0 1 2 3 4 5	
3. Extend elbow (side)		0 1 2 3 4 5	
4. Extend elbow (weight)		0 1 2 3 4 5	
5. Hand to table (front)		0 1 2 3 4 5	
6. Hand to box (front)		0 1 2 3 4 5	
7. Weight to box	-----------------Ibs.		

8. Reach and retrieve		0 1 2 3 4 5	
9. Lift can		0 1 2 3 4 5	
10. Lift pencil		0 1 2 3 4 5	
11. Lift paper clip		0 1 2 3 4 5	
12. Stack checkers		0 1 2 3 4 5	
13. Flip cards		0 1 2 3 4 5	
14. Grip strength	-----------------Ibs.		
15. Turn key in lock		0 1 2 3 4 5	
16. Fold towel		0 1 2 3 4 5	
17. Lift basket		**0 1 2 3 4 5**	

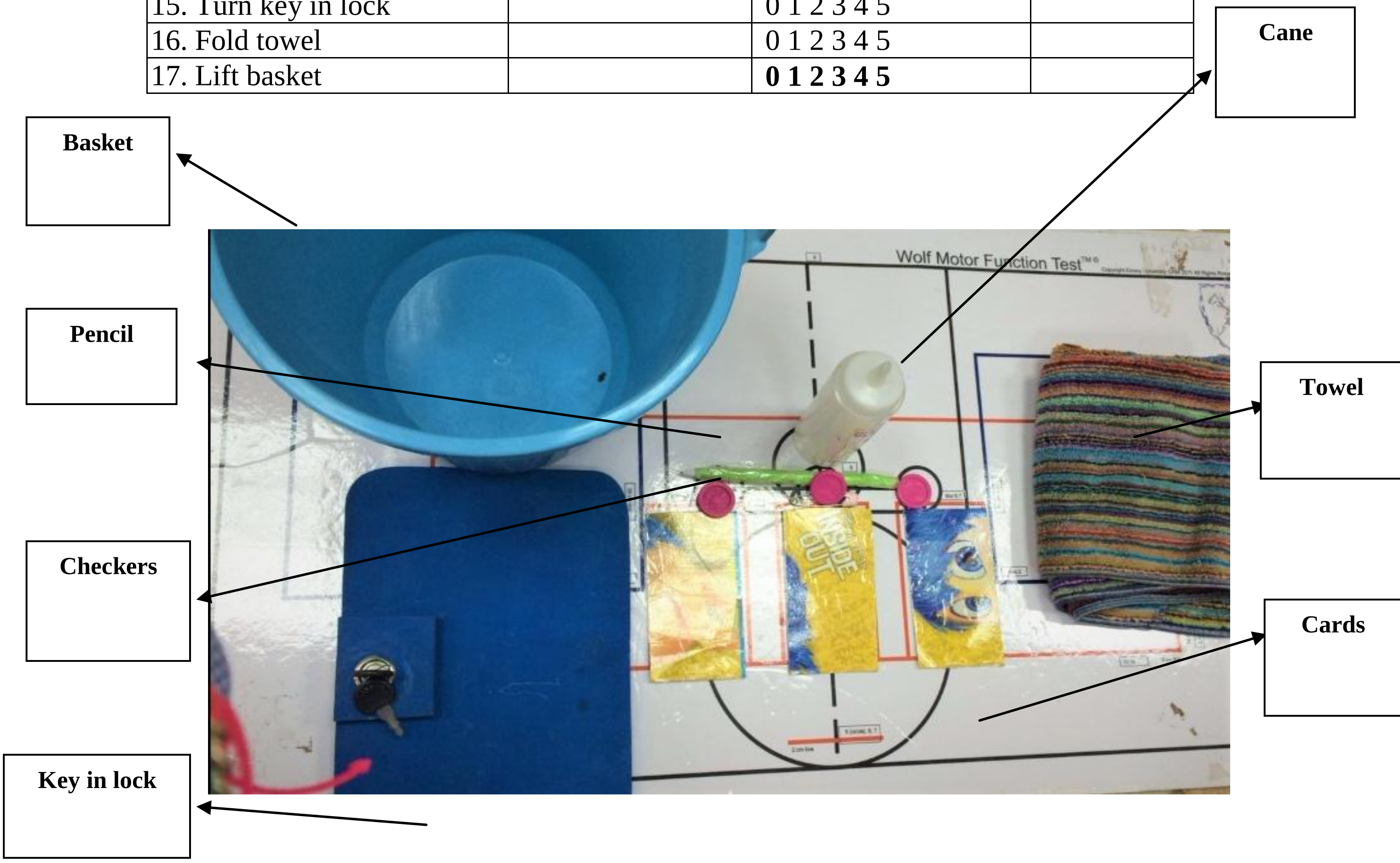

Figure 1: List of objects included in the wolf motor function tes

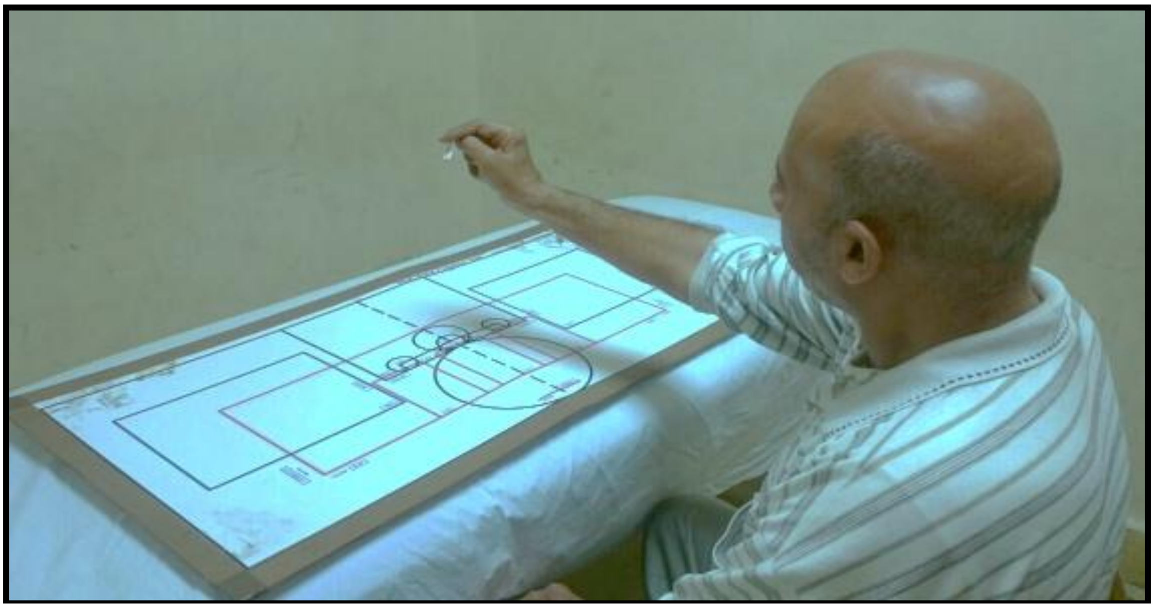

Figure 2: Pick up paper clip

2-Range of motion of shoulder flexion and abduction, was recorded in degrees with the utilization of a standard goniometer.

Active range of motion measurements could have been obtained bedside or in the clinic with a standard goniometer, Subjects were seated in a straight-backed chair and were able to maintain a seated position for the duration of testing.

While seated with the upper extremity hanging down by the side, subjects were instructed to make movements of one segment while keeping the other upper extremity segments still. Patient instructed to move the segment as far as they could then return to the starting position. Because the start position was with the upper extremity hanging down by the side, each movement was first demonstrated by the tester, and replicated by the subject prior to each trial. Two trials of each movement were recorded.

All the measurement outcomes were assessed in pre- and post- testing phases of the study; after applying the treatment program for the patients for successive six weeks.

Treatment procedeurs:

The patients in group (A) (control group) received stretching exercise (Stretching exercise for shoulder girdle muscles Were applied to pectoralis Major, Rhomboids major and minor Latissimus-Dorsi and Teres major, The exercise was applied gradually, within the available range of motion and pain limits., shoulder muscle strengthening exercises for shoulder abductors, upper trapizus, external rotators and serratus anterior**,** Trunk control exercises in form of trunk flexion **figure3** ,extension, side bending and rotation **[1]**. The exercise applied gradually, within the available range of motion and pain limits. The duration of the session was 45 minutes duration with 10 minutes rest in between. This type of exercise was chosen to increase the motor performance of the affected upper extremity by increasing muscle activation and arm flexibility.

Figure 3: Active trunk flexion.

Group (B) received stretching exercise for shoulder girdle muscle, strengthening exercise for shoulder muscle and trunk control training and was all applied to (group B) as it applied for (group A). Patients in the core stabilization exercise group practiced additional core stabilization exercises for three sessions per week, for a period of six weeks **[13]**. The patients in group (B) (study group) received treatment as in group(A) (control group) in addition to core muscle training. The duration of the session was 45 minutes with 10 minutes rest in between. This type of exercise was chosen to increase trunk stability and increase activation of abdominal and back muscle. Group (B) received stretching exercise for shoulder girdle muscle, strengthening exercise for shoulder muscle and trunk control training and was all applied to (group B) as it applied for (group A).

All Patients applied treatment program for three sessions of 45minutes per week, for a period of six week

The core stabilization exercise consisted of two subparts:

- **The bed exercises without devices consisted of:**

Bridge exercise, Bridge exercise with legs crossed, Bridge exercise with one leg, Curl-ups with straight reaching, Curl-ups with diagonal reaching, Quadr-bed exercise and Bird dog exercise

- **The ball exercises consisted of:**

Bridge exercise **Figure 4** and Segmental rotation

❖ The core muscle training was conducted to the study group only the purpose of the fundamental core stability exercises are to gain stability, muscle balance and activation for abdominal wall muscles.

- The core stability exercises were selective, repetitive movements and involved tasks without resistance to improve strength, endurance, and coordination of the core.

Figure 4: Bridging exercise.

<u>Data analysis:</u>

-Descriptive statistical analysis was performed for all pre and post treatment variables and all data were expressed as mean and standard deviation.
-The box and whiskers plots of the tested variable were done to detect outliers.
-Normality test of data using Shapiro-Wilk test was used, that reflect the data was normally distributed for all dependent variables.
-Accordingly, 2×2 mixed design MANOVA was used to compare the tested variables of interest at different tested groups and measuring periods. With the initial alpha level set at 0.05.

Results:

Multiple pairwise comparisons (within and between groups) for each variable

1. **<u>Wolf motor function test WMFT:</u>**

A-function ability score of WMFT for GA and GB:

As illustrated in figure 5, within group's comparison the mean ± SD values of WMFT function ability score in the "pre" and "post" tests were 44.4 ±14.32 and 49±14.11 respectively the group GA. Multiple pairwise comparison tests (Post hoc tests) revealed that there was significant increase of WMFT function ability score at post treatment in compare to pre-treatment (P-value =0.0001*). While, the mean ± SD values of WMFT function ability score in the "pre" and "post" tests were 44.46±8.75 and 51.6 ±7.98respectively in the group GB. Multiple pairwise comparison tests (Post hoc tests) revealed that there was significant increase of WMFT function ability score at post treatment in compare to pre-treatment (P-value =0.0001*)

- **As for, comparison between GA and GB:**

Considering the effect of the tested group (first independent variable) on WMFT function ability score, Multiple pairwise comparison tests (Post hoc tests) revealed that the mean values of the "pre" test between both groups showed no significant differences with (P=0.989). As well as, multiple pairwise comparison tests (Post hoc tests) revealed that there was no significant difference of the mean values of the "post" test between both groups with (p=0.561).

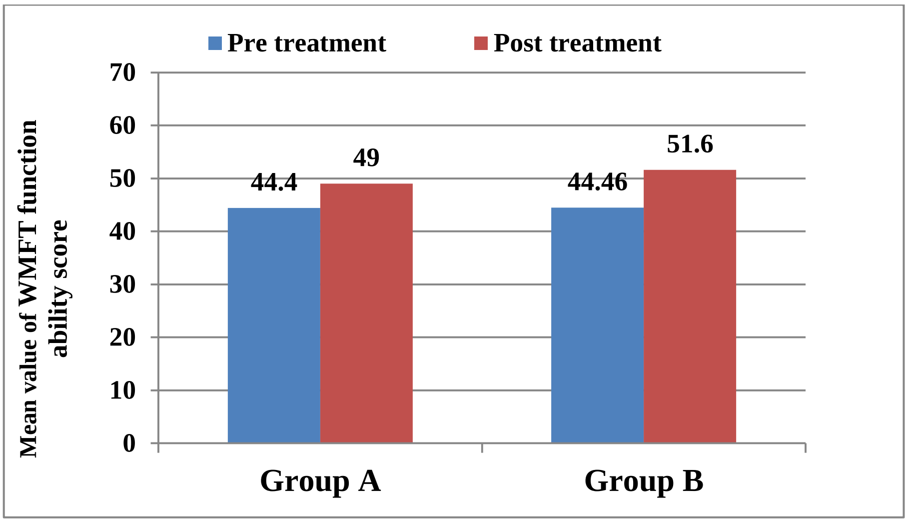

Figure 5:Mean values of WMFT function ability score in both groups.

B- Time of WMFT for GA and GB:

As illustrated in figure 6, within group's comparison the mean ± SD values of WMFT time in the "pre" and "post" tests were 242.3 ±148.42 and219.7±147.23 respectively the group GA. Multiple pairwise comparison tests (Post hoc tests) revealed that there was no significant difference of WMFT time at post treatment in compare to pre-treatment (P-value =0.082). While, the mean ± SD values of WMFT time in the "pre" and "post" tests were253.73±109.53 and 174.2 ±82.92respectively in the group GB. Multiple pairwise comparison tests (Post hoc tests) revealed that there was significant reduction of WMFT time at post treatment in compare to pre-treatment (P-value =0.0001*).

- **As for, comparison between GA and GB:**

Considering the effect of the tested group (first independent variable) on WMFT time, Multiple pairwise comparison tests (Post hoc tests) revealed that the mean values of the "pre" test between both groups showed no significant differences with (P=0.826). As well as, multiple pairwise comparison tests (Post hoc tests) revealed that there was no significant difference of the mean values of the "post" test between both groups with (p=0.332).

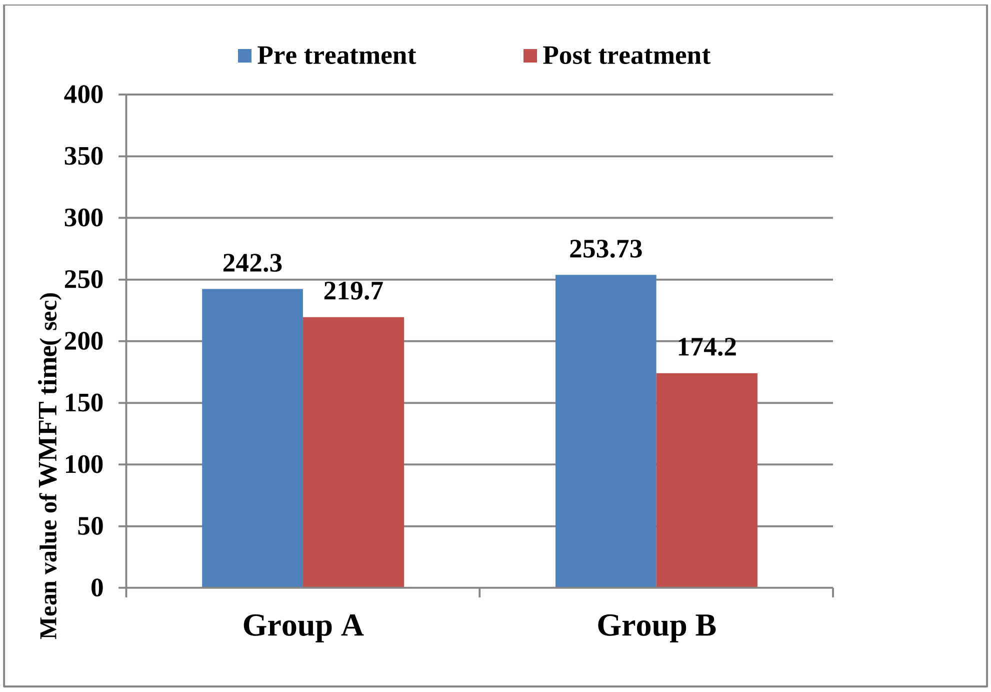

Figure 6: Mean values of WMFT time (sec)in both groups.

***C-Grip strength* of WMFT for GA and GB:**

As illustrated in figure7, within group's comparison the mean ± SD values of grip strength in the "pre" and "post" tests were 8.6 ±3.02 and 9.8±3.29 respectively the group GA. Multiple pairwise comparison tests (Post hoc tests) revealed that there was significant increase of grip strength at post treatment in compare to pre-treatment (P-value =0.038*)While, the mean ± SD values of grip strength in the "pre" and "post" tests were 7.53±1.88and 10.33 ±2.02respectively in the group GB. Multiple pairwise comparison tests (Post hoc tests) revealed that there was significant increase of grip strength at post treatment in compare to pre-treatment (P-value =0.0001*).

- **As for, comparison between GA and GB:**

Considering the effect of the tested group (first independent variable) on grip strength, Multiple pairwise comparison tests (Post hoc tests) revealed that the mean values of the "pre" test between both groups showed no significant differences with (P=0.287). As well as, multiple pairwise comparison tests (Post hoc tests) revealed that there was no significant difference of the mean values of the "post" test between both groups with (p=0.62).

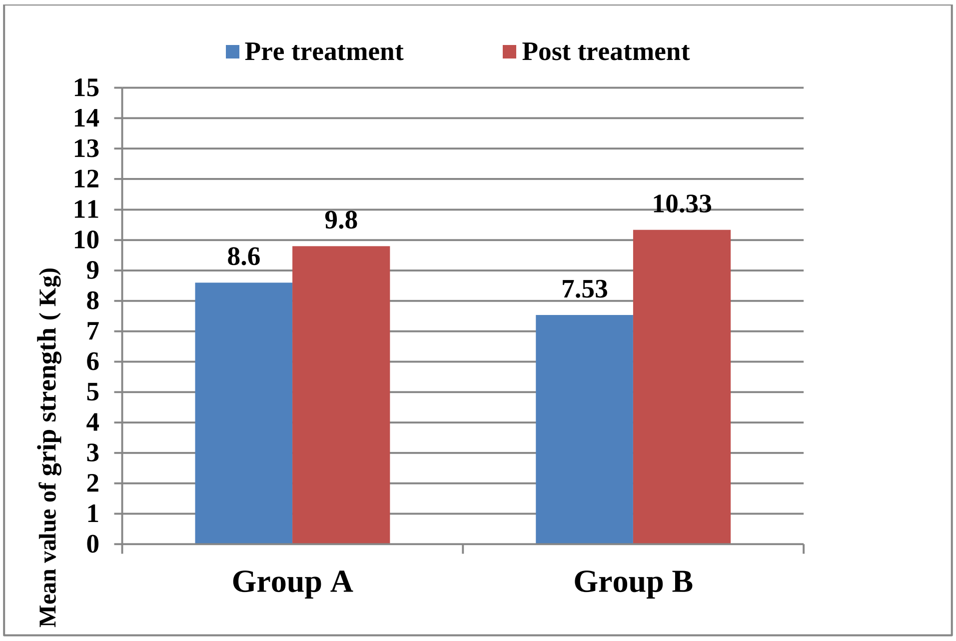

Figure 7: Mean values of grip strength (Kg)in both groups

1.ROM of shoulder:

A-Range of motion of shoulder abduction for GA and GB:

As illustrated in figure 8, within group's comparison the mean ± SD values ofROM of shoulder abduction in the "pre" and "post" tests were 82 ±29.36 and 98±34.89 respectively the group (A). Multiple pairwise comparison tests (Post hoc tests) revealed that there was significant increase of ROM of shoulder abduction at post treatment in compare to pre-treatment (P-value =0.0001*). While, the mean ± SD values of ROM of shoulder abduction in the "pre" and "post" tests were84.33±24.84 and 115 ±21.12respectively in the group (B). Multiple pairwise comparison tests (Post hoc tests) revealed that there was significant increase of ROM of shoulder abduction at post treatment in compare to pre-treatment (P-value =0.0001*)

- **As for, comparison between GA and GB:**

Considering the effect of the tested group (first independent variable) on ROM of shoulder abduction, Multiple pairwise comparison tests (Post hoc tests) revealed that the mean values of the "pre" test between both groups showed no significant differences with (P=0.832). As well as, multiple pairwise comparison tests (Post hoc tests) revealed that there was no significant difference of the mean values of the "post" test between both groups with (p=0.142).

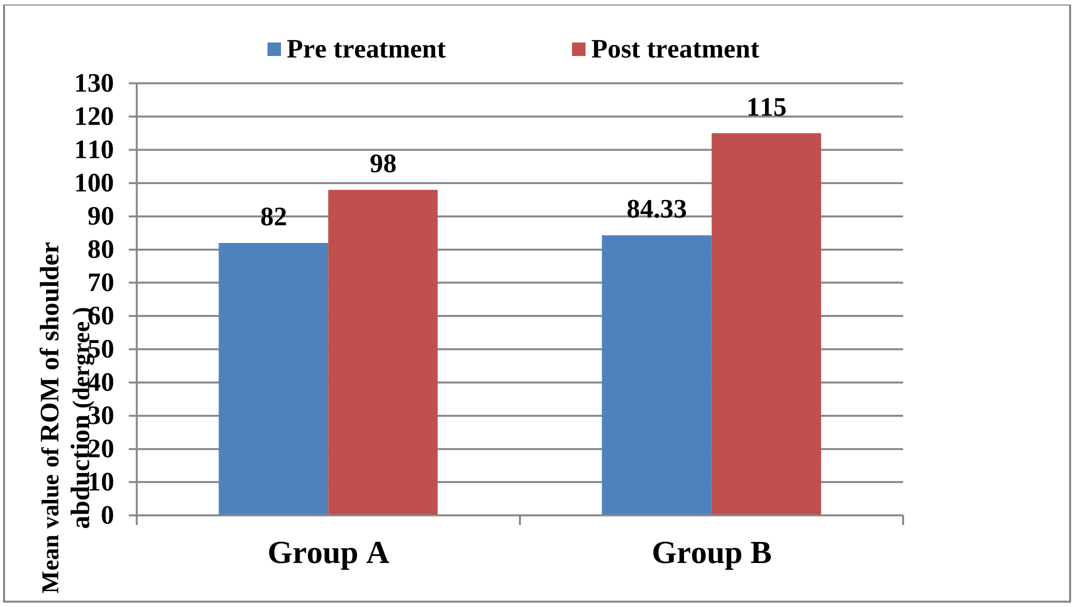

Figure 8: Mean values of ROM of shoulder abduction (degree) in both groups.

B-Range of motion of shoulder flexion for GA and GB:

As illustrated in figure 9, within group's comparison the mean ± SD values of ROM of shoulder flexion in the "pre" and "post" tests were 77 ±24.96 and 94±26.64 respectively the group (A). Multiple pairwise comparison tests (Post hoc tests) revealed that there was significant increase of ROM of shoulder flexion at post treatment in compare to pre-treatment (P-value =0.026*). While, the mean ± SD values of ROM of shoulder flexion in the "pre" and "post" tests were91±28.67 and 117.33 ±28.65respectively in the group (B). Multiple pairwise comparison tests (Post hoc tests) revealed that there was significant increase of ROM of shoulder flexion at post treatment in compare to pre-treatment (P-value =0.0001*)

- **As for, comparison between GA and GB:**

Considering the effect of the tested group (first independent variable) on ROM of shoulder flexion, Multiple pairwise comparison tests (Post hoc tests) revealed that the mean values of the "pre" test between both groups showed no significant differences with (P=0.221). As well as, multiple pairwise comparison tests (Post hoc tests) revealed that there was no significant difference of the mean values of the "post" test between both groups with (p=0.052).

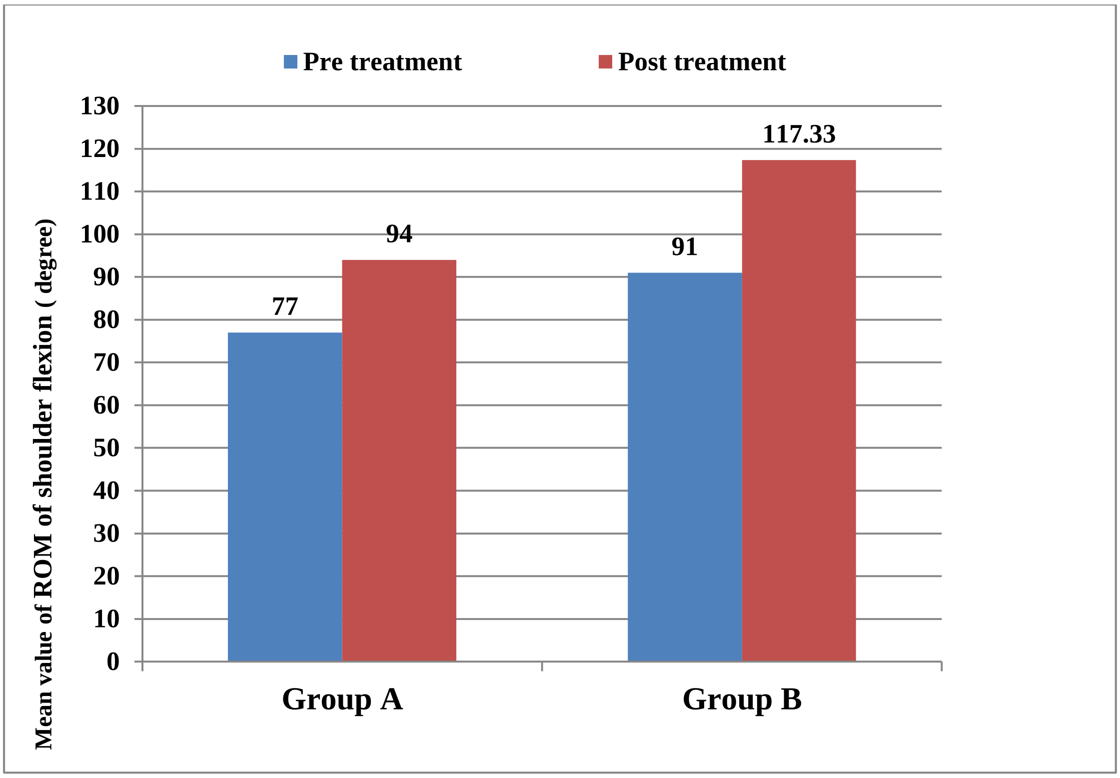

Figure 9: Mean values of ROM of shoulder flexion (degree)in both groups.

Discussion:

Concerning **the primary outcome measure Wolf Motor Function Test** there were no statistical significant difference in all wolf motor function test sub scales in the function ability and time of task between both groups.

Our findings of insignificant statistical difference in the Wolf Motor Function Test in hemiparetic patients was supported by the findings reported by **[14]** in this study the patients in the control group performed conventional exercises for six weeks, and those in the study group performed core stability exercises for six weeks, the result of the modified barthel index revealed no statistical significant difference between the two groups. This indicates that both core stability exercises and conventional exercises have similar effect on the abilities of patients to deal with daily activities and control body balance.

Another study supported our findings was reported by **[9],** in this study thirty patients with subacute stroke were enrolled and randomly assigned to 3 groups, i.e., first group received core muscle strengthening, the second group received trunk neuromuscular electrical stimulation on the posterior back muscles; the third group received the combination of both treatments, treatment was performed 3 times per week for 20 minutes per day over 3 weeks. The results revealed no statistical difference in the modified barthel index scale in the 3 groups before and after the treatment, in the combination group the modified barthel index was slightly higher than the other groups, but the difference was not statistically significant.

Our insignificant difference in the Wolf Motor Function Test between the control and study group was in contrary with findings reported by [**7]** that core stabilization exercises enhance trunk balance to improve upper extremity function as improving proximal stability will improve distal mobility, also **[14]**demonstrated significant improvement in functional reach ability of the upper extremity in people with stroke after an intervention consisting of trunk stability exercise.

Our findings of the insignificant difference of the shoulder range of motion supported by findings reported by [**15]**the results concluded that trunk control exercise has a moderate effect on reduction of upper extremity impairment in chronic stroke patients, in terms of Fugl-Meyer assessment for upper extremity score. There is insufficient evidence to support that trunk exercise improves upper extremity function and reaching trajectory smoothness and straightness in chronic stroke patients.

Another study conducted by **[16]**assessing overhead ball throwing before and after eight weeks of core muscle training, the result showed that there was no statistical significant difference in the functional performance test between the control and the study groups. It was concluded that eight weeks of core training program may have not been sufficient to elicit the task.

For the non-significant improvement in the upper limb function in our sample may contributed to the duration of illness of patients as they were chronic stroke patients more than six months, as the duration of illness is one of the main factors that affect the patient neural plasticity and motor recovery **[17].**

As the longer the duration of illness may lead to maladaptive strategies becoming part of the daily movement repertoire. Compensatory movement strategies may be very difficult to unlearn, frustrating efforts to improve movement for both patient and therapist [**18**].

Based on our results, it could be suggested the **superiority of core muscle** training to be used in improving dynamic balance in stroke patients, also it may offer opportunity for better movement re-education and facilitate better retraining of the upper extremity. However, this concept needs further exploration and appropriately designed intervention studies to examine the effect of core muscle training on upper limb function during the different stages of rehabilitation following stroke in patients.

Reference:

1- AWAD, Amina, et al. Effect of shoulder girdle strengthening on trunk alignment in patients with stroke. *Journal of physical therapy science*, 2015, 27.7: 2195-2200.

2- CHAMPION, Janice; BARBER, Christine; LYNCH-ELLERINGTON, Mary. Recovery of upper limb function. *Bobath Concept*, 2009, 154.

3- HARDWICK, Dustin D.; LANG, Catherine E. Scapular and humeral movement patterns of people with stroke during range of motion exercises. *Journal of neurologic physical therapy: JNPT*, 2011, 35.1: 18.

4- DURALL, Christopher J., et al. The effects of preseason trunk muscle training on low-back pain occurrence in women collegiate gymnasts. *The Journal of Strength & Conditioning Research*, 2009, 23.1: 86-92.

5- CABANAS-VALDÉS, Rosa, et al. The effect of additional core stability exercises on improving dynamic sitting balance and trunk control for subacute stroke patients: a randomized controlled trial. *Clinical rehabilitation*, 2016, 30.10: 1024-1033.

6- YU, Seong-Hun; PARK, Seong-Doo. The effects of core stability strength exercise on muscle activity and trunk impairment scale in stroke patients. *Journal of exercise rehabilitation*, 2013, 9.3: 362.

7- MIYAKE, Yuki, et al. Core exercises elevate trunk stability to facilitate skilled motor behavior of the upper extremities. *Journal of bodywork and movement therapies*, 2013, 17.2: 259-265.

8- ONWUDIWE, C. O., et al. Effects of core strengthening exercises on dynamic balance and gait speed in stroke survivors. *International Journal of Basic, Applied and Innovative Research*, 2018, 7.2: 47-54.
9- KO, Eun Jae, et al. The additive effects of core muscle strengthening and trunk NMES on trunk balance in stroke patients. *Annals of rehabilitation medicine*, 2016, 40.1: 142-151.
10- BOHANNON, Richard W.; SMITH, Melissa B. Interrater reliability of a modified Ashworth scale of muscle spasticity. *Physical therapy*, 1987, 67.2: 206-207.
11- VELOZO, Craig A.; WOODBURY, Michelle L. Translating measurement findings into rehabilitation practice: an example using Fugl-Meyer Assessment-Upper Extremity with patients following stroke. *Journal of Rehabilitation Research & Development*, 2011, 48.10.
12- EDWARDS, Dorothy F., et al. An evaluation of the Wolf Motor Function Test in motor trials early after stroke. *Archives of physical medicine and rehabilitation*, 2012, 93.4: 660-668.
13- CHUNG, Eun-Jung; KIM, Jung-Hee; LEE, Byoung-Hee. The effects of core stabilization exercise on dynamic balance and gait function in stroke patients. *Journal of physical therapy science*, 2013, 25.7: 803-806.
14- SUN, Xibo, et al. Which is better in the rehabilitation of stroke patients, core stability exercises or conventional exercises?. *Journal of physical therapy science*, 2016, 28.4: 1131-1133.
15- KIM, Yonghun; KIM, Eunjung; GONG, Wontae. The effects of trunk stability exercise using PNF on the functional reach test and muscle activities of stroke patients. *Journal of Physical Therapy Science*, 2011, 23.5: 699-702.
16- WEE, SengKwee, et al. Trunk restraint to promote upper extremity recovery in stroke patients: a systematic review and meta-analysis. *Neurorehabilitation and neural repair*, 2014, 28.7: 660-677.
17- TSE, Michael A.; MCMANUS, Alison M.; MASTERS, Richard Sw. Development and validation of a core endurance intervention program: implications for performance in college-age rowers. *The Journal of Strength & Conditioning Research*, 2005, 19.3: 547-552.
18- KANG, Dong-Wha, et al. Neuronal metabolic changes in the cortical region after subcortical infarction: a proton MR spectroscopy study. *Journal of Neurology, Neurosurgery & Psychiatry*, 2000, 69.2: 222-227.
19- MICHAELSEN, Stella Maris; DANNENBAUM, Ruth; LEVIN, Mindy F. Task-specific training with trunk restraint on arm recovery in stroke: randomized control trial. *Stroke*, 2006, 37.1: 186-192.