Efficacy of resistance exercises of non-paretic lower limb on functional activities in chronic stroke patients

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ABSTRACT

Background: Stroke is a frequent cause of problems in body function resulting in limitations of functional activity. Stroke generally leads to greater postural instability, and muscle weakening compared with healthy individuals. Strength of non-paretic limbs can be less than predicted and it tends to be more impaired proximally than distally. The strength of multiple muscle groups of both the paretic and non-paretic lower limbs have been shown to correlate with independence in sit to stand transfer and gait. Purpose of the study: to investigate if resistance exercises of non-paretic lower limb may improve the functional activities in chronic stroke patients. **Methods:** 12 patients with ischemic or hemorrhagic stroke with ages between 45-65 years old, the duration of stroke ranged from 1 to 5 years, and Brunstrom Stage of Recovery ranged from 4 to 6. Resistance Exercises program for adductors and abductors muscles of non-paretic extremity in addition to traditional physical therapy program were used. Portable dynamometer was used to assess any increase in muscle forces of non-paretic lower limb muscles. Also, Functional Independence Measure (FIM) scale was used to assess any improvement in function of these patients. All patients were assessed pre and post intervention without follow-up. **Results:** The study group showed a significant improvement in muscle forces of both adductors and abductors of non-paretic lower extremity and FIM scores. **Conclusion:** Resistance exercises for non-paretic lower limb muscles may show short term improvement on the locomotor function of chronic stroke patients.

Keywords: Resistance exercises, Muscle forces, Non-paretic, Chronic stroke, Function.

INTRODUCTION

Stroke is a frequent cause of problems in body function resulting in limitations of functional activity and participation [1]. Stroke generally leads to greater postural instability, a shift of balance to the non-paralyzed side, an asymmetrical posture, and muscle weakening compared with healthy individuals [2]. Muscle Weakness in stroke patients is caused by many factors such as decreased motor unit firing rates and decreased number of functioning motor units. Apart from the inability to voluntarily produce normal levels of muscle force output caused by injury to supraspinal centers, other mechanisms may contribute to reduced force generation in the paretic limb, such as abnormal motor activation or altered motor control and co-activation and abnormal timing of motor activation [3].

Muscle training regimens result in strength increases in trained maneuvers [4,5,6,7]. These increases, some of which exceeded 100%, were noted regardless of the type of resistance employed. In studies employing a control group, the increases tended to be greater in the strength training group [4,5,7]. Increasing recognition of the importance of muscle strength in stroke recovery is based, in part, on studies that have demonstrated a relationship between muscle strength of paretic and non-paretic limbs and function in persons with stroke. Paretic muscle strength is related to several activities of daily living in individuals with stroke, including ability to rise from a chair [8].

Hip adductors work as secondary hip flexors and extensors during gait cycle while hip abductors are so important for single limb stance phase of gait and stair climbing [9,10,11]. Significant relationships also exist between non-paretic lower extremity (LE) muscle strength and functions such as gait and stair climbing [12]. Muscles of non-paretic limb may actually be impaired, particularly early after stroke. Strength ipsilateral to a brain lesion, which can be less than 60% of predicted, tends to be more impaired proximally than distally, [13].

It was proven that pelvic stability training could improve movement control, hip muscles strength, walking speed and daily activities after stroke [14]. Also, core stability training improves trunk function, standing balance, and mobility in stroke Patients [15].

Training the unimpaired arm of chronic stroke survivors was proven to improve the motion of the impaired arm and the sitting balance in chronic stroke survivors. This recovery that happened after robot-assisted rehabilitation for the unimpaired arm could be mainly due to a control of the compensatory strategies and the empowerment of weak or silent skills, rather than to the acquisition of new or lost abilities on the affected side [16]. The purpose of the current study is to investigate if resistance exercises program of non-paretic lower limb may improve the function in chronic stroke patients.

MATERIALS AND METHODS

Material and Methods:

Study design: Single group pre-post experimental design

Participants: 12 patients with ischemic or hemorrhagic stroke with ages between 45-65 years old, the duration of stroke ranged from 1 to 5 years, muscle tone ranged from 1+ to 2 on Modified Ashworth Scale, and Brunstrom Stage of Recovery ranged from 4 to 6. All the patients were selected from Out-patient's clinics, Faculty of Physical Therapy, Cairo University.

Measurement Procedures: Portable Lafayette dynamometer was used to assess any increase in muscle forces of non-paretic adductors and abductors muscles. Also, functional independence measure scale was used to assess any improvement in transfer and locomotion function of these patients. All patients were assessed pre and post intervention without follow-up.

-Muscle forces:

Examiner asks the patient to lie on his back in supine position while asking him to flex his paretic limb to stabilize the pelvis. Dynamometer was placed on the medial side and lateral side of femoral condyle to assess hip adductors (figure 1) and abductors (figure 2) respectively while asking the patient to push against it without movement.

(Figure 1)

(Figure 2)

- Transfer and Locomotion Function:

The FIM scale contains 18 items, of which 13 items are in physical domains and 5 items are related to cognition. Motor items measure self-care, sphincter control, locomotion, and transfer. Cognitive ones evaluate subject's communication and social cognition. Based on level of independence, each item is scored from 1 to 7, where 1 indicates total dependence and 7 represents complete independence. Possible scores range from 18 to 126. Obtaining higher score means more independence in activities of daily living. FIM score is indicative of patients' level of disability and the burden of their care [17,18]**,** only transfer and locomotion domains will be assessed, (figure 3).

Transfers			
I. Bed, Chair, Wheelchair			
J. Toilet			
K. Tub, Shower			
Locomotion			
L. Walk/Wheelchair			
M. Stairs			

LEVELS	**Independent** 7 Complete Independence (Timely, Safely) 6 Modified Independence (Device)	**NO HELPER**
	Modified Dependence 5 Supervision (Subject = 100%+) 4 Minimal Assist (Subject = 75%+) 3 Moderate Assist (Subject = 50%+) **Complete Dependence** 2 Maximal Assist (Subject = 25%+) 1 Total Assist (Subject = less than 25%)	**HELPER**

Note: Leave no blanks. Enter 1 if patient is not testable due to risk.

(Figure 3), FIM scale: transfer and locomotion section

Intervention Procedures: The rehabilitation program involved 20 min of a range of motion exercises, stretching (Hip adductors and ankle planter flexors) for 30 sec. one repetition and active exercises (Hip abductors and flexors + knee flexors + ankle dorsiflexors) of paretic lower limb muscles in supine and sitting positions addressing the soft tissue stiffness, spasticity, muscle inactivity and weakness of the paretic lower limb. Balance training standing (Weight shifting, step standing and single limb support on paretic limb) and gait training according to each patient needs were administered to them for 20 min. duration [14], in addition to resistance exercises program for adductors and abductors muscles of non-paretic extremity (4 sets * 10 repetition).

Exercises description was one-hour treatment session per day, 3 times a week for 6 weeks, (figure 4) and (figure 5).

(Figure 4): a: Starting position b: End position

(Figure 5): a: Starting position b: End position

Data Analysis: Descriptive statistics (mean and SD) was generated for each dependent variable. The difference between the pre-test and post-test was analyzed with a paired-t test. All statistical tests used a significance level of $p < 0.05$.

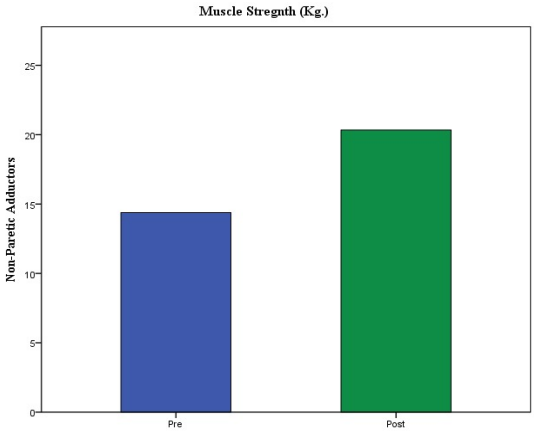
RESULTS

Results:

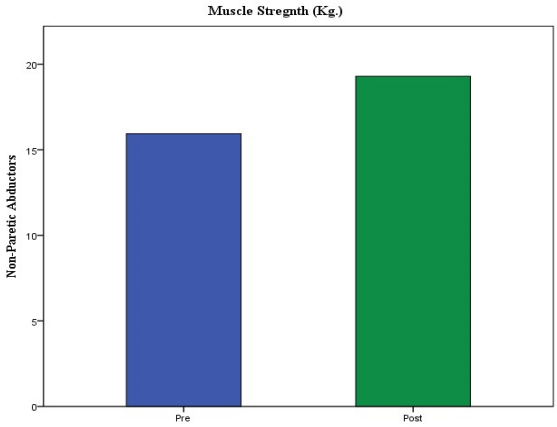
The study group showed a significant improvement in muscle forces of both non-paretic hip adductor and abductor muscles Table 1, (Figure 6,7). Also, there is a significant change in FIM scores especially locomotor function including walk and stair climbing, Table 2, (Figure 8)

Table (1)

Muscle Stregnth (Kg.)				
	N	$\bar{x}$	σ	T-test
Non-Paretic Adductors (Pre)	12	14.39	3.56	-5.74577
Non-Paretic Adductors (Post)	12	20.33	1.47	
Non-Paretic Abductors (Pre)	12	15.93	3.08	-3.33646
Non-Paretic Abductors (Post)	12	19.29	2.06	
			P-value<0.05	



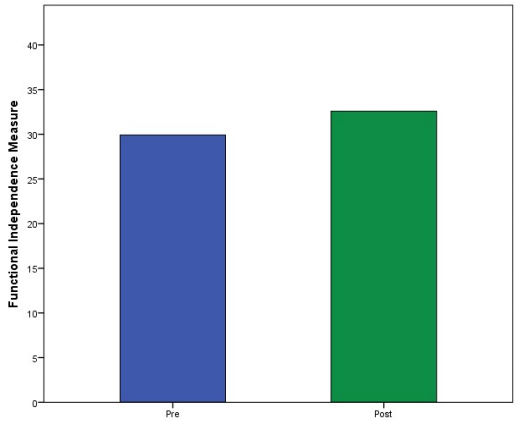
(Figure 6)



(Figure 7)

Table (2)

Functional Independence Measure				
	N	$\bar{x}$	σ	T-Test
Pre	12	29.92	1.73	-5.533
Post	12	32.58	1.44	
			P-value<0.05	



(Figure 8)

DISCUSSION

The present study was conducted to analyze and investigate the effect of resistance exercises of non-paretic limb muscles on the function in chronic stroke patients. There is a significant change in strength of non-paretic lower limb muscles which was transferred as an improvement to both transfer and locomotor function of stroke survivors. Resistance exercises for paretic limbs have shown improvement in strength of muscles while several researchers have reported patients to improve in only some functional activities but not others [5,19,20]. Bilateral resistance exercises for both lower extremities improved the balance and gait significantly in stroke patients [21].

Recently, the functional training concept has already appeared and become recommended instead of isolated single muscle group resistance training for paretic limb muscles. The philosophy behind this assumption is lack of transfer of muscle strength into functional activities due to impaired normal synergy, co-contraction, and spasticity [22]. Intralimb and interlimb coordination is replaced by mass limb movement patterns (abnormal synergies) on the paretic side that require compensatory adjustments of the pelvis and non- paretic side [23]. Any function, to be learned must be analyzed in its components and to be trained according to its missing component in addition to practice with high number of repetitions and motivation till permanent retention of this function occurs and can be performed through different life situations [24].

For demanding functional activities requiring the engagement of muscles on both sides of the body (e.g. sit-to-stand), strengthening of the

supposedly non-paretic muscles may therefore be important [21]. As such impairments have functional activity implications, they should not be overlooked when a strengthening regimen is initiated [25]. The only reported problem in non-paretic lower extremity is weakness without any associated problems [13]. While resistance exercises for paretic side showed improvement in only some functional activities but not others [5,19], resistance training for non-paretic lower limbs can be an additional option to help those functions that did not improve by paretic limbs resistance exercises programs such as sit to stand task, stair climbing, gait [8,12,21].

CONCLUSION

Chronic stroke patients may get short term benefits of resistance exercises for non-paretic muscles. This improvement can be transferred into functional activities in chronic stroke patients especially in stair climbing and gait.

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