Original Article

OPTIMIZING OVERALL FUNCTION OF THE UPPER LIMB IS EFFECTIVE TREATMENT FOR SHOULDER PAIN IN INDIVIDUALS WITH STROKE: A RANDOMIZED CONTROLLED TRIAL.

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ABSTRACT

Background: Shoulder pain is frequent after stroke and interferes with the rehabilitative process and functional outcomes. Treatments used for post-stroke shoulder pain are limited and largely ineffective. **Objectives**: This randomized controlled study was conducted to study the effect of optimizing overall function of upper limb on the basis of pathomechanics and motor relearning as a treatment of hemiparetic shoulder pain.

Subjects and methods: Thirty patients with first ever stroke suffering shoulder pain on movement and at rest were included in this study. Pain was measured by the Visual Analogue Scale (VAS) and Chedoke-McMaster Stroke Assessment (CMSA) was used for measuring motor recovery and functional level. Shoulder abduction, flexion and external rotation ranges of motion (ROM) were also measured. The participants were randomly assigned into two equal groups (G_1 and G_2). Those in G_1 received an exercise therapy based on optimizing overall function of upper limb as a treatment of hemiparetic shoulder pain. Shoulder range of motion exercises were done for the patients represented G_2. Treatments were applied for twelve weeks 5 times per week for 60 minutes.

Results: shoulder pain and motor recovery scores improved significantly in addition to a significant increase in the shoulder ROMs ($p \leq 0.05$).

Conclusion: These results suggest that exercise therapy which emphasize interrelationship of all areas of the upper limb to optimize overall function exerts positive effects on shoulder pain and functional recovery in participants with stroke.

KEYWORDS: Stroke, Shoulder Pain, Optimizing Function.

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INTRODUCTION

Post-stroke shoulder pain on movement of the upper limb has been recognized as an important predictor of poor recovery of power and function of the arm.[1] It is common following stroke, and raises problems because of poor understanding of etiology and lack of proven prevention and treatment strategies.[2] In a prospective study 34% developed shoulder pain following stroke, 28% by two weeks and 87% by two months.[3,4] Sonographic analysis of hemiplegic shoulder revealed that adhesive capsulitis, glenohumeral subluxation, or long head of biceps tendon effusion showed a higher prevalence as cause of hemiplegic shoulder pain one month after stroke, those with supraspinatus tendon pathology showed a higher prevalence at 3 and 6 months.[7]

Although many etiologies have been proposed for shoulder pain after stroke, it appears to be a consequence of spasticity and sustained posture.[5] Shoulder pain may also more common among the patients who neglect following stroke.[6] The factors most frequently associated with shoulder pain are shoulder subluxation, shoulder contractures or restricted shoulder range of motion, spasticity, particularly of the subscapularis and pectoralis muscles. [5,6,8] Magnetic Resonance Imaging (MRI) was used to examine a potential association between structural changes in hemiplegic shoulder and shoulder pain in a series of 89 patients with shoulder pain, 35% of subjects exhibited a tear of at least one rotator cuff, biceps or deltoid muscle and 53% exhibited tendinopathy of at least one rotator cuff, bicep or deltoid muscle. [10] The role of central post stroke pain in the etiology of shoulder pain is unclear.[11]

There is lack of evidence to support the development of clear clinical guidelines for managing shoulder pain after stroke, in part, due to the uncertainty of the etiology of the pain. As a result, a wide variety of treatments have been used, with varying degrees of success.[12] Most of these studies del with the shoulder pain as a localized symptoms and has no relation to the motor function of the upper limb especially the hand . Many studies used either botulinum toxin[13,14,15] or steroids[16,17,18] injections. There is a conflicting evidence that intra-muscular or intra-articular injection improve either post-stroke shoulder pain, ROMs and motor recovery. Additionally, using physical modalities for local treatment of shoulder pain don't effectively reduce pain in individuals after stroke.[19,20] To our best knowledge all researches in this themes employed localized modalities for treatment of shoulder pain, so that this study aimed at investigating the effect of an approach dealing with the hemiparetic shoulder pain as a part of impaired upper limb motor recovery. We tested the hypothesis that exercise therapy focusing on interrelationship of all areas of the upper limb to optimize overall function is efficient in the treatment of hemiparetic shoulder pain in the individuals with stroke

SUBJECTS AND METHODS

In this randomized-controlled clinical trial, 30 patients with age ranged from 44 to 57 year were recruited from the Physical Therapy Department for Neuromuscular Disorders and its Surgery Outpatients' Clinic, Faculty of Physical therapy, Cairo University-Egypt. The purpose and procedures of the study were fully explained to the participants before physical examination which included motor recovery and activities of daily living assessment using Chedoke-McMaster Stroke Assessment (CMSA).

Spasticity was measured using the Modified Ashworth Scale (MAS). The Participants were required to meet the following criteria for inclusion in the study: history of unilateral first ever stroke causing hemiparesis with duration of illness not less than 3 months; medically stable; had the ability to understand procedures of experiment and give study consent form; to be at least in stage 3 of motor recovery of shoulder pain, arm and hand according to the CMSA. They also should have shoulder pain at least 2 weeks before study with a limitation of the passive external rotation of the hemiplegic shoulder of 20° compared with the other (unaffected) side. Patients with history of neurological disorder other than stroke or musculoskeletal impairment of the shoulder complex, cognitive, mental and visual abnormalities were excluded from the study. For all participating subjects, all medications were kept stable during the course of the study. For the treatment allocation; computer-generated random numbers were used to assign patients to two equal groups (G_1 and G_2).

The baseline laboratory measurements was done in the same day of the physical examination followed by randomization. Patients in both groups were assessed for shoulder active flexion and abduction ROM using 2D motion analysis. The participants were asked to sit erectly on a chair with low back support with right angle between the trunk and thigh as well as between the thighs and legs. A video camera (Sony-DCR-SR68 Handycam camcorder) was held 1.5 meters away from the patient and perpendicular to the plane of movement. Adhesive marks were secured over the greater trochanter, tip of the acromion, and lateral epicondyle of the humerus. The patients were asked to move the arm in the frontal plane (abduction) and in the sagittal plane (flexion).

For measuring the shoulder external rotation, the patient arm was supported on a table at 90º glenohumeral flexion with the markers secured over the olecranon process and at midpoint of the wrist joint. The patients were asked to do the movement slowly. The recorded video was imported to the video maker software for windows where the movement can be measured at every second. MB-ruler (MB-ScreenOverlay SDK Shell) was used to measure the angles of shoulder abduction, flexion and external rotation through its protractor overlying the markers secured on the bony landmarks. The angles of shoulder abduction and flexion ROM are represented by the angle between the line connecting the tip of acromion with the greater trochanter and another connecting the lateral humeral epicondyle and the acromion respectively. External rotation is represented by the angle between the vertical line and the line connecting the markers of the olecranon and the midpoint of the wrist. Pain without movement and pain during movement was measured by Visual Analogue Scale (VAS). The outcome measures were calculated as the mean of the pain scores at rest, and pain during movement. The arm, hand function was assessed by means of the CMSA. Which the first is divided into two major sections: impairment inventory which describes how to stage shoulder pain. The second section provides the information needed to score the stage of motor recovery and motor function for the arm and the hand. The outcome measures were calculated as the mean of the shoulder pain scores and of motor recovery and motor function for the arm and the hand. The CMSA uses an ordinal scale ranging from 1 (poorest) to 7 (best) to rate pain and its interfering with functional activities.

An exercise therapy program based on biomechanical understanding of shoulder pathology and motor relearning (BMR) with an aim of emphasizing interrelationship of all areas of the upper limb to optimize overall function was applied to the participants in G_1. This program was done by a neuro-physiotherapist who guided the participants to visualize, copy similar motions by the contralateral arm simultaneously. Analysis of the abnormal pattern of movement with simple explanation was done in order to under stand the differences between normal and abnormal pattern of movements. The therapist also reinforced the intended movements to be done correctly through clear, simple verbal feedback and encouraged the feel of specific motions as well as applying sensory stimuli simultaneously to movements with care not overload the patient with excessive or wordy commands especially those with right sided hemiparesis. As initial practice progresses, the patients were asked to self-examine performance and identify problems, specifically, what difficulties exist, what can be done to correct the difficulties, and what movements can be eliminated or refined. During training, the affected upper extremity was aligned to decrease scapular depression and retraction. Scapular upward rotation, shoulder shrugging, external rotation, forward flexion, abduction, elbow, wrist and fingers extension, thumb opposition and abduction, fingers flexion, abduction and extension were emphasized. Reaching activities as an oriented task were accentuated to simultaneously train the paretic arm. Participants in this group treated 60 min/ session in a frequency of 5 times a week for 12 weeks. Participants who were allocated in G_2 received ultrasound 5 times a week 7 min, 1 MHZ applied to the anterior, lateral and posterior aspect of the glenohumeral joint followed by range of motion (ROM) exercises.

Statistical Analysis

The greatest difference between the 2 treatment groups was expected to be found between baseline and the follow-up, which took place after 12 weeks. Therefore, the absolute change in the outcome scores between baseline and the follow-up measurement was calculated. For measuring the differences at baseline and after treatment between the 2 groups, a nonparametric test (Mann-Whitney U test) was used. The level of statistical significance was set at 0.05. Median differences between the groups and the 95% CIs were calculated. The paired t-test was used to determine within –groups changes in shoulder active ROMs before and after interventions. The Social Package for Social Sciences (SPSS) version 19.0 (SPSS Inc, Chicago, IL, USA) was used for these analyses.

RESULTS AND TABLES

Thirty two subjects were fit to participate in the study, because of travelling two of them withdrew from the study before randomization. Table 1 details the baseline characteristics of the participants. Despite randomization, sex, type and side of lesion were not equally distributed over the 2 groups. No significant differences were found in the duration of illness (*p*=0.89) and duration of shoulder pain (*p*=0.62).

Table 1: Patient Characteristics at Baseline:

Characteristic	Group 1	Group 2
Age mean (SD) years	53.2 (3.96)	53.8(4.85)
Gender M/F	9/6	11/4
Type of lesion, infarction/hemorrhage	12/3	10/5
Side of hemiplegia, left /right	11/4	9/6
Duration of illness mean (SD), month	6.5(2.3)	6.4(2.3)
Duration of shoulder pain mean (SD), week	8.8(2.2)	8.2(2.7)
Hypertonia (MAS grade 1 to1+).	11	10
Hypertonia (MAS grade 2)	4	5
Comorbidity (Diabetes mellitus).	3	5

Table 2. lists the medians and 95% CIs for the pain and the CMSA scores in G_1 and control groups, both pre- and post-treatment. The pretreatment pain scores did not differ between the 2 groups (*p=0.85*) and were reduced in G_1 at post-treatment, compared to pretreatment (*p=0.001*) with a non-significant improvement observed in the control group (*p=0.25*). CMSA scores were of nonsignificant differences between the two group before treatment (*p=0.67*). After interventions the CMSA scores showed significant differences in the study group (G_1) (*p=0.001*), on the other hand nonsignificant differences were observed in the control group (p=0.11).

Table 2: Outcome Measures of the CMSA and VAS at Baseline and after treatment:

Outcome measure	BMR (G_1)			Routine physical therapy (G_2)		
	Baseline n=15	After treatment n=15	p	Baseline n=15	After treatment n=15	p
CMSA	3.5 (3 to 4)	6 (5.5 to 6.5)	0.001*	3.5 (3 to 3.5)	4 (3.5 to 4.5)	0. 11
VAS	3 (2.5 to 3.5)	0.5 (0 to 1)	0.001*	3 (3 to 3.5)	2.5 (2 to 3)	0.85

Values are median (interquartile range) * P is significant(P ≤ 0.05)

Examination of within-group differences in shoulder external rotation, flexion and abduction ROMs revealed a significant improvement in G_1 (table 3) (p=0.001). In contrast, there were no significant differences between pre/post treatment measures of the shoulder ROMs in the control group (p=0.51, 0.61 and 0.13 respectively).

Table 3: Outcome Measures of the shoulder ROM (external rotation, flexion and abduction) at Baseline and After treatment.

Outcome measure	BMR (G_1)			Routine physical therapy (G_2)		
	Baseline	After treatment	P	Baseline	After treatment	P
External rotation,°	33.6±7.3	51.1±3.9	0.001*	33.8±5.3	34.1±6.3	0.51
Flexion,°	81.8±3.9	130.3±5.6	0.001*	81.4±3.1	81.8±3.9	0.61
Abduction,°	75.8±3.1	110.2±6.9	0.001*	79.5± 3.9	80.9±3.3	0.13

Values are mean and standard deviation * P is significant(P ≤ 0.05)

DISCUSSION

This study is intended to test the effect of a Biomechanically based motor relearning exercise therapy on decreasing shoulder pain in individuals with hemiparesis. Our results showed that the BMR exercise therapy group had better pain and functional recovery scores than the control group as well as a significant increase in the shoulder external rotation, abduction and flexion ROMs. This may be attributed to the effect of the a multifaceted program dependent on understanding of the patho-mechanics of the shoulder pain and the role of motor relearning exercises in improving cognitive function and facilitate functional recovery after brain damage. This program deals with the shoulder pain as a part of the upper limb impaired motor control. The BMR exercise therapy focuses on improving the strength of the external rotators of the glenohumeral joint together with the scapular upward rotators which is recommended by Hardwick and Lang[21]. Improving these movements pattern as a part of a motor relearning program has the potential to increase the patient's ability to control spasticity of the antagonists and decrease shoulder pain arising on movement.

Incorporating the shoulder elevators, flexors, abductors, elbow and hand extensors in a strengthening exercise program together with enhancing the patient's ability to control spasticity of shoulder internal rotators, elbow and hand flexors as well as forearm pronators can indirectly improve shoulder pain. This can be explained in the context of integration of the function between proximal and distal parts which emphasize the role of the hand in moving the shoulder movement and preventing it disuse. This tends to agree with Collet et al,Crmaer et al, who stated that movement of the fingers and wrist leads to wide spread brain activation in motor areas. [22,23]

In this study, BMR is a low-intensity exercise program which improves the learning memory by increase the Brain-Derived Neurotrophic Factor (BDNF). Studies suggested that low intensity exercise-induced enhancement in learning and memory is dependent on an increased Brain-BDNF level in hippocampal BDNF level. [24,25] Moreover, two previous reports on rats indicated that strenuous exercises may delay functional recovery following induced cerebral ischemia as they elevate serum corticosterone. [26] Corticosterone is a typical sign of chronic stress, which usually causes reduced body weight and spleen atrophy[27], indicating a response of negative adaptation to stress. Furthermore, corticosterone was shown to reduce BDNF availability in the rat hippocampus.[26]

This BMR exercises therapy also enforce the patient to focus on, copy and repeat the intended movement which improve attention and consequently cognition. This tends to be consistent with Brisswalter et al, who speculated that an increase in arousal level and attention with physical exercises has a positive effect on cognitive performance. [28] This effect highlights the importance of task related awareness and motivational factors. Depending on the fact that changes in the nervous system are provoked by active, repetitive training and practice, and by the continued practice of the activity, incorporating the individuals with stroke in a motor relearning programs enhance their ability to move the upper limb. Increasing patient's awareness in controlling spasticity and activating certain muscles may increase brain cells membrane excitability, growth of new connections or unmasking of pre-existing connections, removal of inhibition and activity-dependent synaptic changes. [29,30] This may results in increasing the patient ability to select a specific movement and inhibit the useless stereotyped pattern of movement. Studying the effect of the transcranial magnetic stimulation in addition to the BMR exercise therapy should be conducted as a part of future researches to overcome shoulder pain in participants with stroke. This trend of changes we observed also warrants further study with a larger sample size and more follow up to allow for a more discerning statistical analysis. Also, new technology that decrease the weight of the upper limb during exercises should be used as a part of this program in order to improve the functional scores.

Limitations:

To the best of our knowledge, this may be the first study that deals with the shoulder pain as a problem triggered as a part of general problem of the upper limb, and both hand and shoulder are functionally related to each other. On the other hand, the small sample size is the main limitation together with the inability to follow up the participants after the study. Nevertheless, we were able to justify the efficacy of the BMR exercise therapy as a treatment of shoulder pain among stroke survivors.

CONCLUSION

Biomechanically based motor relearning exercise therapy which emphasize interrelationship of all areas of the upper limb to optimize overall function exerts positive effects on shoulder pain and functional recovery in participants with stroke.

Conflicts of interest: None

REFERENCES

1. Coskun Benlidayi I, Basaran S. Hemiplegic shoulder pain: a common clinical consequence of stroke. practneurol-2013-000606Published Online First: 12 August 2013.
2. Snels I, Dekker J, Van der Lee J, et al.Treating patients with hemiplegic shoulder pain. Am J Phys Med Rehabil 2002; 81: 150-60.
3. Gamble G, Barberan E, Laasch H et al. Poststroke shoulder pain: a prospective study of the association and risk factors in 152 patients from a consecutive cohort of 205 patients presenting with stroke. Eur J Pain 2002; 6:467-74.
4. Lindgren I, Jonsson A, Norrving B et al. Shoulder pain after stroke: a prospective population based

study. Stroke 2007; 38:343-48.
5. Hecht JS. The role of spasticity in hemiplegic shoulder pain and what to do about it. 57th Annual Assembly of American Academy of Physical Medicine and Rehabilitation, Orlando, Florida 1995; 248-55.
6. Kaplan M. Hemiplegic shoulder pain—early prevention and rehabilitation. West J M. 1995;162(2):151-52.
7. Kim YH, Jung SJ, Yang EJ, Paik NJ. Clinical and sonographic risk factors for hemiplegic shoulder pain: A longitudinal observational study. J Rehabil Med. 2014;46(1):81-7.
8. Lo S, Chen S, Lin H, et al. Arthrographic and clinical findings in patients with hemiplegic shoulder pain. Arch Phys Med Rehabil 2003;84:1786-91.
9. Allen Z. Shanahan E. Crotty M. Does suprascapular nerve block reduce shoulder pain following stroke: a double-blind randomised controlled trial with masked outcome assessment. BMC Neurol.2010; 83.
10. Shah RR, Haghpanah S, Elovic EP, Flanagan SR, Behnegar A, Nguyen V, Page SJ, Fang ZP, Chae J. MRI findings in the painful poststroke shoulder. Stroke 2008;39:1808-13.
11. Walsh K. Management of shoulder pain in patients with stroke. Postgrad Med J 2001;77:645-49.
12. Snels I, Dekker J, van der Lee J et al. Treating patients with hemiplegic shoulder pain. Am J Phys Med Rehabil 2002;81:150-60.
13. Yelnik AP, Colle FM, Bonan IV, et al. Treatment of shoulder pain in spastic hemiplegia by reducing spasticity of the subscapular muscle : A randomized, double-blind, placebo-controlled study of botulinum toxin A. J Neurol Neurosurg Psychiatry 2007;78 :845-48.
14. Kong KH, Neo JJ, Chua KS. A randomized controlled study of botulinum toxin A in the treatment of hemiplegic shoulder pain associated with spasticity. Clin Rehabil 2007;21:28-35.
15. de Boer KS, Arwert HJ, de Groot JH, et al. Shoulder pain and external rotation in spastic hemiplegia do not improve by injection of botulinum toxin A into the subscapular muscle. J Neurol Neurosurg Psychiatry 2008;79:581-83.
16. Snels IA, Beckerman H, Twisk JW, et al. Effect of triamcinolone acetonide injections on hemiplegic shoulder pain : A randomized clinical trial. Stroke 2000;31:2396-401.
17. Lim JY, Koh JH, Paik NJ. Intramuscular botulinum toxin-A reduces hemiplegic shoulder pain: a randomized, double-blind, comparative study versus intraarticular triamcinolone acetonide. Stroke 2000;39:126-31.
18. Laske E, Gunduz B, Celik EC. The effects of local shoulderinjections in hemiplegic shoulder pain. Am J Phys Med Rehabil 2009;88:805-14.
19. Wang RY, Chan RC, Tsai MW. Functional electrical stimulation on chronic and acute hemiplegic shoulder subluxation. Am J Phys Med Rehabil 2000;79:385-90.
20. Koyuncu E, Nakipoglu-Yuzer GF, Dogan A, et al. The effectiveness of functional electrical stimulation for the treatment of shoulder subluxation and shoulder pain in hemiplegic patients: A randomized controlled trial. Disabil Rehabil 2010;32:560-66.
21. Hardwick DD, Lang CE. Scapular and humeral movement patterns of people with stroke during range-of-motion exercises. J Neurol Phys Ther. 2011;35(1):18-25.
22. Chollet F, DiPiero V, Wise RJ, Brooks DJ, Dolan RJ, Frackowiak RS. The functional anatomy of motor recovery after stroke in humans: a study with positron emission tomography. Ann Neurol 1991;29:63–71.
23. Cramer SC, Finklestein SP, Schaechter JD, Bush G, Rosen BR. Activation of distinct motor cortex regions during ipsilateral and contralateral finger movements. J Neurophysiol 1999;81:383–87.
24. Berchtold NC, Castello N, Cotman CW. Exercise and time-dependent benefits to learning and memory. Neuroscience 2010;167(3):588–97.
25. Yau SY, Lau BW, Tong JB et al. Hippocampal Neurogenesis and Dendritic Plasticity Support Running-Improved Spatial Learning and Depression-Like Behaviour in Stressed Rats. PLoS ONE 2011;6(9):e24263.
26. Schaaf MJ, De Kloet ER, Vreugdenhil E. Corticosterone effects on BDNF expression in the hippocampus. Implications for memory formation. Stress 2000;3:201–08.
27. Wong EY, Herbert J. Raised circulating corticosterone inhibits neuronal differentiation of progenitor cells in the adult hippocampus. Neuroscience 2006;137: 83–92.
28. Brisswalter J.; Collardeau M.; René A. Effects of Acute Physical Exercise Characteristics on Cognitive Performance. Sports Medicine 2002;32(9):555-566.
29. Cramer SC, Nelles G, Benson RR et al. A functional MRI study of subjects recovered from hemiparetic stroke. Stroke 1997;28: 2518-27.
30. Furlan M, Marchal G, Vialder F et al. Spontaneous neurological recovery after stroke and the fate of the ischemic penumbra. AnnNeurol 1996;40:216-26.

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