Effect of Adding Somatosensory Motor Control Training to Conventional Therapeutic Exercises on Shoulder Impingement Syndrome

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ABSTRACT

Background : *The most common musculoskeletal condition affecting the upper extremities is shoulder impingement syndrome (SIS) . SIS results in lower shoulder proprioception. somatosensory motor control training encourage both afferent signals and cerebral mechanisms that maintain dynamic joint stability to facilitate unconscious motor responses.*
Purpose: To investigate the effect of somatosensory motor control training on shoulder function, range of motion and proprioception in SIS. ***Patients and Methods:*** *forty four patients of both sexes were chosen. Their ages ranged from 25 to 45 and were diagnosed as SIS stage II. They randomly assigned in to two groups. Group (I) received conventional therapeutic exercises program. Group (II) received conventional therapeutic exercises program in addition to Somatosensory motor control training. Patients were assessed before and after therapy (6 weeks) using shoulder pain and disability index to asses shoulder function. An Inclinometer was used to assess shoulder range of motion and proprioception.* ***Results:*** *In both groups, there was a significant improvement in shoulder function, range of motion and proprioception (P< 0.05). There was a significant difference between both groups regarding shoulder function and proprioception in favor of group (II) (P<0.05) while there was no significant difference between them regarding shoulder range of motion.* ***Conclusion:*** *Somatosensory motor control training added to conventional physical therapy exercises seems to be more effective than conventional physical therapy exercises alone in improving shoulder function and proprioception for patients with SIS.*

Key Words: *shoulder impingement syndrome; inclinometer; joint position sense; shoulder pain and disability index.*

INTRODUCTION

SIS has been described as a repeated mechanical compression of the subacromial structures under the coracoacromial arch during arm elevation. It has been demonstrated that shoulder impingement syndrome resulted in shoulder pain ,disability, lower shoulder proprioception , reduced range of motion and decreased isometric strength of the shoulder muscles [1].

Shoulder pain continues to be challenging to recover from, and it is a major cause for consulting a doctor or physiotherapist [2]. A range of subacromial space conditions, including as calcific tendinitis, subacromial bursitis, rotator cuff tendinosis, and partial thickness rotator cuff tears, are included in SIS [3].

To diagnose SIS, a physical examination and history are required. When sleeping on the affected side or raising the affected arm, people will feel significant pain . They can describe pain that keeps them up at night or a lack of mobility. Pain may trigger stiffness and weakness [4]. Sometimes, patients are unable to identify a specific event or occurrence that triggers their suffering. SIS typically develops over weeks to months and has a delayed or insidious start [5].

Patients diagnosed with (SIS), especially secondary SIS resulting from a muscle imbalance, exhibit a protracted scapula and a more flexed thoracic spine [6]. These alignment abnormalities may affect the kinematics of the shoulder, resulting in poor posture, a persistent loss of range of motion, and an increased prescription of muscle relaxants as patients try to manage their pain [7].

Combinations of exercise therapy and steroid injections are used to treat SIS. Surgery used as a treatment method for individuals who are resistant or severe [8].

There is growing evidence that the best management approach for reducing pain and impairment in people with SIS is by participating in strengthening and stretching exercises .Additionally, there is increasing evidence that proprioceptive shoulder exercises, enhanced joint position awareness, and neuromuscular training are superior than movement-based exercise regimens in terms of efficacy [9].

The ability of the central nervous system to carry out a specific and concrete movement in a more accurate, functional, and coordinated manner through feedforward and/or feedback cues, to enable a more intentional movement through the use of sensory and proprioceptive information in the form of verbal, visual, or haptic inputs, is known as motor control training [10, 11].

A link between musculoskeletal problems and the sensorimotor system has been revealed. The significance of taking this relationship into account while managing patients with shoulder issues through shoulder girdle sensorimotor retraining [12].

However, there is a lack of evidence in previous studies about the effectiveness of various physical therapy exercises , and in particular, it is unclear which exercise regimens are the most clinically successful [13].

Subsequently, the objective of our current study was to detect the effect of Somatosensory motor control training which include proprioceptive exercises, , scapular repositioning exercises through the use of feedback and neurocognitive exercises on shoulder function , range of motion and proprioception.

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MATERIALS AND METHODS

Study Design:
This study is a single blinded randomized controlled trial in which patients were randomly assigned in to two groups ,conventional therapeutic exercises group (I) or somatosensory motor control training added to conventional therapeutic exercises group (II).

By using G-power version 3.1.9.7 for windows and regarding t-test study, alpha level of 0.05, sample size calculated as 38 patients ,3 patients were added to each group as a reserve for any drop out. 44 patients (twenty two in each group) were included in the study.

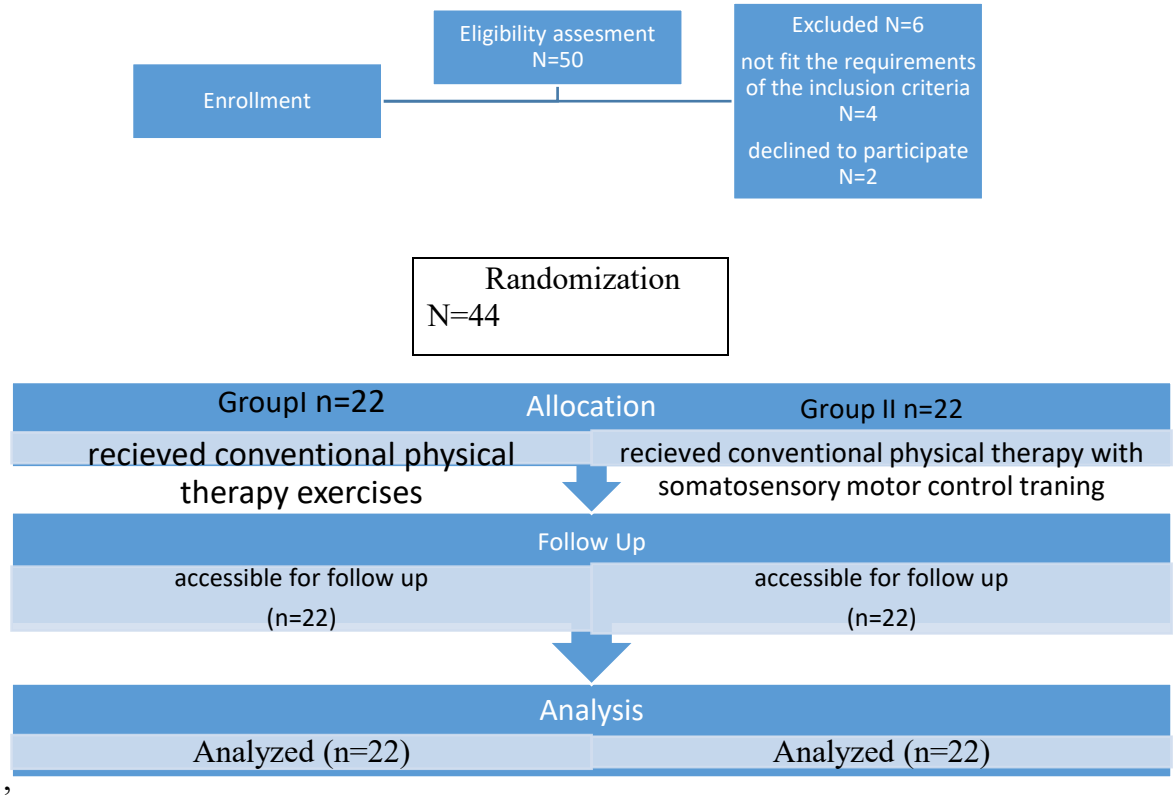


Figure 1: Flow chart of study patients

Patients :

Patients were eligible for inclusion in our study, if they were aged from 25 and 40 years old, were willing to participate in the intervention, had a clinical diagnosis of SIS (Neer's stage II) [6], had shoulder pain for at least three months, had a painful arc of movement during flexion or abduction, positive Neer's or Kennedy-Hawkins Test [14], pain during resisted external rotation and abduction [2].

Patients were excluded if they had prior history of cervical radiculopathy symptoms, neurological disorders, inflammatory disorders, widespread pain condition, complete rotator cuff tear and any previous surgery to the affected shoulder [14].

All Patients were referred by orthopedic surgeons with diagnosis of SIS.

Evaluation and treatment were accomplished at the out-patient clinic of physical therapy in El Mansoura International Hospital in Dakahlia, Egypt in the period from January 2023 to April 2023.

The patients were informed about the study objectives and signed informed consent forms . This study covered standards for research and approved by the ethics committee in the faculty of physical

therapy Cairo university (P.T.REC/012/004033).

Measurement Procedures :

1.Shoulder function, assessed by using Shoulder Pain and Disability index questionnaire (appendix I) [15].

2. Shoulder range of motion: digital inclinometer was used to measure shoulder abduction ,internal and external rotation range of motion which are commonly limited in SIS [16].

3.Shoulder joint proprioception

A digital inclinometer was used to evaluate joint position sense (JPS) of shoulder flexion at 30°,60°and 90°, the device was firmly attached to the subject‘s arm using straps as shown in Figure 2 [17].

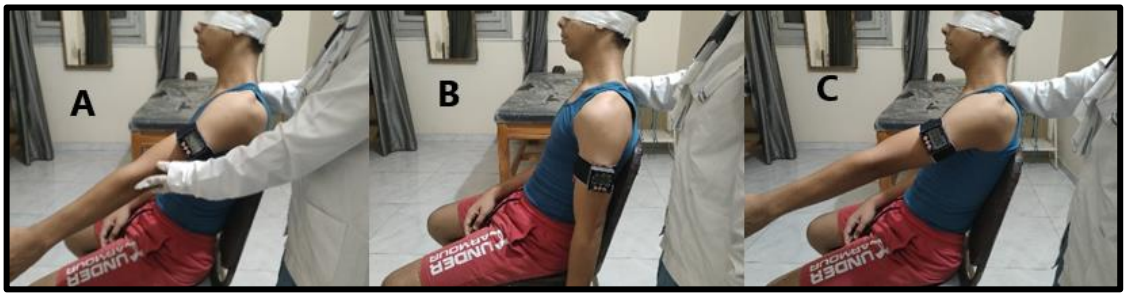


Figure 2: Assessment of joint position sense at 60° of shoulder flexion using digital inclinometer. A : passive placement of the patient’s arm to the target angle (60°)

B: the patient’s arm returned to the starting position.

C: active replacement to the target angle (60°).

Treatment procedures:

Conventional therapeutic exercises program consisted of :.

1.Stretching exercises performed for upper trapezius ,pectoralis minor and posterior region of the shoulder . each stretch consisted of 3 repetitions of 30 s, with an interval of 30 s between repetitions [18].

2. Strengthening exercises : shoulder external rotation exercise, shoulder extension exercise targeting lower trapezius and shoulder protraction exercise targeting serratus anterior muscle. strengthening exercises were completed by using 1-meter long color-coded elastic resistance bands with 3 progressive levels of resistance identified by colors: red, green, and blue [18, 19].

Somatosensory motor control training program consisted of:

1. Proprioceptive exercises [20] balance exercises on unstable surfaces.

2.Scapular repositioning exercises with feedback.

a)Scapular orientation exercise [21]: involved learning optimal scapular orientation at rest. Then participant was asked to actively reproduce this orientation using visual (in a mirror), auditory (from therapist),and kinesthetic cues such as palpation.

b) Shoulder control training through using feedback [22]: Once the scapula was placed into an optimal position, the participant was asked to control the orientation of the scapula while lifting their arm in the frontal, sagittal, and scapular planes and exercises were graded according to visual, auditory, tactile feedback. The exercises will be performed with slow, conscious, and paced movements in 3 sets of 10---15 repetitions [23].

3.Neurocognitive exercises. Participant was asked to distinguish five different concentric circles placed on an inclined plane by touching the surface with a finger [24]. The therapist varied the inclination and position of the plane according to joint movements (task a) as shown in figure 3(A).

Participant was asked to recognize sponges of different texture placed in correspondence of the interscapular space, the medial border of the scapula, the spine of the scapula, the clavicle and the coracoacromial arch (task b) as shown in Figure 3(B).

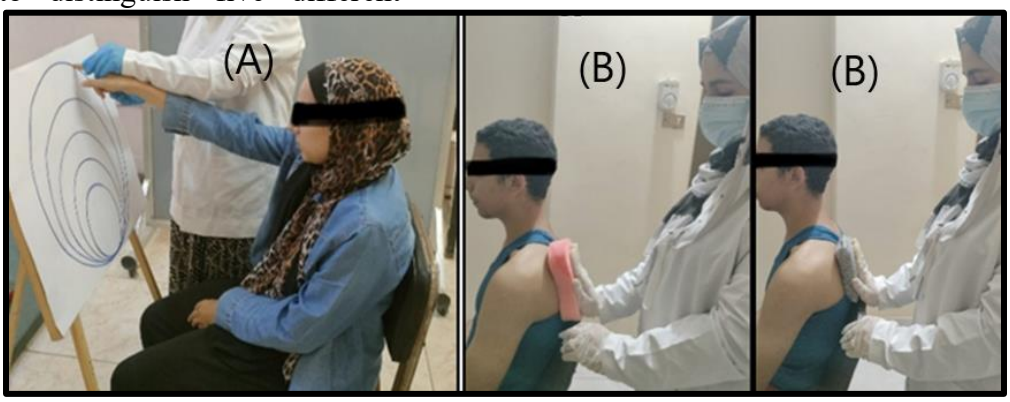


Figure 3: neurocognitive exercises (A) task (a), (B) task (b)

A: patient was asked to distinguish five different concentric circles.

B: patient was asked to recognize sponges of different texture.

Patients in the two groups received a total of 18 treatment sessions (three sessions a week for six weeks) each lasting 35–45 minutes.

Patients were asked to refrain from any other treatment for pain management and from structured exercise programs.

Data Analysis:

Forty four patients were included and analyzed (twenty two in each group) as shown in flow chart figure(1).

Data collected were reviewed and coded. These numerical codes were fed to the computer where statistical analysis was done using the Statistic Package for Social Science Version 25 (SPSS 25).

Analytical statistics: Comparing groups was done using

Chi square-test (X^2) :for comparison of qualitative data.

Student's "t"- test for comparison of quantitative data of 2 independent sample with normal distribution variables.

The coefficient interval was set to 95%. The level of significance was calculated according to the following probability (P) values: $P<0.05$ was considered statistically significant.

RESULTS

General characteristics of the patients:

Participants in both groups did not differ in their demographic data ,as shown in table (1). there was no significant difference between groups (P>0.05).

Table (1): Demographic data of age, body mass index (BMI) and sex

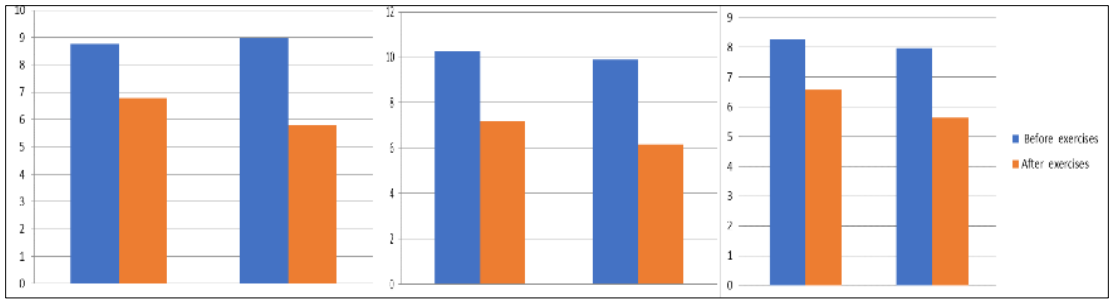
Item	Group I	Group II	Comparison	S
	Mean±SD	Mean±SD	P-value	
Age	29.54±4.82	29.4±4.62	0.834	NS
BMI	31.05±4.96	32.27±4.81	0.41	NS
Sex distribution				
	Group I	Group II	P-value	
Female	9(40.9%)	8(36.4%)	0.757	
Male	13(59.1%)	14(63.3%)		NS

*SD: standard deviation, P: probability, S: significance, NS: non-significant.

1. Shoulder function: Student t test for independent samples revealed that the mean values of the pretest shoulder pain and disability index score between both groups showed no significant differences. On the other hand, student t test for independent samples revealed that there was significant difference of the mean values of the "post" test between both groups.

2. shoulder abduction, internal and external rotation range of motion : Student t test for independent samples revealed that the mean of the pre-test range of motion between both groups showed non-significant differences neither pre-test nor post-test as shown in table (2).

3.Shoulder proprioception (Absolute angular error of shoulder flexion at 30°,60°, 90°) : Student t test for independent samples revealed that the mean of the pre-test absolute angular error values at 30°,60°, 90° shoulder flexion between both groups showed no significant differences. On the other hand, student t test for independent samples revealed that there was significant difference of the mean values of the "post" test between both groups with ($p<0.05$) as shown in table (2) and figure 4.



(A) Group I Group II (B) group I Group II (C) Group I Group II

Figure 4: (A) shoulder joint position sense at 30 degree of the studied groups

(B) shoulder joint position sense at 60 degree of the studied groups

(C) shoulder joint position sense at 90 degree of the studied groups

Table (2): Comparison of SPADI score, shoulder abduction, internal and external rotation ROM and absolute angular error of shoulder flexion at 30°,60°,90° between-group differences Mean±SD and P values.

	Group I (N = 22)	Group II (N = 22)	
	Mean±SD	Mean±SD	P- value
SPADI			
Before exercises	52.27±15.836	55.95±11.968	0.383
After exercises	35.36± 6.06	25.32±5.52	0.008
Shoulder abduction ROM			
Pre test	97.90±11.35	93.90±9.69	0.216
Post-test	134.373±11.347	138.955±9.921	0.090
Shoulder internal rotation ROM			
Pre test	43.30±13.76	48.45±11.57	0.189
Post-test	72.20±15.01	69.85±10.26	0.547
Shoulder external rotation ROM			
Pre test	56.15±13.47	60.68±15.69	0.315
Post-test	89.47±16.12	94.95±14.70	0.922
JPS shoulder flexion 30°			
Pre test	8.77±1.58	8.98±1.89	0.079
Post-test	6.78±1.27	5.80±1.33	0.016
JPS shoulder flexion 60°			
Pre test	10.28±2.60	9.89±2.68	0.708
Post-test	7.21±1.41	6.15±1.21	0.011
JPS shoulder flexion 90°			
Pre test	8.27±1.88	7.98±1.29	0.986
Post-test	6.58±1.17	5.63±1.28	0.014

DISCUSSION

The results of the current study showed a significant improvement in shoulder function and proprioception when somatosensory motor control training added to conventional therapeutic exercises. And there was no significant difference in range of motion.

Shoulder function : In support of our results , neurocognitive rehabilitation using proprioceptive exercises which based on the stimulation and the improvement of high cortical functions such as attention, awareness, memory and language giving patients the ability to interact with the environment in order to know it and give it a meaning was effective in reducing pain and improving function in patients with SIS [24].

Recent randomized controlled trial compared the effects of specific exercises which include scapular orientation and shoulder control exercises (part of somatosensory motor control training in our study) with general exercises including strengthening, stretching and mobility exercises and reported that specific exercise program improved shoulder function and reduced pain on movement and fear of movement significantly more than a general exercise program in people with chronic SIS as in our study [25].

Contrary to our results : joint position, rhythmic stabilization and repositioning exercises when added to stretching , strengthening exercises and cold application in nursing professionals with rotator cuff disorders and ,there was no significant difference between 2 groups with regard to pain and function [26]. but both groups in the previous study received ice application which helped in pain reduction , decreased activation of the upper trapezius and improved function. and both groups followed the posture and joint protection orientations instruction. This can contribute to pain reduction and improvement in the patient condition.

Another systematic review revealed that there is no difference between specific and general exercises in terms of pain and function for people with SIS [27].but the studies included in those reviews were mostly of moderate to low quality with unclear descriptions of the method of randomization, blinding, and inclusion criteria for the diagnosis of SIS.

Range of motion: In support of our results scapular stabilization exercises which include proprioceptive exercises, scapular clock exercise, standing weight shift, double arm balancing, scapular depression, wall push up, wall slide exercises improved shoulder range of motion significantly but there was no significant difference between them and standardized flexibility and strengthening exercises [28].also, another study reported that the addition of proprioceptive exercises to conventional physical therapy exercises may provide better proprioceptive acuity, but no additional positive effects were found on shoulder ROM. [20].

But Azar et al.,2014 found that scapular stabilization exercises was effective in improving shoulder range of motion more than conventional physical therapy in patients with SIS. In this study flexibility exercises was included in scapular stabilization exercises which may be the cause of range of motion improvement [29].

Shoulder proprioception : in agreement with our results shoulder proprioception improved significantly after neuromuscular training which consist of balance, coordination, proprioception, and strength exercises more than traditional strengthening exercises in patients with SIS [30].

Also, a recent study conducted on 33 overhead athletes who were randomly classified into three groups: open kinetic chain (OKC), sling, and control groups. Joint position sense was evaluated using Leighton flexometer. The study resulted in significant difference between groups, indicating that the sling exercises were more effective because they are closed kinetic chain (CKC) and performed on an unstable level [31]. Closed kinetic chain exercises were included in our study as proprioceptive exercises.

Reactive neuromuscular training in the form of rhythmic stabilization exercises which was included in our somatosensory motor control training program was found to be effective in improving shoulder joint position sense significantly compared to control group [32].

Proprioception is necessary for joint stability , motor control and athletic performance. Another study has shown that athletes have better proprioception when compared to inactive participants of the same age , demonstrating that physical activity may have an impact on proprioception [33].

CONCLUSION

Adding somatosensory motor control training to conventional therapeutic exercises was superior to conventional therapeutic exercises alone in improving shoulder function and proprioception for patients with SIS.

RECOMMENDATIONS:

According to the results of our study , further studies should be conducted to evaluate the long term effects of adding somatosensory motor control training to conventional therapeutic exercises in SIS patients.

Also, further studies are recommended to compare somatosensory motor control training and conventional therapeutic exercises in isolation not the combined effect on SIS patients.

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