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Effect of Adding Neural Mobilization Techniques to the Conventional Physical Therapy Program in Treating Shoulder Impingement Syndrome

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Abstract

Background: Shoulder impingement syndrome (SIS) is the most common disorder of the shoulder pain, accounting for 44%-65% of all complaints of shoulder pain. It is characterized by pain and functional restrictions, mostly during overhead activities.

Aim of Study: To determine the efficacy of adding neural mobilization techniques (NMTs) to conventional physical therapy program on scapular upward rotation and ratio of upper trapezius and serratus anterior (UT/SA) isometric muscle strength in treating SIS.

Patients and Methods: Thirty patients with unilateral SIS of both genders were selected, their ages ranged from 20 to 40 years (Mean ± SD was 27.06±4.57, 26.6±5.84. Patients were randomly assigned into two groups. Group A received conventional physical therapy program and group B received NMTs for median, ulnar and radial nerves beside conventional physical therapy program. Treatment program was performed for four weeks (3 sessions/week). All patients were assessed pre and post treatment for scapular upward rotation by using baseline bubble inclinometer and UT/SA ratio by using hand held dynamometer (HHD).

Results: There were no significant differences in both scapular upward rotation and UT/SA ratio between groups pretreatment (p=0.66, 0.64) and post treatment (p=0.33, 0.51), but there was a significant increase in scapular upward rotation and significant decrease in UT/SA ratio within groups (p=0.001 for both groups).

Conclusions: Neural mobilization techniques in addition to conventional physical therapy program had no significant effect on scapular kinematics in patients with SIS.

Key Words: *Shoulder impingement syndrome – Neural mobilization – Conventional physical therapy of SIS.*

Introduction

SHOULDER impingement syndrome (SIS) is a mechanical compression of the rotator cuff tendon, the subacromial bursa and the long head of the biceps tendon in the subacromial space. It is characterized by pain during overhead motions and functional limitations **[1,2]**.

Shoulder impingement syndrome (SIS) is the most common disorder of the shoulder pain, accounting for 44%-65% of all complaints of shoulder pain **[3]**. It was stated that the incidence of rotator cuff tendinopathy over the world was ranged from 0.3% to 5.5% **[4]**.

The pain of SIS is persistent. Pain is mainly in the anterior and lateral area of the acromion and usually it radiates to the lateral aspect of the mid arm. The pain accelerates at night and when sleeping on the affected side. Possibly female patients have difficulty buttoning their bra. Stiffness and weakness are sometimes present due to pain **[5]**.

The treatment of SIS is mainly focused on decreasing pain and dysfunction, and improving shoulder and upper extremity functions **[6]**. Treatment of SIS depends on stage of SIS; in stages I or II, conservative interventions are effective **[6,7]**.

The most recent conventional physical therapy for SIS are scapular stabilization exercise, strengthening exercise, range of motion exercise, proprioception exercise and stretching exercise **[8]**. It was shown that combination between exercise and manual therapy is effective in treating of SIS **[9]**.

It was shown that combination between exercise and manual therapy is effective in treating of SIS **[9]**. Manual therapy includes mobilizations for shoulder joint and cervical manipulations, soft tissue and neural mobilization and mobilization with movement **[10]**. Other interventions such as

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ultrasound, low-level laser and extracorporeal shockwave are less effective in treating SIS [9].

Neural mobilization (NM) is one of the physical therapy treatment methods recommended for neck and arm pain to reduce nerve sensitivity [11].

There are two types of NM: Slider NM and tensioner NM. The slider is neurodynamic method that produces a sliding movement of neural structures relative to their adjacent tissues. So, sliders are generally more useful in decreasing of pain and enhancing excursion of the nerves [12].

The tensioner is a neurodynamic test that produces an increase in tension in neural structures. It depends on natural viscoelasticity of the nervous system and does not pass the elastic limit. Therefore, the tensioner technique does not produce damage and may improve neural viscoelastic, movement and physiological functions in the nervous system [12].

Some studies showed neural involvement in patients with tendenopathy and clarified the role of neural mobilization (NM) for tendenopathy. The utilization of NM may be useful in treating patients with tendonopathies that has neural component [13,14].

Neural mobilization is effective in decreasing the pain by restoring neurodynamic proprieties in upper extremity; improving blood supply of the nerve and the tendon and improving the superficial layer of proprioception [12,15].

The clinical significance of NMTs in patients with SIS is that it decreased the numbness and tingling sensation by reducing the neural sensitivity and neural edema and enhancing the nerve conduction. Normal tissue regeneration depends on mechanical stimulation of nerve during the healing. This may help to improve the tissue's overall physical and mechanical characteristics, such as flexibility and tensile strength [14].

Up to our knowledge, only one study investigated the effects of NMT especially for median nerve only on pain and disability in patients with SIS [15].

Patients and Methods

This study is clinical randomized trial. The study was conducted in Physical Therapy Outpatient Clinic, in Faculty of Physical Therapy, Cairo University, Egypt from June 2021 to January 2022 and ethical approvals were obtained by the Research Committee in Faculty of Physical Therapy, Cairo University with number: P.T.REC/012/003270 at a date 16/6/2021. The necessary official permission to implement study was obtained from the manager of outpatient clinics at faculty of physical therapy.

The patients were referred from the orthopedic surgeon with diagnosis of SIS stage I and II.

Inclusions criteria:

Patients were included if they had unilateral SIS stage I and II without any cervical problems, positive Neer test, Hawkins-kennedy test and Jobe's test and positive painful arc (pain at shoulder abduction between 60° to 120°) [16].

Exclusions criteria:

Patients were excluded if they had shoulder surgery, shoulder injury and osteoarthritis, cervical radiculopathy and other systematic diseases [15].

Assessment instrumentations & procedures:

Patients were evaluated pre treatment and post treatment for scapular upward rotation ROM by base line bubble inclinometer and UT/SA ratio by hand held dynamometer.

1- Baseline bubble inclinometer:

(Item#: 060020 Made in USA. CE: 12-1056 Base).

The inclinometer was used to measure scapular upward rotation. It has “good to excellent” intrarater reliability and established concurrent validity with a 3D motion tracking device [17,18].

Scapular upward rotation ROM:

Patient was in sitting position, then the root of the scapular spine was identified. The inclinometer was placed on the root of the scapula [19]. The patient was asked to elevate glenohumeral joint maximally and the angle of upward rotation of the scapula, as measured by the inclinometer, was recorded. The measurement was recorded three times for each subject and then the mean value was taken. As shown in Fig. (1).

2- Hand held dynamometer (HHD):

(Model 3790, Lafayette Instrument Company. Made in USA).

A study indicated that intrarater reliability of HHD in strength measurement of the shoulder and scapular muscles is good to excellent reliability in healthy subjects as well as in patients with SIS [20].

Fig. (1): Measuring scapular upward rotation with the baseline bubble inclinometer.

Ratio between upper trapezius and serratus anterior strength:

A- *Assessment of upper trapezius isometric strength:*

Patient was in sitting position, his shoulder in neutral position, and HHD was fixed at the patient's shoulder **[21]**. Patient was asked to shrug his shoulder with maximum force against the therapist hand, that hold HHD and then maintained a static state till heard a beep from the HHD after 5 seconds during which the maximum force was recorded in kilogram. As shown in Fig. (2).

The measurement was recorded three times for each subject and then the mean value was taken.

B-*Assessment of serratus anterior isometric strength:*

Patient was in supine lying position, his shoulder 90° flexed and medially rotated and elbow 90° flexed, and the HHD was fixed at the patient's forearm **[21]**. Patient was asked to push with maximum force against the therapist hand, that hold HHD and then maintained a static state till heard a beep from the HHD after 5 seconds during which the maximum force was recorded in kilogram. As shown in Fig. (3).

The measurement was recorded three times for each subject and then the mean value was taken. Then UT/SA ratio was recorded.

Treatment procedures:

Three sessions were given a week for 4 weeks (about totally twelve sessions for each patient).

Treatment procedures for group A:

Group A received conventional physical therapy program (rotator cuff strength, posterior capsule stretch and scapular muscles training exercise) **[9]**.

Patients performed the following exercises against resistance by external weights which are determined by 10 repetition maximum technique.

A- *Rotator cuff strengthening exercise:*

All exercises were performed for 3 sets/10 repetitions. Rest periods of 2s were given between exercise repetitions and 30-60 s between exercise sets **[22]**.

1- *Full cane exercise:*

Patient was in sitting position and was asked to elevate the shoulder at scapular plane with external rotation using weights. As shown in Fig. (4).

2- *External rotation exercise:*

Patient was in sitting position, and was asked to externally rotate the shoulder while the arm at 0º abduction with the elbow flexed 90º and resistance was applied using weights. As shown in Fig. (5).

3- *Prone elevation exercise:*

Patient was in prone and the shoulder in horizontal at 145º abduction and full external rotation and the patient was asked to elevate the arm using weights. As shown in Fig. (6).

B- *Stretching exercise for posterior capsule:*

Sleeper stretch:

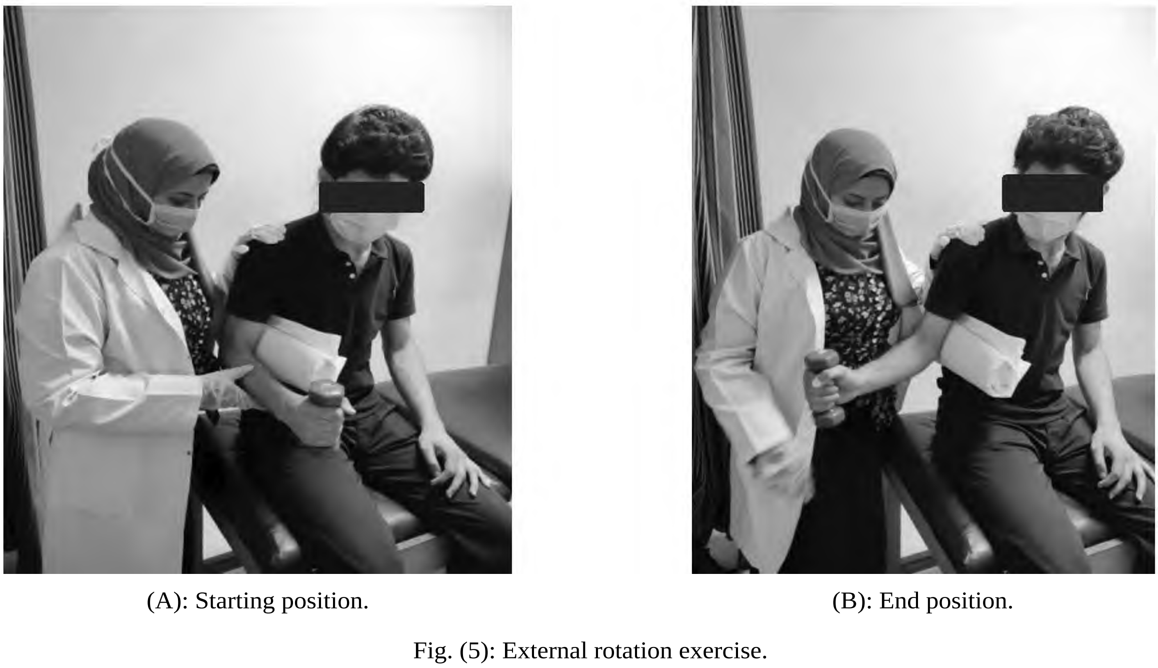
Patient was in sidelying on the side to be stretched, the therapist flexed the shoulder to 90° on the plinth, then the therapist did passive internal rotation by one hand and the other hand supported on the shoulder. It was performed 3 times for 30 seconds. As shown in Fig. (7).

Fig. (2): Upper trapizus muscle isometric strength test.

Fig. (3): Serratus anterior muscle isometric strength test.

(A): Starting position. (B): End position.

Fig. (4): Full cane exercise.



(A): Starting position. (B): End position.

Fig. (5): External rotation exercise.

Fig. (6): Prone elevation exercise.

Fig. (7): Sleeper stretch for posterior capsule.

C- *Scapular muscles training (Cools exercise):*

Each exercise was done 3 sets of 10 repetitions and 1 minute of rest between sets and resistance was applied on the wrist by weights.

1- Prone extension:

Patient was in prone with hand extended beside him or her and the patient was asked to do retraction and extension of the two shoulders. As shown in Fig. (8).

2- Prone horizontal abduction with external rotation:

Patient was in prone and two shoulders in horizontal abduction and elbow extension and the patient was asked to do horizontal abduction of the shoulders with an additional external rotation of the shoulders at the end of the movement. As shown in Fig. (9).

3- Forward flexion in side lying:

Patient was in side lying with hand on the trunk then he or she did forward flexion of the shoulder. As shown in Fig. (10).

4- External rotation in side lying:

Patient was in side lying with hand on the trunk and the elbow was in 90° flexion and towel was between elbow and the trunk and the patient was asked to do external rotation of the shoulder. As shown in Fig. (11).

Treatment procedures for group B:

Group B received the same conventional physical therapy program as group A beside NMTs for median, ulnar and radial nerves.

Neural mobilization was applied using Butler's techniques. Initially, patient took neural sliders and gradually progressed to neural tensioner. NMTs were applied for five seconds with 10 repetitions to control pain. The tension position was held for 10 seconds **[23]**.

For median nerve:

Patient was in supine and physiotherapist applied shoulder girdle depression, then abducted the shoulder, extended the elbow, rotated the arm externally, supinated the forearm, and then extended wrist, fingers and thumb.

Slider technique was applied by lateral side binding of the cervical toward the involved side while distal extension of wrist and fingers, or by lateral side binding of the cervical toward the opposite side or in neutral position while fingers and wrist were being flexed. As shown in Fig. (12).

Tensioner technique was applied by contralateral cervical side binding while distal extension of wrist and fingers and held for 10 seconds. As shown in Fig. (13).

For ulnar nerve:

Patient was in supine and physiotherapist applied wrist extension and forearm supination followed by full range of elbow flexion, then depressed shoulder girdle, physiotherapist maintained this position and added shoulder lateral rotation and abduction, in the final position the patient's hand was near his or her ear with fingers pointing posteriorly.

Slider technique was applied by lateral side binding of the cervical toward the involved side while wrist extension or by lateral side binding of the cervical toward the opposite side or in neutral position while wrist flexion. As shown in Fig. (14).

Tensioner technique was applied by contralateral cervical side binding while extension of wrist and fingers and held for 10 seconds. As shown in Fig. (15).

For radial nerve:

Patient was in supine and physiotherapy applied shoulder girdle depression, then abducted the shoulder, extended the elbow, medially rotated the arm and pronated the forearm, kept the elbow in extension and added wrist, finger and thumb flexion, finally ulnar deviation of the wrist.

Slider technique was applied by lateral side binding of the cervical toward the involved side while wrist and fingers flexion or by lateral side binding of the cervical toward the opposite side or in neutral position while wrist. As shown in Fig. (16).

Tensioner technique was applied by contralateral cervical side binding while flexion of wrist and fingers and held for 10 seconds. As shown in Fig. (17).

(A): Starting position. (B): End position.

Fig. (8): Prone extension.

(A): Starting position. (B): End position.

Fig. (9): Prone horizontal abduction with external rotation.

(A): Starting position. (B): End position.

Fig. (10): Forward flexion in side lying.

(A): Starting position. (B): End position.

Fig. (11): External rotation in side lying.

(A): Starting position. (B): End position.

Fig. (12): Slider techniques for median nerve.

Fig. (13): Tensioner technique for median nerve.

(A): Starting position.

(B): End position.

Fig. (14): Slider technique for ulnar nerve.

Fig. (15): Tensioner technique for ulnar nerve.

(A): Starting position.

(B): End position.

Fig. (16): Sliding technique for radial nerve.

Fig. (17): Tensioner technique for radial nerve.

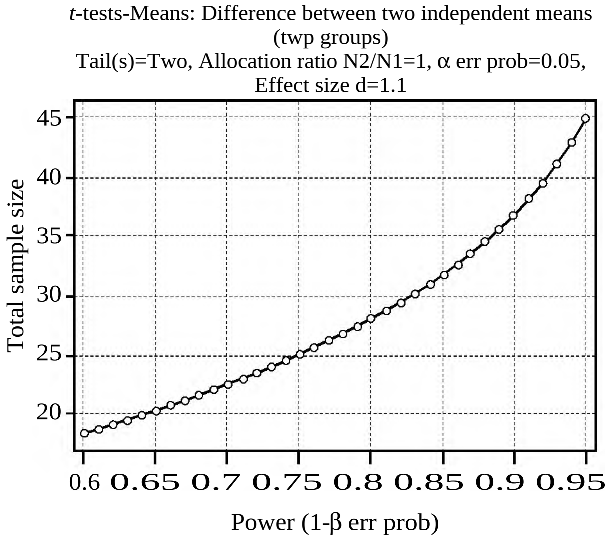


Fig. (18): Sample size calculation.

Statistical analysis:

Descriptive statistics and unpaired *t*-test were conducted for comparison of patients' characteristics between groups. Chi-squared test was conducted for comparison of sex and affected side distribution between groups. Normal distribution of data was checked using the Shapiro-Wilk test. Levene's test for homogeneity of variances was conducted to test the homogeneity between groups. Mixed design MANOVA was performed to compare within and between groups effects on scapular upward rotation and UT/SA ratio. Post-hoc tests using the Bonferroni correction were carried out for subsequent multiple comparison. The level of significance for all statistical tests was set at $p<0.05$. All statistical analysis was conducted through the statistical package for social studies (SPSS) version 25 for windows (IBM SPSS, Chicago, IL, USA).

Results

Sample size calculation:

Sample size calculation was performed using G*POWER statistical software (version 3.1.9.2; Universitat Kiel, Germany) as shown in Fig. (18) and revealed that the required size of each group was 15. The Calculations were made using $\alpha=0.05$, $\beta=0.2$ and large effect size=1.1. Calculation was made based on NRS data from previous study (Akhtar et al., 2020).

Patients characteristics:

Thirty patients participated in this study. Table (1) showed the patients characteristics of the group A and B. There was no significant difference between both groups in the mean age, BMI, sex and affected side distribution ($p>0.05$).

Table (1): Comparison of the mean age, BMI, sex distribution and affected side distribution of the group A & B.

	Group A	Group B	*p*-value
	Mean ± SD	Mean ± SD	
Age (years)	27.06±4.57	26.6±5.84	0.81
BMI (kg/m^2)	25.9±2.53	26.1±4.02	0.86
Sex distribution, n (%):			
Females	7 (47%)	8 (53%)	0.71
Males	8 (53%)	7 (47%)	
Affected side, n (%):			
Dominant side	6 (40%)	8 (53%)	0.46
Non-dominant side	9 (60%)	7 (47%)	

SD: Standard deviation.
p-value: Probability value.

Effect of treatment on scapular upward rotation and UT/SA ratio:

Mixed MANOVA revealed that there was a significant interaction of treatment and time (F= 2.86, $p=0.04$). There was a significant main effect of time (F=1.31, $p=0.29$). There was no significant main effect of treatment (F=1.31, $p=0.29$).

Within group comparison:

Both groups showed a significant increase in scapular upward rotation and a significant decrease in UT/SA ratio post treatment compared with that pre treatment (p>0.001). The percent of change in scapular upward rotation and UT/SA ratio of group A was 69.47 and 12.04% respectively while that in group B was 75.78 and 11.01% respectively. Table (2) and Figs. (19,20).

Table (2): Mean scapular upward rotation and UT/SA ratio of the group A and B.

	Group A	Group B	MD	p-value
	Mean ± SD	Mean ± SD		
Scapular upward rotation (degrees):				
Pre treatment	10.81±4.5	11.48±3.8	–0.67	0.66
Post treatment	18.32±6.13	20.18±4.12	–1.86	0.33
MD	–7.51	–8.7		
% of change	69.47	75.78		
	p=0.001	*p*=0.001		
UT/SA ratio:				
Pre treatment	1.08±0.07	1.09±0.05	–0.01	0.64
Post treatment	0.95±0.08	0.97±0.06	–0.02	0.51
MD	0.13	0.12		
% of change	12.04	11.01		
	p=0.001	*p*=0.001		

SD: Standard deviation.
MD: Mean difference.
p-value: Level of significance.

Between group comparison:

There was no significant difference between groups pre treatment (p>0.05). There was also no significant difference in scapular upward rotation and UT/SA ratio post treatment (p>0.05). Table (2) and Figs. (19,20).

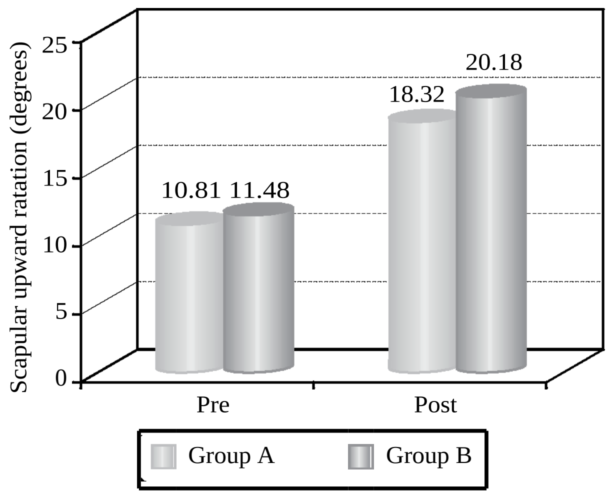


Fig. (19): Mean scapular upward rotation pre and post treatment of group A and B.

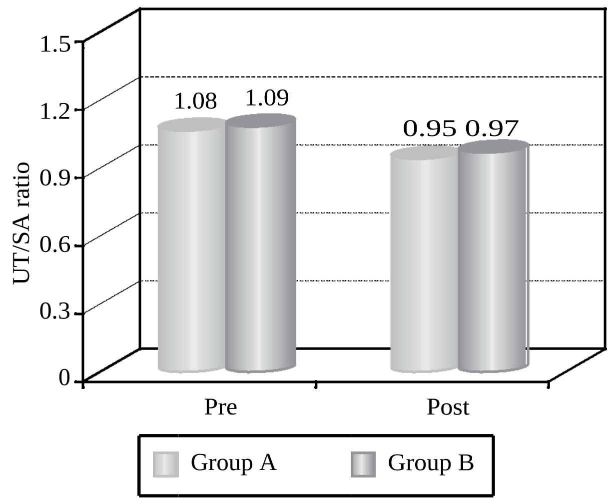


Fig. (20): Mean UT/SA ratio pre and post treatment of group A and B.

Discussion

The results of the study revealed that both groups (A and B) showed significant increase in scapular upward rotation and improvement in UT/SA ratio within groups, but there were no significant differences between the two groups.

This may be attributed to that NM improved scapular upward rotation and scapular muscles strength due to its positive effects on pain and the mechanical effects or by increasing neural vascularity, so improved blood supply to tendons and muscles and improved axoplasmic transport **[24,25]**.

Another possible mechanism was that it increased motor stimulation at a central level and restoration of maladaptive cortical reorganization in these patients. It also caused in muscle relaxation allowing more ROM **[24,25]**.

Also, NM is one of manual therapy that stimulated superficial proprioceptors that decreased pain and improved both ROM and strength **[15]**.

The benefits of NM include facilitation of nerve gliding, reduction of adhesions around the nerve, restoring the relative movements between neural tissues and surrounding mechanical interfaces, dispersion of noxious fluids, increasing neural vascularity and improvement of axoplasmic flow **[12,26]**. All these benefits may contribute in improving scapular ROM and scapular muscles strength.

Up to our knowledge, effect of NM on scapular upward rotation and UT/SA ratio in patients with SIS has not been studied yet. This was the first study investigated the effect of NM on scapular upward rotation and UT/SA ratio in patients with

SIS, so it was not possible for us to compare the results of the current study with other studies.

The results of the current study came in agreement with Yılmaz et al. (2020) who found no significant differences in grip strength, pinch strength, joint mobility and functional level in patients with tennis elbow after adding NMT to conventional physical therapy **[24]**.

In addition to that, Gamelas et al. (2019) found no significant differences in hand grip strength when compared sliding median nerve mobilization to tensioner median nerve mobilization in asymptomatic participants **[27]**.

The results of the current study were consistent with Manchanda et al. (2013) who found that adding NMT to wrist splinting had no significant effect on grip strength in carpal tunnel syndrome (CTS) **[28]**.

Akalin et al. (2002) showed that adding NMT and tendon gliding exercises to wrist splinting in treating people with CTS had no significant effect in hand grip and pinch strength except lateral pinch strength **[29]**.

Drechsler et al. (1997) concluded that hand grip strength was not affected by adding NM for standard physical therapy program in treating tennis elbow at time of discharge or at follow-up **[30]**.

On the other hand, Gaber et al. (2020) compared the effect of NM versus ultrasound on hand grip strength in patients with cubital tunnel syndrome. They clarified that NM had a significant effect in improving hand grip strength in people with cubital tunnel syndrome **[25]**.

The non significant difference between groups might be due to that NMTs were applied for median, ulnar and radial nerves which do not supply scapular muscles. Another explanation for this non significant difference may be due we used scapular muscle exercises in both groups and these exercises have significant effects on both scapular and shoulder muscles strength and ROM as illustrated in several studies **[31,32]**. Short duration protocol of four weeks only may be cause for not detecting any differences between the groups.

Limitations:

The limitations of this study were the short follow-up period. Unfortunately, the effects of NM on scapular ROM and scapular muscles strength in patients with SIS has not been studied yet, so it was not possible to compare the current study results with other studies.

Recommendations:

Further studies will be needed to assess the effect of NMTs on shoulder and other scapular ROMs. Further studies will be required to assess the effect of NMTs on shoulder and other scapular muscles strength. More studies should be conducted to assess the effect of NMTs on long-term follow-up in SIS as we suggest that a long-term follow-up is better for understanding the effect of NM applications. Further studies should be conducted to assess the effect of NMTs on electromyographic activity of shoulder and scapular muscles. Further studies should be conducted to assess the effect of NMTs on sub acromial space measurement.

Conclusions:

On the basis of the current study findings, adding NMT to the conventional physical therapy program had no effects on improving scapular upward rotation ROM or scapular muscles strength in patients with SIS.

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تأثير إضافة تقنيات التحريك العصبى إلى برنامج العلاج الطبيعى التقليدى فى علاج متلازمة انحشار الكتف

الخلفية : متلازمة انحشار الكتف هى أكثر اضطرابات آلام الكتف شيوعاً، حيث تمثل ٤٤٪–٦٥٪ من جميع شكاوى آلام الكتف. يتميز بالألم والإعاقة الوظيفية، غالباً أثناء الأنشطة العلوية.

الهدف من الدراسة : تحديد مدى فاعلية إضافة تقنيات التحريك العصبى إلى برنامج العلاج الطبيعى التقليدى على مدى حركة دوران لوح الكتف لأعلى، وعلى النسبة بين قوة العضلة شبه المنحرفة العلوية وعضلة المنشارية الأمامية.

الطرق : تم اختيار ثلاثين مريضاً يعانون من متلازمة انحشار الكتف (المرحلة الأولى والثانية) أحادى الجانب من كلا الجنسين، وتتراوح أعمارهم من ٢٠ إلى ٤٠ عاماً. تم تقسيم المرضى عشوائياً إلى مجموعتين. تلقت المجموعة (أ) برنا مج العلاج الطبيعى التقليدى وتلقت المجموعة (ب) تقنيات التحريك العصبى لكل من العصب المتوسط والعصب الزندى والعصب الكعبرى بجانب برنا مج العلاج الطبيعى التقليدى. استمر برنا مج العلاج لمدة ٤ أسابيع بمعدل يوم بعد يوم. تم تقييم جميع المرضى قبل وبعد برنامج العلاج لحركة دوران لوح الكتف لأعلى باستخدام الجهاز الخاص بتقييم المدى الحركى ونسبة القوة العضلية بين العضلة شبه المنحرفة العلوية والعضلة المنشارية الأمامية باستخدام جهاز الديناموميتر الرقمى لقياس قوة العضلات.

النتائج : لم يكن هناك فروق ذات دلالات إحصائية فى حركة دوران لوح الكتف لأعلى ونسبة القوة العضلية بين العضلة شبه المنحرفة العلوية والعضلة المنشارية الأمامية بين المجموعات قبل وبعد العلاج، ولكن كانت هناك زيادة كبيرة فى حركة دوران لوح الكتف لأعلى وانخفاض كبير فى نسبة القوة العضلية بين العضلة شبه المنحرفة العلوية والعضلة المنشارية الأمامية داخل كلا المجموعتين.

الخلاصة : إضافة تقنيات التحريك العضبى إلى برنامج العلاج الطبيعى التقليدى ليس له تأثير ذو دلالة إحصائية فى حركة دوران لوح الكتف لأعلى أو قوة عضلات لوح الكتف فى علاج مرضى متلازمة انحشار الكتف.