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Original Article

Outcomes of scapulothoracic mobilisation in patients with neck pain and scapular dyskinesis: A randomised clinical trial

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الملخص

أهداف البحث: لا توجد دراسات متاحة حول آثار تحريك لوح الكتف مع حركة الرقبة على المرضى الذين يعانون من آلام الرقبة وخلل الحركة في لوح الكتف. هدف هذا البحث دراسة آثار إضافة تحريك لوح الكتف مع الرقبة إلى برنامج التمارين العلاجية والشريط اللاصق في المرضى الذين يعانون من آلام الرقبة ولديهم خلل في حركة لوح الكتف.

طرق البحث: تم التعيين العشوائي لأربعين مشاركا يعانون من ألم الرقبة وخلل في حركة لوح الكتف في إحدى المجموعتين لمدة ثلاثة أسابيع: مجموعة التجربة (تحريك لوح الكتف مع الرقبة + تمارين علاجية + شريط لاصق علاجي) أو مجموعة المقارنة (تمارين علاجية + شريط لاصق علاجي). تم قياس شدة الألم، وعتبة الألم بالضغط، والمدى الحركي للرقبة ولوح الكتف، ومؤشر إعاقة الرقبة قبل أول جلسة وبعد الجلسة الثالثة وبعد الجلسة السادسة.

النتائج: انخفض الألم بعد الجلسة السادسة في كلتا المجموعتين. لم يتغير مقدار عتبة الألم بالضغط أو المدى الحركي للوح الكتف، باستثناء حركة الدوران العلوي للوح الكتف حيث قلت هذه الحركة بشكل ملحوظ فقط في مجموعة المقارنة في الجلسة السادسة. تحسن المدى الحركي للرقبة إحصائيا في عدة اتجاهات في كلا المجموعتين. مؤشر إعاقة الرقبة تحسن في كلا المجموعتين. لم تكن هناك فروق ذات دلالة إحصائية بين المجموعات في أي من القياسات في أي جلسة.

الاستنتاجات: لا يبدو أن إضافة تحريك لوح الكتف مع الرقبة إلى التمارين العلاجية والشريط اللاصق العلاجي على مدى ثلاثة أسابيع يضيف فائدة للألم والوظيفة في المرضى الذين يعانون من آلام الرقبة ولديهم خلل في حركة لوح الكتف.

الكلمات المفتاحية: الفقرات العنقية؛ العلاج اليدوي؛ التحريك اليدوي للمفصل مع الحركة؛ العلاج الطبيعي؛ عتبة الألم بالضغط

Abstract

Objectives: The perceived outcomes of scapulothoracic mobilisation with movement (MWM) in patients with neck pain and scapular dyskinesis remain unclear. This study aimed to examine the effects of adding scapulothoracic MWM to the corrective exercise and taping regimen in patients with neck pain and scapular dyskinesis.

Methods: Forty participants with neck pain and scapular dyskinesis were randomly assigned to one of two 3-week regimens: experimental (scapulothoracic MWM + corrective exercises + tape) or comparison (corrective exercises + tape). The visual analogue scale, pressure pain threshold (PPT), cervical and scapular range of motion (ROM), and neck disability index (NDI) were measured at the start and after the third and sixth sessions.

Results: Pain decreased after the sixth session in both experimental (mean difference: 3.1; 95% confidence interval [CI]: 2.1–4.1) and comparison (mean difference: 1.8; 95% CI: 0.81–2.8) groups. Although there was no change in PPT and scapular ROM, scapular upward rotation decreased significantly only in the comparison group in the sixth session ($p = 0.014$). The ROM for neck extension, right rotation, and right and left side bending improved significantly ($p \leq 0.031$) in both groups. The NDI improved in both the experimental (mean difference: 7.2–10.6; 95% CI: 2.5–15.7) and comparison (mean difference: 5.9–10.3; 95% CI: 1.2–15.4) groups. There were no significant differences in outcomes between the groups.

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Conclusions: In this study, the addition of scapulothoracic MWM to the corrective exercise and taping regimen over a 3-week period did not increase pain or improve function in patients with neck pain and scapular dyskinesis.

Keywords: Cervical spine; Mobilization with movement; Scapular dyskinesis; Scapular range of motion; Neck disability index

Introduction

Neck pain is a common condition, especially in people older than 50 years, with a global point prevalence of 4.9%. It is the fourth highest cause of disability, and disability-adjusted life increased from 23.9 million years to 33.6 million years between 1990 and 2010.[1] In KSA, the prevalence of neck pain among patients with a neck disorder was estimated to be 35.8% in 2011–2013.[2]

Treatment modalities for patients with neck pain include conservative and surgical interventions. Conservative care involves medication and non-medication intervention; the treatment plan depends on the accumulation of evidence that indicates no advantages of surgery over conservative treatment or the use of one medication over another medication, or non-medication, in patients with neck pain.[3,4] Physical therapy includes, but is not limited to, neck and/or scapulothoracic range of motion (ROM) exercises, stretching, strengthening, and endurance exercises; aerobic training; dry needling; laser therapy; intermittent mechanical/manual traction; patient education and reassurance; and manual therapy applied mainly to the cervical and/or thoracic spine.[5]

Scapular dysfunction refers to an altered resting position and/or movement of the scapula and has been termed 'scapular dyskinesis'.[6] Currently, treatment options for scapular dyskinesis include neuromuscular coordination, strength training, stretching exercises, and mobilization techniques such as manual stretching, soft-tissue techniques, accessory joint mobilization, and mobilization with movement (MWM).[7] MWM is a type of joint mobilization technique developed by Brian Mulligan, during which a sustained specific force or glide is applied to a joint by a therapist while the patient actively performs a previously impaired movement. MWM has been well established and is commonly used in clinical practice for many musculoskeletal disorders.[8] The scapula is linked to the neck anatomically and functionally[9]; thus, MWM may have positive effects in patients with neck pain. To date, only one randomised clinical trial (RCT) has attempted to determine the effect of Mulligan's MWM in patients with scapular dyskinesis. However, that trial recruited healthy participants and used only scapular position and humeral head position as outcome measures.[10] Therefore, further studies are needed to clarify the efficiency of MWM in patients with neck pain.

Few studies have demonstrated the relationship between scapular dyskinesis and neck pain, and the association of scapular dyskinesis with neck pain is dependent on clinical observations than on scientific evidence.[6] However, to the best of our knowledge, no studies have investigated the effect of scapulothoracic mobilisation with neck movement in patients with neck pain. Therefore, the current study aimed to determine the effects of passive scapular mobilisation with active neck movement on the neck pain, ROM, and function in patients with scapular dyskinesis and neck pain; the results of this study may provide some insights into the potential role of scapulothoracic MWM in neck impairment in these patients. The null hypothesis was that there would be no difference in neck pain, cervical and scapular ROM, and neck function between an experimental group with MWM and a comparison group without MWM amongst neck pain patients with scapular dyskinesis.

Materials and Methods

Study design and setting

This single-blind RCT was conducted at a hospital between April 2016 and February 2017, and the patients were blinded to the treatment assignment. A randomisation website (https://www.randomizer.org) was used to randomise the patients into two treatment groups in a parallel design (1:1 ratio). Patients were alternately allocated according to the generated random number to either (1) the experimental group (MWM + neck and scapulothoracic exercises + taping) or (2) the comparison group (neck and scapulothoracic exercises + taping). In this alternation type of allocation, patients were assigned to either group following a reciprocal pattern until all 40 patients were allocated. The primary investigator was responsible for the random allocation sequence, enrolment of participants, and assignment of participants to the intervention groups.

This study was approved by the institutional review board of the institution and registered at ClinicalTrials.gov (NCT03046160). The study followed the principles of the Declaration of Helsinki for human experimentation. Our findings are reported using the Consolidated Standards of Reporting Trials (CONSORT) guidelines.

Sample size calculation

The sample size was calculated using Tamaño de Muestra, Version 1.1, based on data from a previously published study.[11] Using the visual analogue scale (VAS) as a primary outcome, the following parameters were used to determine the sample size: a two-tailed t-test with two groups, with mean difference of 1.1 cm on the VAS, standard deviation of 0.7 cm, alpha level of 0.05, and power of 80%. The estimated desired sample size was 40, with a minimum of 20 patients per group.

Participants

Patients with neck pain who were referred to the Department of Physical Therapy and agreed to participate in the study were screened for eligibility. The therapist screened the participants for scapular dyskinesis using the scapular

dyskinesis test according to the procedure described previously,[12] in which the patients performed five repetitions of bilateral shoulder flexion and shoulder abduction while holding a weight with either hand (~1.5 kg for patients weighing less than 68 kg or ~2.5 kg for patients weighing more than 68 kg). The therapist observed the movement while standing 2 m away from the patient and assessed the scapulohumeral rhythm through visual observation. Dyskinesis was determined by visually observing scapular winging or dysrhythmia.[13] This test has a satisfactory reliability ($r = 0.48-0.61$)[12] and concurrent validity, as demonstrated by the difference in scapular kinematics between participants with and without scapular dyskinesis.[14] Consecutive patients with neck pain who had a positive scapular dyskinesis test were included in the study if they were adults (25–50 years of age), had neck pain for 3 months or longer before the study, and scored 5 or more on the Neck Disability Index (NDI). Patients were excluded if they had previously undergone neck or shoulder trauma or surgery, or suffered from cervical radiculopathy or severe systemic disease; if they had followed an exercise program for the muscles of the neck or scapula at least 6 months before the study; if they consumed caffeine, nicotine, or analgesics within 8 hours before the study; or if they had any contraindication to manual therapy. All patients provided written informed consent prior to participation.

Outcome measures

Demographic data and outcome measures were evaluated at baseline. All outcomes were measured at three stages: at session 1 (baseline), at session 3 after treatment, and at session 6 after treatment. All outcome measurement and intervention procedures were performed on the side of dyskinesis. If dyskinesis was bilateral, the procedures were performed on the side with greater dyskinesis.

Primary outcome measures

Pain

A 10-cm VAS with endpoints marked as "no pain" to "worst pain imaginable" was used to measure the pain intensity during the study. The VAS is clinically useful, has a moderate concurrent validity (0.71–0.78) when compared with the numeric pain rating scale, and has a high test-retest reliability (intraclass correlation coefficient [ICC] = 0.7–0.99).[15]

Cervical ROM

An electronic system with dual inclinometers (micro-FET^{6IM} ARCON TM Functional Capacity Evaluation, Michigan, USA) (Figure 1) was used to measure cervical ROM, as described previously.[16] This system has good to high intra-rater and inter-rater reliability ($ICC = 0.75-0.92$). Construct validity was demonstrated by a significant difference in ROM between control patients and neck pain patients ($p < 0.001$) and by a strong correlation between the device and radiographic measurements ($r = 0.82-0.97$, $p < 0.001$).[16] With an inclinometer fixed around their heads, patients were seated for all movements, except for cervical rotation, which was performed in a supine position. A slight overpressure was added to ensure that maximum limits of the range were reached.[16] An iPhone application (Clinometer, Peter Breitling, Version 3.3) was used to ensure a zero at the starting point of each measurement, as described previously.[17] Each patient performed the movements in the following order: flexion, extension, left side bending, right side bending, left rotation, and right rotation. A 5-second rest was given between each movement. Three measurements were performed for each movement, and the average was used for the analysis.

Secondary outcome measures

Pressure pain threshold (PPT)

A digital algometer (Somedic AB, Farsta, Sweden) with a 1 cm^2 probe was used to quantify the lowest stimulus intensity at which the patient experienced mechanical pain. This measurement has a high reliability ($r = 0.999$) and construct validity, as supported by its strong correlation with the readings from a force plate ($r = 0.990$).[18] The therapist applied a pressure of 40 kPa/s perpendicular to the skin over the area on the cervical spine that caused the participant the most pain. This area was determined by examining the cervical spine and the upper thoracic spine using central and unilateral posterior-anterior pressures. A mark was placed on a diagram in the data collection sheet to accurately locate the same area in the following sessions. The patients were asked to press a button when the pressure applied turned painful. Three measurements were taken over the tenderest point on the cervical spine, levator scapula, or upper trapezius, with a 30-second rest period between each measurement. The mean value of the three measurements was used for the analysis.

Scapular ROM

A palpation meter with an inclinometer (PALM) (Performance Attainment Associates, St. Paul, MN, USA) was used to measure scapular ROM for four movements: adduction, abduction, depression, and upward rotation. PALM has demonstrated moderate-to-high intra-rater and inter-rater reliability (ICC = 0.67–0.89).[19] Patients were seated on a short back-supported chair with hips and knees positioned at 90° of flexion. The measurements were obtained in two positions, which were as follows:

1) Both shoulders in a neutral position, with palms resting on the ipsilateral thigh. The scapular position was assessed using three parameters: a) *scapular adduction*: the horizontal line distance between the medial border of the scapula and the thoracic spine in the resting position, b) *scapular abduction*: the horizontal line distance between the medial border of the scapula and the thoracic spine with the arm elevated at 60° during scaption, and c) *scapular depression*: the distance between C7 and the acromion (Figure 2A and B).[19]
2) At 60° of active shoulder abduction in the coronal plane: this was done by the therapist using a goniometer. The patient actively maintained this position with the aid of a marker tape placed on an adjacent wall. Participants were given a 5-minute rest period after each measurement to avoid fatiguing them. Measurements were taken from a)

the root of the spine of the scapula to the spinous process of the adjacent thoracic spine, b) the inferior angle of the scapula to the adjacent spinous process of the thoracic spine, and c) the root of the scapular spine to the inferior angle of the scapula (Figure 2, C, D, and E). These three measurements were used to detect changes in *scapular upward rotation* using an equation as described in a previous study,[20] where a positive value indicates the degree of scapular upward rotation, and a negative value indicates the degree of scapular downward rotation.

Neck Disability Index

The ND is a self-reported questionnaire with 10 questions that are used to evaluate functional activities in patients with neck pain. The NDI assesses 10 items about subjective symptoms, activities of daily living, and discretionary activities of daily living. The score for each question ranges from 0 (no disability) to 5 (full disability), with a total raw score of 0−50 or a percentage score of 0%−100%. The raw score was used in the current study, as recommended by the developer of the NDI. The NDI has a moderate-to-high reliability (ICC = 0.50−0.98) and is strongly correlated to other, similar indices ($r \geq 0.70$).[21] In our study, the Arabic version of the NDI was used.[22]

Intervention

Each patient received six sessions over 2 to 3 weeks, with two to three sessions per week, and each session lasted for 30 to 60 minutes. Patients in the experimental group received the manual scapulothoracic MWM technique, in-session supervised scapulothoracic exercises, a corrective elastic tape, and a carry-over home program with the same scapulothoracic exercises. Patients in the comparison group received the same regimen, except for the scapulothoracic MWM technique. A 10-minute resting period was allowed between the assessment and the exercises in every session.

Mobilisation with movement

The patient sat upright, and the therapist stood on the opposite side of the affected scapula. The movement was carried out by the therapist, by reaching across the trunk, with the palm of the medial hand over the clavicle, and the lateral hand controlling the scapular glide; the therapist repositioned the participant's humeral head in a posterolateral glide with a gentle and slight downward pull, and consequently, applied a corrective gliding force to reposition the scapula to the optimal position using an adduction force along with posterior and external rotations of the scapula. Both hands were used to apply the corrective gliding force. While maintaining this position, the patient was asked to move his/her neck toward the side of restricted movement, to the point of onset of pain, and return to the starting point; the therapist applied further pressure toward the restricted neck movement when required. The technique was repeated six to 10 times. The MWM technique was initially indicated if the patient was able to achieve more than 50% of the limited range of movement with less or no pain. Subsequently, the patient was asked to repeat the restricted neck movement one to three times, independent of scapular positioning by the therapist. If the pain improved (≥50%) with this movement, three additional sets of six to 10 repetitions of the MWM technique were performed. All patients in the experimental group were responsive to the MWM technique to varying degrees.

Taping

A 25-cm water-resistant synthetic, active, elastic, and adhesive Kinesio tape (KT TAPE PRO, KT Tape®, USA) was used to correct the scapular dyskinesis. The patients were asked to hold the affected scapula down and move it medially toward the thoracic spine. An I-shaped elastic tape was applied to the belly of the upper trapezius. The anchor of the tape was fixed anteriorly at the coracoid process, with approximately 35% to 40% stretch, to the belly of the upper trapezius fibres and along the course of its lower fibres, to the thoracic spine posteriorly. The tape was divided into five blocks of 5 cm each, and only 10 cm was stretched. The patients were asked to remove the tape a few hours before the subsequent session.

Scapulothoracic exercises

The exercises included cervical retraction, scapular retraction, deep neck flexor strengthening, and active ROM exercises of the neck in all directions. The exercises were performed during the session and at home by holding the positions for 10 seconds with 10 repetitions, and all the exercises were performed five times every day.

Statistical analysis

Statistical analyses were performed using IBM SPSS for Mac (version 24.0, IBM, Armonk, New York, USA). Data normality was analysed using the Shapiro−Wilk test. All data for the outcome measures, except for scapular upward rotation data, were normally distributed at baseline. At baseline, an independent t-test was used to evaluate the differences in continuous data between the two groups, and a chi-square test was used to analyse the differences in the discrete data between the two groups. Normal distribution testing was performed for the demographic data of the participants and the baseline values of the repeated measurements. A mixed-model repeated-measurement analysis of variance was used to analyse within- and between-group differences at the baseline and after the third and sixth sessions (repeated measures were set as GROUP with two levels and TIME with three levels). Bonferonni post-hoc procedures were used for multiple comparisons of the differences over time. For scapular upward rotation, the Mann−Whitney U test was used for between-group analysis, whereas the Wilcoxon test was used for within-group analysis. An intention-to-treat analysis was also performed, because all patient data were analysed according to the group to which the patients were originally assigned. The incomplete data of five patients who dropped out of the study were adjusted by the mean values of the other group. Statistical significance was set at $P < 0.05$.

Results

Participant demographics

Figure 3 shows the CONSORT flow diagram of this study. A total of 64 patients were assessed for eligibility, of which 24 did not meet the inclusion criteria; the remaining 40 patients were randomised to the experimental or comparison group. Two participants in the experimental group and three in the comparison group discontinued treatment; none of the drop-outs were due to adverse events related to the interventions.

There were no significant differences between the experimental and comparison groups in all baseline demographic characteristics ($p \geq 0.103$), except for age, which differed by approximately 4 years ($p = 0.040$) (Table 1). The duration of neck pain for all participants was less than 1 year. Both groups of patients had right scapular dyskinesis, and some patients also had left scapular dyskinesis.

Outcome measures

The mean values and standard deviations for the outcome measures at all sessions are presented in Table 2. The differences in outcome measures for within- and between-group comparisons are shown in Tables 3 and 4, respectively. At baseline, there were no significant differences between the experimental and comparison groups in any outcome measures (VAS, $p = 0.184$; cervical ROM, $p \geq 0.083$; PPT, $p = 0.710$; scapular ROM, $p \geq 0.425$; NDI, $p = 0.670$) (Table 3). After the intervention, the pain, cervical ROM, and NDI of the participants improved significantly in both groups in the third and sixth sessions. Scapular upward rotation had significantly decreased only in the comparison group in the sixth session. There were no significant differences in the PPT between the two groups. No significant differences were found between the groups in any outcome measures at any session after the intervention (Tables 3 and 4) (see details below).

Figure 1: Electronic goniometer to measure neck range of motion.

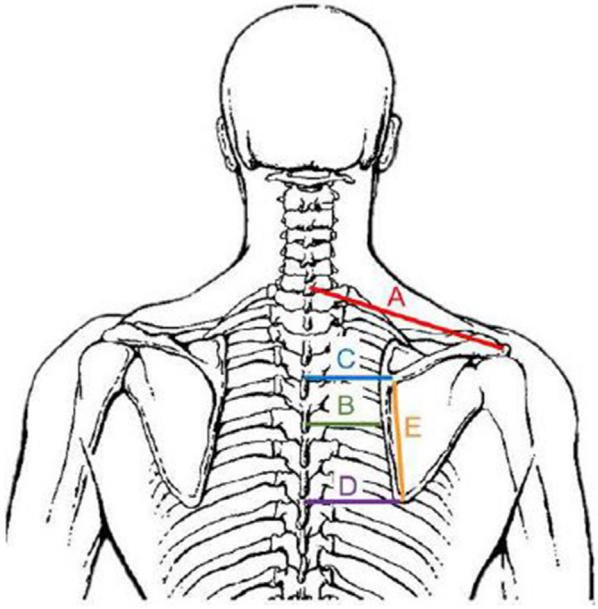

Figure 2: Landmarks of measurement of scapular range of motion. A: distance between C7 and the acromion (depression), B: distance between scapular medial border and the thoracic spine (adduction/abduction), C: distance between the root of the spine of the scapula and the thoracic spine (upward rotation), D: distance between the inferior angle of the scapula and the thoracic spine (upward rotation), and E: distance between the scapular spine root and the inferior angle of the scapula (upward rotation).

Regarding pain intensity as measured by the VAS, there was a significant group-by-time interaction [F (2, 37) = 19.672, $p < 0.001$]. The pain decreased significantly in both groups after intervention in both the third and sixth sessions compared to baseline ($p \leq 0.043$).[23] No significant difference was found in pain between both groups after intervention in the third ($p = 0.276$) or sixth sessions ($p = 0.068$).

For cervical ROM, no significant group-by-time interaction was found for the flexion [F (2, 37) = 0.155, $p = 0.857$] and left rotation [F (2, 37) = 1.347, $p = 0.273$] movements; however, there were significant group-by-time interactions for the extension [F (2, 37) = 7.119, $p = 0.002$], right rotation [F (2, 37) = 9.238, $p = 0.001$], right side bending [F (2, 37) = 3.833, $p = 0.031$], and left-side bending [F (2, 37) = 3.664, $p = 0.035$] movements. Compared to the baseline, significant increases in ROM for cervical extension, right rotation, right side bending, and left side bending were observed after intervention in the sixth session ($p \leq 0.015$) in both groups and for cervical extension in the third session in only the comparison group ($p = 0.004$). No significant differences were found in any cervical movement between both

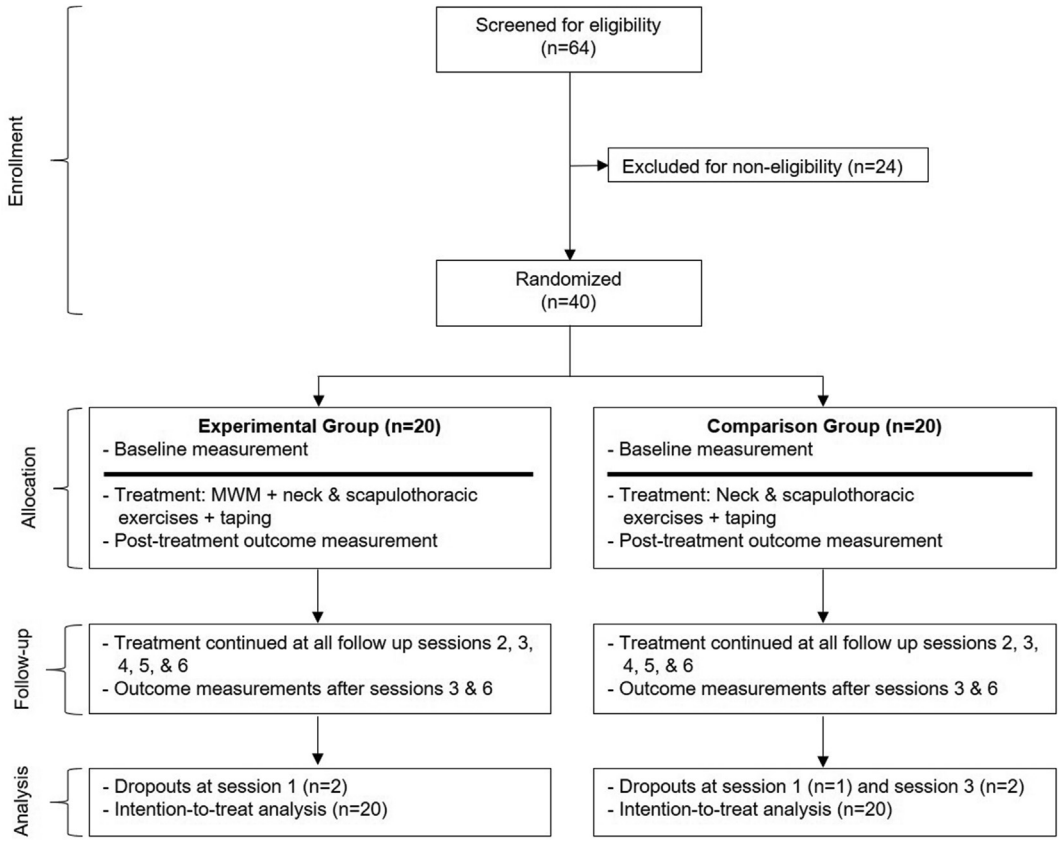

Figure 3: CONSORT flow diagram of the study. MWM, mobilization with movement.

groups after intervention in either the third ($p \geq 0.189$) or sixth session ($p \geq 0.075$).

No significant group-by-time interaction was found [F (2, 37) = 0.278, $p = 0.759$], indicating no significant differences in PPT within each group ($p \geq 0.058$) or between both groups ($p \geq 0.075$) in any session after intervention.

For scapular ROM, there were no significant group-by-time interactions for adduction [F (2, 37) = 0.843,

Table 1: Demographic characteristics of patients in both groups at baseline.

Variable	Experimental group (n = 20)	Comparison group (n = 20)	p-value
Age (years)*	33 ± 6	37 ± 7	0.040
Gender (Female/Male)	16/4	15/5	0.705
BMI (kg/m$_2$)*	26.3 ± 5.5	27.5 ± 6.2	0.510
Pain duration (months)*	13 ± 10	25 ± 29	0.103
Affected Scapula			
Right	11 (27.5%)	8 (20%)	0.342
Left	9 (22.5%)	12 (30%)	
Affected neck movement			
Flexion	11 (27.5%)	5 (12.5%)	0.354
Extension	2 (5%)	5 (12.5)	
Right rotation	2 (5%)	2 (5%)	
Left rotation	0 (0%)	0 (0%)	
Flex + Right rotation	0 (0%)	1 (2.5)	
Flex + Left rotation	0 (0%)	0 (0%)	
Right side bending	1 (2.5%)	3 (7.5%)	
Left side bending	4 (10%)	4 (10%)	

BMI= Body Mass Index.
Values are expressed as frequency (percentage) otherwise stated.
* Values are expressed as mean ± standard deviation.

Table 2: Mean ± standard deviation for outcome measures.

Outcome	Experimental group			Comparison group		
	Session 1 (baseline)	Session 3	Session 6	Session 1 (baseline)	Session 3	Session 6
VAS (cm)	5.4 ± 1.6	3.6 ± 2.0	2.3 ± 1.4	4.7 ± 1.9	3.6 ± 1.9	2.9 ± 2.0
Cervical ROM (°)						
Flexion	49.6 ± 10.6	50.8 ± 6.4	50.1 ± 5.1	47.8 ± 10.7	47.4 ± 6.0	51.2 ± 8.1
Extension	57.9 ± 12.0	62.4 ± 9.3	67.0 ± 10.0	52.9 ± 10.6	60.2 ± 7.2	65.9 ± 7.6
Right rotation	76.4 ± 10.0	76.2 ± 10.1	82.6 ± 4.9	70.9 ± 9.8	75.4 ± 7.9	80.1 ± 8.6
Left rotation	79.7 ± 7.8	79.4 ± 0.8	83.2 ± 7.6	75.0 ± 12.8	76.3 ± 9.9	81.3 ± 9.9
Right side bending	38.3 ± 8.3	42.5 ± 11.3	43.6 ± 3.5	38.2 ± 5.0	40.5 ± 4.2	44.3 ± 9.0
Left side bending	38.9 ± 8.2	43.0 ± 12.0	43.6 ± 4.0	38.7 ± 7.4	40.5 ± 4.0	46.0 ± 10.3
PPT (kPa)	319.9 ± 153.1	307.6 ± 183.4	302.2 ± 142.2	301.3 ± 160.8	306.2 ± 125.3	355.6 ± 134.4
Scapular ROM						
Upward rotation (°)	5.4 ± 11.3	4.7 ± 9.6	1.5 ± 6.0	8.0 ± 9.9	7.4 ± 9.4	2.0 ± 5.6
Depression (cm)	18.0 ± 1.5	18.4 ± 1.8	18.0 ± 1.4	18.5 ± 2.1	18.1 ± 2.1	17.5 ± 1.6
Adduction (cm)	5.4 ± 1.4	5.0 ± 1.3	5.1 ± 1.3	5.1 ± 1.4	5.0 ± 1.3	4.9 ± 1.5
Abduction (cm)	3.7 ± 1.6	3.3 ± 1.3	3.0 ± 1.0	3.7 ± 1.4	3.5 ± 1.9	3.5 ± 1.6
NDI (/50)	25.7 ± 10.5	18.5 ± 7.2	16.1 ± 10.1	27.4 ± 14.1	21.5 ± 11.0	15.1 ± 8.8

VAS = visual analogue scale; ROM = range of motion; PPT = pressure pain threshold; NDI = neck disability index; SD = standard deviation.
$ 95% confidence interval values are based on the analysis of variance test.

$p = 0.439$], abduction [F (2, 37) = 1.864, $p = 0.169$], or depression [F (2, 37) = 2.383, $p = 0.106$), suggesting no significant differences in any session after intervention in these movements within each group ($p \geq 0.058$) or between both groups ($p \geq 0.054$). For upward rotation, however, the Wilcoxon Signed Ranks test demonstrated a significant decrease in ROM after the sixth session in the comparison group ($p = 0.014$), but not in the experimental group ($p = 0.164$). The Mann−Whitney test revealed no significant differences between both groups in any session after the intervention in scapular upward rotation ($p \geq 0.445$).

There was a significant group-by-time interaction [F (2, 37) = 8.799, $p = 0.001$] for the NDI. Neck disability decreased significantly in both groups after the third and sixth sessions ($p \leq 0.016$). This improvement in NDI was 5 points more than that of minimal detectable change

Table 3: Within-group mean difference for all outcome measures.

Outcome	Experimental group (95% CI) [p-value]		Comparison group (95% CI) [p-value]	
	E1 vs E3	E1 vs E6	C1 vs C3	C1 vs C6
VAS (cm)	1.9* (0.83, 2.9) [0.001]	3.1* (2.1, 4.1) [0.000]	1.1* (0.3, 2.1) [0.043]	1.8* (0.81, 2.8) [0.001]
Cervical ROM (°)				
Flexion	−1.2 (−6.3, 3.8) [0.626]	−0.5 (−5.4, 4.3) [0.825]	0.33 (−4.7, 5.4) [0.895]	−3.4 (−8.3, 1.4) [0.161]
Extension	−4.4 (−9.1, 0.3) [0.064]	−9.1* (−14.2, −4.0) [0.001]	−7.2* (−11.9, −2.5) [0.004]	−12.9* (−18.0, −7.9) [<0.001]
Right rotation	0.2 (−4.8, 5.1) [0.951]	−6.2* (−10.4, −1.9) [0.005]	−4.5 (−9.4, 0.5) [0.075]	−9.2* (−13.4, −5.0) [<0.001]
Left rotation	0.3 (−4.9, 5.5) [0.907]	−3.5 (−8.3, 1.4) [0.154]	−1.4 (−6.6, 3.8) [0.592]	−6.4* (−11.3, −1.6) [0.011]
Right side bending	−4.2 (−8.4, 0.1) [0.054]	−5.3* (−9.5, −1.1) [0.015]	−2.3 (−6.5, 1.9) [0.278]	−6.0* (−10.2, −1.8) [0.006]
Left side bending	−4.0 (−8.2, 0.1) [0.057]	−4.7* (−8.4, −0.9) [0.016]	−1.9 (−6.0, 2.3) [0.374]	−7.3* (−11.0, −3.7) [<0.001]
PPT (kPa)	12.3 (−29.5,54.1) [0.555]	17.7 (−38.5,73.9) [0.527]	−4.9 (−46.6, 36.9) [0.815]	−54.3 (−110.5, 1.9) [0.058]
Scapular ROM				
Upward rotation (°)	0.7 [0.831]	3.8 [0.164]	0.6 [0.857]	5.96* [0.014]
Depression (cm)	−0.4 (−1.1, 0.3) [0.223]	0.5 (−0.6, 0.7) [0.891]	0.4 (−0.3, 1.1) [0.239]	0.97 (0.3, 1.6) [0.005]
Adduction (cm)	0.4 (−0.3, 0.98) [0.258]	0.3 (−03, 0.9) [0.315]	0.3 (−0.6, 0.7) [0.917]	0.2 (−0.4, 0.8) [0.591]
Abduction (cm)	0.4 (−0.4, 1.1) [0.302]	0.7 (−0.02, 1.4) [0.058]	0.3 (−0.4, 1.0) [0.439]	0.3 (−0.4, 1.4) [0.440]
NDI (/50)	7.2* (2.5,11.9) [0.004]	10.6* (5.6, 15.7) [<0.001]	5.9* (1.2,10.7) [0.016]	10.3* (5.3, 15.4) [<0.001]

E1 = experimental, session 1 (baseline); E3 = experimental, session 3, E6 = experimental, session 6.
C1 = comparison, session 1 (baseline); C3 = comparison, session 3, E6 = comparison, session 6.
95% CI = 95% confidence interval; VAS = visual analogue scale; ROM = range of motion; PPT = pressure pain threshold; NDI = neck disability index.

Table 4: Between-group mean difference for outcome measures.

Outcome	Baseline [E1 vs C1] (95% CI) [*p*-value]	Session 3 [E3 vs C3] (95% CI) [*p*-value]	Session 6 [E6 vs C6] (95% CI) [*p*-value]
VAS (cm)	0.8 (−0.4,1.9) [0.184]	0.8 (−0.67, 2.7) [0.276]	1.3 (−0.1, 2.7) [0.068]
Cervical ROM (°)			
Flexion	1.8 (−4.9, 8.6) [0.585]	−1.6 (−8.8, 5.6) [0.662]	2.9 (−3.96, 9.7) [0.399]
Extension	4.9 (−2.2, 12.2) [0.171]	2.8 (−3.9, 9.4) [0.403]	3.9 (−3.3, 11.1) [0.280]
Right rotation	5.5 (−0.7, 11.7) [0.083]	4.6 (−2.4, 11.6) [0.189]	3 (−2.9, 8.97) [0.312]
Left rotation	4.8 (−1.97, 11.6) [0.159]	1.7 (−5.7, 9) [0.645]	2.9 (−3.9, 9.8) [0.391]
Right side bending	0.1 (−4.3, 4.4) [0.963]	−1.9 (−7.8, 4.1) [0.535]	0.7 (−5.2, 6.7) [0.809]
Left side bending	0.3 (−4.7, 5.3) [0.915]	−2.2 (−8.1, 3.7) [0.457]	2.7 (−2.7, 7.96) [0.319]
PPT (kPa)	18.6 (−81.9, 119.1) [0.710]	17.1 (−41.9, 76.2) [0.560]	72 (−7.5, 155.6) [0.075]
Scapular ROM			
Upward rotation (°)	−2.6 [0.445]	0.1 [0.981]	−2.1 [0.584]
Depression (cm)	−0.5 (−1.6, 0.7) [0.425]	−0.8 (−1.8, 0.15) [0.093]	−0.9 (−1.9, 0.01) [0.053]
Adduction (cm)	0.3 (−0.6, 1.2) [0.523]	0.3 (−0.6, 1.2) [0.466]	0.14 (−0.7, 1.0) [0.739]
Abduction (cm)	−0.1 (−1.0, 0.9) [0.901]	0.1 (−0.9, 1.1) [0.852]	0.4 (−0.6, 1.4) [0.411]
NDI (/50)	−1.7 (−9.6,6.3) [0.670]	1.3 (−5.4, 8.0) [0.691]	0.3 (−6.9, 7.5) [0.933]

E1 = experimental, session 1 (baseline); E3 = experimental, session 3, E6 = experimental, session 6.
C1 = comparison, session 1 (baseline); C3 = comparison, session 3, E6 = comparison, session 6.
CI = confidence interval; VAS = visual analogue scale; ROM = range of motion; PPT = pressure pain threshold; NDI = neck disability index

(MDC).[21] No significant difference was found between both groups in the third ($p = 0.691$) or sixth session ($p = 0.933$).

Discussion

This study examined the effect of adding mobilisation of the scapula with active neck movement (i.e., MWM) to the scapulothoracic exercise and taping regimen in patients with scapular dyskinesis experiencing neck pain. The pain, cervical and scapular ROM, and NDI of the participants improved with the implementation of exercises and corrective tapes either with or without MWM to the scapula.

The decrease in pain measured by the VAS in our study was more than the minimal clinically important difference (MCID; 1.4 cm)[23] in both groups, except in the third session in the comparison group, where the decrease in pain was 1.1 cm on the VAS. Previous studies have also found that neck pain measured with the VAS improved after passive and active exercises of the neck and scapula were performed by patients with neck pain, which was consistent with the results of the study.[13,24,25] This improvement in pain could partially be explained as the effects of the exercises and/or taping on scapulothoracic correction, which may facilitate the patients to regain the normal patterns of muscular activity through the soft-tissue attachments of the scapula to the cervical and the thoracic spine.[26] In addition, altered scapular kinematics may also contribute to tissue mechano-sensitization and eventual structural hypersensitivity.[13,24,25,27]

This study did not demonstrate an improvement in PPT in either the experimental or the comparison groups. This is likely due to the low-load nature of the interventions used in this study. This finding is inconsistent with that of a previous study, which found that active scapular correction exercises induced an immediate increase in PPT in patients with chronic neck pain and scapular dysfunction.[13] The discrepancy could be due to differences in the algometer and intervention used.

This study found that cervical ROM improved for the following movements in both groups: extension (range: 9.1°−12.9°), right rotation (range: 6.2°−9.2°), right side bending (range: 5.3°−6.0°), and left side bending (range: 4.7°−7.3°); the improvement was seen mainly in the sixth session. However, these values did not reach the MDC values (extension, 16°; right rotation, 13°; right side bending, 10°; and left side bending, 12°).[28] Ha et al.[24] found that passive correction of the scapula significantly improved cervical ROM (right, 12.78°; left, 14.17°) in patients with bilateral scapular downward-rotation syndrome experiencing neck pain compared to those without the syndrome; however, they did not report the baseline ROM in either group to enable the reader to compare the differences in the ROM before and after correction of the scapula. Moreover, scapular ROM improved only for upward rotation in the sixth session in the comparison group; the decrease in scapular upward rotation was more than the MDC (3.5−5.4°).[29] However, no significant differences in cervical ROM were found between the experimental and observation groups. The authors were not able to explain why the scapular upward rotation decreased in the comparison group. No previous studies have been conducted on the effect of active and passive correction of the scapula on scapular ROM. Therefore, the underlying mechanism for the decrease in upward rotation

of scapular ROM in the comparison group, but not in the experimental group, needs to be further investigated.

No previous studies have examined the effects of MWM or scapulothoracic exercises on scapular dyskinesis in patients with neck pain. Kumar et al.[10] found that adding shoulder MWM to scapular stabilisation exercises did not decrease dyskinesis as measured by scapular position and humeral head position in healthy swimmers with scapular dyskinesis. In addition, several studies have reported the beneficial effects of therapeutic exercises with or without manual therapy on scapular dyskinesis in patients with shoulder impingement syndrome and in asymptomatic individuals. However, the methodological quality of these studies is debatable, and the evidence for the effect of exercise on scapular dyskinesis in these populations is conflicting.[30] In our study, NDI improved in both groups in the third and sixth sessions. Since NDI is a pain-dependent questionnaire and the VAS scores for both groups were similar,[25] it is reasonable that there was no difference in NDI scores between the experimental and observation groups in our study. Our results are in agreement with those of the study by Yildiz et al.,[25] which suggested that cervical stretching, craniocervical flexion, cervical retraction exercises, and scapular stabilisation exercises improved NDI in neck pain patients with scapular dyskinesis.

Clinical implications

This study is the first to investigate the effect of scapular mobilisation with active neck movement in patients with neck pain who had scapular dyskinesis. Our findings suggest that therapists could apply a 3-week regimen of scapulothoracic ROM and strengthening exercises, along with adhesive Kinesio tapes, in patients with scapular dyskinesis to improve pain, cervical ROM, and neck function. The addition of scapulothoracic MWM to this regimen may not add further benefits.

Study limitations

A limitation of this study was that the examiners were not blinded to the patients' measurements, which might have biased the results. In addition, a negative control group that was not exposed to experimental treatments was not included in the study. Thus, further studies including a negative control group are needed to confirm our findings.

Conclusion

This study found that pain and disability improved similarly in patients with chronic neck pain accompanied by scapular dyskinesis in both the MWM and comparison groups. The addition of scapulothoracic MWM did not enhance the outcomes of the exercise and corrective tape treatment regimen during the 3-week period.

Recommendations

Further RCTs with both positive and negative control groups are recommended to investigate the effect of active correction of the scapula with active movement of the neck in patients with neck pain who have scapular dyskinesis.

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Conflict of interest

The authors have no conflicts of interest to declare.

Ethical approval

This study was approved by the Institutional Review Board at the University of Dammam (IRB-PGS-2015-03-219; date: 7th December 2015) and registered at ClinicalTrials.gov (NCT03046160).

Informed consent

Informed consent was obtained from all participants included in the study.

Authors contributions

AIA conceived and designed the study, conducted research, collected data, and analysed and interpreted the data. Together with AIA, AMA conceived and designed the study and analysed and interpreted data. All authors contributed to the writing of the initial and final drafts. All authors have critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.

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References

1. Hoy D, March L, Woolf A, Blyth F, Brooks P, Smith E, et al. The global burden of neck pain: estimates from the global burden of disease 2010 study. **Ann Rheum Dis 2014**; 73(7): 1309–1315.
2. Alshami AM. Prevalence of spinal disorders and their relationships with age and gender. **Saudi Med J 2015**; 36(6): 725–730.
3. Verhagen AP, van Middelkoop M, Rubinstein SM, Ostelo R, Jacobs W, Peul W, et al. Effect of various kinds of cervical spinal surgery on clinical outcomes: a systematic review and meta-analysis. **Pain 2013**; 154(11): 2388–2396.
4. Guzman J, Haldeman S, Carroll LJ, Carragee EJ, Hurwitz EL, Peloso P, et al. Clinical practice implications of the bone and joint decade 2000-2010 task force on neck pain and its associated disorders: from concepts and findings to recommendations. **Spine 2008**; 33(4 Suppl): S199–S213.

5. Blanpied PR, Gross AR, Elliott JM, Devaney LL, Clewley D, Walton DM, et al. Neck pain: revision 2017. **J Orthop Sports Phys Ther 2017**; 47(7): A1−A83.
6. Cagnie B, Struyf F, Cools A, Castelein B, Danneels L, O'Leary S. The relevance of scapular dysfunction in neck pain: a brief commentary. **J Orthop Sports Phys Ther 2014**; 44(6): 435−439.
7. Ellenbecker TS, Cools A. Rehabilitation of shoulder impingement syndrome and rotator cuff injuries: an evidence-based review. **Br J Sports Med 2010**; 44(5): 319−327.
8. Hing W, Bigelow R, Bremner T. Mulligan's mobilisation with movement : a review of the tenets and prescription of MWMs. **N Z J Physiother 2008**; 36(3): 144−164.
9. Helgadottir H, Kristjansson E, Mottram S, Karduna A, Jonsson Jr H. Altered alignment of the shoulder girdle and cervical spine in patients with insidious onset neck pain and whiplash-associated disorder. **J Appl Biomech 2011**; 27(3): 181−191.
10. Kumar GP, Yadav KH, Chahar M, Kumar S, Kumar S. Effect of mobilization with movement and corrective exercises in humeral and scapular position among swimmers with scapular dyskinesis: randomized clinical trial. **Int J Ther Rehabil Res 2017**; 6(2): 227−232.
11. Cleland JA, Childs JD, McRae M, Palmer JA, Stowell T. Immediate effects of thoracic manipulation in patients with neck pain: a randomized clinical trial. **Man Ther 2005**; 10(2): 127−135.
12. McClure P, Tate AR, Kareha S, Irwin D, Zlupko E. A clinical method for identifying scapular dyskinesis, Part 1: Reliability. **J Athl Train 2009**; 44(2): 160−164.
13. Lluch E, Arguisuelas MD, Calvente Quesada O, Martinez Noguera E, Peiro Puchades M, Perez Rodriguez JA, et al. Immediate effects of active versus passive scapular correction on pain and pressure pain threshold in patients with chronic neck pain. **J Manip Physiol Ther 2014**; 37(9): 660−666.
14. Tate AR, McClure P, Kareha S, Irwin D, Barbe MF. A clinical method for identifying scapular dyskinesis, part 2: validity. **J Athl Train 2009**; 44(2): 165−173.
15. Kahl C, Cleland JA. Visual analogue scale, numeric pain rating scale and the McGill pain Questionnaire: an overview of psychometric properties. **Phys Ther Rev 2005**; 10(2): 123−128.
16. Law EY, Chiu TT. Measurement of cervical range of motion (CROM) by electronic CROM goniometer: a test of reliability and validity. **J Back Musculoskelet Rehabil 2013**; 26(2): 141−148.
17. Tousignant-Laflamme Y, Boutin N, Dion AM, Vallee CA. Reliability and criterion validity of two applications of the iPhone to measure cervical range of motion in healthy participants. **J NeuroEng Rehabil 2013**; 10(1): 69.
18. Kinser AM, Sands WA, Stone MH. Reliability and validity of a pressure algometer. **J Strength Condit Res 2009**; 23(1): 312−314.
19. da Costa BR, Armijo-Olivo S, Gadotti I, Warren S, Reid DC, Magee DJ. Reliability of scapular positioning measurement procedure using the palpation meter (PALM). **Physiotherapy 2010**; 96(1): 59−67.
20. Mackenzie TA, Bdaiwi Alya, Herrington Lee, Cools Ann. The palpation meter (palm) is reliable for measuring scapular upward rotation in the coronal plane. **Int J Phys Edu Sports Health 2015**; 2(2): 54−59.
21. MacDermid JC, Walton DM, Avery S, Blanchard A, Etruw E, McAlpine C, et al. Measurement properties of the neck disability index: a systematic review. **J Orthop Sports Phys Ther 2009**; 39(5): 400−417.
22. Shaheen AA, Omar MT, Vernon H. Cross-cultural adaptation, reliability, and validity of the Arabic version of neck disability index in patients with neck pain. **Spine 2013**; 38(10): 609−615.
23. Tashjian RZ, Deloach J, Porucznik CA, Powell AP. Minimal clinically important differences (MCID) and patient acceptable symptomatic state (PASS) for visual analog scales (VAS) measuring pain in patients treated for rotator cuff disease. **J Shoulder Elbow Surg 2009**; 18(6): 927−932.
24. Ha SM, Kwon OY, Yi CH, Jeon HS, Lee WH. Effects of passive correction of scapular position on pain, proprioception, and range of motion in neck-pain patients with bilateral scapular downward-rotation syndrome. **Man Ther 2011**; 16(6): 585−589.
25. Yildiz TI, Turgut E, Duzgun I. Neck and scapula-focused exercise training on patients with nonspecific neck pain: a randomized controlled trial. **J Sport Rehabil 2018**; 27(5): 403−412.
26. Wegner S, Jull G, O'Leary S, Johnston V. The effect of a scapular postural correction strategy on trapezius activity in patients with neck pain. **Man Ther 2010**; 15(6): 562−566.
27. Martinez-Merinero P, Lluch E, Gallezo-Izquierdo T, Pecos-Martin D, Plaza-Manzano G, Nunez-Nagy S, et al. The influence of a depressed scapular alignment on upper limb neural tissue mechanosensitivity and local pressure pain sensitivity. **Musculoskelet Sci Pract 2017**; 29: 60−65.
28. Piva SR, Erhard RE, Childs JD, Browder DA. Inter-tester reliability of passive intervertebral and active movements of the cervical spine. **Man Ther 2006**; 11(4): 321−330.
29. Michener LA, Elmore KA, Darter BJ, Timmons MK. Biomechanical measures in participants with shoulder pain: intra-rater reliability. **Man Ther 2016**; 22: 86−93.
30. Nodehi Moghadam A, Rahnama L, Noorizadeh Dehkordi S, Abdollahi S. Exercise therapy may affect scapular position and motion in individuals with scapular dyskinesis: a systematic review of clinical trials. **J Shoulder Elbow Surg 2020**; 29(1): e29−e36.

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