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ORIGINAL RESEARCH

Effects of Scapular Stabilization Exercise Training on Scapular Kinematics, Disability, and Pain in Subacromial Impingement: A Randomized Controlled Trial

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Abstract

Objective: To investigate the effects of 2 different exercise programs on 3-dimensional scapular kinematics, disability, and pain in participants with subacromial impingement syndrome (SIS).

Design: Randomized controlled trial.

Setting: Outpatient clinic and research laboratory.

Participants: Participants who were diagnosed with SIS and who also exhibited scapular dyskinesis (N=30).

Interventions: The participants were randomized in 2 different exercise groups: (1) shoulder girdle stretching and strengthening with additional scapular stabilization exercises based on a kinetic chain approach (intervention group), and (2) shoulder girdle stretching and strengthening exercises only (control group).

Main Outcome Measures: Three-dimensional scapular kinematics, self-reported shoulder pain, and disability were evaluated at baseline, after 6 weeks of training, and after 12 weeks of training.

Results: Significant differences were observed between the control and intervention groups in external rotation and posterior tilt after 6 weeks of training and in external rotation, posterior tilt, and upward rotation after 12 weeks of training. All groups showed improvement in self-reported pain and disability scores; however, there were no significant differences between the groups.

Conclusions: Progressive exercise training independent from specific scapular stabilization exercises provides decreased disability and pain severity in impingement syndrome.

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Shoulder pain may be a significant symptom of subacromial impingement syndrome (SIS).[1] SIS is a commonly diagnosed cause of shoulder pain whose complex etiology is not completely understood. It has been suggested that it involves mechanical compression of the subacromial structures under the coracoacromial arch.[2] This mechanical compression is often associated with multiple causative factors, including poor scapular kinematics or scapular dyskinesis.[3,4] Common causes (eg, postural problems, dysfunction of the force couples, flexibility deficits of the pectoralis minor and posterior capsule) may particularly affect scapulohumeral rhythm.[5] As a result, because of the impaired length-tension relation of the rotator cuff muscles, a deficit in the centralization of the humeral head into the glenoid cavity may occur.[4] Although no clear relation is directly established between scapular dyskinesis and specific pathology, addressing scapular control is widely accepted as an important component of shoulder rehabilitation.[6]

Exercise therapy that includes stretching and strengthening is an effective tool for controlling pain and disability in patients with SIS.[7] Although scapular stabilization exercises are commonly used as part of shoulder rehabilitation programs, the scientific rationale for the training effect of scapular stabilization exercises is less clear. McClure et al[8] reported that a 6-week course of traditional exercises had no effect on scapular kinematics.

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Similarly, Struyf et al[9] reported that a scapular-focused stretching and muscular control training program had no effect on scapular upward rotation in participants with SIS. However, Worsley et al[10] reported increased upward rotation and posterior tilt after a 10-week scapular repositioning training program in a single-group study design. Therefore, the aim of this study was to investigate the effects of 2 different exercise programs on 3-dimensional scapular kinematics, disability, and pain in participants with SIS. The hypothesis of this study was that a shoulder girdle stretching and strengthening program with additional scapular stabilization exercises would improve scapular kinematics and reduce disability and pain compared with a shoulder girdle stretching and strengthening program without additional exercises in participants with SIS.

Methods

A randomized trial with parallel allocation using a 1:1 ratio was carried out in the Department of Physiotherapy and Rehabilitation, Hacettepe University, Ankara, Turkey, between November 2014 and April 2015. The Hacettepe University Institutional Review Board approved the protocol for this study, and all participants were informed of the nature of the study and signed a consent form (GO14/189-35).

Participants

Patients with unilateral shoulder pain lasting >6 weeks were included in the study. A consulting orthopedic surgeon diagnosed the patients with SIS if they exhibited at least 2 of the following: (1) painful arc during flexion or abduction; (2) a positive Neer[11] or Hawkins-Kennedy[1] test; and (3) painful resisted external rotation, abduction, or Jobe test.[12] Patients were eligible for this study if they had type 1 (characterized by prominence of the inferior medial scapular angle) or type 2 (characterized by prominence of the entire medial border) scapular dyskinesis based on observational examination[13] and a positive scapular assistance test[14] or reposition test,[15] to ensure the SIS symptoms were related to scapular dyskinesis. Patients were excluded from this study if they had a history of surgery, fracture, or dislocation and traumatic onset of shoulder pain; existence of type 3 acromion; massive rotator cuff tear; a long head of bicep tendon tear; or degenerative joint disorder at the shoulder complex. Patients were also excluded if they had any rheumatologic, systemic, or neurologic disorders; any neuromusculoskeletal disorder (including cervical radiculopathy); a body mass index >30kg/m^2; or were pregnant. Those who had received steroid injections and physical therapy during the previous 6 months were also excluded.

Sample size calculations using G*Power software[a] were informed by previous studies[8-10,13] that were carried out with similar outcome measure comparisons and suggested 8° differences for asymmetric motion threshold. Therefore, assuming a 5% type 1 error with statistical power of 80%, factoring in a 15% to 20% dropout rate, a sample size of approximately 36 participants were required as a study population.

List of abbreviations:	
MDC	**minimal detectable change**
SIS	**subacromial impingement syndrome**
SPADI	**Shoulder Pain and Disability Index**

The participants were randomly separated into one of the following study groups: intervention group or control group. An independent researcher applied randomization by using computer-generated numbers, which were stratified based on observed scapular dyskinesis type to avoid clustering across study groups. A block size of 4 was used within the 2 strata.

Interventions

All exercises are listed and described in supplemental appendix S1 (available online only at http://www.archives-pmr.org/). Participants in the intervention group followed a supervised 12-week exercise program consisting of a combination of closed and open kinetic chain scapular stabilization exercises followed by shoulder girdle strengthening exercises (ie, rotator cuff strengthening) and stretching exercises (ie, posterior shoulder, pectoralis minor, levator scapula, latissimus dorsi self-stretching exercises). Scapular stabilization exercises based on the kinetic chain approach were chosen from previously published research and included wall slides with squat, wall push-ups plus ipsilateral leg extension, lawnmower with diagonal squat, resisted scapular retraction with contralateral 1-leg squat, and robbery with squat.[16-20] Rotator cuff strengthening exercises incorporated with kinetic chain included resisted shoulder internal rotation at 0° abduction with ipsilateral inward step, shoulder external rotation at 0° abduction with ipsilateral sidestep, and full can with step-up.[17,21]

Participants in the control group followed a supervised 12-week exercise program consisting of strengthening (ie, rotator cuff strengthening) and stretching (ie, posterior shoulder, pectoralis minor, levator scapula, latissimus dorsi self-stretching exercises). Rotator cuff strengthening exercises included resisted shoulder internal rotation at 0° abduction, shoulder external rotation at 0° abduction, and full can. All resisted exercises were performed with elastic bands[b] with red color-coded resistance levels, and progressed through green and blue bands. The exercise program was focused on low range (<90°), closed kinetic chain and scapular stabilization exercises, and progressed to higher range (>90°) open kinetic chain rotator cuff exercises when the patient could perform 10 pain-free repetitions within a given resistance. The physiotherapist monitored exercise progression with weekly visits. To enhance compliance in both groups, participants received a brochure and exercise diary.

Outcome measures

Scapular kinematics, disability status, and pain severity were recorded at baseline, 6 weeks (midpoint), and 12 weeks (postintervention).

Three-dimensional kinematics for the scapula and humerus were assessed using an electromagnetic tracking device[c] interfaced with the Motion Monitor software program.[d] Data collected with this electromagnetic tracking system have been found to be reliable, and this method has been validated when humerothoracic elevation is <120°.[22] Previously reported between-day correlation coefficient values range between .54 and .88, standard error of measurement values range from 3.37° to 7.44°, and minimal detectable change (MDC) values range from 7.81° to 17.27°.[23] Our study found between-day reliability values that ranged from .73 to .95, standard error of measurement values that ranged from 1.75° to 7.06°, and MDC values that ranged from 4.85° to 19.5°.

To collect data, 5 sensors were applied with double-sided adhesive tape and further secured with rigid tape. The thoracic