EFFECTS OF CORE STABILITY TRAINING ON SHOULDER PAIN AND FUNCTION AMONG OVERHEAD ATHLETES WITH SHOULDER IMPINGEMENT SYNDROME

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ABSTRACT

Background: Shoulder impingement syndrome is frequently observed among competitive athletes who participate in overhead sports. Core stability is a fundamental component of functional movements crucial to athletic activities. The optimal core stability generates the proper power and stability for upper extremity function.

Purpose: To assess the influence of core stability training on shoulder pain and function in overhead athletes who have shoulder impingement syndrome.

Subjects & Methods: This study included 32 male and female overhead athletes with unilateral subacromial impingement syndrome, ranging in age from 17 to 35 years. They were randomized and assigned to two equal groups. The control group (N = 16) went through a shoulder strengthening protocol, while the study group (N = 16) performed core stabilization exercises in addition to the shoulder strengthening protocol. The visual analogue scale was used to assess shoulder pain, while the Kelan Jobe Orthopedic Clinic Shoulder and Elbow Score was used to assess shoulder function.

Results: It was found that there were no statistically significant variations in shoulder pain and function between the control and study groups.

Conclusion: The core stability exercises were not superior to improving shoulder pain and function in overhead athletes suffering from shoulder impingement syndrome compared to the standard strengthening exercises.

Keywords: Core stabilization exercises; Kelan Jobe Orthopedic Clinic Shoulder and Elbow score; Overhead athletes; Subacromial impingement syndrome; VAS.

INTRODUCTION

Shoulder impingement syndrome (SIS) is widespread among athletes who play overhead sports [1]. It is described as compression and mechanical erosion of the rotator cuff tendons during arm elevation as they pass underneath the coracoacromial arch. [2]. Impingement syndrome-related shoulder pain frequently impairs an athlete's performance due to highly repeated, rotational motions and forces applied to the shoulder in various susceptible positions. This induced changes in the glenohumeral joint strength, flexibility, and posture, as well as in other links in the kinetic chain [3,4]. Due to these pathological and mechanical alterations, all overhead movement during sports activities induced pain and dysfunction [5].

Treatment for SIS is 90%–95% conservative and frequently consists of stretching exercises, rotator cuff strengthening exercises and scapular stabilization exercises to improve the musculotendinous tissue's ability to withstand strain and stress [5,6]. Dynamic upper-extremity movements like throwing, striking, and serving are generated by the kinetic chain. The coordinated sequence in which body segments are activated, mobilized, and stabilized to create a dynamic activity is known as a kinetic chain. The Hanavan model describes the body segments as a primary bone and the joints on each end [7].

One of the most crucial elements of utilizing an efficient kinetic chain is core stability. It is described as the ability to control the trunk's position and movement over the leg and pelvis to allow optimal generation of force, transfer, and control to the distal segment in combined kinetic chain activities [7]. Because it is positioned like a box in the center of the kinetic chain systemization, with the diaphragm functioning at the top and the pelvic floor and hip girdle muscles at the bottom, the paraspinal and gluteal muscles in the rear, and the abdominals in the front, forces are created and delivered to the extremities via the core area, which serves as a muscle corset. To produce powerful, functional movements of the extremities, the core must function optimally, which leads to the kinetic chain system functioning most efficiently [8].

Core stabilization exercises aim to build a solid base for accurate movement while preserving proper muscle equilibrium around the lumbopelvic-hip complex, resulting in a hard cylinder that resists body perturbations. Therefore, core control is linked to the functional stability of the shoulder [8,9].

Hazar and his co-workers (2014) showed a correlation between shoulder dysfunction and core instability in overhead athletes. This study included a total of 61 athletes who performed overhead activities; 48 were healthy, while 14 had shoulder dysfunction that was identified as a history of a noncontact shoulder injury and a Kerlan-Jobe Orthopaedic Clinic Shoulder and Elbow score lower than 80. The findings of this study showed that overhead athletes with shoulder dysfunction performed poorly on various core stability assessments. Such findings support the use of core stability in developing effective rehabilitation procedures for overhead athletes with shoulder dysfunction [10].

Also, Saeterbakken and his colleagues (2011) studied the impact of a core stability program on maximum throwing speed in female handball athletes. The study group participated in progressively core stability exercises. Throwing performance was assessed utilizing a penalty throw used in handball from a 7-meter distance towards a shock-absorbing mattress target. Following the core stability exercises, the study group showed significant improvements in throwing velocity. These findings indicate that core stability exercises can greatly improve shoulder performance in handball players [11].

Therefore, this study aimed to assess the effect of core stability exercises on shoulder pain and function in overhead athletes diagnosed with shoulder impingement syndrome.

MATERIALS AND METHODS

Study design

This randomized controlled trial study was performed at the 6th October sporting club from February 2023 to December 2023 and was approved via the ethical committee of the faculty of physical therapy at Cairo University with the ethical permission number: P.T.REC/012/004355.

Sample size calculation

Sample size was calculated by G*power software (version 3.1.9.7). F-test ANOVA between factors was selected. Considering an effect size of 0.4, an alpha level of 0.05 (two-tailed), and a power of 0.80.

Participants

In this study, thirty-two male and female overhead athletes with unilateral subacromial impingement syndrome were chosen according to inclusion criteria and randomly assigned to two groups and the randomization was done via a random generator.

Inclusion Criteria: To be diagnosed as having unilateral subacromial impingement syndrome (Neer stage II), Subjects needed to show minimally three of the following **[12]**:

(1) Positive Neer impingement test.
(2) Positive Hawkin's impingement test.
(3) Pain with active shoulder elevation.
(4) Pain when palpating the rotator cuff tendons.
(5) Pain with isometric resisted abduction.
(6) Pain in the C5 or C6 dermatome area.

Male and female overhead athletes with unilateral subacromial impingement syndrome (Neer stage-II) and with age ranges of 17 to 35 years old. The overhead athletes had at least 1-month post-symptoms and played competitive sports for at least 6 hours a week **[13]**.

Exclusion Criteria: Athletes were excluded if they had one of the following: history of shoulder dislocation on the symptomatic side, acromioclavicular joint pathology, cervical spine radiculopathy, past shoulder surgery on the diagnosed side, a positive drop arm test indicating a full-thickness tear of the rotator cuff, shoulder instability **(**positive apprehension or sulcus sign) and received steroid injections during the last six months before the study **[13,14,15,16]**.

Treatment procedures

Both the study and control groups conducted their exercise regimen three days per week for six weeks. **The control group (N = 16)** received a strengthening physiotherapy program that consisted of a crossed-arm stretch and a unilateral self-stretch. Three repetitions of 30 seconds of holding were done, with a 30-second rest between each repetitions. Strengthening training sessions were performed with thera-band as follows: shoulder external rotation while the arm was at the side and elbow 90° flexion, shoulder extension. As they advanced to using the green band shoulder, an external rotation with their arm abducted 45° in the scapular plane and the elbow flexed 90°, scapular retraction and shoulder flexion through a 0°to 60° arc. Each exercise was carried out in three sets of ten times, with a 60-second rest interval between each set. The plyometric exercise was also performed by utilizing a soft-weighted ball (1 kg) with the shoulder in an external rotation motion, throwing the ball up in the air, and then performing a delayed catch of the ball **[5,17,18,20,21]**.

The study group (N = 16) received the same intervention as the control group in addition to core stabilization exercises: elbow-toe exercise, curl-up exercise, back bridge exercise, and side bridge exercise using unstable surfaces (e.g., Bosu Balance Trainer, Swiss ball, balance disk). The intensity of the core stability exercise program was gradually increased over six weeks. During training weeks 1-2, participants did three sets of each exercise with a 40-second maintenance interval. During training weeks 3-4, contraction times were increased to 45 seconds. Maintenance times were increased to 50 s during training weeks 5 and 6. The rest period between sets was equivalent to the respective maintenance time (e.g., 40 seconds during weeks 1-2). An additional 2-3 minute break was given between exercises. All overhead athletes were evaluated before and after the treatment plan **[11,17,19,26]**.

Measurement procedures

Shoulder pain was assessed using the visual analog scale (VAS). A single handwritten mark was used to record each score at one point along a 10-cm line **[22]**.

Shoulder function was assessed by using the Kelan Jobe Orthopedic Clinic Shoulder and Elbow Score (KJOC). Franz et al. created the Kerlan-Jobe Orthopedic Clinic Shoulder and Elbow Score to evaluate the upper extremity function in overhead athletes. It had questions with a VAS-like structure. A higher function or performance level was shown by the far right and lower KJOC scores were related to increased discomfort, disability, and function limits **[23,24]**.

Data analysis

An unpaired t-test was used to compare subject characteristics between groups. The chi-squared test (Fisher's exact test) was utilized to compare the gender, dominant side, and sports distribution between groups. The Shapiro-Wilk test was used to verify that the data was normally distributed. Levene's test for homogeneity of variances was performed to examine the homogeneity between groups. A mixed MANOVA was used to assess the influence of treatment on VAS and KJOC scores. Post-hoc tests utilizing the Bonferroni correction were conducted for consecutive multiple comparisons. All statistical tests were set at $p < 0.05$, indicating significance. All statistical analyses were performed with the Statistical Programming for Social Sciences (SPSS) version 25 for Windows (IBM SPSS, Chicago, IL, USA).

RESULTS

The study included thirty-two overhead athletes who had a confirmed unilateral subacromial impingement syndrome diagnosis. **Table 1** shows the subject demographics for groups A and B. All subject demographics were not significantly different across groups ($p > 0.05$).

Effect of treatment on VAS and KJOC score: The Mixed MANOVA showed no significant interplay between treatment and time (F = 1.36, p = 0.26). There was a substantial main impact time (F = 59.03, $p < 0.001$). There was no significant major impact of treatment (F = 0.32, $p = 0.96$).

Within-group comparison: In both groups, there was a significant reduction in VAS and a significant increase in KJOC score post-treatment compared with pretreatment ($p > 0.001$) **(Table 2)**.

Between-group comparison: There was not a significant distinction between the groups before treatment (p>0.05). A comparison of groups following treatment revealed no significant difference in VAS and KJOC scores ($p > 0.05$).

Table 1. Comparison of subjects' characteristics between control and study group.

	Control group	Study group		
	Mean ±SD	**Mean ±SD**	**t- value**	**p-value**
Age (years)	19.81 ± 3.87	20.25 ± 4.27	-0.30	0.76
Weight (kg)	67.41 ± 14.69	66.63 ± 10.07	0.18	0.86
Height (cm)	172.18 ± 10.89	174.25 ± 6.79	-0.64	0.53
BMI (kg/m²)	22.59 ± 4.01	21.80 ± 2.31	0.68	0.49
Sex, N (%)				
Males	8 (50%)	7 (44%)	(χ^2 = 0.13)	0.72
Females	8 (50%)	9 (56%)		
Dominant side, N (%)				
Right side	16 (100%)	15 (93.7%)	(χ^2 = 1.03)	0.31
Left side	0 (0%)	1 (6.3%)		
Sport, N (%)				
Basketball	0 (0%)	1 (6.3%)	(χ^2 = 8.41)	0.35
Handball	5 (31.3%)	3 (18.8%)		
Javelin	1 (6.3%)	0 (0%)		
Modern pentathlon	1 (6.3%)	3 (18.8%0		
Speedball	1 (6.3%)	0 (0%)		

Swimming	5 (31.3%)	3 (18.8%)	
Tennis	1 (6.3%)	0 (0%)	
Volleyball	1 (6.3%)	5 (31.3%)	
Water polo	1 (6.3%)	1 (6.3%)	

SD, standard deviation; χ^2, chi-squared value; p-value, probability value

Table 2. Mean VAS and KJOC score pre and post-treatment of control and study group:

	Pre-treatment	**Post-treatment**			
	Mean ±SD	**Mean ±SD**	**MD**	**% of change**	**p-value**
VAS					
Control group	٦٢,٦٣ ± 15.03	15.06 ± 7.62	47.57	75.95	0.001
Study group	63.38 ± 9.51	14.25 ± ٧.86	49.13	77.52	0.001
MD	-0.75	0.81			
	p = 0.86	***p = 0.76***			
KJOC (%)					
Control group	49.67 ± 15.26	82.26 ± 9.11	-32.59	65.61	0.001
Study group	56.16 ± 19.65	82.83 ± 13.29	-26.68	47.50	0.001
MD	-6.49	-0.58			
	p = 0.31	***p = 0.88***			

VAS, visual analog scale; KJOC, Kelan Jobe Orthopedic Clinic Shoulder and Elbow Score; SD, standard deviation; MD, mean difference; p-value, probability value

DISCUSSION

The impacts of core stability on athletic performance and its role in reducing sports injuries in overhead athletes were considered for this study. The current study was conducted to investigate the effect of core stabilization exercises on shoulder pain and function in overhead athletes with shoulder impingement syndrome. The present study demonstrated no statistically significant differences in shoulder pain or function between both groups after therapy ($p > 0.05$). However, both groups showed a substantial reduction in VAS and increased KJOC scores after treatment compared to pretreatment ($p > 0.001$). The percentage of change for improvement in shoulder function was higher in the core stability group compared to the control group. It has been observed that 6-week core training programs are not enough to produce significant improvement in core stability. Whether using programs that are longer in duration will be able to produce significant improvement.

The findings of this study regarding shoulder pain and function agreed with the findings of Onat et al. (2020), who found that there was no significant difference in outcome scores compared to baseline values between the shoulder exercise group and core stabilization exercise group. However, there were significant improvements in pain intensity at rest, during exercise, and at sleep, as well as shoulder range of motion and function in both groups with unilateral shoulder impingement syndrome. The lack of a control group and follow-up testing to evaluate long-term effects may have contributed to these findings [17].

Also, agreed with the results of Endo and Sakamoto (2014), who found that there were no

statistically significant differences in core stability between the baseball athletes with shoulder pain while pitching and those without

shoulder pain, also there was no significant difference in dynamic balance between the both groups. These results may be because the core stability was tested using a core endurance test which involved static isometric holds and for baseball players, very quick movements are required. Therefore there is a need for an evaluation that focuses on dynamic core stability. It was found that players who experienced shoulder pain demonstrated a significant increase in tightness of the shoulder internal rotators, the axis-leg quadriceps and hamstring muscles [25,27].

Limitations:

The current study had limitation, including the short duration of the training program that prevented further training adaptation.

Conclusion

Through this research, the core stabilization exercises were found to be significantly effective post-treatment compared with that pretreatment on shoulder pain. However, there were no statistically significant differences in shoulder pain and function between both groups after treatment.

Recommedation:

So more research with a larger treatment

period and with more types of core stabilization exercises and cycling of change in intensity, frequency and types of core exercise may be required to challenge overhead athletes throughout the treatment period and to investigate the impact of core stability training on their symptoms.

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