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Effects of Rehabilitation Program on Shoulder Girdle Muscles Electromyography Activity in Overhead Throwing Athletes with Scapular Dyskinesis

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Abstract

Background: This study was designed to examine the effect of an 8-week rehabilitation training program on electromyography activity of shoulder girdle muscles in the overhead throwing athletes with scapular dyskinesis. **Methods**: Thirty-eight female athletes (volleyball players, n = 20 and handball players, n = 18) participated in this study and were randomly assigned into two groups including experimental (n = 20, volleyball n = 10, and handball, n = 10) and control (n = 18, volleyball n = 10, and handball n = 8) groups. Before and after 8 weeks rehabilitation training program, the electrical activity in the upper (UT), middle (MT), lower trapezius (LT), serratus anterior (SA), and infraspinatus (IS) muscles were measured at abduction movement in the shoulder (30° anterior to frontal surface). **Results:** After 8 weeks of training program, the electrical activity of the UT muscle significantly decreased for the EXP group (0-45°, $p = 0.001$; 0-90°, $p = 0.001$, and 0-135°, $p = 0.001$), and in comparison to CG (0-45°, $p = 0.001$; 0-90°, $p = 0.001$, and 0-135°, $p = 0.001$). The electrical activity of the MT, LT, SA, and IS muscles significantly increased for the EXP group (0-45°, $p < 0.05$; 0-90°, $p < 0.05$, and 0-135°, $p < 0.05$) after 8 weeks of training intervention, and in comparison to CG (0-45°, $p < 0.05$; 0-90°, $p < 0.05$, and 0-135°, $p < 0.05$). **Conclusions**: An 8-week rehabilitation training program succeeded in decreasing activity of UT muscles and increasing activity of SA, LT, MT and IS resulting in rehabilitation of the overhead throwing athletes with scapular dyskinesia.

Keywords: Scapular dyskinesia, Overhead athletes, Shoulder muscles, Training program

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1. Introduction

It appears that performing repetitive overhead throwing tasks induced shoulder complex dysfunction in several sport disciplines which used hands such as volleyball. Regarding prolong used of shoulders during sport tasks the injury risk of overused shoulder increased (i.e., 30% for volleyball and 18% for handball players) (1). In fact, effective overhead activity in sports such as volleyball and handball need to proper synchronizations and activations of muscles in girdle shoulder during forceful rotational movements to induce appropriate balance in mobility and functional stability in the shoulder (2). The consequence of repeated overhead activity is chronic neck and shoulder pain that most prevalent in overhead throwing sports. There were several pathology of shoulder

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injuries including subacromial impingement syndrome, rotator cuff tears, joint laxity, labral lesions, internal impingement, and scapular dyskinesis (3).

Scapular dyskinesis is common in athletes with shoulder injuries (i.e., more than 70%). There were some reasons to alterations of scapular motion such as neurologic dysfunction, fatigue, or inhibition by intra-articular glenohumeral or subacromial processes (4). Collectively, scapular injury is prevalent in sports that need to overhead throwing tasks and the athletes who performed throwing movements with one hand, the glenohumeral and scapular joint experience more stress to transfers of power from the lower extremities and their trunk to the arm (4-6). The possible change in this phenomena induced increases stress on the glenohumeral and scapular-thoracic joints resulting in increases of injury risk (7). To data, strong relationships between neck and shoulder pain and scapular dysfunction have been reported and several experimental and review studies addressed that scapular dyskinesis is in relation to shoulder pathologies and scapular dysfunction. In addition, the symptoms of shoulder pathology could be decreased by improving or correcting the abnormal scapular mechanics which confirmed by previous studies (8-10).

In literature, a large number of studies addressed that manual and exercise therapy could be a good treatment modality for restoring normal scapular kinematics; however, to date, no paper has thoroughly approached rehabilitation program for patients with shoulder dyskinesis and there is scarce literature on the reported rehabilitation training effects on scapular dyskinesia in overhead athletes (9, 11, and 12). Therefore, the primary purpose of this paper was to examine the effects of science-based training for the rehabilitation of scapular dyskinesis in athletes with scapular dyskinesis. The main aim of this research was to investigate about the level of shoulder muscle activity of female volleyball and handball players with scapular dyskinesis at different angles of arm elevation at the scapular level following the 8 weeks of rehabilitation training program.

2. Materials and Methods

Participations

Thirty-eight female athletes with scapular dyskinesis (volleyball players, n = 20 and handball players, n = 18) volunteered to participate in the study and were allocated to two groups as follow: experimental (EXP, n = 20, volleyball n = 10, and handball, n = 10) and control (CON, n = 18, volleyball n = 10, and handball n = 8) groups. Details of the characteristics for each group are given in Table 1. The sample size was calculated based on a previous study by Huang, Ou (1). A priori power analysis was computed using G × Power (Version 3.1.9.2, University of Kiel, Germany) and indicated that sample size of n = 20 for each group would be sufficient to find the effects of rehabilitation training program on scapular dyskinesis with an alpha level of 0.05 and 0.80 actual power. The players fulfilled the following inclusion criteria: (1) scapular movement disorder (right and left scapular asymmetry for at least 1.5 cm) for positive scapular dyskinesis test (5, 13), (2) no history of injuries such as dislocation or fractures in any of the bones of the shoulder girdle, (3) lack of complete tear of shoulder girdle muscle, (4) lack of adhesive capsulitis, (5) scapular muscle atrophy, (6) absence of severe upper musculoskeletal disorders including forward head, forward shoulder, kyphosis, scoliosis which examined by physician(14). For including the subjects in the final analyses, all subjects should complete all the training sessions and performed all test assessments. After being informed about the study procedures, benefits and possible risks, the subjects signed an informed consent form in accordance with Research Committee of the University and guidelines of the university’s Institutional Review Board.

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Table 1. Descriptive data of the experimental (EXP, n = 20, volleyball n = 10, and handball, n = 10) and control (CON, n = 18, volleyball n = 10, and handball n = 8) groups

Variables	EXP	CON
Age (y)	22.2 ± 2.4	23.7 ± 1.8
Height (cm)	167.8 ± 3.1	169.1 ± 5.4
Body mass (kg)	63.8 ± 3.4	65.3 ± 2.5
Body mass index (kg.m^{-2})	22.6 ± 0.8	22.7 ± 1.0
Training age (y)	7.4 ± 1.5	6.7 ± 1.3

Study design

In a randomized-controlled longitudinal design, subjects were divided into 2 groups, including experimental and control groups. The study duration lasted 10 weeks. The main training intervention period lasted 8 weeks and the subjects in the rehabilitation program groups performed equal volume and similar training 3 times a week. Pre, and post 8-week training, the electrical activity of the upper, middle, lower trapezius, serratus anterior and infraspinatus muscles were measured during shoulder abduction (30° anterior to frontal surface). Two measurements with 10 subjects with 96 h apart were used to determine the reliability of tests and the intraclass correlation coefficient (ICC) of all tests were r ≥ 0.95.

Testing procedures

The subjects were familiarized with the training, and testing procedures for 3 days before the pre-test day. All tests (i.e., pre- and post-tests) were performed a week pre and post the 8 weeks of training intervention.

Anthropometric measurement

Weight was measured to the nearest 0.1 kg using a medical scale (Tanita, BC-418MA, Tokyo, Japan). Height was measured to the nearest centimeter using a wall-mounted stadiometer (Seca 222, Terre Haute, IN, United States).

Scapular dyskinesis measurement

The lateral scapular slide test was performed to identify scapular dyskinesis as previously described in detail by Kibler, Sciascia (15) with test-retest and interest reliability between 0.84 and 0.88. In this test, the lower angle of the scapula is marked with a marker on the skin, then its distance from the adjacent vertebra were measured at three standing positions including: (1) hands next to the body, (2) hands on the waist with thumb on the back and four fingers on the front, and (3) the arms at 90° in the abduction position with the thumb downwards. For this study, the differences in side to side measures of scapular were assessed. All measurements were taken 2 times and the average of two measurements was recorded for further analysis. The differences between the sides were calculated by subtracting the value for the dominant side from the value for the non-dominant side. In addition, the absolute values for these differences were recorded to data analysis. The difference of ≥1.5 cm for the each three position was considered as positive result for the scapular dyskinesis.

Electromyography measurement

In this study, the electrical activity of the upper (UT), middle (MT), lower trapezius (LT), serratus anterior (SA) and infraspinatus (IS) muscles was recorded during shoulder abduction at 30° anterior to the frontal plane. To measure the electromyography (EMG) activity of the selected muscles, an 8-channel surface EMG (ME6000, Finland) with a sampling frequency of 1000 Hz was used. Cleaning the skin with an alcohol, the disposable Ag-Ag Cl adhesive electrodes were mounted

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on the muscles with the distance of 2 cm from the center to the center. Electrodes were positioned for all muscles according to SENIAM guidelines (16), and reference electrodes were placed on the acromion appendage and the cervical vertebra (17). The subjects performed arm elevation on the scapular level with superior hand in 3 positions as follow: (1) performing shoulder abduction of 45° (from 0 to 45°) on the scapular level for 1 second and holding it for 3 seconds, (2) performing shoulder abduction of 90° (from 0 to 90°) on the scapular level for 2 seconds and holding it for 3 seconds, and (3) performing shoulder abduction of 135° (from zero to 135°) on the scapular level for 3 seconds and holding it for 3 seconds.

A chronometer was used to adjust the rhythm of the shoulder abduction movement. To determine angles a biometric goniometer sensor SG150 wired to a DAQ board (BSN-daqA8W) with 24-bit resolution at 200 Hz sampling frequency. Also, the DAQ digital output was connected to one of the analog input channels of ME6000. In the specific angle the DAQ generate a pulse on digital output. So, at the specific angles of joint, EMG signals are marked. A metal base was used to control the abduction motion at the scapular level. This base was positioned 30 degrees anterior to the frontal surface. The 130 ° abduction was determined for each subject using a metal clamp that was removable on the metal base (the inclinometer measured the abduction angle of each subject and the metal clamp was adjusted to the metal base at that angle). In order to prevent lateral movement of the head and trunk during the tests, the subject was asked to look at the specified target in his or her view at a distance of 2 meters and to perform an abduction motion without moving the trunk. Repeating each abduction test and 3 min rest between maximal voluntary isometric contractions (MVIC) tests were considered to prevent fatigue. After abduction movement tests, MVIC muscle tests were obtained. A 30-second rest between repetitions of each abduction test and a 3-minute rest between IMVIC tests were considered to prevent fatigue. In order to normalize the electromyography signals, the RMS information of each muscle was divided into the MVIC of that muscle and then multiplied by 100.

Rehabilitation training program

The training protocol included a mixture of 12 exercises (i.e., which focused on activation of the kinetic chain in the foot, trunk and scapula). The subjects in the training group participated in 3 days (Tuesday, Thursday, and Saturday) per week rehabilitation training program for 8 weeks. The control group did not perform any exercise and were in training room when experimental group trained exercises. In each training session, subjects performed 10 minutes warm-up, 40 minutes rehabilitation training, and 10 minutes cool-down. The subjects in this study completed all training sessions which monitored by researcher and certificated strength and conditioning coach to ensure that all training sessions were performed correctly with an appropriate rest intervals. Table 2 presented the rehabilitation training program.

Table 2. Rehabilitation training program.

Week	Exercise	Set	Repetitions/ time	Rest (set/exercise)
	One leg standing with rotation and retraction of the scapula	3	10	30/90 sec
	Trunk extension, retraction of the scapula during low-row	3	30 sec	30/90 sec
Week	Scapular clock	3	10	30/90 sec
1	Depression and rotation of the humeral with hand on ball	3	10	30/90 sec
	Sleeper stretch	3	30 sec	30/90 sec
	Closed-chain scapular control exercise	3	10	30/90 sec
	One leg standing with rotation and retraction of the scapula	3	12	30/90 sec
	Trunk extension, retraction of the scapula during low-row	3	45 sec	30/90 sec
Week	Scapular clock	3	12	30/90 sec
2	Depression and rotation of the humeral with hand on ball	3	12	30/90 sec

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	Sleeper stretch	3	45 sec	30/90 sec
	Closed-chain scapular control exercise	3	10	30/90 sec
Week 3 and 4	One leg standing with rotation and retraction of the scapula	4	12	30/90 sec
	Trunk extension, retraction of the scapula during low-row	4	45 sec	30/90 sec
	Scapular clock	4	12	30/90 sec
	Depression and rotation of the humeral with hand on ball	4	12	30/90 sec
	Sleeper stretch	4	45 sec	30/90 sec
	Closed-chain scapular control exercise	4	10	30/90 sec
Week 5	Wall wash	3	10	30/90 sec
	Punches	3	30 sec	30/90 sec
	Seated push-ups	3	10	30/90 sec
	Blackburn exercises	3	10	30/90 sec
	Shoulder extension and retraction	3	10	30/90 sec
	Open-chain scapular stretching exercise	3	10	30/90 sec
Week 6	Wall wash	3	12	30/90 sec
	Punches	3	45 sec	30/90 sec
	Seated push-ups	3	12	30/90 sec
	Blackburn exercises	3	12	30/90 sec
	Shoulder extension and retraction	3	12	30/90 sec
	Open-chain scapular stretching exercise	3	12	30/90 sec
Week 7 and 8	Wall wash	4	12	30/90 sec
	Punches	4	45 sec	30/90 sec
	Seated push-ups	4	12	30/90 sec
	Blackburn exercises	4	12	30/90 sec
	Shoulder extension and retraction	4	12	30/90 sec
	Open-chain scapular stretching exercise	4	12	30/90 sec

Statistical analyses

A 2-way ANOVA with repeated measures (2 [group] x 2 [time]) was used to find significant differences between groups. When a significant F value was achieved, Bonferroni post hoc test was performed to determine the pairwise differences between the values. The data is reported as mean ± SD. The ICC was used to determine the reliability of the measurements. The level of significance was set at $P \leq 0.05$.

3. Results

At baseline there were no significant differences between the groups in all muscles ($p > 0.05$). After 8 weeks of training program, the electrical activity of the UT muscle significantly decreased for the EXP group (0-45°, $p = 0.001$; 0-90°, $p = 0.001$, and 0-135°, $p = 0.001$), and in comparison to CG (0-45°, $p = 0.001$; 0-90°, $p = 0.001$, and 0-135°, $p = 0.001$) (Table 3). The electrical activity of the MT muscle significantly increased for the EXP group (0-45°, $p = 0.009$; 0-90°, $p = 0.003$,

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and 0-135°, p = 0.001) after 8 weeks of training intervention, and in comparison to CG (0-45°, p = 0.01; 0-90°, p = 0.04, and 0-135°, p = 0.001). After 8 weeks of training program, the electrical activity of the LT muscle significantly increased for the EXP group (0-45°, p = 0.001; 0-90°, p = 0.001, and 0-135°, p = 0.001), and in comparison to CG (0-45°, p = 0.001; 0-90°, p = 0.001, and 0-135°, p = 0.001). The electrical activity of the SA muscle significantly increased for the EXP group (0-45°, p = 0.001; 0-90°, p = 0.001, and 0-135°, p = 0.001) after 8 weeks of training intervention, and in comparison to CG (0-45°, p = 0.001; 0-90°, p = 0.001, and 0-135°, p = 0.001). After 8 weeks of training program, the electrical activity of the IS muscle significantly increased for the EXP group (0-45°, p = 0.001; 0-90°, p = 0.001, and 0-135°, p = 0.001), and in comparison to CG (0-45°, p = 0.001; 0-90°, p = 0.001, and 0-135°, p = 0.001).

Table 3. Pre to post changes in electromyography activity in the experimental and control groups.

		0-45°		0-90°		0-135°	
		Pre	**Post**	**Pre**	**Post**	**Pre**	**Post**
UT	**EXP**	6.2 ± 2.3	3.2 ± 1.4*†	12.5 ± 3.5	7.5 ± 1.3*†	16.5 ± 2.9	10.4 ± 3.8*†
(%MVIC)	**CON**	6.2 ± 1.4	6.2 ± 0.9	11.3 ± 3.1	12.3 ± 1.9	16.3 ± 1.1	16.3 ± 1.6
MT	**EXP**	6.4 ± 2.8	8.5 ± 2.2*†	10.5 ± 2.9	11.6 ± 2.3*†	12.8 ± 2.6	14.7 ± 3.3*†
(%MVIC)	**CON**	6.4 ± 2.4	6.4 ± 1.9	9.5 ± 2.1	9.6 ± 2.4	12.9 ± 1.9	12.7 ± 2.2
LT	**EXP**	4.2 ± 1.1	10.2 ± 2.3*†	8.2 ± 2.1	15.2 ± 3.4*†	11.1 ± 3.8	19.1 ± 3.6*†
(%MVIC)	**CON**	5.2 ± 0.9	4.2 ± 1.1	8.1 ± 2.7	8.1 ± 2.9	11.1 ± 2.3	11.1 ± 2.9
SA	**EXP**	3.1 ± 1	10.1 ± 5.5*†	10.2 ± 2.5	17.2 ± 7.3*†	14.2 ± 3.9	22.2 ± 5.9*†
(%MVIC)	**CON**	3 ± 1.1	3.1 ± 1.3	10.2 ± 3.7	9.2 ± 2.8	14.2 ± 2.8	13.3 ± 3
IS	**EXP**	3.1 ± 1.1	6.3 ± 1.8*†	4.2 ± 1.2	8.2 ± 2.6*†	4.2 ± 1.8	9.2 ± 1.7*†
(%MVIC)	**CON**	3.1 ± 1.2	3.1 ± 1.9	4.2 ± 1.8	3.1 ± 2.1	4.1 ± 1.7	4.2 ± 1.8

Upper (UT), middle (MT), lower trapezius (LT), serratus anterior (SA), and infraspinatus (IS). Values are mean ± SD.*significant differences compared to pre ($p < 0.05$), † significant differences compared to CON group ($p < 0.05$).

4. Discussion

The purpose of this research was to investigate the effect of an 8-week training program on the electromyography activity of selected shoulder girdle muscles in the overhead throwing athletes with scapular dyskinesia during the shoulder abduction. The findings of the present study show that the training program presented in the EXP group improved the level of muscle activity at the different abduction angles. The MT, LT, SA and, IS muscles indicated increases in electrical activity compared to pre-test, and the level of activity of the upper trapezius muscle decreased compared to pre-exercise. In addition, these changes were significant in comparison to CON group.

Typically, the overhead sports (i.e., volleyball and handball) requires upper extremity movement at angles greater than 90°of the shoulder abduction and need to more neuromuscular coordination of the shoulder complex due to the nature of these sports. In addition, these sports need to repetitive overhead movements and weakness in shoulder work induces damages in the shoulder bone or girdle muscles. Some authors addressed that proper position of the shoulder is associated with normal shoulder function. In contrast, abnormal scapular position or motion induced excessive distraction force and posterior structural change resulting scapular dysfunctions in competitive overhead athletes (18).

In this study, we found that rehabilitation program could be a good training modality to improve symptoms of scapular dyskinesia by improving neuromuscular adaptations in the girdle muscles in overhead throwing athletes.

In investigating the level of shoulder muscle activity in the patients with scapular dyskinesia, the previous studies have reported decreases in UT activity and increases in SA activation, and lower / middle trapezius activity in the patients with scapular dyskinesia (5, 19). Neuromuscular control of the muscles around the scapula depends on the balanced ratio of scapular protraction-retraction, and the proper scapular muscle recruitment is essential for scapular stability during shoulder movement (4, 15, and 20). When the rotator cuff muscles are shortened on the length-tension curves (21), the patterns of muscle activation changed. The scapulothoracic dysfunction caused by this same muscle imbalance increases the pressure on the rotator cuff muscles, which is not capable of producing maximum force and thus, the secondary result is a weak rotator cuff (22, 23). Merolla et al (2010) in the study to determine external rotation strength in the pitcher's throwing shoulder demonstrated that external rotation strength is weaker compared with the non-throwing shoulder (24). The results of the study by Huang, Lin (3) showed that the scapular muscles activation plays an important role to stabilize and scapular motivators in the people with scapular dyskinesia (3). Shoulder disorders such as pain, restricted range of motion, and functional disability is associated with impaired scapular kinematics. According to these statements, it appears that patients with shoulder impingement have some problems including insufficient posterior tipping, external rotation, and upward rotation; decreased serratus anterior and lower trapezius activity; and increased upper trapezius muscle activity (3).

The UT muscle is known as the main propulsion muscle and its task is to raise the collarbone and perform the upper rotational movement of the scapula. Increased activity of this muscle occurs during lifting of the scapular clavicle and anterior tilt, as a compensatory strategy in the athletes with scapular dyskinesia trying to move the arm (25). The increase in activity of the trapezius following the training program has been mentioned in previous studies (2, 26). To interpret the results of increased trapezius activity, in spite of scapular dyskinesia, we can refer to the tonic and phasic systems. Janda has classified the upper trapezius muscle along with the muscles such as the levator scapular and sternocleidomastoid muscles in the group of tonic muscles and the medial, inferior, and anterior trapezius muscles in the phasic muscles group. Due to the features of the tonic muscular system that tends to increase activity, stiffness, shortening and rapid onset, as well as the characteristics of the phasic muscular system that tends to weaken, decrease activity, inhibit, increased length and delay in onset, we can explain an increase in the level of activity of the upper trapezius and a decrease in the activity of the inferior trapezius and serratus anterior muscles (27).

Numerous studies have reported the relationship between abnormal biomechanics and injuries caused by overuse of the shoulder girdle and occurring changes in the scapular movement. The reduction in pain and improvement in the strength of infraspinatus seen in these athletes after strengthening the scapular muscle structure indicates the role of scapular positioning to maintain the optimal relationship of rotation-tension of the rotator cuff muscles (24). The scapular muscles work synergistically to control the movement of the scapula and, for optimal scapular stability, the scapular muscle pattern activation is required. During hand elevation, LT helps posterior tilt and external scapular rotation (28). The scapula plays a key role between the upper limb and the trunk; the muscles that surround it provide proximal stability for the upper limb activities, so that the scapular stability is mainly caused by a pair of muscular forces. The pair of forces is equal and opposing muscle forces that produce rotation around the center of motion. The trapezius muscles during the shoulder abduction cause in the form of force pairs the upper scapular rotation, and play an important role in maintaining the normal position of scapula and scapulohumeral rhythm. (15). Increased upper trapezius activity, decreased lower trapezius and serratus anterior activity in the patients with scapular dyskinesia alters the balance of the pair of scapular muscle forces during arm elevation and results in muscle imbalance in these subjects (26).

Many studies have examined the effectiveness of a scapula-based rehabilitation program. Vande Velde et al showed that a 12-week scapular training program led to a significant increase in the isokinetic strength of scapular muscles in the healthy adolescent swimmers (29). In addition, Merolla, De Santis (24), after six months of training program for the volleyball players with scap-

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ular dyskinesia reported increases in the power of external glenohumeral rotators. De Mey, Danneels (30) reported that after 6 weeks of training the overhead throwing athletes improved scapular muscle strength. In this study, the superficial EMG activity of four major scapular muscles were recorded before and after the training program and found positive effects of training to improve the activity of these muscles. The purpose of their research conducted by Kim et al, as they described the eight-week scapula stabilizer training program in the archers with scapular dyskinesia. After one-year follow-up case study, the measurement included shoulder deviation, position of the shoulder and the strength of the shoulder stabilizers (30). Considering the workout strategy by Kibler (31), in this research we used a set of training program as the kinetic chain. The scapular biomechanics is essential for the overhead throwing athletes and a disorder in any part of the kinetic chain like the lower trunk performance can have a severe impact on it. A specialist who considers a training program for this type of the athletes should have a thorough understanding of the kinetic chain and of the importance of having a focused rehabilitation program to restore these athletes to the level of performance required by their specialty. In addition, the closed-chain exercises can also reduce stress and restore normal function to the muscle tissues that are in imbalance, and lead to faster rehabilitation.

5. Conclusion

According to the findings of the present study, it seems that weakness in the shoulder griddle muscles plays an important role in scapular dyskinesia of the overhead athletes. An 8-week rehabilitation training program succeeded in decreasing activity of UT muscles and increasing activity of SA, LT, MT and IS. Rehabilitation of the overhead throwing athletes with scapular dyskinesia, in the form of a movement pattern and focusing on the activation of the foot, trunk and shoulder motor chain, is the essential part of an exercise program.

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Conflicts of Interest

The authors report no conflict of interest

References

1. 1. Huang T-S, Ou H-L, Huang C-Y, Lin J-J. Specific kinematics and associated muscle activation in individuals with scapular dyskinesis. Journal of shoulder and elbow surgery. 2015; 24(8):1227-34.
2. 2. Garcia D, Roppel T, Scheresky M, Omdahl S. EMG of Serratus Anterior, Upper, Middle, and Lower Trapezius during Glenohumeral Abduction in a Participant with Scapular Dyskinesia: A Case Study. 2018.
3. 3. Huang T-S, Lin J-J, Ou H-L, Chen Y-T. Movement pattern of scapular dyskinesis in symptomatic overhead athletes. Scientific Reports. 2017; 7(1):1-7.
4. 4. Burkhart SS, Morgan CD, Kibler WB. The disabled throwing shoulder: spectrum of pathology Part III: The SICK scapula, scapular dyskinesis, the kinetic chain, and rehabilitation. Arthroscopy. 2003; 19(6):641-61.
5. 5. Ben Kibler W. The role of the scapula in athletic shoulder function. The American journal of sports medicine. 1998; 26(2):325-37.
6. 6. Burkhart SS, Morgan CD, Kibler WB. Shoulder injuries in overhead athletes: the “dead arm” revisited. Clinics in sports medicine. 2000; 19(1):125-58.
7. 7. Huang T-S, Huang H-Y, Wang T-G, Tsai Y-S, Lin J-J. Comprehensive classification test of scapular dyskinesis: A reliability study. Manual therapy. 2015; 20(3):427-32.
8. 8. Lugo R, Kung P, Ma CB. Shoulder biomechanics. European journal of radiology. 2008; 68(1):16-24.
9. 9. Warner JJ, Micheli LJ, Arslanian LE, Kennedy J, Kennedy R. Patterns of flexibility, laxity, and strength in normal shoulders and shoulders with instability and impingement. The American Journal of Sports Medicine. 1990; 18(4):366-75.
10. 10.Ludewig PM, Hoff MS, Osowski EE, Meschke SA, Rundquist PJ. Relative balance of serratus anterior and upper trapezius muscle activity during push-up exercises. The American journal of sports medicine. 2004; 32(2):484-93.
11. 11.Tsai N-T, McClure PW, Karduna AR. Effects of muscle fatigue on 3-dimensional scapular kinematics. Archives of physical medicine and rehabilitation. 2003; 84(7):1000-5.

[DOI: 10.52547/jsipb.1.1.1]

12. 12.Ekstrom RA, Donatelli RA, Soderberg GL. Surface electromyographic analysis of exercises for the trapezius and serratus anterior muscles. Journal of Orthopaedic & Sports Physical Therapy. 2003; 33(5):247-58.
13. 13.Ozunlu N, Tekeli H, Baltaci G. Lateral scapular slide test and scapular mobility in volleyball players. National Athletic Trainers' Association, Inc; 2011.
14. 14.Hannah DC, Scibek JS, Carcia CR. Strength profiles in healthy individuals with and without scapular dyskinesis. International journal of sports physical therapy. 2017; 12(3):305.
15. 15.Kibler BW, Sciascia A, Wilkes T. Scapular dyskinesis and its relation to shoulder injury. JAAOS-journal of the American academy of orthopaedic surgeons. 2012; 20(6):364-72.
16. 16.Stegeman D, Hermens H. Standards for surface electromyography: The European project Surface EMG for non-invasive assessment of muscles (SENIAM). 2007.
17. 17.Mercer SR. Surface electrode placement and upper trapezius. Advances in Physiotherapy. 2002;4(2):50-3.
18. 18.Tate AR, Mcclure P, Kareha S, Irwin D. Effect of the scapula reposition test on shoulder impingement symptoms and elevation strength in overhead athletes. Journal of orthopaedic & sports physical therapy. 2008; 38(1):4-11.
19. 19.Ou H-L, Huang T-S, Chen Y-T, Chen W-Y, Chang Y-L, Lu T-W, et al. Alterations of scapular kinematics and associated muscle activation specific to symptomatic dyskinesis type after conscious control. Manual Therapy. 2016; 26:97-103.
20. 20.Wilk KE, Meister K, Andrews JR. Current concepts in the rehabilitation of the overhead throwing athlete. The American journal of sports medicine. 2002; 30(1):136-51.
21. 21.Cools A, Witvrouw E, Declercq G, Vanderstraeten G, Cambier D. Evaluation of isokinetic force production and associated muscle activity in the scapular rotators during a protraction-retraction movement in overhead athletes with impingement symptoms. British journal of sports medicine. 2004; 38(1):64-8.
22. 22.Happee R, Van der Helm F. The control of shoulder muscles during goal directed movements, an inverse dynamic analysis. Journal of biomechanics. 1995; 28(10):1179-91.
23. 23.Kebaetse M, McClure P, Pratt NA. Thoracic position effect on shoulder range of motion, strength, and three-dimensional scapular kinematics. Archives of physical medicine and rehabilitation. 1999; 80(8):945-50.
24. 24.Merolla G, De Santis E, Sperling JW, Campi F, Paladini P, Porcellini G. Infraspinatus strength assessment before and after scapular muscles rehabilitation in professional volleyball players with scapular dyskinesis. Journal of shoulder and elbow surgery. 2010; 19(8):1256-64.
25. 25.Oliveira VMAd, Batista LdSP, Pirauá ALT, Pitangui ACR, Araújo RCd. Electromyographic activity and scapular dyskenesia in athletes with and without shoulder impingement syndrome. Revista Brasileira de Cineantropometria & Desempenho Humano. 2013;15(2):193-203.
26. 26.Lopes AD, Timmons MK, Grover M, Ciconelli RM, Michener LA. Visual scapular dyskinesis: kinematics and muscle activity alterations in patients with subacromial impingement syndrome. Archives of physical medicine and rehabilitation. 2015; 96(2):298-306.
27. 27.Page P, Frank CC, Lardner R. Assessment and treatment of muscle imbalance: the Janda approach: Human kinetics Champaign, IL; 2010.
28. 28.Easwaran PG, Sharma U, Palekar TJ. Comparison of Scapular Muscles Activation with Shoulder Retraction and Shoulder Elevations in Individuals with Scapular Dyskinesia. 2019.
29. 29.Van de Velde A, De Mey K, Maenhout A, Calders P, Cools AM. Scapular-muscle performance: two training programs in adolescent swimmers. Journal of athletic training. 2011; 46(2):160-7.
30. 30.De Mey K, Danneels L, Cagnie B, Cools AM. Scapular muscle rehabilitation exercises in overhead athletes with impingement symptoms: effect of a 6-week training program on muscle recruitment and functional outcome. The American journal of sports medicine. 2012; 40(8):1906-15.
31. 31.Kibler WB. Rehabilitation of rotator cuff tendinopathy. Clinics in sports medicine. 2003; 22(4):837-47.

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