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Core Strength, Balance and Scapular Dyskinesia in Upper Extremity Sports: A Cross-Sectional Study

Üst Ekstremite Sporlarında Kor Kuvvet, Denge ve Skapular Diskinezi: Gözlemsel bir Araştırma

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ABSTRACT

Objective: This study aimed to assess the effect of scapular dyskinesia on core strength and upper extremity dynamic balance.

Materials and Methods: The study included 49 volunteer participants who were active volleyball or basketball players at Aydın Adnan Menderes University Faculty of Sport Sciences. The presence of dyskinesia in the study was assessed with the Lateral Scapular Slide Test; core strength was assessed with the Modified Side Plank Test and the Biering-Sorenson Test; and, upper extremity balance was evaluated with the Upper Quarter Y-Balance Test (YBT-UQ). Independent groups t-test and Mann Whitney U test were used to compare independent group differences.

Results: While 17 (34.7%) athletes had scapular dyskinesia, 32 (65.3%) did not have scapular dyskinesia. In athletes without dyskinesia, Modified Side Plank Test scores and dominant YBT-UQ total scores, and non-dominant YBT-UQ total scores were statistically higher than those with scapular dyskinesia ($p<0.05$). No significant difference is detected between groups according to Biering-Sorenson Test ($p>0.05$).

Conclusion: Based on the present results, it is recommended to include exercises for developing balance and core muscles to provide scapular stabilization in the training of the upper extremity sports.

Keywords: Balance, core strength, scapular dyskinesia, upper extremity

ÖZ

Amaç: Bu çalışma, skapular diskinezinin kor kuvveti ve üst ekstremite dinamik dengesi üzerindeki etkisini değerlendirmeyi amaçladı.

Materyal ve Metot: Çalışmaya Aydın Adnan Menderes Üniversitesi Spor Bilimleri Fakültesi'nde aktif olarak voleybol veya basketbol oynayan 49 gönüllü dahil edildi. Çalışmada diskinezi varlığı Lateral Scapular Slide Test ile; kor kuvveti, Modifiye Yan Plank Testi ve Biering-Sorenson Testi ile; üst ekstremite dengesi ise üst ekstremite Y-Denge Testi (YBT-UQ) ile değerlendirildi. Bağımsız grup farklılıklarının karşılaştırılmasında bağımsız gruplar t testi ve Mann Whitney U testi kullanıldı.

Bulgular: 17 (%34,7) sporcuda skapular diskinezi bulunurken, 32 (%65,3) sporcuda skapular diskinezi yoktu. Diskinezisi olmayan sporcularda, Modifiye Yan Plank Testi puanları ve dominant YBT-UQ total skorları ve non-dominant YBT-UQ total skorları, skapular diskinezisi olanlardan istatistiksel olarak daha yüksekti ($p<0,05$). Biering-Sorenson Testine göre gruplar arasında anlamlı bir fark saptanmadı ($p>0.05$).

Sonuç: Mevcut sonuçlara dayanarak, üst ekstremite sporlarının eğitimine skapular stabilizasyonu sağlamak için denge ve core kasları geliştirmeye yönelik egzersizlerin dahil edilmesi önerilmektedir.

Anahtar Kelimeler: Denge, kor kuvveti, skapular diskinezi, üst ekstremite

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INTRODUCTION

Athletes using their upper extremities make high-speed specific movements. To perform these movements, it is important to have various features such as flexibility, muscle strength, coordination, synchronicity, and neuromuscular control in the shoulder girdle.[1]

Movement, muscle strength, and endurance are also required around the lumbar spine to attain functional stability during shoulder movements. The most crucial elements of muscle activation in this region are the core muscles.[2] The core muscles, frequently used in upper extremity sports, are the muscle groups that actively work in the forward-throwing movement. Power transfer with minimal energy from the lower extremity to the upper extremity occurs with a strong core region.[3]

Researchers have focused on core muscles as well as the neighboring structures because of their functions, and have shown that the scapula, shoulder muscles, and lower extremity muscles operate in coordination with the core muscles and create controlled movements.[4]

Balance is an integral part of core stability. Neuromuscular imbalance occurs between many synergistic and antagonistic muscles. This imbalance can cause excessive joint movement and instability in overhead movements.[5,6]

The presence of Scapular dyskinesia (SD) in overhead athletes is usually explained by the dominant scapula having one or more of the inferior, protraction and abduction components compared to the non-dominant scapula.[7] The scapula is positioned between the trunk and arm; it provides energy transfer from the lower extremity and trunk to the upper extremity to maximize its potential while minimizing the risk of injury. In order to achieve adequate scapular control, it is the strength of the trunk muscles that enables the athlete to use the lower and upper extremities synchronously. Therefore, loss of control in the scapular region may be related to loss of control in the trunk muscles, which are responsible for stabilising the extremities.[8]

Considering the high prevalence of shoulder injuries that occur in upper extremity sports and SD is associated with shoulder injuries. Therefore, there is a need to examine further the correlation between SD and core strength and balance. This study aimed to assess the effect of scapular dyskinesia on core strength and upper extremity dynamic balance.

MATERIALS AND METHODS

Ethics Committee Approval: Ethical approval of the study was obtained from Aydın Adnan Menderes University Faculty of Medicine Ethics Committee (Date: 27.04.2020, decision no: 2020/63). The research was carried out according to the Helsinki Declaration Principles.

Study Group*:* This study was planned as a cross-sectional study. The subjects consisted of 56 playing basketball and volleyball athletes at the university. All athletes who agreed to participate in the study were included based on the inclusion criteria. Between the ages of 18-25, studying at Aydın Adnan Menderes University Faculty of Sport Sciences and using their upper extremities were included in the study. Individuals with cardiovascular, physical or psychological disorders were not included in the study. A total of 49 volunteer basketball (n=21) and volleyball (n=18) players (26 men, and 23 women) participated in the study.

Procedures*:* Before the study, all participants signed a voluntary consent form describing the purpose and possible risks of the study. After the anthropometric measurements, a standardized 10-minute warm-up program was applied before the tests were applied. The warm-up program included running and dynamic stretching, similar to Çakır and Ergin's (2022) study.[9] The Modified Side Plank Test and the Biering-Sorenson Test were used to assess the core strength values of the athletes participating in the study. The Upper Quarter Y-Balance Test (YBT-UQ) was used to determine the balance values, and the Lateral Scapular Slide Test (LSST) was used to determine SD.

After the tests were completed, the participants were divided into two groups according to the presence of scapular dyskinesia: with dyskinesia and without dyskinesia.

Instruments

Demographic Information Form: In the study, the researcher-designed Demographic Information Form, which included questions about gender, age, the sports branches of athletes, and tenure in sports (years), was used.

Modified Side Plank Test: The lateral bridge test is used to evaluate the lateral core muscles. The participant was positioned in the side-lying position. The participant was asked to move their hips away from the table using their feet and the lower part of their elbows. The test was finalized when the participant could not keep this position.[10]

Biering- Sorenson Test: It is known as the oldest endurance test in the literature. The participant was in the prone position, with the pelvis and lower extremities fixed on the treatment table, while the torso was held in the horizontal plane without support. The test was terminated after 240 seconds or when they could not maintain the horizontal plane.[10]

Upper Quarter Y-Balance Test (YBT-UQ): It is used to evaluate the balance, functionality, and stability of the upper extremity and trunk. The assess-

ment was started in a push-up position with both arms shoulder-width apart. Starting with the non-dominant hand, the maximum reachable distance was recorded in the medial, inferolateral, and superolateral directions.[11] During the tests, in cases where the feet were off the ground, significant flexion of the hip occurred, the load was transferred to the reaching arm, or the elbow of the stable arm was flexed, the test was deemed invalid, and the test was restarted. The evaluation was performed 3 times and the score was obtained by dividing the sum of the 3 repetition distances for each direction by the length of the upper extremity.[12] For UE composite score calculation, this formula was used = (medial+ inferolateral + superolateral) x100 / 3 x arm length.

Lateral Scapular Slide Test (LSST): The LSST was evaluated bilaterally in three different positions: with the arms at the sides in a neutral position, the hands at the waist with the thumbs facing back, and the shoulders in the abduction and the arms in maximum internal rotation. Scapular position measurements were made bilaterally in the same horizontal plane between the lower angle of the scapula and the spinous processes of the thoracic vertebrae in all three test positions.[13]

Statistical Analysis: Data analysis was made with SPSS 25.0 (IBM SPSS Statistics 25, Armonk, NY: IBM Corp.). Continuous variables are presented as mean ± standard deviation, Median (Q1-Q3). Categorical variables are expressed as numbers and percentages. The conformity of the data to the normal distribution was examined with the Shapiro-Wilk test. In the examination of independent group differences, an independent groups t-test was used when parametric test assumptions were met, and when the assumptions were not met, the Mann-Whitney U test was used. The Chi-square analysis was used to analyze the differences between categorical variables. In all analyses, $p<0.05$ was considered statistically significant.

The sample size was calculated with the G-Power 3.1.9.4 program. Assuming that the effect size planned to be reached would be strong (d=0.9) when a total of at least 32 people (at least 16 people for each group) were included in the study, it was calculated that 80% power could be reached at the 95% confidence level. The sample of the study consisted of 4 teams. All 56 athletes in these teams were reached. Meeting the inclusion and exclusion criteria of the study, all athletes who agreed to participate in the study were included in the study (n=49). It was observed that 17 of these athletes were SD-positive, and 36 of them were SD-negative. When the results obtained from these athletes were examined, it was seen that the effect size was strong (d=0.77). At this effect size level, it was calculated that our study reached 81% power at a 95% confidence level.

RESULTS

The demographic information of 49 participants is summarized (Table 1).

SD was positive in 34.7% (n=17) of the participants, and 65.3% (n=32) did not have SD. After the analyses of the SD assessment, the participants were grouped according to their positivity status, and the analyses were completed. Accordingly, modified side plank test scores, dominant YBT-UQ total scores, and non-dominant YBT-UQ total scores of

Table 1. Demographic data.

		Median (Q1-Q3)	
Age (year)		22 (20.5 - 22)	
Height (cm)		182 (172.5 - 188)	
Weight (kg)		71 (59 - 79)	
BMI (kg/m2)		21.43 (19.69 - 22.91)	
Tenure in sports (years)		10.5 (8.75 - 13)	
Gender (n; %)	Female	23	46.9
	Male	26	53.1

Table 2. Comparison of Biering Sorenson and Modified Side Plank, YBT-UQ Test Scores according to SD presence.

	Dyskinesia	No Dyskinesia	p
Biering Sorenson(sec)**	94.9 (53.43 - 153.29)	106.14 (80.98 - 142.1)	0.319
Modified side plank(sec)**	43.59 (35.98 - 62.4)	64.02 (51.69 - 90.08)	**0.015**
YBT-UQ dominant superolateral(cm)*	91.24 ± 13.76	96.72 ± 15.24	0.222
YBT-UQ dominant medial(cm)*	121.94 ± 9.56	120.16 ± 10.57	0.564
YBT-UQ dominant inferolateral(cm)**	103 (92 - 103)	103 (89 - 103)	0.492
YBT-UQ non-dominant superolateral(cm)*	95.12 ± 15.35	99.88 ± 15.76	0.315
YBT-UQ non-dominant medial(cm)*	129.12 ± 4.53	129.66 ± 2.98	0.619
YBT-UQ non-dominant inferolateral(cm)**	100 (97 - 102)	100 (98 - 102)	0.824
YBT-UQ dominant total(cm)*	1.28 ± 0.1	1.35 ± 0.09	**0.029**
YBT-UQ non-dominant total(cm)*	1.35 ± 0.1	1.42 ± 0.08	**0.007**
YBT-UQ Total Difference(cm)**	-0.09 (-0.1 - -0.01)	-0.08 (-0.12 - -0.02)	0.266

Bold means statistically significant; *: Means ± StD. The comparison was made by using the t-test; **: Values are Median (Q1-Q3); Comparison was made by using the Mann Whitney U test.

the participants with positive SD test were found to be significantly lower ($p<0.05$) (Table 2).

DISCUSSION AND CONCLUSION

According to the results of this study, upper extremity athletes with SD had lower balance and core strength than those without SD.

We found a statistically significant difference between the Modified Side Plank Test values, the dominant YBT-UQ total score, and the non-dominant YBT-UQ total score values of individuals with SD.

In a systematic review by Burn et al., it has been stated that the SD presence is higher in athletes who do overhead sports than those who do not.[14] In another study, the highest prevalence of SD was shown in handball players.[15] It has been stated that the presence of SD is two times higher in male kickboxers than in sedentary individuals.[16] Sarı[17] found the rate of SD to be 40 % in 54 athletes playing overhead sports. In our study, the presence of SD was 34.4%. Similar to our study, Koslow et al. reported 26.8% of individuals with SD in at least one of the three positions.[18] However, in the study of Sezik (2018), the rate of SD was higher than that found in the present study.[19] It is thought that this result may be due to the lower age group (15.15 ± 0.4) in their study compared to the present study.

In the evaluation of SD, there are tests such as LSST, scapular assistance test (SAT), scapular retraction test (SRT), lateral scapular slide test (LSST), isometric scapular pinch test, and the wall pushup test.[20] Some researchers use LSST in their studies, similar to ours, because it is reliable and easy to apply in SD assessment.[21,22] However, Jildeh et al. recommend the use of new computational methods through technology-based artificial intelligence for SD evaluation.[20]

We did not find any literature on examining the core strength of SD status in athletes using their upper extremities. A study with handball players by Bauer et al.,[23] looked at the relationship between YBT-UQ and core strength. In this literature, these researchers evaluated the core muscles, which we evaluated with the Biering Sorensen Test, with a component of the Bourban test (Dorsal chain).[23]

In our study, it was found no statistical difference regarding the Biering Sorensen Test score and SD status. The Biering-Sorenson test mostly gives the isometric endurance of the hip and back extensor muscles. It has also been used as a good assessment tool to predict the risk of non-specific low back pain in patients/clients following a study[11] and therefore is thought to be unaffected by SD.

In the Modified Side Plank test, which we used in the assessment of core strength, the activation of local muscles such as M. Quadratus lumborum and the abdominal wall is required.[7] In our study, a statistical difference was observed in the modified side plank test according to the SD status. Modified Side Plank values were found to be lower in individuals with SD. Tawde et al.[24] measured the muscle strength of neck flexors using the folded stabilizer pressure biofeedback unit and analyzed them according to their SD status. A statistical difference was found in the cervical core muscles in terms of the presence of SD in violin players. This study on violin players is the only study we can discuss. It was observed that there is no study in the literature evaluating core muscle strength in SD in the field of sports. In this sense, the present work is unique.

The YBT-UQ has been used in many populations because it is an inexpensive, portable, and easy-to-interpret field test.[25] Scapular stability and mobility, thoracic rotation, and core stability are required to maintain balance while performing the test.[26] Some researchers evaluated the relationship between YBT-LQ and core muscle strength in upper extremity sports.[23,27,28]

Amasay et al.[29] evaluated the relationship between the YBT-UQ and SD in healthy university students. However, no study in the literature evaluated the relationship between the YBT-UQ and SD in upper extremity sports.

Therefore, our study investigated the effect on the YBT-UQ scores of athletes with SD.

In our study, there was a statistical difference between the dominant YBT-UQ and the non-dominant YBT-UQ scores in the presence of SD. The assumption was that athletes with SD would show lower scores in all aspects of the YBT-UQ. In our study, it was also found a statistically significant relationship between core muscles and the YBT-UQ. They must remain in the plank position while performing the YBT-UQ. Again, while performing this test, trunk stabilization should be good to provide extremity mobility.[30] We think that our finding is due to the good YBT-UQ value in patients with strong core muscles. Studies prove the positive relationship between core muscles and the YBT-UQ supporting our conclusion.[23,27,28]

In our study, there are limitations and strengths. The small sample size and the fact that we only evaluated the dominant side in the Modified Side Plank Test are the limitations of our study. The strength of our study is that it is a study that has not been performed in this field and that it includes both sports sciences and health sciences. There are few studies on this subject in the literature. This study is thought to contribute to the literature for future research.

In conclusion, upper extremity strength, which is an absolute factor for success in volleyball and basketball athletes, and upper extremity balance, which is equally important for shot-point production, can be

affected by SD. A well-stabilized shoulder is important for athletes using the upper extremities. When the athletes were examined in the study, it was seen that SD was effective on the athletes as predicted in the hypotheses. For this reason, as a clinical finding, we suggest that SD should be evaluated before and after training since the presence of SD will affect the athletes' core muscle strength and upper extremity balance, thus, their sports performance. In this way, possible injuries will be prevented. Among our recommendations, the suggested benefits of closed kinetic chain upper extremity exercises similar to the YBT-UQ can be added to training for rehabilitation and many sports as they include increased shoulder stability and proprioception.

Ethics Committee Approval: Ethical approval of the study was obtained from Aydın Adnan Menderes University Faculty of Medicine Ethics Committee (Date: 27.04.2020, decision no: 2020/63). No personal information was written on the data collection form to ensure privacy. The research was carried out according to the Helsinki Declaration Principles.

Conflict of Interest: No conflict of interest was declared by the authors.

Author Contributions: Concept – FU, NÖ; Supervision – AK; Materials – NÖ; Data Collection and/ or Processing – EE; Analysis and/ or Interpretation – FÜ, EE; Writing – NÖ, AK.

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