

## The Relation between Scapular Dyskinesis and the Upper Quarter Y-Balance Test

Research Article

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### Abstract

The shoulder is a complex mechanical system. Alterations in the position and/or orientation of its joints may interfere with optimal shoulder coordination. Scapular dyskinesia (SDK) is defined as mal-positioning or mal-movement of the scapula along the thoracic wall. It is not well established the role of scapular dyskinesia as the cause or the effect of shoulder pathologies. The Upper-Quarter Y-Balance test (UQYBT) has been suggested as a return-to-play tool for athletes with upper extremity injuries. The objective of this study was to quantify the relation between the UQYBT and SDK. Six males and five females participated in the study, age 18-30 years old. All participants' shoulders were evaluated by a certified athletic trainer using Kibler Scapular Dyskinesia Test (SDT) as having dyskinesia or not. Each participant performed three of the SDT and three of the UQYBT. The outcomes of the UQYBT were the highest score for each direction Superior-Lateral Reach (SLR), Inferior-Lateral Reach (ILR), and Medial Reach (MR) and the Composite score. An independent *t*-test with unequal variances was performed to determine statistical differences between normal and SDK shoulders during the UQYBT. Results indicate significant differences between the normal and SDK shoulders in the Composite score ( $p=.048$ ). No significance was found during the ILR, SLR, and MR. In conclusions, when the SDK shoulder was stabilizing during the UQYBT higher scores were seen in every direction compared to the normal shoulder. These suggest that SDK may affect the scores of UQYBT.

**Keywords:** Shoulder Testing; Biomechanics; Scapular Dyskinesia; Functional Testing; Balance.

### Introduction

The shoulder complex is a unique mechanical system in the human body consisting of three bones: the scapula, humerus and clavicle. These bones interact with each other through three joints (sternoclavicular, acromioclavicular, glenohumeral) and one articulation (scapulothoracic). The interaction between these bones produces smooth coordinated movements of the shoulder, such as reaching. Alterations in the position and/or orientation of any of these joints and articulation may interfere with optimal shoulder coordination. Abnormal shoulder kinematics has been found to be associated with musculoskeletal disorders such as rotator cuff impingement syndrome [1-3], unstable shoulder hypermobility [4], and frozen shoulder [5, 6].

Scapular dyskinesia is defined as mal-positioning or mal-movement of the scapula along the thoracic wall during static

glenohumeral position or dynamic movement. It is identified with increased protraction of the inferior angle and medial border of the scapula, and scapular dysrhythmia and or asymmetry bilaterally [7, 8]. It is believed that multiple factors may cause scapular dyskinesia such as bony, neurological and/or muscular sources. Some examples are clavicle fracture, long thoracic nerve palsy, and serratus anterior activation [8]. It is not well established the role of scapular dyskinesia as the cause or the effect of shoulder pathologies. On its own, scapular dyskinesia is neither an injury nor musculoskeletal disorder [8]. With current research on shoulder pathologies, there is a link between scapular dyskinesia and shoulder conditions such as rotator cuff pathologies, glenohumeral instability, acromioclavicular joint injuries, and adhesive capsulitis [7, 9, 10].

Currently, there are several tests to determine scapular dyskinesia, such as the Lateral Scapular Slide Test and the Scapular Dyskinesia

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Test (SDT). Reliability and validity of the Lateral Scapular Slide Test was relatively low [11]. On the other hand, the SDT, the most common visual test used, was found to have moderate reliability (k value, 0.4 - 0.6) [12, 13] as well as the validity [14]. The SDT was introduced by Ben Kibler (2002). The test incorporates glenohumeral flexion and abduction with resistance (3 lb or 5 lb depends on body weight) to determine the presence of scapular dyskinesis. Clinicians visually observe the movement of the scapula throughout the different range of motions and subjectively classify scapular motion patterns as having dyskinesis or not [12].

The Upper Quarter Y-Balance Test (UQYBT) was developed as a clinical upper extremity functional test. The UQYBT implements three dynamic movements while the participant is in the push-up position. During the test, the participant needs to stabilize his body in the push-up position while reaching in three different directions medial, superior-lateral, and inferior-lateral. The UQYBT can be used to compare between limb-to-limb movement limitations and asymmetries. There is a limited amount of research on the UQYBT. Westrick et al. (2012) examined the reliability and the effects of arm dominance on the UQYBT results. The test re-test reliability proved excellent with an (ICC > 0.9) however, no significant difference was observed in performance score between dominant and non-dominant arms [15]. A different study by Gorman et al. (2012) demonstrated similar findings as Westrick et al. (2012) with no significant differences between dominant and non-dominant arms and reported good to high test re-test reliability (ICC > 0.8) and excellent inter-rater reliability (ICC = 1). Gorman et al. (2012) also examined gender differences during the UQYBT. No significant difference was found when comparing scores with respect to arm length [16].

The Upper-Quarter Y-Balance test has been suggested as a return-to-play tool for athletes with upper extremity injuries. However, to the best of the authors' knowledge there are no known studies that have investigated the influence of scapular dyskinesis on UQYBT scores. The purpose of this study is to determine a relation between the UQYBT and the Scapular Dyskinesis Test. We hypothesized that a supporting arm with scapular dyskinesis would present a lower score than a supporting arm without dyskinesis on the UQYBT.

## Materials and Methods

### Participants

Eleven students from Barry University participated in this study, six males and five female, aged 18-30 years old. Exclusion criteria were shoulder surgery within the past year, acute or chronic subluxations/dislocations of either shoulder, or acute ligament injuries to their ulnar or elbow lateral collateral ligaments. The inclusion criteria included the ability to perform a 10 minutes warm-up on an upper extremity ergometer, lift 3 lb or 5 lb dumbbell weights in glenohumeral abduction and flexion, and perform at least five push-ups with correct form. This study was approved by the University's IRB Committee.

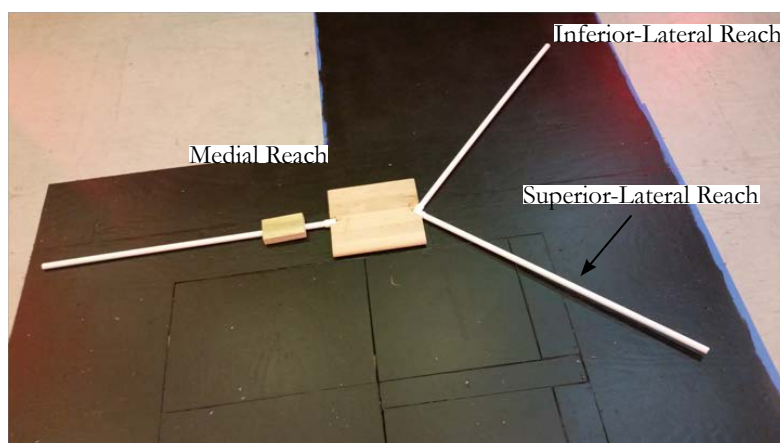
### Instrumentation

The UQYBT apparatus was designed based on the specifications of previous studies [16]. PVC pipes were connected to a wood block in the medial, inferior-lateral, and superior-lateral reach directions. Each pipe was 90 cm in length and was marked in 0.5 cm increments (Figure 1). The SDT was performed using a 3 lb or 5 lb dumbbell weights depending on the participant's body weight.

### Procedures

Upon arrival to the Motion Analysis Center (MAC) Lab the participants were instructed to perform 10 minutes of warm-up on the upper extremity ergometer. Once the participants finished the warm-up, they were instructed on the correct way to perform the SDT and the UQYBT. Based off previous literature those who weighed less than 150 lb used a 3 lb weight during the SDT and those who weighed 150 lb or more performed the SDT with a 5 lb [13, 14]. Participants performing the SDT stood feet shoulder width apart for both flexion and abduction. When performing shoulder flexion, their forearms were in neutral with thumbs pointing up. During abduction, their palms were facing down toward the floor. Both shoulder flexion and shoulder abduction were performed three times. Participants elevated and lowered their arms to a two-second count during both tests

Figure 1. UQYBT Apparatus.



conditions. The participants were to pause for one second once they reached 90 degrees of either flexion or abduction before returning to the starting position. A rest interval of two minutes was taken between each trial to eliminate the affect of fatigue. Scapular dyskinesis was determined based on prominence of the inferior angle, medial border, early elevation of the acromion, or asymmetry of the scapulae during the lowering of the arms by a certified Athletic Trainer.

After performing the SDT, each participant performed three reaches in each of the three directions (medial, inferior-lateral, and superior-lateral) during the UQYBT (Figures 2-4). When performing the UQYBT participants were instructed to get in a push-up position with their feet shoulder width apart. The arm being tested would be supporting the body weight on the stationary plate, while the other arm moved the block. The reach distance was measured based on the final block position. The participant's toe location was marked with tape to ensure that their feet remained in the same position throughout all testing trials. Participants were asked to keep their feet in these positions throughout each reaching trial. The medial reach required the individual to push the block with their arm straight to their side and fingertips at the edge of the block (Figure 2). The superior-lateral reach involved crossing over the stabilizing arm (Figure 3), whereas the inferior-lateral reach requires the individual to cross underneath the stabilizing arm to push the block (Figure 4). A rest period of one minute between each trial was given to eliminate the effect of fatigue. Three trials were performed in one direction

before moving to next direction. If participant knees touched the ground, their body collapsed to the floor, failed to return to the starting position after moving the block, or the individual shoved the block without maintaining contact, he or she would repeat the trial. Upper extremity length was measure on the right side for each participant, from C7 to the tip of the middle finger, with the shoulder maintained at 90° of abduction.

### Data Analysis

Statistical analysis was performed on the data using SPSS version 21 (IBM Corp. Armonk, NY). Test-retest reliability, using intraclass correlation (ICC), was performed on the scores of each of the three different reaches. The highest score for each type of reach in the UQYBT was indentified for further analysis. In addition, the composite score was calculated for each group. The composite score is the average of the three different reaches. These scores were then normalized to the participant's arm length. The means of the normalized scores were further analyzed using an independent t-test, assuming unequal variances, to identify significant differences in scores between normal shoulders and scapular dyskinesis shoulders ( $\alpha=.05$ ).

### Results

High reliability, ICC (3,1)>.95 was observed in every reach direction using the ICC (3,1) in the UQYBT for both normal (n=10) and scapular dyskinetic (SDK) (n = 12) groups (Table 1).

**Figure 2. UQYBT: Medial Reach.**



**Figure 3. UQYBT: Superior-Lateral Reach.**



Figure 4. UQYBT: Inferior-Lateral Reach.

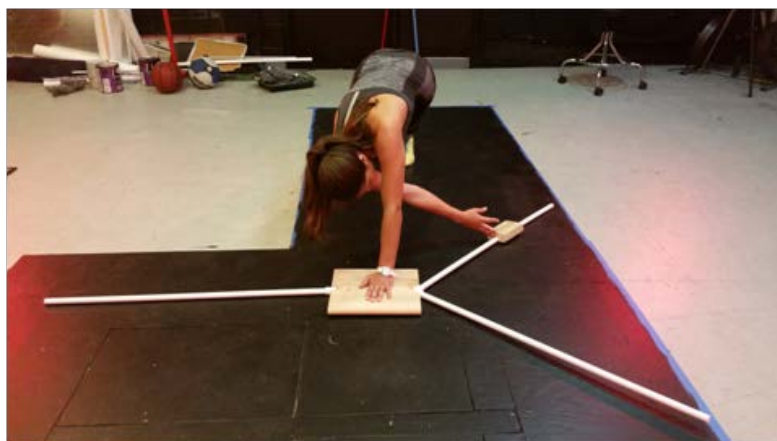


Table 1. UQYBT reach score Intra Class Correlation.

Reach	SDK	Normal
Superior-Lateral Reach	.99	.99
Inferior-Lateral Reach	.99	.98
Medial Reach	.97	.95

To identify differences between the two groups the highest scoring trials were used for each participant in each direction (Figure 5). Each reach score was then normalized to participant’s arm length for further analysis. The independent t-test with unequal variances identified significant differences in the Composite score (p-value = .048), where the SDK group had higher scores, on average, than the normal group. Although no significance differences were observed for the MR (p-value = .062) and SLR (p-value = .093) and ILR (p-value = .159), on average, the SDK group had the higher scores in all three directions (Table 2 and Figure 5).

**Discussion**

The Upper-Quarter Y-Balance test (UQYBT) has been suggested as a return-to-play tool for athletes with upper extremity injuries. In addition, difference in scores between sides or between pre and post testing, can indicate higher susceptibility for upper extremity injuries. The purpose of this study was to investigate the influence of scapular dyskinetic shoulders on the scores of the Upper Quarter Y-Balance Test (UQYBT). The assumption was that SDK shoulders would demonstrate lower scores during UQYBT in all directions. However, this study found that SDK shoulders had higher scores than normal shoulders, of which the Composite score was significantly different. Although not significant, on average MR, SLR, and ILR demonstrated higher scores in SDK shoulders too. It may be concluded that scapular dyskinesis can have an effect on the scores when stabilizing the body during the UQYBT, as well as when reaching.

An SDK shoulder is not necessarily a weak shoulder. In the case of UQYBT, the SDK shoulder was able to stabilize the body while the normal shoulder performed the reach. On the contrary, when the normal shoulder was stabilizing the SDK shoulder had a reduced mobility, which contributed to the lower reach score. On average, the SDK group scores were higher than the

normal group by about 10 cm, in every direction, although only Composite score was significantly different. These observed differences might be related to the motions required the scapula to externally rotate around the thoracic wall, as well as upwardly rotate during the UQYBT. Previous studies have associated scapular dyskinesis with decreased in upward rotation, external rotation, and increased posterior tilting [8, 14]. This may explain the lower results while the SDK shoulder is reaching. In addition, a lack of mobility of the SDK shoulder while stabilizing may have been compensated by excessive trunk rotation, which we did not measure in the current study.

Comparing our study results to the other two studies measuring scores in the UQYBT our reach scores were in some cases lower than the results of the other studies, however the patterns were the same. On average, the participants achieved the highest scores during the MR, followed by the ILR, and the lowest scores during the SLR in both groups the SDK and normal shoulders. These differences can be attributed to the difference in study-pooled population. Our study had participants with scapular dyskinesis, whereas Gorman et al. (2012) had a large healthy and physically active population, and the population that was studied by Westrick et al. (2012) was from USA Military Academy of West Point [15, 16]. A more active population with no identified shoulder pathology may score higher on the UQYBT.

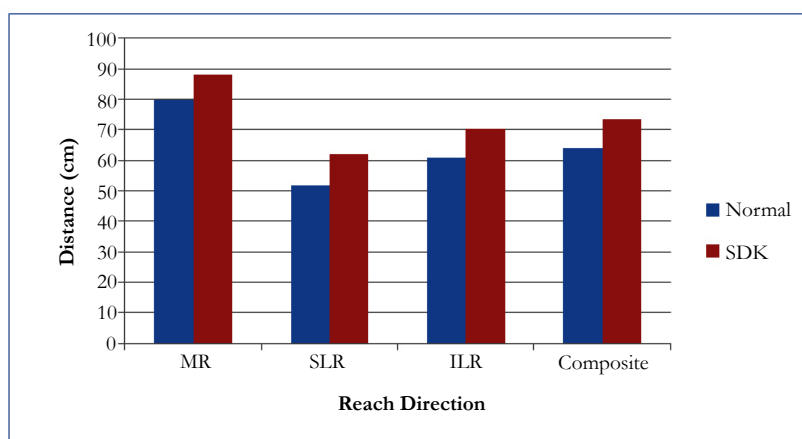
The UQYBT proved to have very high reliability in measuring normal and SDK groups during all reach directions, ICC (3,1) = .95 - .99. These results were similar to the ones observed by Gorman et al. (2012) and Westrick et al. (2012), ICC ranging from .80 to .99 [15, 16]. Gorman et al. (2012) indicated that the highest reliability were in the SLR (ICC = .920 - .990), and the lowest in the ILR (ICC = .800 - .960) [16]. Our study has found high reliability for all reach directions between trials using one rater. These findings might indicate that the UQYBT could be an excellent tool to compare between two sets of data collected in

Table 2. Mean UQYBT reach scores normalized to the upper extremity length between the normal and SDK groups.

Reach	Normal (SD)	SDK (SD)
Medial Reach (%)	92.1 (6.7)	98.6 (8.7)
Superior-Lateral Reach (%)	60.4 (12.9)	70.1 (12.8)
Inferior-Lateral Reach (%)	70.9 (14.7)	79.7 (13.0)
Composite (%)	74.5 (8.3)	82.8* (10.3)

\* Significantly different  $p < .05$

Figure 5. Comparison UQYBT Scores between SDK and Normal Shoulders.



different times. For example, data collected pre and post season could be used to identify positive or negative changes in scores for the dominant and non-dominant arms to evaluate the quality of specific training program. On the other hand, UQYBT score pre and post injury could be used as another tool to assist in determining athlete return to play.

The UQYBT has been recommended as a measure of dynamic stability between limbs. It has been suggested that the non-dominant shoulder can be used as a baseline measure when testing an injured extremity. Therefore, insinuating that the stabilizing shoulder with the higher distance reached is healthier shoulder. However, our study found that if the client has an SDK, it might influence the validity of the test. Dyskinesia does not necessarily mean that there is an injury; however, mal-movement of the scapula may cause the moving arm during the UQYBT to achieve lower scores compared to the normal shoulder. This information is critical for clinicians who administer this test, because if an individual has scapular dyskinesia there may be false findings during the UQYBT based on the assumption that the SDK shoulder would be associated with higher score reach when stabilizing. Clinicians should perform the SDT on their patients before implementing the UQYBT. This knowledge can allow the healthcare professional to incorporate rehabilitation or strengthening programs for the individual to the correct shoulder in order to prevent an injury from occurring.

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