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Effect of the Scapula Reposition Test on Shoulder Impingement Symptoms and Elevation Strength in Overhead Athletes

A high incidence of shoulder pain among athletes performing repetitive overhead activity has been reported.[2,26,29,30,33,45] Several etiologic factors have been postulated with varying levels of supportive evidence. These include reduced motor performance of the rotator cuff,[36,39,52] lack of sufficient flexibility of the soft tissues about the shoulder,[13,49] glenohumeral joint laxity,[6,50] poor posture,[19,46] bony structural abnormalities,[5,11] and abnormal scapular motion termed *scapular dyskinesis*.[27,34] Results of studies assessing 3-dimensional scapular motion in those with pathology have been inconsistent, with some studies demonstrating increased posterior tilting,[32] decreased posterior tilting,[9,27,28] decreased upward rotation,[9,27] increased upward rotation,[12,32] increased superior translation,[28,32] and increased internal rotation.[27,51] In addition to the variability of findings in these studies, the magnitude of differences between those with healthy shoulders and those with pathology is typically small (in the 3° to 5° range), and it is unclear whether these differences, although statistically significant, are really of clinical significance. Because of the variability of findings in symptomatic subjects and the generally small kinematic differences found compared to asymptomatic subjects, correctly identifying patients with relevant scapular dysfunction is difficult.

An alternative approach in attempting to identify those with scapular motion abnormalities is the use of symptom altering tests. The premise of these tests is to assess the magnitude of symptoms during provocation tests or shoulder movements when the scapula is in its natural position and then to repeat the provocative tests and shoulder movements with the examiner manually altering scapular motion or position. Two symptom alteration tests have been reported in the literature. The Modified Scapular Assistance test involves application of both an upward rotary and retraction force to the scapula by a single examiner in an effort to reduce pain during arm elevation. Rabin et al[40] reported satisfactory interrater reliability of this test for clinical use. The Scapula Retraction Test has been described as

• **STUDY DESIGN:** Two-group, repeated-measures design.

• **OBJECTIVES:** To determine whether manually repositioning the scapula using the Scapula Reposition Test (SRT) reduces pain and increases shoulder elevation strength in athletes with and without positive signs of shoulder impingement.

• **BACKGROUND:** Symptom alteration tests may be useful in determining a subset of those with shoulder pathology who may benefit from interventions aimed at improving scapular motion abnormalities.

• **METHODS AND MEASURES:** One hundred forty-two college athletes underwent testing for clinical signs of shoulder impingement. Tests provoking symptoms were repeated with the scapula manually repositioned into greater retraction and posterior tilt. A numeric rating scale was used to measure symptom intensity under both conditions. Isometric shoulder elevation strength was measured using a mounted dynamometer with the scapula in its natural position and with manual repositioning. A paired *t* test was used to compare the strength between positions. The frequency of a significant increase in strength with scapular repositioning, defined as the minimal detectable change (90% confidence interval), was also assessed.

• **RESULTS:** Of the 98 athletes with a positive impingement test, 46 had reduced pain with scapular repositioning. Although repositioning produced an increase in strength in both the impingement ($P = .001$) and nonimpingement groups ($P = .012$), a significant increase in strength was found with repositioning in only 26% of athletes with, and 29% of athletes without, positive signs for shoulder impingement.

• **CONCLUSION:** The SRT is a simple clinical test that may potentially be useful in an impairment based classification approach to shoulder problems.

• **LEVEL OF EVIDENCE:** Diagnosis, Level 4.
J Orthop Sports Phys Ther 2008;38(1):4-11. doi:10.2519/jospt.2008.2616

• **KEY WORDS:** *posture, rotator cuff, shoulder*

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stabilization of the scapula in a position of retraction in relation to the thorax by manual application of force along the medial border of the scapula.[21] Kibler and colleagues[21] measured pain and elevation strength during isometric shoulder elevation in the scapular plane with the scapula in its natural position and when manually retracted in a group of 20 patients with shoulder pathology and 10 asymptomatic controls. They reported an increase in shoulder elevation strength when tested with the scapula manually maintained in a retracted position compared to when tested with the scapula in its natural "rest" position in all of their patients. However, because no warm-up trials were reported and the natural position was always tested first, strength gains may have been due to a practice or testing order effect instead of manual repositioning. In addition, this test was described using 2 examiners (1 to apply the retraction, and another to measure the strength using a dynamometer), which may be clinically impractical.

In pilot testing, we have found that passive maximal retraction of the scapula often decreased shoulder elevation force, and other investigators[44] have found decreased elevation strength with full active scapular retraction. Therefore, we modified the test position described by Kibler et al[21] by emphasizing posterior tilting and external rotation of the scapula but avoiding full retraction and named it the Scapula Reposition Test (SRT).

Authors of 2 case studies of patients with shoulder pathology have described the use of scapular repositioning as a diagnostic tool.[16,42] With the application of a manual repositioning maneuver, the patients' symptoms were reduced. Subsequent therapeutic interventions aimed at achieving optimal scapular positioning on the thorax were successfully used in both of these cases. However, a larger scale study is needed to determine if manual application of force to reposition the scapula produces consistent, clinically recognizable improvements in symptomatic persons. The purpose of this study was to examine whether the SRT reduces pain and increases shoulder elevation strength in athletes with and without positive signs of shoulder impingement who were participating in overhead sports at the time of testing. Additionally, we explored the relationship between changes in pain and strength with the SRT.

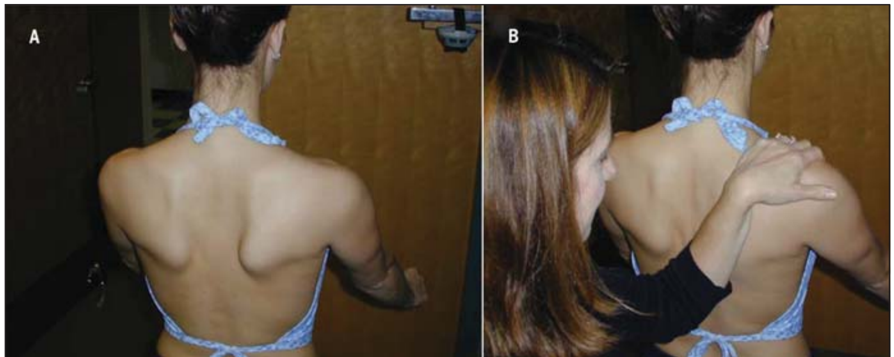

Figure 1. Posterior view of subject with winging of the scapulae bilaterally. (A) Subject in the natural scapula position; (B) examiner manually repositions subject for the scapula reposition test.

METHODS

Subjects

A convenience sample of 142 college athletes who were engaged in sports requiring repetitive overhead movements were recruited via posted flyers. There were 111 males and 31 females. The mean ± SD age was 20.8 ± 2.8 years. There were 49 athletes involved in baseball, swimming, or volleyball, and 93 athletes who played water polo. Subjects had to be actively competing in an overhead sport and could not be obese (body mass index greater than 30), or have a recent history of rotator cuff tear, shoulder dislocation, or traumatic shoulder injury. Prior to testing, all subjects signed a consent form approved by Temple University and Arcadia University Institutional Review Boards.

Procedure

As part of a larger study, demographic information was collected and subjects underwent a physical examination by an athletic trainer, which consisted of shoulder range of motion, strength, and special tests assessment. As part of the examination, 3 tests for impingement (Neer,[35] Hawkins,[14] and Jobe[18]) were performed as originally described, with the scapula in its natural resting posture. These tests generally have been found to have high sensitivity but low specificity, which makes them suitable for screening purposes but limits their usefulness in making a specific diagnosis.[8,24,37] The prevalence of athletes with at least 1 positive test was calculated. If any of these tests were found to be positive for symptom provocation, the subject was asked to rate his/her pain using a verbal numeric rating scale (VNRS) with 0 being no pain and 10 being the worst pain imaginable. The reported reliability of a VNRS for symptom severity in an upper extremity orthopedic population is excellent[43] and it has been used to assess both traumatic and nontraumatic pain.[4]

Any pain-provoking test was then repeated with the scapula manually repositioned using the SRT. The SRT was performed by grasping the scapula with the fingers contacting the acromioclavicular joint anteriorly and the palm and thenar eminence contacting the spine of the scapula posteriorly, with the forearm obliquely angled toward the inferior angle of the scapula for additional support on the medial border (**FIGURE 1**). In this manner, the examiner's hand and forearm applied a moderate force to the scapula to encourage scapular posterior tilting and external rotation (inferior angle and medial border moved anteriorly towards thorax), and to approximate the scapula

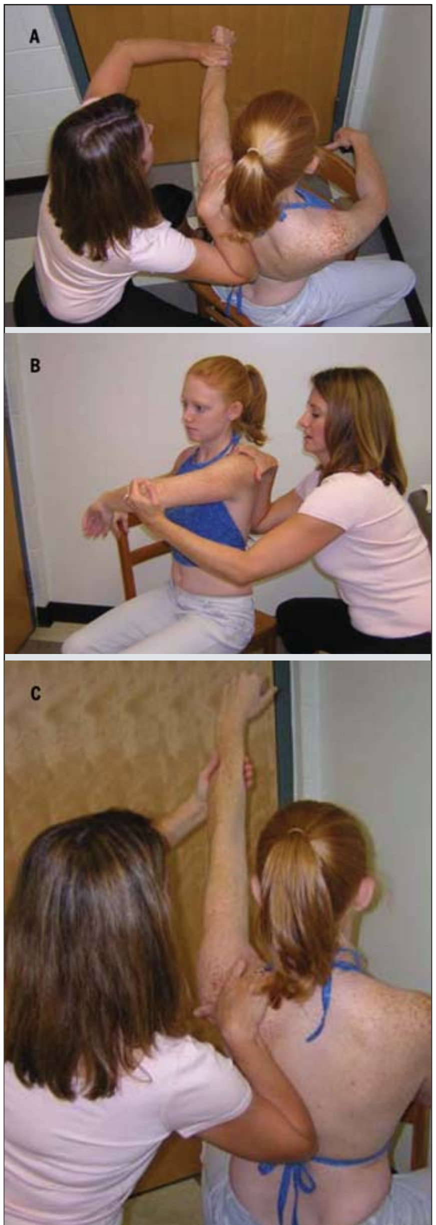

Figure 2. Clinician using the Scapula Reposition Test during performance of clinical impingement tests. (A) Jobe test, (B) Hawkins-Kennedy test, (C) Neer test.

to a mid position on the thorax. The tester avoided bringing the scapula to end range retraction. As the SRT was applied, the impingement provocation tests that originally produced symptoms were repeated (**FIGURE 2**). The subject was then asked to rate his/her symptoms again using the VNRS. Because our athletes were competing at the collegiate level, we expected relatively low pain levels and therefore chose a 1-point reduction in symptoms with the SRT as a significant change in pain.

Isometric elevation strength in the Jobe's test position (arm elevated to 90° in the plane of the scapula and internally rotated by pointing the thumb down) was measured by 1 of 2 physical therapists using a dynamometer (Microfet; Hoggan Industries, Draper, UT) attached to a height-adjustable bar affixed to the frame of a door with clamps (**FIGURE 3**). Excellent interrater and intrarater reliability have been reported with use of a handheld dynamometer for assessment of shoulder strength in symptomatic[15] and healthy subjects,[1] and force measures from a dynamometer have been used on athletes during rested and competition conditions.[7] By rigidly mounting the dynamometer, we were able to eliminate measurement variability due to variations in tester strength and stabilization, which has been reported as a limitation with use of the handheld dynamometer.[7]

Subjects stood with the arm maximally internally rotated and passively elevated to 90° of abduction, 30° anterior to the frontal plane with the elbow extended. The dynamometer height was adjusted and the athlete was positioned so that the Microfet pad would contact the distal forearm just proximal to the ulnar styloid process. Positioning of the subject was facilitated through the use of masking tape applied to the floor at a 30° angle for use as a foot guide to maintain the appropriate scapular plane orientation. Each subject was tested unilaterally on the side provoking symptoms, or on the more symptomatic side if symptoms of pain with impingement tests were bilateral. If the subject was asymptomatic, the dominant side was selected for testing. After 3 submaximal practice trials, testing consisted of 3 repetitions of 5-second maximum isometric shoulder elevation contractions with the scapula in its natural position and also with the scapula manually repositioned using the previously described SRT. The mean strength value from the 3 maximum trials was

Figure 3. Subject positioned for shoulder elevation strength measure using the mounted dynamometer.

used. The order of scapular testing position was randomized by the use of a coin toss. A 1-minute rest was given between repetitions and a 2-minute rest was given between scapular positions (natural and manually repositioned) to minimize the effect of fatigue. These testing and rest intervals have been used for measurement of shoulder elevation strength with varying scapular positions in a previous study.[44]

Interrater reliability between the 2 therapists performing the testing has been previously established on 13 athletically active subjects ranging in age from 22 to 28 years, each of whom performed 3 maximum isometric shoulder elevation contractions using the same test protocol. Intraclass correlation coefficients ($ICC_{3,3}$) of 0.982 and 0.964 were calculated for shoulder elevation strength with the scapula in its natural position and with manual repositioning using the SRT, respectively. The standard error of measurement (SEM), in Newtons, was determined using the formula $SD \times \sqrt{1-ICC}$ and calculated to be 3.1 N and 4.9 N for the natural and SRT conditions, respectively. The "empty can" position has been shown to preferentially activate the supraspinatus muscle[48] and has been used in a study similar to ours.[21]

Data Analysis

The frequency of positive impingement tests was determined by the report of pain by the athlete on any 1 or more of the 3 impingement tests performed on the initial examination. A reduction in symptoms with the SRT was defined as a decrease by 1 point or greater on the VNRS during performance of the same provocation test while the SRT was performed. The mean elevation torque from the 3 trials for both test positions was calculated by multiplying the force registered on the dynamometer times the subject's arm length (acromion to ulnar styloid process with the elbow fully straightened).[22] Torque values (Nm) were normalized by dividing by the subject's mass (kg). A paired *t* test was used to compare the normalized elevation torque in both positions for the pooled data for the groups of athletes with and without positive impingement signs. A mixed-model 2-way ANOVA was also performed for torque values, with the 2 factors being scapular position (natural and SRT) and group (impingement and nonimpingement). A clinically significant change in strength with the SRT was defined using the minimal detectable change score with 90% confidence bounds (MDC90), calculated as the average $SEM \times 1.64 \times \sqrt{2}$. The MDC90 indicates that a change of this magnitude has a 90% probability to be greater than measurement error associated with repeated measures. A chi-square analysis was performed to compare the frequency of strength gains between the subjects in the impingement and nonimpingement groups. To determine the relationship between a reduction in pain and a significant increase in elevation strength, an odds ratio was calculated.

TABLE 1 Normalized Torque Values for Isometric Scapular Plane Elevation at 90°*

Group	Natural Position	Scapula Reposition Test
Impingement (n = 98)	0.65 ± 0.17	0.68 ± 0.19†
Nonimpingement (n = 44)	0.72 ± 0.19	0.75 ± 0.19†

* *Data are means ± SD, expressed in Nm per kg of body mass.*
† *Represents a statistically significant increase in torque from the natural position using a paired t test (P<.05).*

TABLE 2 Number (%) of Subjects With a Significant Change in Strength Secondary to the Scapula Reposition Test

Group	Weaker*	No Change	Stronger*
Impingement group (n = 98)	7 (7%)	66 (67%)	25 (26%)
Non impingement group (n = 44)	2 (5%)	29 (66%)	13 (29%)

* *A significant change in strength was based on the minimal detectable change calculated using 90% confidence limits.*

TABLE 3 Contingency Table for Significant Strength Improvement Versus a Significant Pain Decrease With Scapular Reposition Test (SRT)

Group	No Pain Decrease	Pain Decrease
No force improvement with SRT	37	36
Force improvement with SRT	15	10

RESULTS

At least 1 positive shoulder impingement test was present in 98 of 142 athletes (69%), 42 of 142 (30%) had at least 2 positive tests, and all 3 impingement tests were negative for 44 athletes (31%). Of those with at least 1 positive impingement test, the mean ± SD VNRS for the most provocative test was 2.8 ± 1.5. Of the 98 athletes with at least 1 positive impingement test, 46 (47%) had a reduction in symptoms by 1 point or greater on the VNRS, with scapular repositioning during performance of the same provocative test. Twenty-four out of the 46 had a decrease in pain of 2 or more points, while the decrease in pain for the other 22 was the minimum criterion of 1 point. However, 7 of the 22 athletes who had a 1-point reduction with the SRT only had a 1-point pain rating during the performance of the test without repositioning of the scapula. Normalized torque values for the subjects in the impingement and nonimpingement groups are presented in **TABLE 1**. Scapular repositioning produced a statistically significant increase in normalized torque in both the impingement (P = .001) and nonimpingement groups (P = .012).

TABLE 2 presents the number of athletes with and without at least 1 positive shoulder impingement test, demonstrating a significant strength change as defined by a change greater than 9.3 N, as based on the MDC90. The frequencies were not different between those with and without impingement (χ^2, P = .52). Similarly, the mixed-model 2-way ANOVA demonstrated a significant effect of position (natural versus SRT), but there was no interaction between group (impingement versus nonimpingement) and position. This reflects the fact that the presence of impingement did not affect strength gains with the SRT. For the group with at least 1 positive impingement test, **TABLE 3** presents the data in the form of a contingency table for the number of athletes with and without a significant reduction in pain versus the number of athletes with and without a significant improvement in strength as previously defined using the MDC90 value. The odds ratio (95% CI) was 1.45 (0.58-3.67), indicating that it was almost equally likely for a subject to demonstrate a significant increase in strength whether or not the subject exhibited a decrease in pain.

DISCUSSION

Although the inclusion criteria required participation in an overhead sport at the time of the study, the majority of the subjects incurred symptoms during provocation testing for shoulder impingement. Of the 142 athletes, 98 (69%) were symptomatic with at least 1 impingement provocation test and 62 (44%) noted shoulder symptoms or pain on a self-report measure. This is consistent with previous reports of a high prevalence of shoulder pain among overhead athletes.[2,26,29,30,33,45] We chose a low threshold of pain for a positive impingement test because we considered this a screening exam in a subclinical population. Likewise we chose a 1-point decrease in pain with the SRT as an indicator of improvement. This threshold is less stringent than a 2-point change, which has been reported as representing an important change in pain for patients seeking care for musculoskeletal pain.[10,41] We considered a 1-point change justified because these athletes were not seeking treatment for their symptoms and their average pain was 2.8/10, which is lower than that reported in patient samples with impingement.[3,32]

The results of this study indicate that with the SRT there was a statistically significant increase in normalized torque in both the impingement and nonimpingement groups. However, using the MDC90 threshold, only 26% of athletes with, and 29% of athletes without, at least 1 positive shoulder impingement test had a significant increase of strength beyond measurement error, secondary to the SRT. Therefore, less than a third of the athletes demonstrated a significant increase in strength when the scapula was manually stabilized and possibly held closer to the thorax. Strength gains may have been facilitated simply by providing a more stable proximal fixation of the scapula for the muscles, such as the deltoid and rotator cuff that attach on the scapula and are used to perform shoulder elevation. [20] Alternatively, increased strength may have been the result of an improved length-tension relationship of the rotator cuff or scapular musculature secondary to an altered scapular position. Application of the SRT imparts a force to posteriorly tilt, externally rotate, and retract the scapula as well as encourage upper thoracic extension. In a posture with greater thoracic flexion and a more anteriorly tilted scapula, arm elevation to horizontal could place the deltoid and supraspinatus in a shortened position, which would likely reduce their tension-generating capacity.[19,25] The SRT could keep these muscles closer to the middle of their length-tension curve. Our results are in agreement with those of Kebeatse and colleagues,[19] who found that for healthy individuals in a slouched posture, there was significantly less scapular posterior tilting and the muscle force exerted at 90° scapular plane abduction was decreased 16.2% compared to the force exerted with a more erect posture.

The fact that only half of subjects with impingement symptoms reported pain reduction with the SRT and only 26% of subjects demonstrated relevant changes in strength reinforces the notion that shoulder impingement is multifactorial. A finding of increased shoulder elevation strength with scapular repositioning may provide a clinical test to identify the subset of those with shoulder pathology that may benefit from interventions designed to improve scapular musculature function. The Neer[35] and Hawkins[14] tests are possible clinical indicators of an impingement syndrome, but do not guide specific interventions. In contrast, the SRT may help identify specific impairments leading to proper choice of interventions.

In our study, the dynamometer was mounted to a rigid structure to minimize measurement variability. This allowed the athlete to perform a maximal effort without the clinician's ability to resist this effort affecting the strength measurement. However, the handheld dynamometer is a widely used and accepted clinical tool and the SRT could also be performed by a single clinician using 1 hand for repositioning of the scapula and the other hand to provide resistance through the handheld dynamometer (**FIGURE 4**). Clinically, the contralateral extremity could be used as the norm,[38] or a clinically significant increase in scapular strength with repositioning could be assessed.

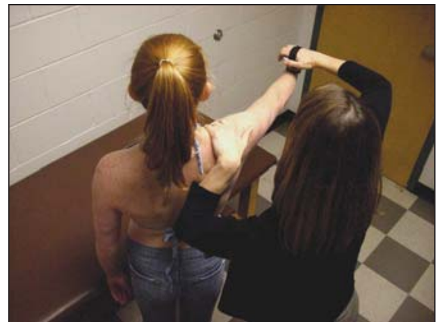

Figure 4. Therapist using a handheld dynamometer to measure elevation force while performing the scapula reposition test.

Kibler et al[21] have reported on the effect of a similar repositioning maneuver, the Scapula Retraction Test, using what is described as a "proprioceptive reminder" via minimal forearm pressure on the scapula during the same isometric resisted elevation task used in this study. They reported a 24% mean increase in strength between the empty can in the natural posture and repositioned test in symptomatic subjects, with all 20 symptomatic subjects demonstrating strength gains with repositioning. Our symptomatic subjects only achieved a 4% mean increase, which amounted to an approximately 0.5-kg increase in strength. Our comparatively lower force increase may be explained by methodology differences. First, our subjects with impingement represented a subclinical, college-age population, some of whom were asymptomatic except with provocation testing, while others had only mild symptoms. The subjects in the Kibler et al[21] study were older with a wide age range (mean ± SD, 43 ± 16 years) and had diagnoses of labral injury, glenohumeral instability, or impingement with medical imaging (MRI) evidence of pathology, and were described as having decreased supraspinatus strength and scapular dyskinesis on clinical exam. Of the 142 subjects in our study, less than one third demonstrated scapular dyskinesis, as determined by a visual classification system.[31,47] Also, Kibler et al[21] did not report the amount of strength increase for individual subjects, therefore the frequency of significant strength changes beyond measurement error cannot be determined. Perhaps more importantly, the possibility of strength changes from a practice effect or from fatigue exists in the Kibler et al[21] study because they used a 1-repetition maximum isometric contraction with no stated practice or warm-up trials and did not randomize testing order between normal and repositioned conditions. Most protocols demonstrating acceptable reliability using dynamometers use either the mean or maximum value from 3 trials after a submaximal effort practice.[7,17,23,44] Given these limitations, Kibler et al's[21] conclusion that strength gains were found in all symptomatic subjects should be interpreted cautiously. We feel that our use of the MDC90 to identify those with a significant change likely represents an increase in strength that a clinician could detect and use to justify an intervention strategy aimed toward strengthening of the scapular musculature. The MDC90 was 9.3 N (2.1 lb), which was approximately 10% of the average force across all subjects.

In their asymptomatic control group, Kibler et al[21] reported that 7 of the 10 subjects had increased strength with repositioning. In this study, we also found strength gains in asymptomatic subjects. This consistent finding implies that strength gains with scapular repositioning are not exclusive to those with symptoms or pathology. Use of the SRT in asymptomatic athletes or manual laborers may have value in identifying those in whom enhanced elevation force may be possible by training the scapular musculature or stretching structures that may be contributing to suboptimal scapular positioning.

Regardless of the presence or absence of impingement symptoms, more than 70% of all athletes did not demonstrate a clinically significant change in torque with the reposition test. As most of the subjects in this current study were Division I athletes competing in water polo, with minimal or no symptoms, they were well trained, and it was possible that they functioned optimally in their current shoulder posture. This seems to be consistent with the results of Smith and colleagues,[44] who found that isometric shoulder elevation strength in the sagittal plane was significantly greater when tested in the neutral resting scapular posture of healthy adults compared to a more retracted scapular position. Nine of the athletes in our study demonstrated a significant decrease in elevation torque with the SRT. This may mean that they already exhibited optimal scapular positioning, allowing a stable fixation for the rotator cuff musculature.

The strength gains found in some of the athletes with the SRT were not related to a decrease in pain, as the odds ratio was 1.45, indicating that it is almost equally likely for a subject to demonstrate a significant increase in strength whether or not they exhibited a decrease in pain. This is in agreement with the findings of Kibler et al,[21] who found that the visual analog scores of patients with impingement, instability, and labral pathology were not significantly different during measurement of elevation strength with the normal scapula posture and while performing the Scapula Retraction Test. This implies that a pain inhibition mechanism is not likely responsible for the increase in torque but rather a change in biomechanics affecting the shoulder girdle.

Limitations

This study was performed on collegiate athletes and, although many reported symptoms or incurred symptoms during provocation testing, none of the athletes were symptomatic enough to require treatment or to prevent them from participating in their sport at the time of the study. This was reflected in the low pain levels reported by these athletes. The effect of the SRT on a clinical population with higher pain levels and significant functional loss is not known and caution should be taken when considering the generalizability of these findings. Additionally, the effect of the SRT on pain was determined by the application of this test by a single tester, which limits generalizability. Further studies should include testing with the use of a handheld dynamometer by multiple testers in both clinical and subclinical populations.

CONCLUSION

In this study, a high percentage of athletes participating in overhead sports exhibited clinical signs of shoulder impingement. Manually repositioning the scapula resulted in a small reduction in pain during impingement testing in nearly half of the athletes. Manual repositioning of the scapula significantly increased strength in a subgroup of athletes, regardless of the absence or presence of impingement symptoms. The SRT is a simple clinical test that may potentially be useful to identify impairments related to shoulder pathology. Further research with patient samples would be needed to validate its usefulness in identifying a subset of those with shoulder impingement syndrome who would benefit from interventions aimed at improving scapular position. ◉

KEY POINTS

FINDINGS: Manually repositioning the scapula, using the scapula reposition test, yields increased elevation strength and decreased pain in a subset of overhead athletes. Strength increases are not explained by decreased pain.

IMPLICATION: The scapula reposition test may be a way to identify athletes most suitable for interventions addressing the scapula, such as strengthening, taping, or bracing.

CAUTION: This study only assessed overhead athletes who were either asymptomatic or whose symptoms did not cause them to seek medical care. Therefore, direct extrapolation of these results to a patient population is not possible.

ACKNOWLEDGEMENTS: *This research was funded by grants from the Orthopaedic Section of the American Physical Therapy Association and by the National Athletic Training Association. The authors would also like to acknowledge the recruiting assistance of Dan Sharidan, Head Coach, Villanova Water Polo and the editorial assistance of Ann Barr, PT, PhD and Mary Barbe, PhD.*

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