Comparison of Shoulder Posture and Scapular Kinematic among Swimmers with and Without Shoulder Pain

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Abstract

Background: Posture impairment can be an integral component of overuse injuries in the sport. The purpose of this study was to compare the shoulder posture and scapular kinematic among swimmers with and without shoulder pain.

Methods: Thirty-six swimmers, 18 swimmers without shoulder pain, and 18 swimmers with shoulder pain, were selected as samples in consultation with an orthopedic specialist. Static and dynamic posture including FH-FSP were measured using a digitized, side-view photograph; pectoralis minor length using a tape measure; scapular anterior tilting index via a ruler; scapular rotation as well as protraction by a DIveta method.

Results: The results showed that FH and FS angle were significantly greater in the swimmers with shoulder pain than those without shoulder pain. On the other hand, scapular protraction and rotation were not significantly different between the groups. However, pectoralis minor length was significantly shorter in the swimmers with shoulder pain than those without shoulder pain. FS angle and pectoralis minor length were significant predictors for shoulder pain.

Conclusions: The results of our study regarding the role of posture and scapular kinematics in the shoulder pain are inconclusive due to the large number of confounding variables that may have influenced the results. Future studies should be performed to evaluate the effects of these variables.

Keywords: Scapula, Position, Protraction, Upper cross syndrome.

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Introduction

Good posture refers to the natural and balanced maintenance of various parts of the body.¹,² In such postures, muscles activity is minimum and the body is at minimum fatigue and pain with maximum efficiency.³ Poor posture in the long term can result in negative patterns and compatibility in the joints and soft tissues of the body.³,⁴ The negative compatibility includes shortness and stiffness of the agonist muscles where prolongation and weakness of the antagonist muscles lead to postural abnormality. These muscle changes as muscle imbalance affect the natural state of the body and is associated with morbidity.⁵

Janda referred to the "upper cross syndrome" as the muscle imbalance associated with the upper quarter of body affecting the posture of neck and thoracic spine and shoulder girdle.⁶ Principally, the muscles of upper posterior of the neck and pectoral area that are the tonic muscles are short while the muscles of the deep anterior of neck and shoulder area that are phasic are inhibited and weakened.⁶,⁷ This syndrome leads to the scapular muscles imbalance, impaired scapula movement and position, and in turn spinal malalignments, shoulder pain, as well as biomechanical dysfunction of the Glenohumeral join.⁸,⁹

Abnormal scapular movements and its position relative to the thoracic are associated with various shoulder injuries, including shoulder impingement, rotator cuff rupture, and Glenohumeral joint instability that is very common in athletes.⁹ Ludewig and Reynolds¹⁰ recently reported a significant reduction in the rate of rotation of the shoulder, posterior tilt of the scapula, and external rotation by the arm elevation in patients with impingement syndrome and rotator cuff rupture. In 1996, Inman and Abbott¹¹ firstly proved the relationship between the shoulder ranges of motion and scapular position during arm movement. It was confirmed by other studies revealing an association between scapular kinematics and Glenohumeral joint pathologies.⁹ In a study, Su et al.¹² found that swimmers with a tight latissimus dorsi show changes in the scapular internal rotation, and posterior tilt of scapula during the arm elevation. Scibek Carpenter¹³ and Fayad Roby-Brami¹⁴ observed differences in scapular rhythm in those who had complete rapture or pain in the rotator cuff as well as those with shoulder impingement as compared with normal individuals.

Although there is a great deal of evidence about the association between some injuries, such as shoulder impingement, rotator cuff rupture, as well as latissimus dorsi stiffness and scapular kinematics,⁸,¹²,¹⁵ there is still lack of evidence on the relationship between the upper crossed syndrome and scapular kinematic as well as position.

Understanding the effects of upper cross syndrome on the scapular kinematics and muscle activity is important since upper crossover syndrome is correctable and can provide a pathway to improve shoulder mechanics thereby reducing the risk of shoulder pain. In addition, clinicians need to know what factors affect the scapular kinematic during arm movement in order to prescribe a more effective rehabilitation program. Accordingly, the purpose of this study was to investigate the effect of upper crossover posture on the scapula kinematics (protraction and upper rotation) in swimmers with and without pain.

Materials and Methods

This research is descriptive. The statistical population consisted of swimmers with an age range of 18 to 50 years from Islamabad Gharb city. Among them, 12 subjects with upper cross syndrome with pain, 12 subjects with upper interstitial syndrome without pain, and 12 healthy subjects with...
orthopedic diagnosis were selected as a statistical sample. The statistical sample of this study was based on Forte, de Castro16 study. This study was conducted in the summer of 1394 at Zainibee club in Islamabad Gharb city.

Inclusion criteria were as follows: presenting at least two of the symptoms such as forward head posture, kyphosis, rounded shoulder, and internal rotation of the arm, weakness of deep flexor muscle of neck, shortness or stiffness of sternocleidomastoid, stiffness or shortness of the chest muscles.10 The stiffness of the upper trapezius muscles and levator scapula as well as weakness of the lower and middle trapezius muscles were the other inclusion criteria.17 In addition, one positive test for upper cross syndrome was another inclusion criterion. Neck flexion test was used to assess the weakness of the deep flexor muscles of neck and shortness or stiffness of the sternocleidomastoid muscle. To perform this test, the participants laid on the back, then gently elevated their head and looks at their foot. If the deep neck flexors are weak, the sternocleidomastoid muscle is activated too much and the jaw moves forward while the chin is protrated. This causes excessive neck extension.18 Jull’s test was also conducted in these participants. The subject would lay on the back on the table, lifting their head up to 1 cm from the table; in this case, the chin is tucked and the participant should not lift their head up or down. This test is positive if the patient’s chin pokes, the head shakes, or the head rises up or falls.18 Exclusion criteria were as follows; dislocation of Glenohumeral and Acromio-Clavicular joints, surgery, and fractures, shoulder instability, cervical pain syndromes, neurological diseases, rheumatoid arthritis, diabetes, and depression.9,20

After selection, the subjects completed the questionnaires containing the demographic information completed through the interview. They also signed the written consent form after gaining full knowledge of the study process.

Pain intensity at rest, during activity, and at night were measured on a VAS ranging from 0 (no pain) to 100 (worst possible pain).21 Forward-head, forward-shoulder posture (FH-FSP) was assessed using a digitized, side-view photograph taken in a relaxed-standing posture. Initially, tragus and acromion anterior tip were marked with an adhesive dot, and a pointer was taped to the skin overlying the C7 vertebra.22 A side-view photograph was obtained with Adobe AutoCAD 2010 being to calculate the forward head angle (FHA) and forward shoulder angle (FSA).

Scapular protraction and rotation were assessed using DiVeta method (1990).1 The lower angle, the root of the scapula, the tip of the acromion, and thoracic vertebrae spine corresponding to the root of the scapular spine were marked by a marker through the surface anatomy. A anthropometric meter was used to measure the distance from the thoracic vertebrae spine corresponding to the root of the scapular spine to the acromion process (BAE), the distance from the root of the scapular spine to the tip of the acromion (AE), the distance between the inferior angle of the scapula and the corresponding mark on the thoracic spine (CD), and the distance between the marks on the thoracic spine corresponding to the root of the scapular spine and the inferior angle of the scapula (BC). All measurements were recorded to the millimeter. The following formula was used to determine scapular protraction and scapular rotation: scapular protraction = BAE/AE and scapular rotation = tanθ = CD/BC.53

Scapular anterior tilting index was 100 times the distance between the posterior border of the acromion and the table in a relaxed supine position23 divided by the body height.18 Resting pectoralis minor length was measured with 1 mm resolution in a relaxed-standing posture.18 The distances between caudal edge of the fourth rib at the sternum and the medial-inferior aspect of the coracoid process, the insertion and origin of the muscle, were estimated upon complete exhalation. PML index was calculated from the average of three trials. PML is a measure of the relative length of pectoralis minor: PMI = 100 × PM length (cm)/subject height (cm), where PM is the pectoralis minor.

SPSS statistical software (version 18.0, SPSS Inc., Chicago, IL, USA) was used for statistical analyses. The Shapiro-Wilk test indicated that all data were normally distributed. We used independent t-test to compare the variables of shoulder posture and scapular kinematics between the groups. Logistic regression models were used to determine the odds of sport injury with psychological variables as predictors. Significance level was set at 0.05.

Results

Participant characteristics were similar between groups and there were no significant differences between the groups in terms of age, weight, height, sports history, and practice session (Pvalue > 0.05) (table 1).

<table>
<thead>
<tr>
<th>Variables</th>
<th>Swimmer without pain</th>
<th>Swimmer with pain</th>
<th>t</th>
<th>Pvalue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (y)</td>
<td>26.5 ± 7.2</td>
<td>24.3 ± 6.3</td>
<td>0.97</td>
<td>0.30</td>
</tr>
<tr>
<td>Weight (Kg)</td>
<td>72.5 ± 4.9</td>
<td>70.2 ± 5.4</td>
<td>1.50</td>
<td>0.20</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>171.6 ± 5.76</td>
<td>170.3 ± 6.3</td>
<td>0.70</td>
<td>0.50</td>
</tr>
<tr>
<td>Sports history (y)</td>
<td>7.5 ± 2.6</td>
<td>9.35 ± 2.3</td>
<td>2.01</td>
<td>0.07</td>
</tr>
<tr>
<td>Practice session (h/w)</td>
<td>3.4 ± 1.2</td>
<td>4.2 ± 1.4</td>
<td>1.80</td>
<td>0.08</td>
</tr>
</tbody>
</table>

The data for the postural variables and scapular kinematic variables in each group are reported in table 2. Regarding FHP and FSP variables, our results show significant differences between groups (Pvalue < 0.05). FH angle was significantly greater in the swimmers with shoulder pain than pain-free swimmers (Pvalue < 0.05). In addition, FS angle was also significantly greater in the swimmers with shoulder pain than those without it (Pvalue < 0.05).
Discussion

The purpose of this study was to compare the postural variables and scapular kinematics between subjects with shoulder pain and healthy subjects. According to the results, FH and FS angle were significantly larger in the swimmers with shoulder pain than without shoulder pain. In addition, pectoralis minor length was significantly shorter in the swimmers with shoulder pain than pain-free subjects. Therefore, it was assumed that these postural impairments may change the position of the scapula and impair the scapular kinematics in swimmers with shoulder pain, which was confirmed in our study. In line with our study, a research has shown FSP to be significantly greater in individuals with shoulder pain as compared to healthy individuals.29 FSP is defined as forward deviation of the shoulders associated with scapular protraction which is caused by a muscular imbalance between a shortened pectoralis minor and a lengthened middle trapezius.29 FSP also places the lower trapezius and serratus anterior in the positions that lead to weakness of these muscles thought to negatively influence scapular tilting.30,31 Overall, this muscle imbalance would increase anterior scapular tilt and scapular internal rotation as important factors that can be associated with shoulder pain.32 Thus, this altered scapular kinematics, anterior scapular tilt, is correlated to short pectoralis minor and week serratus anterior as well as lower trapezius muscles. These changes are thought to produce a compressive impingement under the acromion, creating a mechanical block to elevation of the humerus and irritation of the subacromial tissues leading to shoulder pain.

The present study compared the postural variables and scapular kinematics between subjects with shoulder pain and healthy subjects. The swimmers without shoulder pain group exhibited a significantly greater FH, FSP, and scapular anterior tilt than those with shoulder pain. On the other hand, pectoralis minor length was greater in the swimmers with shoulder pain than those without it. The results showed that FH, FS angle, anterior tilting, and resting pectoralis minor length are significant predictors of shoulder pain explaining lead to subacromial space narrowing, which in turn leads to shoulder pain.15

As mentioned previously, there was no significant difference in scapula protraction and rotation between swimmers with shoulder pain and those pain; these results are inconsistent with the findings of a previous study. Additionally, no significant difference was found between the groups in terms of scapular kinematics, anterior scapular tilt, is thought to negatively influence scapular tilting.30,31 Overall, this muscle imbalance would increase anterior scapular tilt and scapular internal rotation as important factors that can be associated with shoulder pain.32

<table>
<thead>
<tr>
<th></th>
<th>Swimmers without pain</th>
<th>Swimmers with pain</th>
<th>t</th>
<th>Pvalue</th>
</tr>
</thead>
<tbody>
<tr>
<td>FSP (degree)</td>
<td>51.8 ± 3.5</td>
<td>58.2 ± 3.9</td>
<td>5.2</td>
<td>0.001</td>
</tr>
<tr>
<td>FSP (degree)</td>
<td>55.2 ± 4.1</td>
<td>59.7 ± 4.3</td>
<td>3.2</td>
<td>0.010</td>
</tr>
<tr>
<td>Scapular protraction (mm)</td>
<td>17.3 ± 2.7</td>
<td>18.6 ± 3.1</td>
<td>1.5</td>
<td>0.200</td>
</tr>
<tr>
<td>Scapular rotation (degree)</td>
<td>34.2 ± 4.8</td>
<td>36.1 ± 3.6</td>
<td>1.3</td>
<td>0.200</td>
</tr>
<tr>
<td>Scapular anterior tilt (% height)</td>
<td>2.9 ± 0.30</td>
<td>4.3 ± 0.7</td>
<td>7.8</td>
<td>0.001</td>
</tr>
<tr>
<td>Pectoralis minor length (% height)</td>
<td>10.1 ± 0.6</td>
<td>7.9 ± 0.4</td>
<td>12.9</td>
<td>0.001</td>
</tr>
</tbody>
</table>

Table 2. Independent t-test results for comparison of variables between the groups

<table>
<thead>
<tr>
<th>Variables</th>
<th>β</th>
<th>S.E.</th>
<th>Wald</th>
<th>OR</th>
<th>Pvalue</th>
</tr>
</thead>
<tbody>
<tr>
<td>FSP (degree)</td>
<td>2.43</td>
<td>0.38</td>
<td>18.2</td>
<td>1.24</td>
<td>0.001</td>
</tr>
<tr>
<td>Pectoralis minor length (% height)</td>
<td>-2.83</td>
<td>0.23</td>
<td>32.2</td>
<td>0.83</td>
<td>0.200</td>
</tr>
</tbody>
</table>

Table 3. Logistic regression analysis for variables predicting shoulder pain

Regarding scapular kinematic, only the degree of scapular anterior tilting was significantly larger in the swimmers with shoulder pain than those without pain (Pvalue < 0.05). However, independent t-test analysis revealed that there were no significant differences in terms of scapular protraction and scapular upward rotation between the groups (Pvalue > 0.05). Resting pectoralis minor length was also significantly shorter in the participants with shoulder pain than pain-free subjects (Pvalue < 0.05).
56% of the variance in shoulder pain and correctly classifying 68.0% of cases. Hence, shortening of pectoralis minor and FS angle, scapular anterior caused by it increases the likelihood of occurrence of shoulder pain in the swimmers. Inclusion of the assessment of pectoralis minor muscle length, FS angle, and scapular anterior as a routine part of the shoulder pain examination may aid treatment decision-making to acquire better outcomes. Future studies should attempt to assess the influence of these variables. The important question to answer is the relationship between mobility and posture as well as shoulder pain or the impact of mobility on these two variables.

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Conflict of Interest

The authors declare that they have no conflict of interest.

References

1. Kendall FP, McCreary EK, Kendall HO. Muscles, testing and function: testing and function: Lippincott Williams and Wilkins; 1983.