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Original investigation

Investigation of Posterior Shoulder Tightness on Scapular Dyskinesis

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ABSTRACT

Purpose: It has been theorized that posterior shoulder tightness may contribute to scapular dyskinesis; however, it is not yet clear. The aim of the study was to investigate the association between posterior shoulder tightness and scapular dyskinesis in asymptomatic individuals.

Methods: This was a cross-sectional study including 121 male participants (242 shoulders). Scapular dyskinesis was identified by the Scapular Dyskinesis Test, and the participants were grouped as 'dyskinesis' and 'no dyskinesis' on the dominant and non-dominant sides. Posterior shoulder tightness was assessed by measuring glenohumeral horizontal adduction.

Results: Dyskinesis was detected in 67.8% of participants. The mean angles of posterior shoulder tightness in individuals with and without dyskinesis on the dominant side were 35.23 (SD 7.50) and 35.43 (SD 8.17) degrees, respectively. On the non-dominant side, the mean angles of posterior shoulder tightness were 39.26 (SD 8.70) and 38.41 (SD 8.50) degrees in individuals with and without dyskinesis, respectively. There was no statistically significant difference in posterior shoulder tightness between the groups ($p>0.05$).

Conclusion: The findings of the study showed that there was no association between posterior shoulder tightness and scapular dyskinesis in asymptomatic individuals.

Keywords: shoulder, scapula, kinematics, range of motion

INTRODUCTION

The scapula is a link between the upper extremity and the trunk. Scapular function is an important component of shoulder stability, motion, and motor control (1, 2). The scapula provides stable base for optimal muscle activation for shoulder complex function (3), and assists for force to be transferred up through the trunk to the arm (2).

Scapulothoracic joint has movements in three planes, and these movements are upward/downward rotation, internal/external rotation, and anterior/posterior tilt. Scapular movements during elevation of the arm are upward rotation, posterior tilt, and internal or external rotation (4, 5) Alterations of normal scapular motions or position have been termed scapular dyskinesis (6). Multiple factors have been identified that may cause dyskinesis. These factors are bone tissue changes (e.g., clavicle fracture), neurological diseases (e.g., long thoracic nerve palsy), joint-related factors (e.g., glenohumeral instability), and soft tissue changes (e.g., inflexibility of the pectoralis minor muscle) (1). Posterior shoulder tightness has also been theorized as a potential factor for dyskinesis (1).

Previous studies have indicated that dyskinesis is associated with shoulder diseases (7, 8). Reductions in scapular upward rotation and posterior tilt during glenohumeral elevation could result in shoulder impingement (9). In addition, increased scapular protraction or decreased of anterior tilt angle of the scapula may contribute to anterior glenohumeral instability (10, 11). Scapular dyskinesis increases the risk of developing shoulder pain in asymptomatic athletes (12). This condition can also be present in asymptomatic subjects (13). Therefore, evaluation of posterior shoulder tightness may be used to establish possible protocols for the prevention of scapular dyskinesis or to guide treatment in the above-mentioned diseases which may be caused by scapular dyskinesis.

Posterior shoulder tightness has been demonstrated in patients with shoulder impingement syndrome (14), and in healthy overhead athletes (15). Therefore, to make robust inference regarding effect of posterior shoulder tightness on scapular dyskinesis, it should be studied in a healthy population who does

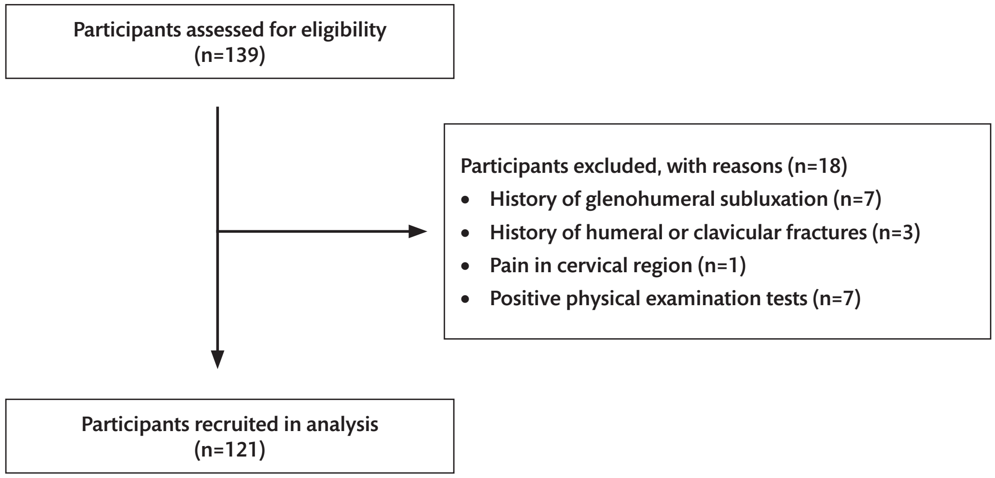

Figure 1. Flow chart of the study.

not participate in overhead sports. The purpose of this study was to investigate association between posterior shoulder tightness and scapular dyskinesis in asymptomatic individuals. It was hypothesized that the shoulder with scapular dyskinesis had more posterior shoulder tightness than those without dyskinesis.

METHODS

Study design and participants

This was a cross-sectional study involving college students. In the study, 121 participants (242 shoulders) were recruited from a university (Figure 1). All participants were right side dominant. This study approved by the Non-invasive Research Ethics Board of Dokuz Eylül University School of Medicine (protocol no: 1545-GOA; decision no: 2014/21–14). A written informed consent form was obtained from all participants.

Inclusion criteria were as follows:

1. Male participants with age ranging from 18 to 30 years.
2. Did not participate in overhead sports (i. e., volleyball, basketball, swimming) as an amateur or professional for at least one year.

The exclusion criteria were as follows:

1. Presence of known any orthopaedic or neurologic pathology, or current pain in the shoulder, cervical, or thoracic regions.
2. A history of fracture or surgery of the humerus, scapula, or clavicula.
3. Any kind of neurological disorders which affect movement system.
4. Positive Neer, Hawkins-Kennedy, and apprehension tests (to rule out rotator cuff disease and glenohumeral instability).

Procedures

Firstly, scapular dyskinesis was evaluated by a physiotherapist, and participants were grouped as 'dyskinesis' and 'no dyskinesis'. Posterior shoulder tightness then was assessed by measuring glenohumeral horizontal adduction with a bubble inclinometer (Fabrication End Inc, NewYork, ABD). All assessments and measurements were performed by the same physiotherapist.

Identifying of scapular dyskinesis

Dyskinesis was identified using the Scapular Dyskinesis Test as proposed by McClure et al (16). The reliability and validity of the Scapular Dyskinesis Test have been established (kappa coefficients ranged from 0.48 to 0.61; odds ratios were 0.79 and 0.68) (16, 17).

The participants were asked to remove their shirts during the study to allow observation of the posterior thorax. The examiner explained and demonstrated the test procedure, and the participants practiced each movement before the beginning of the test. Testing began with arms at the side of the body, elbows straight, and shoulders in neutral rotation. The examiner observed the participant's scapula from the back a distance of 2 to 3 m. Each participant then were asked to perform five repetitions of bilateral, active shoulder flexion, and bilateral, active shoulder abduction with dumbbells in their hands using the thumbs up position. The participants elevated their arms to the end position over a 3 second count, and then lower their arms to the initial position over a 3 second count. The weight of the dumbell was adjusted by body weight of the participants, 1.4 kg for those weighing <68.1 kg and 2.3 kg for those weighing ≥68.1 kg (16). According to this test, each shoulder was rated as having *normal scapula*, *subtle dyskinesis* or *obvious dyskinesis* (16). The definitions of terms were introduced by McClure et al. as follows: *normal scapula:* "no evidence of abnormality"; *subtle dyskinesis:* "mild or questionable evidence of abnormality, not consistently present"; *obvious dyskinesis:* "striking, clearly apparent abnormality, evident on at least 3/5 trials" (16).

In this study, normal scapula was grouped as 'no dyskinesis', subtle and obvious dyskinesis were grouped as 'dyskinesis'.

Measurement of posterior shoulder tightness

Posterior shoulder tightness was measured a supine position

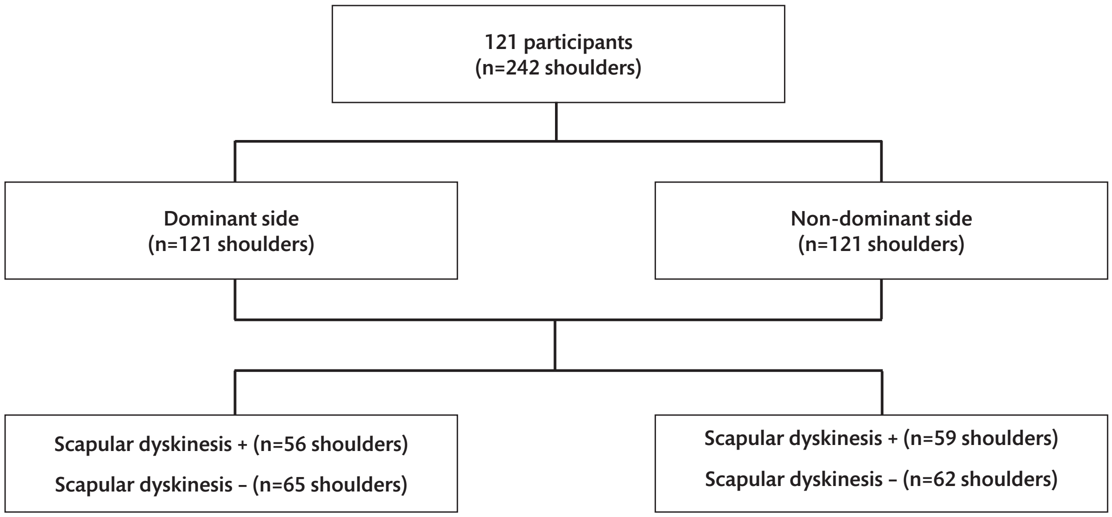

Figure 2. Distribution of shoulders across groups based on the Scapular Dyskinesis Test.

Table 1. Demographic characteristics of the participants

	Dominant side			Non-dominant side		
	Dyskinesis (n=56)	**No dyskinesis (n=65)**	**p**	**Dyskinesis (n=59)**	**No dyskinesis (n=62)**	**p**
Age (years) (X ± SD)	21.03±1.95	21.47±2.06	0.181	21.10±2.13	21.43±1.90	0.257
Weight (kg) (X ± SD)	76.64±10.33	76.67±10.32	0.251	76.96±11.71	76.37±8.80	0.091
Height (m) (X ± SD)	1.79±0.06	1.78±0.06	0.899	1.79±0.06	1.78±0.05	0.915
BMI (kg/m²) (X ± SD)	23.73±2.78	24.09±2.89	0.413	23.73±2.99	24.11±2.69	0.311

p>0.05; **SD:** standard deviation; **BMI:** body mass index.

with the glenohumeral joint at 90° of abduction, and the elbow at 90° of flexion (18). The examiner grasped the lateral border of the scapula, and applied force to prevent scapular protraction, rotation and abduction movements. The inclinometer was placed on the ventral midline of the humerus by an assistant. The examiner then performed passive glenohumeral horizontal adduction until scapular protraction was felt, and a value was recorded (intraclass correlation coefficient for intratester reliability and intertester reliability are 0.93 and 0.91, respectively) (18). Each participant's horizontal adduction motion was measured three times with a ten second rest between each measurement, and the mean values were used for statistical analysis.

Sample size estimation

Sample size calculation was performed based on data from Myers et al.'s study (19). In this stuy, posterior shoulder tightness and glenohumeral range of motion deficits were examined in an athletic population with and without internal impingement, and it was found that the mean glenohumeral internal rotation angles in individuals with and without impingement were 42.5±12.1 and 51.1±14.4 degrees, respectively (19). With α=0.05 and a power of 80%, the minimum required sample size was found to be 78 participants.

Data analysis

Data analysis was performed using SPSS v17.0 software (SPSS Inc., Chicago, IL, USA). The Shapiro-Wilk test was used for testing the normality of the data. Since the data were not normally distributed, the Mann-Whitney U test was used for comparisons of continuous variables. The significance level was set at 0.05.

RESULTS

A total of 121 participants were enrolled in this study. The demographic data of the participants are shown in Table 1. There were no statistically significant differences in demographic characteristics between the groups (p>0.05) (Table 1). In the study, 'dyskinesis' and 'no dyskinesis' were identified in 82 participants (67.8%) and 39 participants (32.2%), respectively. The distribution of participants in 'dyskinesis' group according to the dominance of their arm was as follows: 23 participants on the dominant side, 26 participants on the non-dominant side, 33 participants on both sides (115/242 shoulders, 47.5%) (Figure 2). There was no statistically significant difference in posterior shoulder tightness between the groups (p>0.05) (Table 2).

Table 2. Comparison of posterior shoulder tightness

	Dominant side			Non-dominant side		
	Dyskinesis (n=56)	**No dyskinesis (n=65)**	**p**	**Dyskinesis (n=59)**	**No dyskinesis (n=62)**	**p**
PST (mean angle°± SD)	35.23±7.50	35.43±8.17	0.960	39.26±8.70	38.41±8.50	0.511

p>0.05; **PST:** posterior shoulder tightness; **SD:** standard deviation.

DISCUSSION

It is speculated that posterior shoulder tightness may be a predisposing factor of scapular dyskinesis in the literature; however, the present study revealed that there was no association between posterior shoulder tightness and scapular dyskinesis on asymptomatic individuals.

In this study, to minimize bias, there were reasons to analyse the groups separately and to recruit male subjects. The literature indicates that there is a difference in range of motion measure of the glenohumeral joint between the dominant and non-dominant sides (20). Therefore, participants were grouped as 'dyskinesis' and 'no dyskinesis' on the dominant and non-dominant sides, and the analysis were performed on the dominant and non-dominant groups separately. Furthermore, it has been reported that mobility of the glenohumeral joint is different between male and female (21). For practical reasons related to ease of implementation of the Scapular Dyskinesis Test and to provide homogeneity in terms of age and gender, male participants with age ranged from 18 to 30 years were recruited in this study.

Posterior shoulder tightness is a condition resulting from the structural changes of the posterior capsule, posterior component of the glenohumeral capsuloligamentous complex, posterior parts of the rotator cuff muscles, and posterior parts of the deltoid muscle (22). These structures are primarily related to the stability and mobility of the glenohumeral joint, and the results obtained from this study suggested that the above-mentioned structures seemed to have no relationship with scapular dyskinesis. The pectoralis minor muscle attaches to the coracoid process and provides scapular control during arm elevation. Inflexibility of this muscle may cause anterior tilt of the scapula during arm elevation, and consequently scapular kinematics may change (23). In addition, an increased activation or tightness of the upper trapezius muscle, and a decreased activation of the lower trapezius and serratus anterior muscles may contribute to place the scapula in a protracted position (1). Furthermore, Seitz et al. showed that the presence of scapular dyskinesis significantly alters the thickness of the lower trapezius muscle during isometric contraction (24). Based on these reports and the findings described throughout the present study, it may be argued that alteration in scapular muscle coordination or tightness of the upper trapezius muscle may be more important determinants of scapular dyskinesis than changes in muscles and ligaments crossing the glenohumeral joint. However, this hypothesis needs to be confirmed with further studies.

There are studies that have examined the relationship between posterior shoulder tightness and scapular positioning in overhead throwing athletes, and these studies have reached opposite conclusions to those reported in the present study (25–27). The differences in the findings of this study compared to the previous studies may be attributable to the difference in target population. Alteration in scapular kinematics is a chronic adaptation in throwing athletes (28). Furthermore, changes in glenohumeral range of motion in result of osseous adaptation have been detected in this population (29). However, such adaptation processes cannot be mentioned for the participants in the present study. Based on these information, it is reasonable to speculate that the contribution of posterior shoulder tightness on scapular dyskinesis may depends on the population being studied.

Lee et al. studied 18 participants, and reported that posterior shoulder tightness is correlated with the forward scapular posture in a healthy population (30). There could be several possible explanations for the different conclusions. One possibility may be that the sample size was rather small in the mentioned study compared to the present study; therefore, the external validity of these findings may be limited. Second, this difference might be related to the methods used for assessing scapular positioning. The method used in the mentioned study was a static measurement method (30). This method assesses only forward shoulder posture (31), while the method used in the present study assesses scapular positioning in multiple axis movements. Furthermore, the Scapular Dyskinesis Test has more acceptable clinimetric properties than static measurement methods (31). These facts also should be taken into account when comparing the present results with the previous study.

In the present study, the prevalence of dyskinesis was 67.8% in participants, and 47.5% in shoulders. Yeşilyaprak et al. studied healthy subjects, and found a prevalence of 29.4% of dyskinesis in shoulders (32). A possible reason for this discrepancy may be due to the variability in categorization of shoulders with dyskinesis amongst studies. In the present study, subtle dyskinesis was grouped as 'dyskinesis', whereas it was grouped as 'no dyskinesis' in the mentioned study (32).

This study has some limitations. Firstly, all assessments and measurement were performed by one examiner, and this may lead to bias. Secondly, postural abnormalities, inflexibility of upper trapezius and pectoralis minor muscles, and strength or activation levels of the scapular muscles were not evaluated. These factors may contribute to the development of dyskinesis (1). Therefore, the implications emerging from this study should be interpreted cautiously because the above-mentioned factors may influence the results.

In conclusion, the present study indicates that there is no association between posterior shoulder tightness and scapular dyskinesis. The prevalence of dyskinesis is 67.8% in this population. The study included young and healthy individuals who are not participating in overhead sports; therefore, the findings cannot be generalized to patients with shoulder disease or to athletic populations.

Informed Consent: A written informed consent form was obtained from all participants.

Compliance with Ethical Standards: This study approved by the Non-invasive Research Ethics Board of Dokuz Eylül University School of Medicine (protocol no: 1545-GOA; decision no: 2014/21-14)

Peer-review: Externally peer-reviewed.

Author Contributions: Concept - ES; Design - ES, DK; Supervision - DK; Materials - ES; Data Collection and/or Processing - ES; Analysis and/or Interpretation - ES, DK; Literature Search - ES; Writing Manuscript - ES; Critical Review - ES, DK

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

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REFERENCES

1. Kibler WB, Ludewig PM, McClure PW, Michener LA, Bak K, Sciascia AD. Clinical implications of scapular dyskinesis in shoulder injury: The 2013 consensus statement from the "scapular summit". Br J Sports Med 2013;47:877-885. [CrossRef]
2. Kibler WB, Sciascia A, Wilkes T. Scapular Dyskinesis and Its Relation to Shoulder Injury. J Am Acad Orthop Surg 2012;20:364-372. [CrossRef]
3. Paine R, Voight ML. The role of the scapula. Int J Sports Phys Ther 2013;8:617-629. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3811730/
4. McClure PW, Michener LA, Sennett BJ, Karduna AR. Direct 3-dimensional measurement of scapular kinematics during dynamic movements in vivo. J Shoulder Elb Surg 2001;10:269-277. [CrossRef]
5. Ludewig PM, Phadke V, Braman JP, Hassett DR, Cieminski CJ, LaPrade RF. Motion of the shoulder complex during multiplanar humeral elevation. J Bone Joint Surg Am 2009;91:378-389. [CrossRef]
6. Kibler WB, Sciascia A. Current concepts: scapular dyskinesis. Br J Sports Med 2010;44:300-305. [CrossRef]
7. Ludewig PM, Reynolds JF. The Association of Scapular Kinematics and Glenohumeral Joint Pathologies. J Orthop Sport Phys Ther 2009;39:90-104. [CrossRef]
8. Clarsen B, Bahr R, Andersson SH, Munk R, Myklebust G. Reduced glenohumeral rotation, external rotation weakness and scapular dyskinesis are risk factors for shoulder injuries among elite male handball players: A prospective cohort study. Br J Sports Med 2014;48:1327-1333. [CrossRef]
9. Michener LA, McClure PW, Karduna AR. Anatomical and biomechanical mechanisms of subacromial impingement syndrome. Clin Biomech (Bristol, Avon) 2003;18:369-379. [CrossRef]
10. Weiser WM, Lee TQ, McMaster WC, McMahon PJ. Effects of simulated scapular protraction on anterior glenohumeral stability. Am J Sports Med 1999;27:801-805. [CrossRef]
11. Kikuchi K, Itoi E, Yamamoto N, et al. Scapular inclination and glenohumeral joint stability: A cadaveric study. J Orthop Sci 2008;13:72-77. [CrossRef]
12. Hickey D, Solvig V, Cavalheri V, Harrold M, Mckenna L. Scapular dyskinesis increases the risk of future shoulder pain by 43% in asymptomatic athletes: A systematic review and meta-analysis. Br J Sports Med 2018;52:102-110. [CrossRef]
13. Pluim BM. Scapular dyskinesis: Practical applications. Br J Sports Med 2013;47:875-876. https://doi.org/10.1136/bjsports-2013-092722
14. Tyler TF, Nicholas SJ, Roy T, Gleim GW. Quantification of Posterior Capsule Tightness and Motion Loss in Patients with Shoulder Impingement. Am J Sports Med 2000;28:668-673. [CrossRef]
15. Myers JB, Oyama S, Goerger BM, Rucinski TJ, Blackburn JT, Creighton RA. Influence of humeral torsion on interpretation of posterior shoulder tightness measures in overhead athletes. Clin J Sport Med 2009;19:366-371. [CrossRef]
16. McClure P, Tate AR, Kareha S, Irwin D, Zlupko E. A clinical method for identifying scapular dyskinesis, part 1: reliability. J Athl Train 2009;44:160-164. [CrossRef]
17. Tate AR, McClure P, Kareha S, Irwin D, Barbe MF. A clinical method for identifying scapular dyskinesis, part 2: validity. J Athl Train 2009;44:165-173. [CrossRef]
18. Laudner KG, Stanek JM, Meister K. Assessing Posterior Shoulder Contracture: The Reliability and Validity of Measuring Glenohumeral Joint Horizontal Adduction. J Athl Train 2006;41:375-380. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1748419/
19. Myers JB, Laudner KG, Pasquale MR, Bradley JP, Lephart SM. Glenohumeral range of motion deficits and posterior shoulder tightness in throwers with pathologic internal impingement. Am J Sports Med 2006;34:385-391. [CrossRef]
20. Günal I, Köse N, Erdogan O, Göktürk E, Seber S. Normal range of motion of the joints of the upper extremity in male subjects, with special reference to side. J Bone Joint Surg Am 1996;78:1401-1404. [CrossRef]
21. Barnes CJ, Van Steyn SJ, Fischer RA. The effects of age, sex, and shoulder dominance on range of motion of the shoulder. J Shoulder Elb Surg 2001;10:242-246. [CrossRef]
22. Salamh PA, Kolber MJ. The reliability, minimal detectable change and construct validity of a clinical measurement for quantifying posterior shoulder tightness in the post-operative population. Int J Sports Phys Ther 2012;7:565-575. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3537463/
23. Borstad JD, Ludewig PM. The Effect of Long Versus Short Pectoralis Minor Resting Length on Scapular Kinematics in Healthy Individuals. J Orthop Sport Phys Ther 2005;35:227-238. [CrossRef]
24. Seitz AL, Baxter CJ, Benya K. Muscle thickness measurements of the lower trapezius with rehabilitative ultrasound imaging are confounded by scapular dyskinesis. Man Ther 2015;20:558-563. [CrossRef]
25. Laudner KG, Moline MT, Meister K. The relationship between forward scapular posture and posterior shoulder tightness among baseball players. Am J Sports Med 2010;38:2106-2112. [CrossRef]
26. Thomas SJ, Swanik CB, Higginson JS, et al. A bilateral comparison of posterior capsule thickness and its correlation with glenohumeral range of motion and scapular upward rotation in collegiate baseball players. J Shoulder Elb Surg 2011;20:708-716. [CrossRef]
27. Borich MR, Bright JM, Lorello DJ, Cieminski CJ, Buisman T, Ludewig PM. Scapular Angular Positioning at End Range Internal Rotation in Cases of Glenohumeral Internal Rotation Deficit. J Orthop Sport Phys Ther 2006;36:926-934. [CrossRef]

28. Myers JB, Laudner KG, Pasquale MR, Bradley JP, Lephart SM. Scapular position and orientation in throwing athletes. Am J Sports Med 2005;33:263–271. [CrossRef]

29. Crockett HC, Gross LB, Wilk KE, et al. Osseous adaptation and range of motion at the glenohumeral joint in professional baseball pitchers. Am J Sports Med 2002;30:20–26. [CrossRef]

30. Lee JH, Cynn H, Yi CH, Kwon O, Yoon TL. Predictor variables for forward scapular posture including posterior shoulder tightness. J Bodyw Mov Ther 2015;19:253–260. [CrossRef]

31. Larsen CM, Juul-Kristensen B, Lund H, Søgaard K. Measurement properties of existing clinical assessment methods evaluating scapular positioning and function. A systematic review. Physiother Theory Pract 2014;30:453–482. [CrossRef]

32. Yeşilyaprak SS, Yüksel E, Kalkan S. Influence of pectoralis minor and upper trapezius lengths on observable scapular dyskinesis. Phys Ther Sport 2016;19:7–13. [CrossRef]