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Original research

The influence of posterior glenohumeral joint capsule tightness and humeral retroversion on clinical measurements☆

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ABSTRACT

Objectives: To assess the influence of posterior capsule tightness and humeral retroversion on shoulder motion measurements.
Design: Cross-Sectional study.
Setting: Controlled university laboratory.
Participants: 75 asymptomatic individuals were assigned to one of 4 groups: control (n = 28); posterior capsule tightness only (n = 17); humeral retroversion only (n = 15); and combined posterior capsule tightness and retroversion (n = 15).
Main outcome measures: Six clinical measurements were compared across groups: bicipital forearm angle, low flexion, glenohumeral internal and external rotation, horizontal adduction and extension with internal rotation.
Results: The group with both adaptations had decreased internal rotation compared to the control and retroversion only groups, as well as increased external rotation compared to the control and posterior capsule only groups. There were no between group differences for the horizontal adduction or extension with internal rotation measurements. The retroversion only and combined groups showed decreased bicipital forearm angle compared with the control and posterior tightness groups. The posterior capsule tightness and combined groups demonstrated decreased low flexion compared to the other groups.
Conclusion: The combination of osseous and soft tissue adaptions alter shoulder motion measures more than a single adaption, making a comprehensive clinical assessment vital when managing individuals with shoulder pain.

1. Introduction

Individuals who perform repetitive overhead activities or sports frequently demonstrate shoulder range of motion (RoM) alterations (Crockett et al., 2002; Osbahr, Cannon, & Speer, 2002; Reagan et al., 2002; Thomas et al., 2012; Tokish, Curtin, Kim, Hawkins, & Torry, 2008). Studies have consistently demonstrated decreased glenohumeral internal rotation (IR) and increased external rotation (ER) RoM on the dominant shoulder of throwing athletes (Cieminski et al., 2015; Crockett et al., 2002; Manske, Wilk, Davies, Ellenbecker, & Reinold, 2013; Osbahr et al., 2002; Reagan et al., 2002; Thomas et al., 2012; Tokish et al., 2008). Tissue alterations such as increased humeral retroversion (HR), posterior capsule tightness (PCT), and/or posterior shoulder muscle tightness may explain these RoM changes (Crockett et al., 2002; Myers, Laudner, Pasquale, Bradley, & Lephart, 2006; Osbahr et al., 2002; Reagan et al., 2002; Tyler, Nicholas, Roy, & Gleim, 2000). Recently, similar RoM alterations were reported in a sample of non-athletes with shoulder pain (Land, Gordon, & Watt, 2017), suggesting that these alterations are also common in the general population.

Humeral retroversion represents the degree of humeral torsion along its longitudinal axis and increased HR is commonly present on the dominant arm of overhead throwing athletes (Myers et al., 2006; Reagan et al., 2002; Thomas et al., 2012; Tokish et al.,

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2008). Repetitive ER forces produced during the overhead throw are proposed to contribute to increased amounts of retroversion (Edelson, 2000; Larson, 2015; Manske et al., 2013; Thomas et al., 2012). The bicipital forearm angle (BFA) (Ito, Eto, Maeda, Rabbi, & Iwasaki, 1995) is a valid and reliable indirect measure of HR that has been used in many studies (Dashottar & Borstad, 2013; Habechian, Lozana, & Camargo, 2018; Thomas et al., 2012; Yamamoto et al., 2006). BFA is inversely related to HR (Yamamoto et al., 2006) and corresponds to the angle between the ulna and vertical when the humerus is in slight abduction and the elbow is positioned in 90° of flexion for the supine patient.

Posterior capsule tightness (PCT), described as a response to repetitive high tensile loading on the posterior capsule during the deceleration phase of throwing (Burkhart, Morgan, & Kibler, 2003a,b), is also a prevalent tissue alteration in individuals who perform overhead sports or activities (Posner, Cameron, Wolf, Belmont, & Owens, 2011). Over time, the capsule may become increasingly stiff and restrict normal glenohumeral motion. PCT may also develop in response to degenerative joint processes (Land et al., 2017). Clinical measurements of PCT quantify horizontal adduction (HAD) in the supine (Warner, Micheli, Arslanian, Kennedy, & Kennedy, 1990) or side lying positions (Tyler, Roy, Nicholas, & Gleim, 1999). However, in a cadaver study of posterior capsule strain, Borstad and Dashottar (Borstad & Dashottar, 2011) report that a measure of IR RoM at 60° of arm flexion (Low Flexion; LF) had higher strain on the posterior capsule than HAD (Borstad & Dashottar, 2011). While HAD may best reflect posterior shoulder muscle adaptations (Laudner, Stanek, & Meister, 2006), other studies demonstrate higher strain on posterior shoulder muscles with shoulder extension and IR (EIR) compared to HAD (Dashottar, Costantini, & Borstad, 2014; Muraki, Aoki, Uchiyama, Murakami, & Miyamoto, 2006).

Although the altered shoulder RoM and suspected tissue alterations are more prevalent in throwing athletes than other individuals, determining the source for motion changes in any symptomatic individual is critical for effective treatment. A key problem for measuring motion changes at the shoulder is that the interaction effects among the potential tissue alterations on the clinical measurements used for assessment of motion is unknown. One approach to addressing this problem is to evaluate how HR and PCT, separately and in combination, influence the measurements used in clinical practice. Thomas et al. (Thomas et al., 2012) correlated HR, PCT and IR RoM deficits from a single measurement session in those suspected of having posterior shoulder tightness, but the interaction effects were not also evaluated. Therefore, the purpose of our study was to identify the influence of PCT and HR on six clinical measurements used to assess shoulder motion in asymptomatic individuals with suspected PCT and/or HR. Our hypothesis was that PCT and HR in combination would have a greater influence on posterior shoulder motion measurements than when PCT or HR were present alone.

2. Methods

Eighty-one individuals between 18 and 40 years of age with no current shoulder pain were recruited. Using G-Power software (version 3.1), with the power set at 0.8 and α at 0.05, the sample size estimate was calculated to be 15 individuals per group considering a 10° difference in HR between groups when using ANOVA as the statistical test. A 10° HR difference was used for calculating sample size estimates because it was both the largest angular value required to demonstrate a meaningful difference between subjects and the least common motion deficit noted in the general population. The study was approved by the Institutional Review Board at the Ohio State University. The participants gave their written and informed consent to participate in this study, which was conducted according to the Helsinki Statement.

We excluded individuals if they had: ligamentous laxity or glenohumeral joint instability based on positive Sulcus (Neer & Foster, 1980), Apprehension (Rowe & Zarins, 1981) or anterior drawer tests (McClure, Michener, & Karduna, 2006); impingement syndrome; a history of clavicle, scapula or humerus fracture; a history of shoulder surgery or traumatic injury; adhesive capsulitis or scoliosis; a systemic musculoskeletal pathology. From among those recruited, seventy-five individuals enrolled in the study.

2.1. Procedures

Enrolled individuals provided demographic information (sex, age, height, weight, arm dominance) and reported their present and past history of physical activity. Prior to the clinical measurements, each individual had a clinical examination that included an active movement assessment and application of special tests to assess for instability or rotator cuff pathology. A licensed physical therapist with 5 years of experience performed the assessment.

Following the assessment, all individuals were evaluated bilaterally for the clinical measurements described below (Fig. 1). Two measurements, BFA and LF, were used to assign participants to groups, and were also included in the statistical analysis to determine if they interact with each other and/or the other motion measurements such that they influence clinical interpretation. The mean of two measurements was used for analysis and group assignment. The first author took all measurements prior to group assignment and was blinded to all measurement values.

We used the LF Test (Fig. 1A) to quantify PCT (Borstad & Dashottar, 2011). This test is performed with the humerus at 60° of sagittal plane arm elevation. In this position, the examiner supports the arm and allows glenohumeral IR to reach the end of passive motion. A digital inclinometer placed on the distal surface of the forearm measures the angle between the forearm and the horizontal and lower LF values indicate PCT (Borstad & Dashottar, 2011). The validity and intra-rater reliability of the LF test have been reported as excellent (Borstad & Dashottar, 2011; Borstad, Dashottar, & Stoughton, 2015). Based on prior data (Borstad et al., 2015), we considered the posterior capsule to be tight with a 7° or greater decrease in the LF test in comparison to the contralateral side.

HR was measured indirectly by the BFA (Fig. 1B), as described in previous studies (Dashottar & Borstad, 2013; Habechian et al., 2018; Ito et al., 1995; Thomas et al., 2012; Yamamoto et al., 2006). Individuals are positioned supine with the elbow in 90° of flexion.

Fig. 1. Clinical measurements: Low Flexion Test (A); Bicipital Forearm Angle (B); Internal Rotation (C); External Rotation (D); Horizontal Adduction (E); and Extension with Internal Rotation (F).