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BIOMECHANICS RESEARCH

Predictor variables for forward scapular posture including posterior shoulder tightness☆

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Summary The purpose of this study was (1) to determine the relationships between the degree of forward scapular posture and the pectoralis minor index, the strength of the serratus anterior, the thoracic spine angle, and posterior shoulder tightness, and (2) to identify predictors of forward scapular posture, including posterior shoulder tightness. The study recruited eighteen subjects with forward scapular posture and objectively measured the acromion distance, the pectoralis minor index, and the strength of the serratus anterior muscle of each participant. The amount of glenohumeral horizontal adduction and internal rotation were evaluated to measure posterior shoulder tightness. There were high intra-rater reliabilities in all measurements. The measurement results showed a statistically strong negative correlation between the degree of forward scapular posture and the pectoralis minor index. They also revealed a moderate positive correlation between the degree of forward scapular posture and the thoracic spine angle and a moderate negative relationship between the degree of forward scapular posture and the amount of the glenohumeral horizontal adduction. A multiple regression analysis indicated that a total multiple regression model explained 93% of the amount of forward scapular posture. All predictor variables, including posterior shoulder tightness, should be considered while assessing, managing, and preventing forward scapular posture.

☆ We deny any conflicts of interest including personal, financial, or other related to our submitted manuscript titled "Predictor variables for forward scapular posture including posterior shoulder tightness."

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Introduction

Forward scapular posture is protraction and anterior tilting of the scapula (the lateral scapular movement around the thorax) (Wu et al., 2005). The condition is attributed to various shoulder disorders, such as subacromial impingement, adhesive capsulitis, and brachial plexus radiculitis (Kuhn et al., 1995). Moreover, an altered scapular position may decrease glenohumeral rotation range of motion and strength (Smith et al., 2002, 2006), and alter neuromuscular activation patterns (Cools et al., 2004). Consequently, these shoulder complications reduce the functional ability of the shoulder (Lin et al., 2006) and the quality of life of the patient (Chipchase et al., 2000).

Several factors may cause forward scapular posture such as, muscle imbalance, soft tissue damage, poor posture, and repeated overhand motion (Burkhart et al., 2000; Decker et al., 1999; Finley and Lee, 2003; Ha et al., 2012; Laudner et al., 2006; Ludewig and Cook, 1996; Moseley et al., 1992; Wang et al., 1999). The most common indicator is decreased flexibility or shortness of the pectoralis minor, which may give rise to forward scapular posture (Borstad and Ludewig, 2005). Injury of the long thoracic nerves that innervate the serratus anterior muscle (Martin and Fish, 2008) or weakness of the serratus anterior muscle itself, without nerve involvement, can also cause forward scapular posture since the serratus anterior helps to stabilize the inferior angle of the scapula against the posterior thoracic wall (Ekstrom et al., 2004). Greater thoracic kyphosis may alter the scapular position significantly (Kebaetse et al., 1999; Finley and Lee, 2003), tending to increase scapular protraction (Ayub, 1991; Grimsby and Gray, 1997) and anterior tilting (Ha et al., 2012), which diminishes range of motion and function of the shoulder (Briggs et al., 2007; Chipchase et al., 2000). Consequently, the length of the pectoralis minor, weakness of the serratus anterior, and greater thoracic kyphosis have all been targeted in the treatment of forward scapular posture.

Additionally, posterior shoulder tightness has been associated with changes in glenohumeral range of motion (Laudner et al., 2006; Tyler et al., 2000) and is common in subjects with forward scapular posture. Prior studies have neglected to investigate posterior shoulder tightness as a possible cause of forward scapular posture or have neglected to determine the association between the degree of forward scapular posture and posterior shoulder tightness. Therefore, this study proposed to (1) determine the relationships between the degree of forward scapular posture and the pectoralis minor index, the strength of the serratus anterior, the thoracic spine angle, and posterior shoulder tightness (the amount of glenohumeral horizontal adduction and internal rotation), and (2) identify predictors of forward scapular posture, including posterior shoulder tightness. The researchers hypothesized that (1) there would be moderate to strong correlations between the degree of forward scapular posture and the pectoralis minor index, the strength of the serratus anterior, the thoracic kyphosis angle, and posterior shoulder tightness (glenohumeral horizontal adduction and internal rotation), and (2) the pectoralis minor index (shortness), the strength of the serratus anterior, the thoracic spine angle, and posterior shoulder tightness would all predict the degree of forward scapular posture.

Methods

Subjects

We recruited 28 subjects in the beginning of the study. Eighteen subjects (male 8, female 10) with forward scapular posture participated in this study through measuring forward scapular posture. Forward scapular posture was confirmed by measuring the distance between the anterior border of the acromion and the wall in standing posture (Peterson et al., 1997; Struyf et al., 2009); a distance equal to or greater than 7 cm indicated forward scapular posture. The study measured test–retest reliability of acromion distance for measuring forward scapular posture; the intraclass correlation coefficient (ICC) was 0.90 (95% confidence interval: 7.60–8.99). The mean and standard deviation of age, weight, and height were 33.78 $\pm$ 11.15 years, 57.81 $\pm$ 9.10 kg, and 1.64 $\pm$ 0.07 m, respectively. The dominant arm (the preferred arm when performing eating and writing tasks) was used in all tests (Yoshizaki et al., 2009). All subjects were at least 18 years of age and right side dominant. Advertising and personal contact recruited the volunteers. Clinical screening tests (shoulder active range of motion, impingement, and glenohumeral instability/apprehension tests) of all subjects ensured that no underlying pathologies existed in the dominant shoulders (Borstad and Ludewig, 2005). The study excluded those who reported existing shoulder pathologies, histories of shoulder surgeries, orthopedic or neurological disorders, current shoulder pain limiting activities, or regular physical training involving the dominant shoulder.

Procedures

The intra-rater reliability of all measurements was examined by a licensed physical therapist with 10 years of clinical experience. The assessor measured each of the following twice: the acromion distance, for forward scapular posture definition, the pectoralis minor muscle length, the thoracic spine angle, serratus anterior muscle strength, and the amount of glenohumeral horizontal adduction and internal rotation, and used the mean values from the two measurements. The Yonsei University Institutional Review Board approved the study protocol and each subject gave informed consent prior to data collection.

Pectoralis minor muscle length test (pectoralis minor index)

The subjects gazed straight ahead to ensure a consistent standing posture. To measure the length of the pectoralis minor, marks were made on the skin over the inferomedial aspect of the coracoid process and the caudal edge of the fourth rib adjacent to the sternum, which are the origin and the insertion of the pectoralis minor, respectively. The assessor measured the distance between the two with a soft tape measure. The values were normalized by dividing