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Scapular muscles weakness in subjects with traumatic anterior glenohumeral instability

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ABSTRACT

Objective: To investigate possible alterations on scapular muscle strength in subjects with traumatic anterior glenohumeral instability.
Design: Cross-sectional study. Setting: Laboratory setting. Participants: Fifty-two subjects of both sexes: 26 healthy and 26 with traumatic anterior glenohumeral instability.
Main outcome measures: Subjects performed maximal isometric and concentric isokinetic contractions of shoulder protraction and retraction in scapular and sagittal planes, at slow (12.2 cm/s) and fast (36.6 cm/s) speeds.
Results: Subjects with glenohumeral instability presented lower peak force of protraction and retraction during isometric and fast speed tests in the scapular plane; and of isometric protraction in the sagittal plane.
Conclusions: People with traumatic anterior glenohumeral instability present muscle weakness of scapular protractors and retractors. Considering the importance of the scapulothoracic muscles for the dynamic stability of the glenohumeral joint, strengthening of these muscles is recommended for rehabilitation of traumatic anterior glenohumeral instability.

1. Introduction

Traumatic anterior glenohumeral instability is the most prevalent type of shoulder instability, with a rate of 23.9 per 100,000 person/year in emergency departments (Zacchilli & Owens, 2010) and a recurrence rate of 39% in the general population (Olds, Ellis, Donaldson, Parmar, & Kersten, 2015). In this condition, the static and dynamic stabilization of the glenohumeral joint is compromised due to the avulsion of the anterior inferior glenoid labrum (Gil, DeFroda, & Owens, 2017) and the rotator cuff muscles weakness (Edouard et al., 2011; Saccol, Zanca, Ejnisman, de Mello, & Mattiello, 2014). Rotator cuff and scapulothoracic muscles have a direct association with glenohumeral function (Merolla et al., 2010; Phadke, Camargo, & Ludewig, 2009) and several shoulder disorders present with scapular impairments, such as movement abnormalities, alterations in muscle activation patterns and periscapular muscles weakness (Kibler, Ludewig, McClure, Michener, Bak, & Sciascia, 2013). However, few studies have studied scapular alterations in traumatic anterior glenohumeral instability (Hung & Darling, 2014; Paletta, Warner, Warren, Deutsch, & Altchek, 1997; Struyf et al., 2014). They have shown conflicting results for muscle activity (Struyf et al., 2014) and scapular orientation (Hung & Darling, 2014; Paletta et al., 1997). In addition, no research on the performance of scapulothoracic muscles has been found in this population.

Scapular muscles strength may be assessed during scapular protraction and retraction movements (Cools, Witvrouw, Danneels, Vanderstraeten, & Cambier, 2002). Shoulder protraction is mainly performed by serratus anterior (Ekstrom, Bifulco, Lopau, Andersen, & Gough, 2004) while scapular retraction primarily activates the middle and lower fibers of trapezius and rhomboids muscles (Yoo, 2013). Strength impairment during scapular protraction has been reported in subjects with shoulder impingement symptoms (Cools, Witvrouw, Declercq, Vanderstraeten, & Cambier, 2004), but, to our

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knowledge, has not been investigated in subjects with shoulder instability.

Considering the importance of the scapulothoracic muscles for providing a stable base for the rotator cuff action, which is essential for glenohumeral stability (Phadke et al., 2009), the aim of this study was to investigate possible alterations on scapular muscles strength in people with traumatic anterior glenohumeral instability. It was hypothesized that subjects with glenohumeral instability would present lower strength during scapular protraction and retraction when compared to healthy subjects.

2. Methods

2.1. Subjects

A convenience sample of 52 subjects, 38 men and 14 women, ranging from 16 to 40 years were evaluated in this cross-sectional study. Twenty-six subjects with traumatic anterior glenohumeral instability were assigned as the shoulder instability group. Twenty-six healthy subjects (control group) were paired for sex, sport and time of sports practice with the shoulder instability group. This study was conducted in agreement with the Declaration of Helsinki. All participants read and signed an informed consent form and this study was approved by the University Human Research Ethics Committee.

Subjects of both groups practiced recreational physical activities: strength training (n = 16), handball (n = 10), mixed martial arts (n = 8), football (n = 4), futsal (n = 4), tennis (n = 2), soccer goalkeeper (n = 2), basketball (n = 2), water polo (n = 2) and jogging (n = 2). According the Walch (1987) classification for shoulder risk in sport, 76.9% (n = 40) of the subjects in our sample were involved in sports with cocking or high risk (cocking and blocking), 19.2% (n = 10) were involved in contact sports and 3.8% (n = 2) in risk free activities (Walch, 1987).

Inclusion criteria for the shoulder instability group was self-reported history of at least one episode of traumatic glenohumeral dislocation or subluxation in the anterior direction in a period from six weeks to one year prior to the study participation (Kuhn, Helmer, Dunn, & Throckmorton, 2011; Siegler et al., 2010). Inclusion criteria for control group were no history of shoulder disorders and symptoms in the upper limbs and cervical region in the six months preceding the study participation.

Exclusion criteria for both groups were the presence of shoulder pain at rest, shoulder impingement symptoms (Cools et al., 2004) generalized ligamentous laxity (Beighton & Horan, 1969; Boyle & Witt, 2003), previous fracture in shoulder and arm bones, previous shoulder surgery or physical therapy treatment in the six months prior to the study participation (Michener, Walsworth, Doukas, & Murphy, 2009).

2.2. Procedures

Subjects were assessed in two sessions with a one-week interval. In the first session, a physical therapist performed a clinical evaluation that included records of anthropometric and demographic data, time of sports practice, number of hours of training per week, shoulder instability classification and the application of questionnaires. In the second session, maximal isometric and concentric strength of shoulder protraction and retraction were assessed using an isokinetic dynamometer. Subjects were asked to maintain normal routine during the one-week interval.

2.2.1. Clinical evaluation

Anterior glenohumeral instability was classified for severity and frequency (Kuhn et al., 2011). Severity is distinguished into subluxation and dislocation. Subluxation is described by the patient as a feeling that the “shoulder left its position and returned without any help” and dislocation when the patient requires help to reduce it (Kuhn et al., 2011). Frequency refers to the number of episodes of subluxation or dislocation and is classified into three types: one-time instability, occurring only once in lifetime; occasional instability, occurring 2 to 5 times in a year; and frequent instability, occurring more than five times in a year (Kuhn et al., 2011).

For sample characterization, two questionnaires were used in this study. The Western Ontario Shoulder Instability Index (WOSI) questionnaire was used in this study to evaluate quality of life. This is the most recommended method for assessing quality of life in subjects with glenohumeral instability (Taylor, Garewal, & Evans, 2015; Van Der Linde et al., 2014) and consists of 21 items divided into domains: physical symptoms, sports/recreation/work, lifestyle and emotions. Each item is graded on a visual analog scale from 0 to 100 mm, and total score ranges from 0 (no deficit) to 2100 points (worst condition) (Barbosa et al., 2012; Kirkley, Griffin, McLintock, & Ng, 1998). In order to facilitate interpretation and comparison with previous studies, WOSI scores were represented in percentage (Alexandra; Kirkley, Griffin, & Dainty, 2003). Upper limb symptoms and physical function were assessed using the Disabilities of the Arm, Shoulder and Hand (DASH) Outcome Measure, which consists of 30 items and two optional domains, for sports or instruments playing and related to work. For both questionnaires, higher scores represent worst condition.

2.2.2. Muscle strength assessment

Scapular protraction and retraction muscle strength were evaluated using an isokinetic dynamometer (Biodex Multi-Joint System-Pro 3, New York, USA). Firstly, subjects performed a standardized warm-up of ten repetitions of free active movements of shoulder abduction, flexion and circumduction in the clockwise and counterclockwise directions. Subjects were assessed in the seated position with trunk stabilization provided by a strap diagonally positioned from the contralateral shoulder to the ipsilateral hip. The dynamometer's supplementary device for closed kinetic chain was used. Tests were performed with the arm at 90° of elevation in the sagittal and scapular planes, in randomized order. The participants were instructed to keep the elbow extended during all the movements and the forearm in neutral position.

For movements performed in the sagittal plane (Fig. 1A), the dynamometer chair was positioned at 0° of rotation. For the scapular plane (Fig. 1B), the dynamometer was positioned at 45° of rotation and the chair was rotated 15° toward the opposite side, resulting in a 30° angle anterior to the frontal plane (Cools et al., 2002). The affected shoulder was assessed in the subjects with glenohumeral instability. In order to minimize a possible influence of dominance in the results, the assessed side of healthy subjects was paired with each participant from the Shoulder Instability Group, according to the arm dominance. For example, if the shoulder with instability was in the dominant side, the paired subject in the Control Group had the dominant side assessed.

Previous to tests, maximal active range of motion (ROM) of shoulder protraction and retraction in the testing position was determined for each subject, using the dynamometer measurement. Maximal strength was assessed during isometric and isokinetic concentric contractions at linear speeds of 12.2 cm/s and 36.6 cm/s, which correspond to the angular velocities of 60°/s and 180°/s, respectively (Cools et al., 2002). Isometric contractions were performed in a middle point between maximum active ROM of protraction and retraction. Subjects performed three maximal isometric contractions of five seconds for shoulder protraction and retraction with 30 s rest between them (Ekstrom et al., 2004).