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Original article

The comparison of scapular upward rotation and scapulohumeral rhythm between dominant and non-dominant shoulder in male overhead athletes and non-athletes

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ABSTRACT

Previous studies have stated that the scapulohumeral rhythm dysfunction can make person prone to glenohumeral joint pathologies. The purpose of this study was to compare scapular upward rotation and scapulohumeral rhythm between dominant and non-dominant shoulder in male overhead athletes and non-athletes. Seventeen overhead athletes and seventeen non-athletes volunteered for this study. Two inclinometers were used to measure humeral abduction and scapular upward rotation in rest position, 45°, 90° and 135° humeral abduction in frontal plane. Findings indicated there was no significant asymmetry in scapular upward rotation and scapulohumeral rhythm in different abduction angles between dominant and non-dominant shoulder in non-athletes. In contrast, overhead athletes' dominant shoulders have more downward rotation in scapular rest position and more upward rotation in 90° and 135° shoulder abduction than non-dominant shoulders. Also, overhead athletes presented scapulohumeral rhythm asymmetry between dominant and non-dominant shoulder in 90° and 135° humeral abduction as dominant shoulders have less scapulohumeral rhythm ratio than non-dominant shoulders. Furthermore, overhead athletes dominant shoulders have more scapular downward rotation in scapular rest position, more scapular upward rotation in 90° and 135° humeral abduction and less scapulohumeral rhythm ratio in 45°, 90° and 135° humeral abduction than non-athletes in dominant shoulders. We suggest that clinicians should be aware that some scapular asymmetry may be common in some athletes. It should not be considered as a pathological sign but rather an adaptation to extensive use of upper limb.

1. Introduction

Shoulder pain is the third most common type of musculoskeletal pain (Fabrice et al., 2012), and can have a major impact on health-related quality of life (Fabrice et al., 2012). Among competitive overhead athletes the reported prevalence of shoulder pain is 30–45% (Gabriel et al., 2013). Generally, overhead activities require combined and coordinated motions of the scapulothoracic (ST) and glenohumeral (GH) joints. Because the scapula links the humerus to the trunk, ST motion is necessary to achieve full humerus-to-trunk elevation. Cathcart first described the contribution of the ST to normal shoulder complex kinematics (Yoshizaki et al., 2009). The kinematic interaction between the scapula and the humerus was termed the "scapulohumeral rhythm" (SHR) by Codman (1934), and subsequently, this has been shown to be valid for analysis of dynamic motion of the shoulder complex, with the classic 2:1 ratio described by Inman et al. (1944). Numerous studies have investigated the 2 or 3 dimensional (3D) motion of the GH joint and scapula using the SHR. Hence, the SHR has been established as the

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kinematic hallmark indicating motion of the shoulder joint (De Groot, 1999; Sahara et al., 2007; Yoshizaki et al., 2009). Studies showed that scapular upward rotation is significantly increased in patients with full-thickness rotator cuff tears compared with controls in both sagittal and scapular plane elevation (Mell et al., 2005). Also, an increased scapular component is generally thought to contribute to the SHR ratio in frozen or stiff shoulder (Vermeulen et al., 2002; Rundquist et al., 2003; Rundquist, 2007). In contrast, Ogston and Ludewig (2007) reported that shoulders with multidirectional instability have an increased ratio (*glenohumeral to scapulothoracic*)

Instrumentation accessibility has often precluded clinicians from being able to quantify glenohumeral and scapulothoracic joint contributions to scapulohumeral rhythm. To enhance accessibility, Johnson et al. (2001) validated use of a digital inclinometer to quantify SHR, which has since been incorporated into a variety of clinically oriented research studies (Laudner et al., 2008) While many studies involving digital inclinometers have been successful in quantifying SHR, no studies involving inclinometers have attempted to examine scapulohumeral rhythm between dominant and non-dominant shoulder in healthy overhead athletes and non-athletes specifically. Also, because the demands placed on shoulders of overhead athletes and non-athletes are different, we expected to see differences in scapular posture and scapulohumeral rhythm between overhead athletes and non-athletes. We hypothesized that the asymmetry would be present in scapulohumeral rhythm in healthy overhead athletes and non-athletes between dominant and non-dominant shoulder. Identifying asymmetry in scapular position and scapulohumeral rhythm in healthy overhead athletes and non-athletes is important because it provides a basis for comparison with injured overhead athletes and non-athletes. Therefore, the purpose of this study was to investigate the comparison of scapular upward rotation and scapulohumeral rhythm between dominant and non-dominant shoulder in overhead athletes and non-athletes.

2. Methods

2.1. Participants

Thirty four subjects in two groups of overhead athletes (handball players, n = 10 and volleyball players, n = 7) and non-athletes (n = 17) participated in this study. The descriptive data of the participants are presented on Table 1. Overhead athletes were professional players in major leagues (handball and volleyball) of Iran. None of the non-athletes had the involvement on sports activities on a regular basis. The dominant limb was identified as the arm that would be used to throw a ball. Only men were recruited for this study to control possible sex differences. Those with a previous history of shoulder surgery or traumatic injury (dislocation, subluxation, or acromioclavicular joint sprain) were excluded from this study. Participants with shoulder or elbow pain within 6 months of testing also were excluded from the study.

Table 1
Profile of research subjects.

Groups	N	Age (year)	Height (cm)	Mass (kg)	BMI (kg/m^2)
Overhead athletes	17	3.1 ± 22.43	6.02 ± 197.3	5.1 ± 92.46	0.55 ± 23.8
Non-athletes	17	3.4 ± 22.21	5.2 ± 182.3	6.2 ± 83.5	0.63 ± 24.9

BMI: body mass index.

2.2. Instrumentation

Two inclinometers (Acumar Digital Inclinometer Serial – MT3738) were used to measure humeral and scapula range of motion in scapular rest position, 45°, 90° and 135° shoulder abduction in frontal plane. Using an electromagnetic tracking system, Johnson et al. (2001) validated use of the digital inclinometer to quantify scapular upward rotation associated with varying amounts of humeral elevation (r = 0.66–0.89). Our reliability results presented a good Intraclass correlation coefficient (ICC = 0.86–0.91) for measurement of scapular upward rotation in scapular rest position, 45°, 90° and 135° abduction.

2.3. Procedures

An inclinometer was used to measure shoulder elevation and another inclinometer was used to measure scapular upward rotation. All subjects were assessed in a relaxed, standing (barefoot) position. Subjects were asked to perform full extension at the elbow, neutral wrist position, and with the thumb leading in the coronal plane. First inclinometer was attached parallel to the humerus, just under the deltoid insertion, with use of a tape. Scapular upward rotation was measured using the second inclinometer. This was achieved by manually aligning the base of the inclinometer along the spine of the scapula (Fig. 1). Subjects were asked to actively move their arms (dominant or non-dominant randomly) from rest position to 45°, from rest position to 90° and from rest position to 135° abduction and to hold arm in these positions for measurement (measured with first inclinometer) in frontal plane (randomly). Standing posture and postural sway were controlled by asking subjects to look at a target approximately 2 m ahead of them positioned at eye level. Scapular resting position was measured in 0° shoulder abduction. Three trials with a 30 s rest between trials were performed for each shoulder (at rest position, 45°, 90° and 135° abduction) and means of them were calculated. The scapulohumeral rhythm was calculated by dividing the GH elevation (i.e. GH elevation = Total shoulder motion − SUR) by the scapular upward rotation (scapulothoracic) (Struyf et al., 2011). All testing was carried out by one investigator who was blind to group allocation.

2.4. Data analysis

Kolmogorov–Smirnoff test was used for determination of normality. Our data was normally distributed and thereby we used paired sample test for comparison of scapular upward rotation and scapulohumeral rhythm between dominant and non-dominant

Fig. 1. Measurement of scapular upward rotation at 90° humeral abduction.