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HUMERAL RETROVERSION IN OVERHEAD THROWING ATHLETES

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The purpose of this study was to compare the dominant shoulder humeral retroversion of handball and volleyball players and a control group to understand if throwers show the same behaviour concerning humeral torsion. The dominant shoulder of 33 subjects (11 volleyball players, 11 handball players and 11 non-athletes) was submitted to a shoulder semiaxial radiograph in order to identify the humeral retroversion angle. Handball players showed significantly (p=0.03) less humeral retroversion than volleyball players which could be related with less external rotation range-of-motion found on previous studies. Volleyball players presented more retroversion angle, so more external rotation, allowing the correct alignment of the articular surfaces and glenohumeral stability, being able to have a cocking phase with more amplitude achieving maximal performance.

KEY WORDS: Humeral retroversion, internal rotation, external rotation, overhead athletes.

INTRODUCTION: Retroversion of the humerus or humeral torsion is defined as the rotation angle of the proximal humerus relative to the elbow (Yamamoto, Itoi et al. 2006), i.e., the acute angle, in a medial and posterior direction, between the axis of the elbow joint and the axis through the centre of the humeral head (Pieper 1998). In a radiographic study, involving 100 shoulders, Kronberg et al. (1990) reported an average retroversion of 33° in the dominant and 29° in the non-dominant shoulder.
Murachovsky et al. (2007) in a study involving seventeen handball athletes reported an average retroversion of 36º in players who started earlier practicing (10 years age) and 26º in the ones that started later in life practicing handball. Also Pieper et al. (1998) found an augmented angle of retroversion (up to 15°) in the dominant shoulder of 51 handball players, when compared with the non-dominant shoulder. This retroversion seems to increase the available external rotation range-of-motion (ROM) and at the same time reduced the ability of the rotator cuff to control high forces or velocities through the extremes to shoulder ROM which could lead to excessive humeral head translation and culminate in shoulder pain (Crockett, Gross et al. 2002; Ellenbecker and Roetert 2002). Borsa et al. (2008) argues that increased ROM through osseous changes may provide an adaptative benefit, sparing the joint capsule from excessive strain and disruption, maintaining glenohumeral joint stability. It is theorised that more external rotation range in the dominant arm, could allow increased cocking of the throwing arm and thus increasing the ability to generate power and speed on release (Wang and Cochrane 2001). So therefore, it is unclear whether there are benefits or disadvantages associated with changes in humeral torsion. Also no studies to date have analyzed volleyball players or even compared handball players with non-throwers with respect to the osseous adaptation on the throwing shoulder, namely about the humeral retroversion angle. Thus the purpose of this study was to compare throwing and non-throwing as well as handball and volleyball players with respect to the angle of humeral retroversion.

METHODS: Thirty three subjects divided into three groups: the handball players (age = 22.47±3.47 years; height = 184.27±4.05cm; body mass = 86.27±5.97 kg); the volleyball players (age = 26.55±7.44 years; height = 194.45 ± 5.97 cm; body mass = 91.09 ± 9.18 kg) and the control group (age = 26.27 ± 5.79 years; height =, 179.27 ± 5.83 cm; body mass = 76.27 ± 7.41 kg) participated in this study. Data about shoulder injury diagnosis was collected from each subject and those with a previous history of shoulder surgery or traumatic injury (e.g. dislocation, subluxation) were excluded.

The angle of humeral retroversion was determined by posterior-anterior radiographs taken with subject standing with the shoulder on flexion (90º) and horizontal abduction (20º) and elbow flexed to 90º while the forearm was kept fully supinated. On Rx images, the humeral head axis was determined by marking anterior and posterior points where round articular surface becomes flat (points A & B, Figure 1). A line was then drawn connecting these two points (Line AB, Figure 3). A perpendicular line to line AB was drawn that represented the humeral head axis. Distal humeral axis was determined by a line drawn parallel to the anterior articular surface of the distal humerus (line CD, Figure 1).

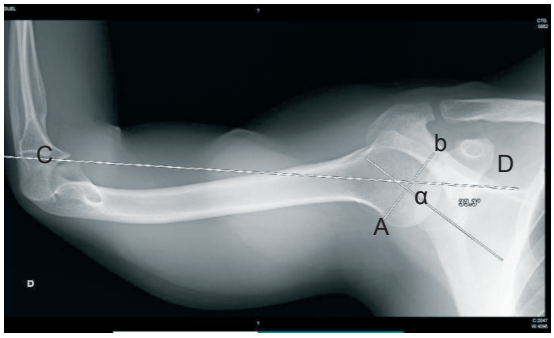

Figure 1: HRV angle (α) via semiaxial radiograph, created by intersection of the proximal humeral axis (⊥ to Line AB) and distal humeral axis (Line CD).

Humeral retroversion angle was determined by the intersection of proximal and distal humeral axes (α, Figure 1). An activity index (index of sports practice) was calculated considering the number of days, hours and years of training, of each overhead athlete, in order to describe its relation to the humeral torsion angle. A one-way ANOVA ($p < 0.05$) approach was use to compare the humeral retroversion angle across the groups. Additionally, a correlation matrix was calculated between retroversion angles and index of sports practice. All subjects signed an informed consent, allowing the data collection or this study.

RESULTS: Handball players showed a mean retroversion angle of 21.9º ± 8.3º (mean ± std. deviation), volleyball players showed 29.7º±11.3º and the non-throwers group presented 28.2º ± 10.1º. A significant difference was found between volleyball and handball players ($p=0.032$), and no difference was found between volleyball and non-athletes group or handball and non-athletes group. In average volleyball players have more 7.7º humeral torsion angle than handball players and more 3.4º than non-athletes. Considering handball, this group has less 4.3º than non-athletes group. No difference was found between the activity index and the humeral retroversion angles in both groups (handball and volleyball players), so activity (sports practice) was not a difference factor between handball or volleyball players.

DISCUSSION: Overhead athletes competing in a high and strenuous level and repetitive nature have consistently demonstrated more retroversion of their dominant arms (Pieper 1998; Ellenbecker and Roetert 2002; Osbahr, Cannon et al. 2002; Whiteley, Ginn et al. 2006). Some researchers have speculated that humeral osseous adaptation may contribute to risk of injury in the overhead throwing athlete. Some studies found a paradoxical relationship between loss of internal rotation range of motion and increase in external rotation range of motion in dominant arm of throwing athletes (Crockett, Gross et al. 2002; Osbahr, Cannon et al. 2002; Reagan, Meister et al. 2002; Borsa, Wilk et al. 2005). These authors suggested that these changes could not be only due to capsule laxity and posterior capsular tightness and that osseous component may contribute to this kind of adaptations.

The most common theory suggested that a shift towards retroversion increases the available external rotation range of motion, and this may cause a reduced ability of the rotator cuff to control high forces or velocities through the extremes of shoulder range which could potentially lead to excessive humeral head translation and culminate with shoulder pain (Crockett, Gross et al. 2002; Ellenbecker, Bailie et al. 2002).
In our study handball players demonstrated a smaller humeral retroversion angle than volleyball players, and non-athletes group. Volleyball players seem to have, under this perspective, a higher risk to develop shoulder pain, because they show more retroversion angle, which could mean more external rotation amplitude, on the other hand, handball players seem to have a more protective response from the shoulder. However some studies, like Borsa *et al* (2008) state that increased range through osseous changes may provide an adaptative benefit, sparing the joint capsule from excessive strain and disruption thus maintaining glenohumeral joint stability, according to this analysis volleyball players could have a more protective position.
This relationship between humeral torsion and performance has been investigated by only a few researchers(Crockett, Gross et al. 2002; Nakamizo, Nakamura et al. 2008; Tokish, Curtin et al. 2008), which theorize that more external rotation range in the dominant arm, could allow increased cocking of the throwing arm and thus increasing the ability to generate power and speed on release (Wang and Cochrane 2001). Humeral retroversion has also been related to age (Yamamoto, Itoi et al. 2006) but no relation of age and this humeral torsion angle was found.

CONCLUSION: This study identified differences between volleyball and handball players concerning the humeral retroversion angle, demonstrating that probably volleyball players have more shoulder external rotation amplitude, because they showed more retroversion angle. This will allow them to keep the alignment of the articular surfaces and glenohumeral stability, being able to have a cocking phase with more amplitude achieving maximal performance. The handball players on our study showed less humeral retroversion which may be related with less external rotation range-of-motion. A few studies have been done, to date, to study this relationship. We propose in future to analyze this humeral torsion angles and its relation with shoulder rotation angles (internal and external rotation).

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