SHOULDER EXTERNAL ROTATION RANGE-OF-MOTION ASSESSMENT ON THROWER ATHLETES. THE EFFECTS OF TESTING END-RANGE DETERMINATION (ACTIVE VS PASSIVE)

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SUMMARY
The purpose of this study was quantifying the effects of the end-range determination (active vs. passive) on the external rotation ROM in overhead throwing athletes. In 24 healthy male subjects (12 athletes and 12 non-athletes), a 6DOF electromagnetic tracking device was used to measure active and passive shoulder external motion in supine position. Thoracohumeral (TH) and glenohumeral (GH) external angles were calculated and a 2-way repeated-measures ANOVA was used to describe the effects of the end-range determination (active vs. passive) across groups (athlete vs. non-athlete). No differences were found between groups either for the TH (p=0.784) or GH (p=0.364), however on both TH and GH a significant (p=0.00) main effect was found related with end-range determination in a way that the highest values are associated with passive motion. Athletes showed bigger difference (passive = 109.2º ± 2.9º, active = 103.4º ± 3.1º) between active and passive motion than non-athletes. No differences were found between athletes and non-athletes.

INTRODUCTION
Throwing athletes have been shown to have several morphologic changes in their dominant extremities. Among the differences between dominant and non-dominant arms, such as muscle hypertrophy and increased strength or increased bone density of the humerus, increased shoulder external rotation has been identified [1]. These findings have important implications in the rehabilitation process of athletes with shoulder problems. The reason for this altered range-of-motion (ROM) is unclear, but is believed to be an adaptation to the throwing sports demand [2]. The study of these adaptations is important for two main reasons: the available range of internal and external rotation impacts shoulder function, from simple activities of daily living to more complex tasks, as the ones used by the athletes; and also, the measurement of internal and external rotation can be used as an indicator of capsular tightness [3]. Clinical evaluation of glenohumeral joint internal and external rotation often uses one or two arm positions uses in order to describe patterns of external rotation and identified shoulder dysfunction. Also goniometry is as an integrated part of shoulder assessment after injury or surgery or during preseason or preventative musculoskeletal screenings [4]. From a biomechanical perspective these measurements have three key limitations: 1) the end-range is determined by clinical end-feel, as opposed to an objective assessment of torque; 2) goniometers may be designed and used to assess glenohumeral motion, they are really measuring both glenohumeral and scapulothoracic motion; and 3) the effect of the plane of motion has not been well documented [3]. Several procedures are currently used for testing humeral rotation which includes placing the patient supine or in a sitting position with the arm abducted to 90º. On both procedures of ROM testing, the end-range has been actively determined by the patients with or without the effects of gravity, or by the examiner, following a standard goniometry procedure, passively positioning the arm determined by capsular end-feel, by scapular liftoff or by pain. However, no studies to date have specifically investigated how humeral rotational pattern is affected by end-range determination in overhead throwing athletes.

The purpose of this study was to quantify the effects of the active vs. passive end-range determination on the external rotation ROM in overhead throwing athletes.

METHODS
Two groups of twelve male subjects were recruited from the community to participate in this study: the athletes group (age= 25.6 ± 5.7 years; height = 186.0 ± 7.9 cm; body mass=84.6 ± 8.9 kg) and non-athletes group (age = 28.3 ± 6.2 years; height = 172.7 ± 8.8 cm; body mass = 73.3 ± 13.3 kg). In a supine position, subjects placed their dominant arm at 90º of abduction with elbow flexed at 90º. From this initial position, subjects moved their arm to the extreme position of the ER (end-range) under to condition of end-range determination: active and passive. On the active condition subjects were instructed to move their arms to maximal ER, without moving the trunk. The protocol for passive arm movement was identical to the active one, except arm motion was controlled by the investigator. On both conditions, no allowance for scapular protraction or elevation was permitted. The scapulothoracic joint was stabilized via a posterior directed containment force by the examiner hand on the coracoid process and the anterior aspect of the acromion. This procedure replicates the one used on standard goniometry for shoulder rotation. The 3D shoulder kinematics was recorded by means of an electromagnetic tracking device (100Hz) (Flock-of-Birds) controlled by a specific software (Motion Monitor v. 7.0). After calibration, the reliability of the system was 0.3mm for the position and 0.15º for orientation. In data collection a four sensors setup was used: the thorax sensor firmly attach to the skin by a double-glued tape over T1; the arm sensor attached by means of a cuff just below the deltidoid attachment; and the scapular sensor firmly glued on the superior flat surface of the acromion process. A 4th sensor
mounted on a hand-held stylus (±6.5 cm) was used on bony landmarks digitalization in order to link sensors to local anatomical coordinate systems (LCS) and subsequently calculated segments and joint rotations by combining the LCSs with the sensor motions. Segments LCSs and joint rotations definition were made according to the shoulder ISB standardization protocol [5]. Humeral position was calculated with respect to thorax and scapula. Thoracohumeral and glenohumeral angles were calculated in order to describe the humeral position with respect to the thorax and scapula, respectively. Scapular position (Euler angles) with respect to the thorax, protraction, lateral rotation and spinal tilt, as well as thoracohumeral and glenohumeral axial angles were recorded at the end-range of active and passive ER end-range. Data were filtered (Butterworth; Cut-off=10Hz). A 2-way repeated-measures ANOVA was used to calculate the effects of the end-range determination (passive or active) across groups (athlete and non-athlete). For all statistical tests, a specific software was used (SPSS Statistics 17.0) and results were considered significant at P values < 0.05.

RESULTS AND DISCUSSION

No differences were found between groups either for the TH (p = 0.784) or for the GH (p = 0.364). Both TH and GH showed a significant (p<0.001) main effect with end-range determination in a way that the highest values are associated with passive motion. Athletes showed bigger difference (passive = 109.2 ± 2.9, active =103.4 ± 3.1) between active and passive motion than non-athletes, however no differences were found between athletes or non-athletes (Figure 3).

Clinically it is relevant to know which is the best way to evaluate shoulder ER, because throwers seem to demonstrate a glenohumeral ER gain [2]. In this study, differences were found between active and passive end-range determination on both TH and GH angles. Our findings show that the end-range shoulder ER was higher when this end-range was determined by the examiner. These results emphasize the importance of the end-range determination in a clinical setting particularly on functional assessment of the throwers shoulder. Most of the studies in the literature assessed shoulder rotational range of motion in the supine position, and the arm at 90º abduction, as we did. According to our findings the amplitude of passive shoulder external rotation is bigger among athletes than non-athletes, although this difference was not a statistically significative one. This could be due to sports, and the adaptations that overhead sports induce. We also found that active motion was higher in non-athletes, possibly because athletes use their scapula along the throwing motion, and not only the glenohumeral like the experimental setup asked for, in opposition to what occurs with non-athletes. Differences between instruments, electromagnetic tracking device and goniometers were also found, like expected, amplitude means were higher when using the electromagnetic tracking device, for both groups, but non-athletes showed higher values on this device, and athletes demonstrated higher values in goniometry when comparing non-athletes. As mentioned before usually the end-range is determined by the clinical end-feel, while using the electromagnetic tracking device we are able to achieve an objective assessment of arch motion, which may be in the basis of the differences found between goniometry and the data collected by the electromagnetic tracking device. At the supine position the scapula was stabilized allowing the same movement between this bone and the humerus, justifying highest values on passive motion.

CONCLUSIONS

Results emphasize the importance of end-range determination in a clinical setting particularly on functional assessment of the thrower’s shoulder. Athletes showed more passive external rotation than non-athletes possibly due to sports, and the adaptations that overhead sports induce. Using an electromagnetic tracking device we are able to achieve an objective assessment of the arch motion, while using goniometry we only get a subjective clinical end-feel.

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REFERENCES