HUMERAL RETROVERSION, CORRECTED RANGE-OF-MOTION, AND FAST SCORES IN COLLEGIATE BASEBALL PITCHERS

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The purpose of this study was to examine the relationship between corrected shoulder rotational range of motion and the Functional Arm Scale for Throwers (FAST) after accounting for humeral retroversion in collegiate baseball pitchers. Nineteen male NCAA Division I collegiate baseball pitchers participated in the study and completed a modified FAST form. Humeral retroversion was measured and total rotational range of motion, corrected internal rotational range of motion, and corrected external rotational range of motion were calculated. No relationships were found between rotational ROM and the FAST score. The findings suggest further research needs to be performed on patient reported outcomes specific to changes in rotational ROM.

KEYWORDS: Bicipital groove, functional arm scale for throwers, ultrasound

INTRODUCTION: Throwing a baseball is a physically demanding motion that requires detailed coordination of muscles and joints, while placing high loads of stress throughout the body (Fleisig et al., 1999). Consequently, baseball pitchers can suffer from various non-contact injuries. Understanding the arthrokinematics of the shoulder, including rotational motion, is essential to preventing and treating injuries throughout a baseball season (Fleisig et al., 1999). Due to anatomical adaptations in pitchers, the measurement of rotational range-of-motion (ROM) must be corrected by accounting for humeral retroversion (HR) (Thomas et al., 2012). Measuring patient reported outcome measures such as the Functional Arm Scale for Throwers (FAST) may help clinicians track how pitchers feel about their upper extremity in terms of throwing sports (Sauers et al., 2017). However, the relationship between corrected rotational range of motion of the shoulder and patient reported outcomes has yet to be determined. Therefore, the purpose of this study was to investigate the relationship between corrected shoulder rotational ROM (external rotation, internal rotation, and total rotation) and the FAST scale in baseball pitchers.

METHODS: This study was conducted on 19 male NCAA Division I collegiate baseball pitchers from a single university team. This study was approved by the Institutional Review Board and all participants provided written informed consent. Exclusion criteria consisted of any current upper extremity musculoskeletal conditions that were diagnosed by a physician, which may impede an accurate shoulder ROM test.
A questionnaire was used to collect information such as age, years of playing collegiate baseball, and throwing arm. Participant demographics are presented in Table 1.

Table 1: Pitcher Demographics

Category	Mean ± SD
1. Age (years)	21.21 ± 1.58
2. Height (cm)	187.55 ± 5.55
3. Mass (kg)	95.62 ± 9.67
4. BMI	27.17 ± 2.38
5. Years of College Baseball	3.26 ± 1.52
6. Fastball	100% of participants

7. Curveball	58% of participants
8. Changeup	95% of participants
9. Slider	53% of participants
10. Number of Types of Pitches	3.05 ± 1.25

Participants were also asked to complete a modified FAST scale with seven Likert-style questions and provided five response options using a numbered scale: 1 = not affected at all, 2 = slightly, 3 = moderately, 4 = severely, 5 = unable to perform. The scores from the individual questions were combined to create a total modified FAST score with possible scores ranging from 7 to 35. Two questions from Huxel Bliven et al's simplified 9-item FAST pitcher module were removed since they refer to injury and this study's participants were free from injury at the time of data collection. The FAST scale questions used in this study are shown in Table 2.

Table 2: Modified FAST Scale Questions

Question
1. How much has your arm limited velocity of pitches?
2. How much has your arm limited you to throw bullpen sessions?
3. How much has your arm limited your ability to hit your spots?
4. How much has your arm affected your pitch count?
5. How much has your arm limited your ability to throw different pitches?
6. How much has your arm changed how you feel throwing pitches?
7. Do you feel like you need more time to recover in between pitching outings?

Humeral retroversion was measured while the participants laid supine on a treatment table. The subjects' arms were placed at 90 degrees of shoulder humeral abduction and 90 degrees of elbow flexion. One examiner placed the ultrasound transducer (Terason uSmart 3300 MSK, Burlington, MA) in short axis on the anterior aspect of the participant's shoulder and identified the bicipital groove. Once the bicipital groove was identified, the grid mode was used to align the greater tuberosity with the horizontal grid line on the screen. While this was performed, a second examiner measured the vertical and horizontal distance on the participants forearm and marked the midpoint, to create a landmark where an inclinometer was placed for measurement. The participant's arm was then rotated manually into external rotation (ER) until the examiner performing the ultrasound exam observed that the bicipital groove was pointed vertically on the ultrasound screen and that the greater and lesser tuberosities were in line with the horizontal grid. The second examiner then used the digital inclinometer to measure the degree of rotation, which provided researchers with the angle of HR. This measurement was repeated three times, and the mean of the three measurements was recorded for analysis. Following measurements of the dominant (throwing) shoulder, measurements were recorded on the non-throwing shoulder using the same methods.

Next, passive internal rotation (IR) and ER measurements of the throwing shoulder were recorded with the participant in the supine position and the glenohumeral joint in 90 degrees of abduction. Each participant's scapula was stabilized, and the shoulder was manually rotated by the first examiner until the participant's scapula began to lift off the exam table. The second examiner then measured the rotational ROM using the inclinometer. This measurement was repeated three times, and the mean of the three measurements was recorded for analysis. These methods were repeated on the non-throwing side.

Total rotational range of motion (TRROM) was calculated using the formula TRROM = IR + ER. Corrected internal rotational range of motion (IR_c) was calculated using the formula IR_c = IR + HR. Corrected external rotational range of motion (ER_c) was calculated using the formula ER_c = ER – HR. All data were analyzed with Excel, with an alpha level set at <.05. Linear regression analysis was performed to examine the relationship between corrected rotational ROM and FAST scores.

RESULTS: The sample of 19 Division I baseball pitchers contained both right-handed pitchers (n=13) and left-handed pitchers (n=6), all of which were participating in the baseball season. The average total FAST score for participants was 13.37 $\pm$ 4.80 points.
Shoulder range of motion measurements are presented in Table 3. When compared bilaterally, the throwing arm ER was greater than the non-throwing arm ER. However, throwing arm IR was less than the non-throwing arm IR. The total rotational range of motion value was greater on the throwing shoulder than the non-throwing shoulder. After accounting for humeral retroversion, the throwing arm ER_c remained greater than the non-throwing arm ER_c. Interestingly, the throwing arm IR_c was also greater than the non-throwing arm IR_c.
When examining the relationship between TRROM for the throwing arm and total modified FAST score, there was statistical significance although the correlation level was very low (r^2= 0.007, p= 1.80*10^-13). There were no high correlations between either the throwing arm ER_c and total modified FAST scores (r^2= 0.066, p=0.73), or between throwing arm IR_c and total modified FAST scores (r^2= 0.009, p=0.13).

Table 3: Shoulder Range-of-Motion Measurements

	Throwing Arm (Mean $\pm$ SD)	Non-Throwing Arm (Mean $\pm$ SD)
Humeral Retroversion	11.62 $\pm$ 1.86°	3.96 $\pm$ 0.96°
Internal Rotation	50.75 $\pm$ 5.73°	53.56 $\pm$ 8.88°
External Rotation	98.42 $\pm$ 6.42°	87.79 $\pm$ 6.86°
Total Rotation	149.18 $\pm$ 9.98°	141.35 $\pm$ 10.97°
Corrected Internal Rotation	62.38 $\pm$ 6.32°	57.53 $\pm$ 8.84°
Corrected External Rotation	86.80 $\pm$ 5.54°	83.82 $\pm$ 6.79°

DISCUSSION: Increases in chronic shoulder injuries in college baseball pitchers has resulted in a need to examine the throwing shoulder in depth, as sports medicine professionals search to find ways to prevent injury and identify risk factors that may predispose throwing athletes to shoulder injuries. For example, performing shoulder ROM screenings can provide useful clinical measurements that athletic trainers may use to evaluate individual metrics of pitchers. Furthermore, the FAST scale has been shown to be a reliable tool in evaluating throwing athletes' subjective perceptions (Huxel Bliven et al., 2017).
In this study we examined a modified version of the FAST pitchers' subscale to determine if this patient-reported outcome assessment was related to pitchers' shoulder corrected rotational ROM. However, no significant correlations between total modified FAST scores and shoulder corrected rotational ROM were found. This implies that scores from this subjective scale alone may not give clinicians insight into rotational ROM deficits. Therefore, repeated ROM assessments throughout the season may give better objective data to help prevent or treat shoulder injury in pitchers. Although this is the one of the first studies to examine the relationship between the FAST scale and measures of ROM, the researchers who developed the FAST scale have found it to be a valid tool to measure patient perceptions of their throwing function (Huxel Bliven et al., 2017). Because this scale has been found to be very specific and sensitive for measuring patient reported outcomes, it could be a valid measurement tool to be used during a rehabilitation process following injury.
Data from this study did provide meaningful values that contribute to previous published research on shoulder rotational ROM (e.g., Wilk et al., 2002, 2011; Downar & Sauers, 2005). The pitchers in this study had an average ER of 98.42° $\pm$ 6.42° and an IR of 50.75° $\pm$ 5.73° on their throwing arms prior to accounting for HR, similar to professional baseball players examined by Downar and Sauers (2005) (ER=108.9 $\pm$ 9.0° and IR=56.6 $\pm$ 12.5°). This supports the idea that before accounting for HR, sports medicine professionals may observe greater ER and less IR in the throwing shoulder compared to the non-throwing shoulder. However, this study shows that once accounting for HR (i.e., corrected), IR_c in the throwing shoulder is greater compared to the non-throwing shoulder. This suggests that changes in throwing shoulder ROM should be corrected, instead of assuming posterior capsule thickening and/or anterior shoulder instability as a culprit in IR deficit. Furthermore, because of the discrepancy between throwing

arm and non-throwing arm HR values (11.62° ± 1.86° versus 3.96° ± 0.96°) bilateral comparison for rotational ROM (or glenohumeral internal rotation deficits) may be misleading. Instead, changes of total rotational ROM in the throwing arm which are identified throughout the season may be better indicators for preventing or treating shoulder injuries.
Some limitations were present in this study. For instance, only shoulder ER and IR ROM values were measured and investigated in relation to FAST scores. In the throwing motion, there are other clinical ROM measurements that contribute to the throwing motion such as shoulder flexion, extension, adduction, and abduction. Another limitation to this study is that the participants in this study were from one university in the Midwest. Regional factors such as weather and opportunity to play baseball year-round may also contribute to the data that was collected. Lastly, because only pitchers participated in this study, the total modified FAST score used in this study was modified from the 9-question pitcher's subscale to a 7-question scale.
Further research is needed to determine when it is ideal to examine shoulder ROM in pitchers. Many sports medicine professionals collect baseline ROM data; however, there is no current literature outlining ROM testing schedules in the healthy and asymptomatic baseball pitchers during the season. Additionally, investigating structures and muscle architecture in the shoulder after pitching outings may give researchers better insight into structures to focus on to restore ROM in the shoulder. Lastly, more research on patient outcome assessments used to track pitchers' perception of shoulder function is needed to help clinicians create individualized programs for pitchers during the season.

CONCLUSION: This case study showed no significant correlations exist between total modified FAST scores and shoulder corrected rotational ROM in baseball pitchers. These results imply that scores from this subjective scale alone may not give clinicians insight into rotational ROM deficits. Additionally, this study shows that using diagnostic ultrasound to account for HR is important since IR_c in the throwing shoulder is actually greater compared to the non-throwing shoulder. This suggests that sports medicine professionals should consider changes in throwing shoulder ROM with this correction in mind, instead of assuming posterior capsule thickening and/or anterior shoulder instability as a culprit in IR deficit.

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