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ORIGINAL RESEARCH

THE EFFECTS OF A DAILY STRETCHING PROTOCOL ON PASSIVE GLENOHUMERAL INTERNAL ROTATION IN OVERHEAD THROWING COLLEGIATE ATHLETES

Roy Aldridge, PT, EdD[1]
J. Stephen Guffey, PT, EdD[1]
Malcolm T. Whitehead, PhD[1]
Penny Head, PT, ATC[1]

ABSTRACT

Introduction/Purpose: Shoulder dysfunction and injury are common in throwing athletes. Loss of internal rotation has been correlated to shoulder pathologies. The purpose of this study was to assess the effects of a stretching protocol on passive internal rotation. The purpose of this study was assess the effects of a stretching protocol on passive internal rotation motion in the throwing shoulders of collegiate baseball players.

Study Design: Pre-Post, intervention, using a within subjects comparison of a convenience sample.

Methods: Glenohumeral internal rotation and external rotation of the throwing and non-throwing shoulders of NCAA Division I baseball players were measured using a universal goniometer. Determinations were made as to the degree of Glenohumeral Internal Rotation Deficit (GIRD) in the throwing shoulder. A daily (5 days per week), 12-week posterior capsule stretching program was administered. Post-stretching internal rotation and external rotation measures were again obtained. The coaches and athletic trainers of the included team monitored the players for shoulder injuries and innings of training/competition lost due to shoulder injuries during the 12 week intervention.

Results: A significant increase in range of motion was found for dominant arm internal rotation (IR) and total range of motion (TOT) following the stretching program. No statistically significant improvement in range of motion was found for external rotation (ER), non-throwing arm internal rotation (NDIR), non-throwing arm external rotation (NDER), and non-throwing arm total motion (NDTOT).

Conclusions: Implementation of a posterior capsule stretching program may be helpful to facilitate increased passive internal rotation range of motion at the glenohumeral joint. Further research should be performed using a control group not receiving the stretching program in order to more completely establish the impact of stretching on measures of passive glenohumeral range of motion.

Key Words: GIRD, glenohumeral internal rotation, stretching

Level of Evidence: 1b

[1] Arkansas State University, State University, Arkansas 72467

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CORRESPONDING AUTHOR

Roy Aldridge, PT, EdD
Associate Professor
Arkansas State University
State University, Arkansas 72467
raldridge@astate.edu

INTRODUCTION

The throwing motion in the overhead-throwing athlete, such as a baseball player, is a complex biomechanical phenomenon. This highly skilled movement, performed at extreme velocities, requires a delicate combination of flexibility, strength, coordination, synchronicity, and neuromuscular control. The athletes' throwing shoulder must exhibit adequate dynamic stability that provides sufficient mobility to accommodate the throwing motion, while preserving stability needed to prevent symptoms and/or injury.[1]

In previous studies,[2-5] altered mobility patterns have been reported in the throwing shoulder of baseball players, especially when compared to the non-throwing shoulder. The throwing shoulder typically presents with hypermobility in some directions while demonstrating hypomobility in others. This atypical mobility pattern may be attributed to the structural changes found in the glenohumeral joint capsule, labrum, rotator cuff musculature, ligaments, and osseus structures that occur in response to the demands of overhead throwing. The throwing motion used in baseball requires the arm to be forcefully propelled forward from a position of full external rotation to near full internal rotation. The posterior rotator cuff must act in an eccentric fashion to decelerate and control the arm as it internally rotates and horizontally adducts across the body.[6]

Previous authors have suggested that the throwing shoulder typically exhibits increased external rotation and decreased internal rotation when compared to the non-throwing shoulder. This loss of internal rotation in the throwing shoulder is defined as the glenohumeral internal rotation deficit (GIRD).[7] Both soft tissue and osseous tissue changes have been linked to GIRD. Increased external rotation and decreased internal rotation in the dominant extremity have been correlated with an increase in humeral retroversion.[8] From a soft tissue perspective, asymmetric capsular tightness (especially posterior tightness) has also been suggested as a cause of the observed loss of internal rotation.[7] In a study by Burkhart, et al, evidence was presented to support the prediction that asymmetric glenohumeral capsular tightness could contribute to a wide variety of pathologies.[9] As a result of Burkhart's work, those who care for pitchers in professional baseball have begun to develop stretching programs to address internal rotation deficits. These programs have been reported to be effective at reducing innings lost and surgical procedures performed on the throwing shoulder of professional pitchers.[10]

Craig Morgan, MD explained the concept known as the *pathological cascade* of the throwing shoulder. He stated that the first sign of shoulder pathology is a painless loss of velocity and command caused by an early loss of glenohumeral internal rotation secondary to a posterior capsule contracture. Once this cascade has begun, the GIRD will cause the posterior inferior capsular contracture to become progressively less mobile. This increased posterior tightness, Morgan asserted, would lead to posterior shoulder stiffness and an inability to properly prepare for competition.[11] Progression of the cascade includes a third stage that presents as posterior shoulder pain without mechanical symptoms. This pain is felt during the late cocking and early acceleration phases of the throwing cycle due to posterior superior glenohumeral instability. The posterior inferior capsular contracture forces the humerus into a posteriorly and superiorly shifted position, adding undue strain on the posterior superior labral-glenoid complex. This posterior superior shifting allows an increase in external rotation that places the posterior superior rotator cuff in position to contact the glenoid margin resulting in symptoms of internal impingement. The contracture and resultant posterior superior shift lead to the development of mechanical symptoms usually evident in the late cocking and early acceleration of the players throwing phase, representing the fourth stage of the cascade. These symptoms occur due to the subsequent failure of the bicep and posterior superior labrum anchor, secondary to the capsular contracture.[11] This loss in anchoring tension on the glenoid attachments allows anterosuperior translation of the humeral head during forced humeral elevation and internal rotation, as seen with overhead throwing, leading to the "SLAP event" (Superior Labral Anterior-Posterior) and subsequent tearing of the posterior superior labral rim.[12] According to Morgan, the SLAP event can be avoided by initiating posterior capsular stretches early in the cascade to eliminate contracture. Once the SLAP event has occurred, mechanical symptoms most often become a surgical issue. As the player continues to throw through these symptoms, subacromial and rotator cuff symptoms will develop.[11]

In some cases of GIRD there may be no increase in external rotation. In these cases there exists a likelihood of pathological internal impingement. Myers et al stated that throwers with pathologic internal impingement will exhibit significantly increased posterior shoulder tightness and glenohumeral internal rotation deficit without significantly increased external rotation gain.[13] Based on the review of the related literature, the authors of the current study decided to assess the glenohumeral internal and external rotation range of motion of the shoulders of NCAA Division I baseball players.

Therefore, the two specific purposes of this research were: 1) to determine the prevalence of glenohumeral internal rotation deficit in the sample of Division I collegiate baseball players , and 2) to determine the effectiveness of a twelve-week posterior capsule stretching program on GIRD.

The authors hypothesized that the posterior capsule stretching program would statistically improve the internal rotation measures over a twelve week period.

METHODS

A sample of convenience obtained from a NCAA Division I baseball team (n = 28; all members of the team) was used to conduct this study. Descriptive characteristics for subjects are displayed in Table 1. The study design and data collection methods were approved by the University (can reinsert the identifier) Institutional Review Board (IRB) for Research with Human Subjects and all subjects provided informed consent prior to participating in the study. Range of motion was assessed prior to and following a daily (five days per week) 12-week posterior capsule stretching program. Measurements included internal rotation (IR), external rotation (ER), and total motion arc (TOT) of the throwing arm and internal rotation (NDIR), external rotation (NDER), and total motion arc (NDTOT) of the non-throwing arm using a plastic, universal goniometer with the scapula stabilized as described by Norkin and White.[14] In order to obtain goniometric measurements, the subjects were positioned supine, the arm being measured was placed in 90 degrees shoulder abduction with the elbow at 90 degrees flexion. All motions were measured passively. All measurements were performed by graduate physical therapy students who had been trained by the authors. Passive force was applied by the examiner until non-glenohumeral accessory motion was observed. Prior to data collection a pilot study was performed to develop research protocols and train data collectors. Each of the data collectors demonstrated test – retest reliability before collecting data presented in this research. Initial measures were made at the beginning of the fall term as the players reported for fall practice. Post-intervention measures were made three months later at the end of the fall training/competition period.

Table 1. *Physical characteristics of participants.*

Variable	
Age (years)	20.0 ± 1.5
Height (cm)	185.3 ± 5.3
Mass (kg)	86.7 ± 7.4
Values presented are mean ± *SD*.	

While all players were involved in the daily posterior capsule stretching program, some players were found to initially have significant internal rotation deficits, that is to say, they exhibited GIRD. To place a subject in the GIRD category the authors chose to require that the subject's internal rotation deficit must have exceeded the bounds of two out of three accepted definitions of GIRD. If the difference between the internal rotation of the non-throwing shoulder versus throwing shoulder was greater than 20 degrees ($GIRD_1$),[15] the difference between internal rotation of the throwing shoulder and the non-throwing shoulder was greater than 10% of the total rotation (internal rotation + external rotation) of the non-throwing shoulder ($GIRD_2$), and the difference between internal rotation of the throwing shoulder and the non-throwing shoulder was greater than 20% of the internal rotation of the non-throwing shoulder ($GRID_3$).

To the authors' knowledge, the players did not previously participate in an internal rotation stretching program prior to this data collection. The baseball program training staff was instructed in the posterior capsule stretching program. Each day of practice or competition included the stretching exercises supervised by the training staff. Each stretch was performed 3–5 repetitions. Each repetition was held for 30 seconds. The stretching program lasted for a period of twelve weeks. The stretches used can be seen in Figures 1–6. They were collectively known as sleeper stretches.[15]

Figure 1. *Sleeper Stretch 1, performed in prone.*

Figure 2. *Sleeper Stretch 2, performed in prone with scapular stabilization.*

Figure 3. *Sleeper Stretch 3, traditional position, self-stretch performed in sidelying with arm at 90 degrees of abduction.*

Figure 4. *Sleeper Stretch 4, alternate sidelying position, self-stretch with arm elevated above 90 degrees.*

Figure 5. *Sleeper Stretch 5, alternate sidelying position, self-stretch with arm at 45 degrees.*

Figure 6. *Sleeper Stretch 6, passive stretch performed in supine, with stabilization of the scapula.*

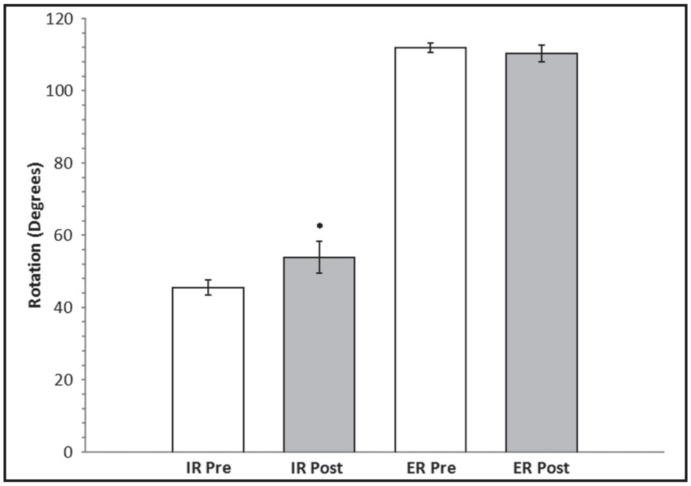

Figure 7. *Comparison of Internal and External rotation, pre- and post-intervention. *Denotes statistically significant difference.*

At the end of the twelve weeks of stretching, measures of glenohumeral rotation were again collected. Range of motion was assessed in order to determine IR, ER, TOT, NDIR, NDER, NDTOT and the presence of GIRD prior to and following the stretching program. Analysis of variance was performed in order to determine differences within the cohort following the stretching program with the level for statistical significance set at $\alpha \leq 0.05$.

RESULTS

Results of analysis of variance are presented in Table 2. A significant increase in range of motion was found for IR and TOT following the stretching program. There was no statistically significant improvement in range of motion found for ER, NDIR, NDER, and NDTOT. Prior to the stretching intervention 10 of the 28 or 36% subjects were considered to have GIRD by the standards established for this research. Following the stretching intervention only 6 players met the criteria set to be classified as exhibiting GIRD (21% of subjects). Collectively, this represents a 15 % decrease in the number of athletes exhibiting GIRD following the 12-week stretching regimen. During the period of stretching intervention there were no reported innings or games lost due to shoulder pain or injury. Furthermore, no medical or rehabilitative (other than the stretching program) treatments to the throwing shoulder were required for any of the subjects who met the GIRD criteria.

DISCUSSION

The throwing shoulder of overhead athletes must be able to tolerate extreme forces of torque and velocity while accommodating significant range of motion. The throwing motion can place a dramatic stresses upon the soft tissues supporting the glenohumeral joint.[16] The balance of range of motion and stability needed to protect the throwing shoulder from injury while providing for effective performance is difficult to achieve and maintain due to the repetitive stresses, soft tissue adaptations, and the potential presence of osseous anomalies (humeral retroversion) associated

Table 2. *Range of motion prior to and following a twelve week posterior shoulder stretching program.*

Variable	Pre-Stretching	Post-Stretching	*p*
Throwing Arm			
Internal Rotation (IR)	48.89 ± 8.46	54.07 ± 13.85	0.04*
External Rotation (ER)	105.07 ± 13.43	106.89 ± 10.91	0.29
Total Motion Arc (TOT)	153.96 ± 13.55	160.96 ± 16.98	0.04*
Non-Throwing Arm			
Internal Rotation (NDIR)	61.57 ± 10.69	63.10 ± 14.65	0.32
External Rotation (NDER)	94.00 ± 17.13	92.82 ± 13.24	0.38
Total Motion Arc (NDTOT)	155.57 ± 23.28	155.92 ± 20.99	0.47

Values presented are mean ± *SD*.
* Significantly different from pre-stretching ($p \leq 0.05$).

with overhead throwers. Once this "balance" is disrupted, continued throwing at a competitive intensity can lead to stresses that begin the pathological cascade.[11] Whether the changes seen in the shoulders of overhead throwers are acquired or congenital, the throwing motion shifts the total arc of motion toward external rotation and diminishes internal rotation. Soft tissue adaptations that result can be addressed by consistent participation in a stretching program focused on internal rotation.[7] While the protocol used in the current study did not include joint mobilization, recent evidence suggests that non-angular (joint mobilizations) stretching can be effective in addressing internal rotation deficits.[17] Cools et al reported that joint mobilization could be as effective as angular stretching exercises to address GIRD.[17] One might conclude, based on the study cited above and those already mentioned, that GIRD can be the result of adaptive changes in contractile tissue, non-contractile soft tissue, and bony anomalies that are likely congenital. It is possible that no matter the source of the internal rotation deficit, regular stretching may be beneficial to any athlete who throws overhead. Also important to consider is the fact that even those in the current study who did not exhibit GIRD did exhibit improvements in range of motion. If one accepts the idea of a progressive cascade leading to shoulder pathology, stretching those who perform the act of throwing overhead, whether GIRD is present or not, might be a effective preventative intervention.

The current study, like previous studies of professional overhead throwing athletes,[7] supports the implementation of a daily stretching program. The results of the current study demonstrated that this stretching protocol has the ability to increase shoulder internal rotation and total motion arc in the throwing shoulder of collegiate baseball players. Such a program can facilitate increases in internal rotation passive range of motion, and may promote posterior glenohumeral capsular and posterior rotator cuff length which could reduce lost performance time due to shoulder injury. During this 12-week stretching program the athletes experienced no shoulder injuries. It is possible that the stretching program positively contributed to this absence of injury.

The ability to generalize these results is limited due to the lack of a control group. Because these athletes were all interested in optimal performance, no "at risk" throwers were left untreated to measure whether the incidence of shoulder problems would have been greater without the stretching protocol. The authors of the current study were interested to see that no increases in ROM were seen in the non-throwing, non-stretched upper extremity. In this sense the athletes served as their on controls. While generalization of results may be somewhat limited due to lack of a true control group, this dominant to non-dominant comparison supports the conclusions drawn by the authors.

Future studies should include a control group for comparison and/or a group receiving joint mobilization of the glenohumeral and scapulothoracic articulations. The authors plan to continue this line of research longitudinally over the course of these subjects' playing careers to assess the long term effects of a comprehensive stretching program.

CONCLUSION

Implementation of a posterior capsule stretching program may be helpful to facilitate an increase in passive internal rotation range of motion in the dominant (throwing) shoulder of collegiate baseball players. Such a stretching program may be useful as a means of reducing innings lost due to injury in collegiate baseball players. Further research should be performed using a control group not receiving the stretching program in order to more effectively evaluate the impact of a comprehensive stretching program as a means of preventing GIRD related shoulder pathology in overhead throwing athletes.

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