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original research

The Acute Effects of Sleeper Stretches on Shoulder Range of Motion

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Context: The deceleration phase of the throwing motion creates large distraction forces at the shoulder, which may result in posterior shoulder tightness and ensuing alterations in shoulder range of motion (ROM) and may result in an increased risk of shoulder injury. Researchers have hypothesized that various stretching options increase this motion, but few data on the effectiveness of treating such tightness are available.

Objective: To evaluate the acute effects of "sleeper stretches" on shoulder ROM.

Design: Descriptive with repeated measures.

Setting: Biomechanics laboratory and 2 separate collegiate athletic training facilities.

Patients or Other Participants: Thirty-three National Collegiate Athletic Association Division I baseball players (15 pitchers, 18 position players; age = 19.8 ± 1.3 years, height = 184.7 ± 6.4 cm, mass = 84.8 ± 7.7 kg) and 33 physically active male college students (age = 20.1 ± 0.6 years, height = 179.6 ± 6.6 cm, mass = 83.4 ± 11.3 kg) who reported no recent participation (within 5 years) in overhead athletic activities.

Intervention(s): Range-of-motion measurements of the dominant shoulder were assessed before and after completion of 3 sets of 30-second passive sleeper stretches among the baseball players. The ROM measurements in the nonthrower group were taken using identical methods as those in the baseball group, but this group did not perform any stretch or movement between measurements.

Main Outcome Measure(s): Internal and external glenohumeral rotation ROM and posterior shoulder motion (glenohumeral horizontal adduction).

Results: In the baseball group, posterior shoulder tightness, internal rotation ROM, and external rotation ROM were −3.5° ± 7.7°, 43.8° ± 9.5°, and 118.6° ± 10.9°, respectively, before the stretches and were −1.2° ± 8.8°, 46.9° ± 9.8°, and 119.2° ± 11.0°, respectively, after the stretches. These data revealed increases in posterior shoulder motion ($P = .01$, effect size = 0.30) and in internal shoulder rotation ($P = .003$, effect size = 0.32) after application of the stretches. No other differences were observed in the baseball group, and no differences were noted in the nonthrower group.

Conclusions: Based on our results, the sleeper stretches produced a statistically significant acute increase in posterior shoulder flexibility. However, this change in motion may not be clinically significant.

Key Words: flexibility, soft tissue, throwing athletes

Key Points

- Sleeper stretches acutely increased posterior shoulder motion and internal shoulder rotation in the dominant arm of baseball players.
- External shoulder rotation was not different after the stretches.
- The statistically significant acute increases in shoulder range of motion may be clinically insignificant.

Researchers[1–7] have extensively examined alterations in the range of motion (ROM) of the dominant shoulder of throwing athletes, such as decreased internal rotation, increased external rotation, and increased posterior shoulder tightness (limited glenohumeral [GH] horizontal adduction). Such alterations have been linked empirically to bony[8–12] and soft tissue[13,14] adaptations that result from the large rotational and distractive forces acting on the GH joint during the throwing motion.[15–18]

Bony adaptations among throwing athletes often appear as increased humeral retroversion. This increase has been reported to decrease shoulder internal rotation[11,12] and increase external rotation,[9–12] leaving the total arc of motion (sum of total internal and external rotation)[19] relatively unchanged.[8,12] Furthermore, investigators[20,21] have hypothesized that the deceleration phase of the throwing motion is a major contributor to the development of posterior shoulder soft tissue tightness, resulting in alterations of shoulder ROM similar to those of bony adaptations. As the humerus internally rotates during the follow-through phase of the throwing motion, the posterior inferior capsule may be placed in a primary location to resist the deceleration forces, becoming a direct restraint against these loads.[20] Accumulation of such forces may result in tightness of the posterior capsule and other dynamic restraints (posterior deltoid, infraspinatus, teres minor, and latissimus dorsi), which causes altered ROM.[20,21]

Because throwing athletes often endure large forces and large numbers of repetitions, such athletes routinely participate in a variety of shoulder stretching exercises before and after a bout of throwing. They use these stretches to attempt to lengthen soft tissue restraints so that they can increase throwing velocity and control and can limit the incidence of injury and muscle soreness. Techniques typically involve both passive and ballistic stretches in several directions, such as internal and external rotation, flexion, extension, and horizontal adduction. Recently, clinicians and athletes have adopted a new stretch to isolate the soft tissue of the posterior aspect of the shoulder. This technique is known as a "sleeper stretch" because it is applied in the side-lying position. To perform the sleeper stretch, scapular movement is restricted, and then the shoulder is internally rotated to isolate the posterior soft tissue restraints.

Although the use of sleeper stretches is commonplace among throwing athletes, no data that detail the acute effects of this stretching technique are available. Therefore, the purpose of our study was to report the acute effects of sleeper stretches on posterior and rotational shoulder ROM.

METHODS

Participants

Participants included 33 National Collegiate Athletic Association (NCAA) Division I baseball players (15 pitchers, 18 position players; age = 19.8 ± 1.3 years, height = 184.7 ± 6.4 cm, mass = 84.8 ± 7.7 kg) and 33 physically active male college students (age = 20.1 ± 0.6 years, height = 179.6 ± 6.6 cm, mass = 83.4 ± 11.3 kg) who reported no recent participation (within 5 years) in overhead athletic activities. Physical activity in the nonthrower group was defined as regular participation in a lower extremity physical activity for a minimum of 3 days per week for at least 20 minutes each day. No participant reported a recent history (within 2 years) of upper extremity injury or any previous upper extremity surgeries.

Instrumentation

We used the Pro 3600 Digital Inclinometer (SPI-Tronic, Garden Grove, CA) to measure GH horizontal adduction motion and internal and external shoulder rotation motion. This device provides a real-time digital reading of angles with respect to either a horizontal or vertical reference and is accurate up to 0.1°, as reported by the manufacturer. The digital inclinometer was modified with a reference line positioned along the midline of the device, which was used for proper alignment of anatomic landmarks (Figure 1).

Procedures

All participants attended 1 testing session. Data for the baseball group were collected in the athletic training facilities of 2 separate NCAA Division I universities, while the data for the nonthrower group were collected in the biomechanics laboratory of a university. Before participation, each volunteer provided informed consent. The university institutional review board approved the study.

We examined the GH horizontal adduction and the internal and external rotation ROM in the dominant arm of each participant. The ROM measurements in the baseball group were taken before and after completion of the sleeper stretch. The ROM measurements in the nonthrower group were taken using identical methods as those in the baseball group, but this group did not perform any stretch or movement between measurements.

Figure 1. Measurement of glenohumeral joint internal rotation range of motion with scapular stabilization and alignment of the inclinometer.

Glenohumeral Horizontal Adduction Measurement

To assess GH horizontal adduction, we placed participants in a supine position with both shoulders flush against a standard examination table. The tester stood at the head of the examination table toward the head of the participant and positioned the test shoulder and elbow into 90° of abduction and flexion, respectively. The tester stabilized the lateral border of the scapula by providing a posteriorly directed force (toward the examination table) to limit scapular protraction, rotation, and abduction motions. The tester's other hand then held the proximal portion of the participant's forearm slightly distal to the elbow and passively moved the humerus into horizontal adduction. At the end range of horizontal adduction, a second tester recorded the amount of motion present. To measure GH horizontal adduction, the digital inclinometer was aligned with the ventral midline of the humerus. The angle created by the end position of the humerus with respect to 0° of horizontal adduction (perpendicular plane to the examination table, as determined by the digital inclinometer) (Figure 2) then was recorded as the total amount of GH horizontal adduction motion.

We assessed a priori reliability and validity of the posterior shoulder ROM measurement. We measured 24 shoulders without previous injury or surgery using an intraclass correlation coefficient (ICC) (2,k) formula.[21] Each participant's ROM was measured and reassessed a minimum of 48 hours later. The ICC and standard error of measurement (SEM) values for posterior shoulder tightness were 0.93 and 1.6°, respectively. Furthermore, the validity of this method was shown to have a moderate to good linear relationship between posterior shoulder motion and internal shoulder rotation motion ($r = .72$, $P = .001$).

Shoulder Internal-External Rotation Measurement

To measure internal shoulder rotation, the examiner positioned the participant supine with the shoulder and elbow in 90° of abduction and flexion and with the humerus supported to ensure a neutral horizontal position (humerus level with acromion process). With 1 hand, the

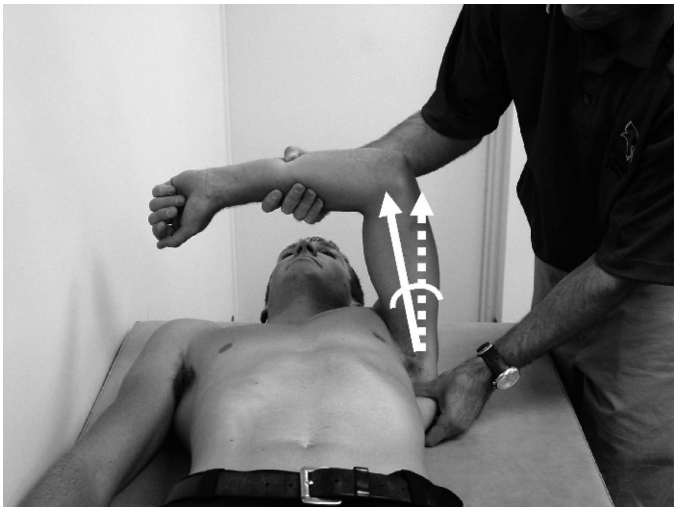

Figure 2. Angle created by the end position of the humerus with respect to the starting position (perpendicular plane to the examination table) to measure posterior shoulder motion.

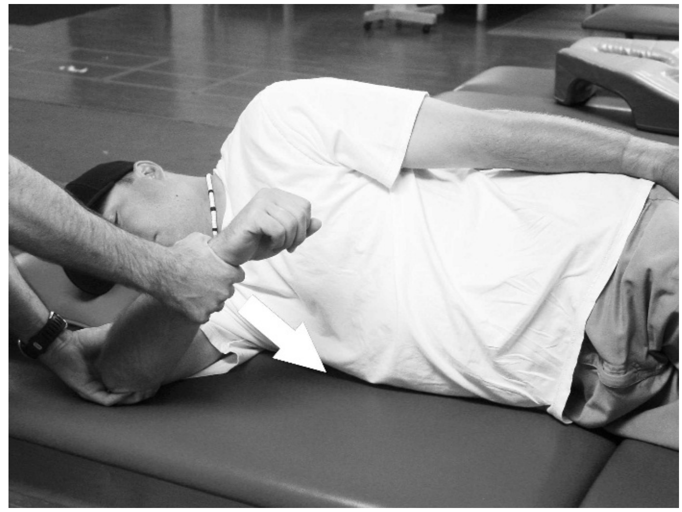

Figure 3. Sleeper stretch performed in side-lying position with passive internal rotation.

examiner passively internally rotated the humerus, and, with the other hand, he stabilized the scapula by applying pressure to the anterior acromion[22] until termination of humeral rotation (Figure 1). At this position, the digital inclinometer was aligned with the ulna (using the olecranon process and the ulnar styloid for reference),[23] providing an angle between the forearm and a perpendicular plane to the examination table. Next, this process was repeated for external rotation measurements.

We assessed a priori intratester reliability of the rotational measurements. Twenty shoulders without any previous injury or surgery were measured using an ICC (2,k) formula. Each participant's rotation motion was measured and then reassessed approximately 24 hours later. The ICC and SEM values for external and internal rotational motion were 0.95 and 3° and 0.98 and 2°, respectively.

Sleeper Stretches

The primary investigator (K.G.L.) applied sleeper stretches to the baseball players who were in the side-lying position on the dominant side. Participants' shoulders and elbows were positioned into 90° of flexion with the lateral border of the scapula positioned firmly against the treatment table. Next, the investigator passively internally rotated each participant's shoulder by grasping the distal forearm and moving the arm toward the treatment table (Figure 3). Pressure was held constant at the end ROM for 30 seconds and then repeated twice with 30 seconds' rest between stretching episodes.

Data Analysis

We used separate repeated-measures analyses of variance (ANOVAs) to test whether a difference existed in shoulder ROM within both groups. The α level was set at .05. To compare the sensitivity of change in shoulder ROM, effect sizes were calculated for differences. Effect size was calculated as (posttest mean – pretest mean) / SD. We used SPSS (version 11.5; SPSS Inc, Chicago, IL) to analyze the data.

RESULTS

The baseball group had increases of 2.3° in posterior shoulder motion (P = .01, effect size = 0.30) and 3.1° in internal rotation (P = .003, effect size = 0.32) after application of the sleeper stretches (Table 1). No difference was found in the baseball group for external rotation after the stretch (Table 1) or in the nonthrower group for any of the measurements (Table 2).

DISCUSSION

Athletes who participate in overhead activities requiring ballistic shoulder rotation, such as baseball, softball, tennis, and volleyball, routinely present with posterior shoulder tightness. Therefore, an easy, applicable, and specific stretching technique for lengthening soft tissues in the posterior aspect of the shoulder is essential to ensure proper shoulder ROM, kinematics, and kinetics and to rehabilitate athletes with disorders associated with this tightness. The results of our study demonstrate that the sleeper stretch results in statistically significant acute increases in GH internal rotation and posterior shoulder motion. However, these changes may be clinically insignificant.

Research and clinical observations[20,25,26] have shown that posterior shoulder tightness results in various kinematic alterations, such as decreased shoulder internal rotation, horizontal adduction, abduction, and flexion and increased external rotation. Because of the vulnerability of the shoulder during repetitive overhead motions, such as throwing, even small changes in ROM may lead to soft tissue microtrauma and ensuing shoulder lesions.[27] Lesions that recently have been associated with posterior shoulder tightness include subacromial impingement,[27–29] superior labrum anterior-posterior lesions,[14,20] and internal impingement.[2]

Despite the recognized importance of maintaining shoulder flexibility in the throwing athlete, very few data detailing the effectiveness of specific stretches that clinicians and athletes use are available. Johansen et al[30] described a stretching technique that was similar to the sleeper stretches used in our study. For this stretch, athletes lie prone with 90° of shoulder abduction and elbow flexion and full forearm pronation. The inferior angle of the

Table 1. Pretest and Posttest Range of Motion for the Baseball Group

Measurement	Pretest, °	Posttest, °	Difference, °	*P* Value
Internal rotation	43.8 ± 9.5	46.9 ± 9.8[a]	+3.1	.003
External rotation	118.6 ± 10.9	119.2 ± 11.0	+0.6	.17
Posterior shoulder	−3.5 ± 7.7	−1.2 ± 8.8[a]	+2.3	.01

[a] Increase in motion compared with pretest measurement ($P < .05$).

scapula then is stabilized against the thorax, while maintaining scapular retraction, and an examiner applies a passive shoulder internal rotation motion. The authors believed that this stretch would assist in isolating the posterior GH capsule and rotator cuff.

Wilk et al[19] described a stretching technique for the posterior aspect of the shoulder that involves positioning and movements that are similar to the posterior shoulder measurements used in our study. For this stretch, the athlete lies supine with the scapula stabilized against the treatment table, and the examiner applies a passive stretch by horizontally adducting the humerus. Although no data describing the effectiveness of these 2 stretching techniques have been provided, clinicians and athletes routinely perform these stretches to prevent and rehabilitate numerous shoulder disorders. One disadvantage of these stretches is that they both require assistance.

To ensure a similar application force among participants in our study, a clinician applied the passive sleeper stretches. However, such stretches are easily administered without assistance. Athletes and clinicians may be inclined to stretch the posterior aspect of the shoulder by simply performing cross-body adduction. However, the side-lying position enables stabilization of the scapula against the upper body and the treatment surface, thereby enabling more isolation of the posterior GH joint. We recommend performing both cross-body adduction and sleeper stretch to target both the scapulothoracic and GH articulations. The sleeper stretch also may be modified to enable increased horizontal adduction with internal rotation by elevating the humerus off the table with a folded towel placed under the posterior distal humerus or with the athlete's body rotated forward. This increased horizontal adduction is hypothesized to increase the stress placed on the posterior shoulder structures.

The baseball players in our study were tested before the beginning of the collegiate season and, therefore, may not have acquired the adaptive tightness that often results from repeated throwing over the course of a season. This may help explain why, although statistically significant, the improvements in internal rotation and posterior shoulder tightness (3.1° and 2.3°, respectively) appeared clinically insignificant. Furthermore, these results are based on an acute lengthening of the soft tissue. Investigators[31,32] have reported increased elongation after repeated stretches compared with 1 stretch. Conversely, McClure et al[33] found no increase in shoulder internal rotation ROM after a 4-week intervention using the sleeper stretches. However, they did not measure GH horizontal adduction during this study, and the insignificant findings for GH internal rotation may have been affected by sleeper stretches being applied by each participant without supervision. Furthermore, these authors performed their measurements on separate days, which may have resulted in lower precision of measurement. Regardless, the conflicting results of these studies add to the confusion concerning the best stretching intervention for such athletes.

Although large, clinically significant increases in acute internal rotation and posterior shoulder tightness were not noted in the participants who underwent sleeper stretches in our study, this technique may be important in limiting the amount of ROM that these athletes routinely lose during the baseball season. Future researchers should address whether such minor increases in ROM have any effect on performance and injury prevention.

We acknowledge a few limitations in our study design. Our sample size was relatively small, resulting in a power of 59.1 based on the mean difference and SD for shoulder internal rotation. A power analysis revealed that 58 participants per group would have been required to obtain a power of 0.8. As such, the clinically insignificant findings may have been a characteristic of the insufficient sample size. Other athletes whose sports require different biomechanics and forces on the shoulder or who present with pathologic symptoms may have results that are different from those that we reported. Future investigators should focus on measuring posterior shoulder motion in a variety of populations, including baseball players of various performance levels and ages, other overhead athletes, nonathletic populations, and individuals with various shoulder disorders. Finally, an experienced clinician applied the stretches to the participants. As stated, the athlete can independently apply these stretches and may produce results that are different from those of our study. Therefore, clinicians should teach their patients and athletes proper motion, stabilization, and force application for optimal benefits.

CONCLUSIONS

Our study provides insight into the effectiveness of sleeper stretches for acutely increasing shoulder ROM. More specifically, this stretch resulted in significant increases in internal shoulder rotation and posterior shoulder ROM in the dominant arm of baseball players,

Table 2. Pretest and Posttest Range of Motion for the Nonthrower Group

Measurement	Pretest, °	Posttest, °	Difference, °	*P* Value
Internal rotation	43.1 ± 7.9	42.7 ± 7.9	−0.4	.62
External rotation	99.4 ± 9.1	99.1 ± 9.4	−0.3	.69
Posterior shoulder	22.0 ± 7.1	22.2 ± 6.3	+0.2	.79

but it may have produced insignificant clinical changes. Because of the large forces and repetition of the throwing motion, posterior shoulder tightness is a common trait in baseball players. This stretching technique may prevent or limit tightness that is commonly experienced during the competitive season. However, our results cannot confirm that the sleeper stretch produces large, acute increases in shoulder ROM.

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