Patterns of Shoulder Flexibility Among College Baseball Players

Lisa Johnson

ABSTRACT: In this study, I investigated and analyzed the various joint motions in the shoulders of college baseball players. Twenty-six players (age= 20.38±1.36 yr) from two colleges were examined for upper extremity range of motion (ROM), including shoulder flexion, extension, internal rotation at 90° abduction, and external rotation at 90° abduction. Joint motions were measured using a JAMAR®, six-inch, double-arm goniometer. Pitchers demonstrated 22° more shoulder flexion and 21° more external rotation at 90° abduction than infield position players, and 17° more shoulder flexion than outfield position players. There was no significant difference between the dominant arm flexibility of infield and outfield position players. When comparing the dominant to nondominant arm relative to the position, infield position players demonstrated 5° less shoulder flexion and 6° more external rotation on the dominant side at 90° abduction. Pitchers did not demonstrate any significant difference between the dominant and nondominant arm. There was, however, an indication that pitchers had a tendency to exhibit greater flexibility during flexion and external rotation at 90° abduction in the dominant side than in the nondominant side.

The baseball player, as a throwing athlete, subjects the shoulder to various degrees of physical stress. From the time that the ball is taken from the glove to the point at which the follow-through ends, the shoulder is maneuvered through varying positions and placed under varying degrees of stress (3,4,6,9,10). The shoulder adapts to these demands by developing physical characteristics that lead to alterations in the range of motion (3,4,6,7).

There is a correlation between an athlete's shoulder joint mobility and the performance of a pitch (3,9,11). The act of throwing involves multiple muscle groups and the interaction of tendons, muscles, and bones (3). A flexible joint allows the muscles to work with each other, rather than against one another, which allows the ball to reach its destination with greater accuracy and speed (3,9,11). If flexibility is not emphasized and accomplished in a regular conditioning program, the pitch will be affected, and the athlete's risk of injury will be increased (1,3,10). If the typical range of motion (ROM) of the throwing shoulder is known, it can be used to help determine conditions that may predispose the athlete to injury or diminished performance.

In this study, we examined the ROM of the movements necessary to throw a baseball—shoulder flexion, extension, internal rotation at 90° abduction, and external rotation at 90° abduction.

Methods

Thirty-two college baseball players from Eastern Mennonite College (EMC) and James Madison University (JMU), both in Harrisonburg, VA, volunteered for upper extremity ROM testing. The flexibility exercises used by each team were similar (based on my observation). Athletes who indicated having current injuries or who played more than one position were excluded from this study. Thus, 26 healthy baseball players were chosen for testing (11 from EMC, 15 from JMU; age=20.4 ± 1.4 yr; ht=71.5 ± 2.2 in; wt=175.5 ± 17.5 lb; position: infield=8, outfield=9, pitchers=9; throwing arm: R=23, L=3; years involved in baseball=12.9 ± 1.4 yr).

Using the standard technique developed by Norkin and White (8), passive bilateral upper extremity ROM was measured with a JAMAR®(Clifton, NJ), six-inch, double arm goniometer during extension, internal rotation at 90° abduction, and external rotation at 90° abduction. A variation of the standard technique was used to measure shoulder flexion.

The standard technique for the evaluation of shoulder flexion was altered in order to study the functional ability of the

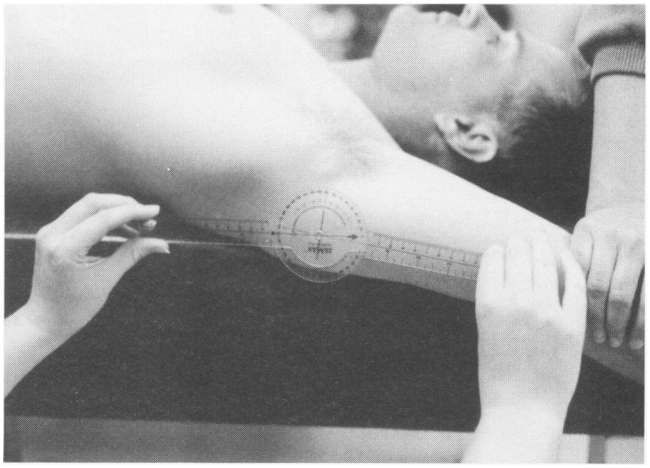

Fig 1.—Altered technique for measuring shoulder flexion range of motion

Lisa Johnson is a health science and athletic training major at James Madison University in Harrisonburg, VA.

shoulder complex. The subject was placed in a supine position with the knees flexed and the shoulder over the edge of the supporting surface. This method increased the ROM allowing scapulothoracic, sternoclavicular, and acromioclavicular motion to occur with glenohumoral motion (8). The stationary arm of the goniometer then was aligned with the mid-axillary line of the thorax. The arm was moved through its range of motion, and the moving arm of the goniometer was aligned with the lateral midline of the humerus (Fig 1).

One-way analysis of variance (ANOVA) and Scheffé post hoc tests were used to compare differences between positions of the dominant arm measurements. Paired t-tests were used to compare differences between the measurements of the dominant arm and measurements of the nondominant arm of subjects within the given positions.

Results

Means and standard deviations for total ROM in the various groups and arms (dominant and nondominant) are outlined in the Table. Infielders demonstrated 6° more external rotation at 90° abduction [t(8)=-1.95, p=.04] and 5° more shoulder flexion [t(8)=2.90, p=.01] on the dominant side than on the nondominant side.

Pitchers did not demonstrate any significant difference between the dominant and nondominant sides. There was, however, an indication that pitchers had a tendency to exhibit greater flexibility during flexion [t(9)=1.76, p=.06] and during external rotation at 90° abduction [t(9)=1.67, p=.06] on the dominant side than on the nondominant side. No significant differences were found between the dominant and nondominant arms of outfielders (internal rotation [t(9)=.02, p=.50]; external rotation [t(9)=-1.11, p=.15]; flexion [t(9)=1.12, p=.15]; extension [t(9)=-0.09, p=.46]).

Pitchers exhibited greater dominant arm ROM than infield and outfield position players. Pitchers demonstrated 22° more shoulder flexion [F(2,23)=12.65, p=.0004, Scheffé p=.001] than infielders, and 17° more flexion [Scheffé p=.005] than outfielders. Pitchers also demonstrated 21° more external rotation during abduction than infielders [F(2,23)=5.16, p=.02, Scheffé p=.02] and 16° more than outfielders (Scheffé p=.069). No other comparisons between positions were significant [Scheffé>.50 & F(2,23)<.54, p>.60].

Dominant Versus Nondominant Shoulder Range of Motion (degrees; mean ± SD)

	Flexion	Extension	Internal Rotation (90° Abduction)	External Rotation (90° Abduction)
Pitcher				
Dominant	209±10.7[bc]	96±10.0	111±15.2	136±14.6[bd]
Nondominant	202± 6.6	98±12.2	116±12.2	128±12.9
Infield Player				
Dominant	187±10.1[ab]	92±21.2	110±11.8	115±5.8[ab]
Nondominant	192±10.3[a]	87±16.6	114±11.9	109±7.8[a]
Outfield Player				
Dominant	192±7.2[c]	90±8.7	106±12.8	120±19.2[d]
Nondominant	195±6.5	90±9.1	106±10.6	114± 8.0

a. Dominant and nondominant arms difference (p<.05)
b. Pitchers' dominant arms greater than infield players' arms (p<.05)
c. Pitchers' dominant arms greater than outfield players' arms (p<.05)
d. Pitchers' dominant arms may be greater than outfield players' arms (p=.07)

Discussion

Dominant Versus Nondominant Arm

External rotation of the shoulder at 90° abduction. The examination of throwing mechanics may help explain the increase in external rotation found in the dominant arms of infield position players in this study. In the cocking phase of throwing, the shoulder is maximally externally rotated with the arm at 90° abduction (Fig 2) (3,10). Researchers who have studied the external rotation of the shoulder have found a significant difference between the dominant and nondominant arms of throwing athletes (3,4,10). During film analysis of 15 major league pitchers, a mean external rotation of 160° was measured (10). The exact contribution of the total amount of trunk extension and joint movement of the scapulothoracic and glenohumoral joints was not determined (10).

Fig 2.—Cocking phase of throwing (Note the external rotation of the arm.)

Other investigators, such as Brown, et al. (4), have studied the external rotation of the shoulder among major league players with the shoulder in two positions: 0° abduction and 90° abduction. These researchers found a significant difference between the dominant and nondominant arm when the arm was at 90° abduction, but not at 0° abduction (4). Because of the difference in the measurements at 0° and 90°, they assumed that the difference in external rotation at 90° abduction was an adaptation to throwing mechanics (4). This specific alteration of increased external rotation is believed to be a requirement for throwing a baseball successfully (11).

In this study, the absence of a difference in external rotation at 90° abduction between the dominant and nondominant arms of pitchers may be related to past injuries. Although the subjects were healthy, the physical histories of several individuals indicated that previous injuries had occurred to the arm and/or shoulder.

These injuries could have altered the anatomy of the shoulder and arm, or the throwing mechanism itself, which may affect external rotation as indicated by Andrews and Gillogy (3).

In contrast, Brown, et al (4) found a significant difference in external rotation among pitchers, which indicated that pitchers had greater external rotation in the dominant arm. Although this study made an effort not to include athletes with current upper extremity injuries from the analysis, no notation was made about whether any previous pathological problems existed (4).

Brown et al (4) also found a significant difference in external rotation in position players. However, they did not define "position players," or the number of infielders and outfielders that they studied. Therefore, no assumption can be made about whether the differences between the present study and the study by Brown et al (4) are comparable.

Shoulder Flexion. Differences in shoulder flexion in the dominant side of infield position players could be attributed to incomplete use of full range of motion by the infield player, based on current research (4). In players who do not use their range of motion to their full extent, unilateral tightness of the pectoralis major and latissimus dorsi may be present, which adds to the significant decrease in motion (4). A specific example of this phenomenon can be found in infielders who throw short distances with little follow-through.

The tendency of pitchers to demonstrate greater flexion in the dominant arm compared to the nondominant arm conflicts with literature on the subject. Investigators, such as Brown et al (4) found that flexion in the dominant arm was much less than in the nondominant arm. Further research will be necessary to clarify the discrepancy between these studies.

The difference in results could be attributed to the mechanism of throwing and to the testing method used by the experimenter. A study of professional versus amateur pitchers indicated that amateur pitchers use all of the rotator cuff muscles of the shoulder; therefore, they use less lateral trunk flexion and more shoulder rotation (5). Reduced lateral trunk flexion is indicative of pitchers who throw side arm (10). The tendency toward greater shoulder flexion among pitchers in the present study may be an indication that these pitchers use a different throwing technique, one in which the shoulder joint rotates through its full range of motion.

The measuring technique may have affected the results, also. The technique chosen by Brown et al. (4) was set by the American Academy of Orthopaedic Surgeons, which does not measure the functional ROM of the shoulder. The method used in this study allows full ROM, and may give a clearer indication about the functional ability of the throwing shoulder.

Internal rotation of the shoulder at 90° abduction. When measuring internal rotation, other investigators found a significant difference between the dominant and nondominant sides of major league pitchers (2,4,10). This was not true in the current study. This may be an indication of preexisting pathological conditions, which cause an alteration of the follow-through among some collegiate pitchers (3). Previous injuries may have led to anatomical differences or muscle selection during throwing (5).

Dominant Arm: Pitchers Versus Infielders and Outfielders

Shoulder Flexion. One would expect to find a greater difference in shoulder flexion between pitchers and other players because of repetitive throwing by pitchers, which produces alteration in shoulder ROM (3,4). The greater shoulder flexion among pitchers when compared to infield and outfield position players in the current study can be explained by the mechanics of throwing and the degree of ball handling by the athlete.

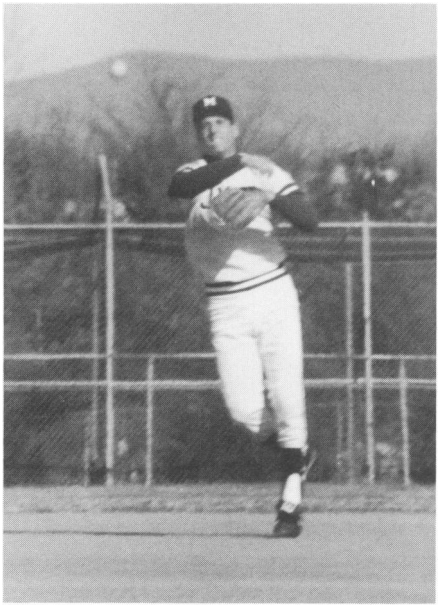

Fig 3.—When throwing to first base, a shortstop uses less trunk flexion and more glenohumeral movement than a pitcher does when pitching to home plate.

In pitching, the athlete uses complex body movements to throw the ball across the plate. When the ball is released, the arm position relative to the head is determined by trunk flexion (6,10). If a pitcher's movement is compared to that of a shortstop making a play at first base, one would find that the infielder is using more glenohumoral movement than trunk flexion (Fig 3). This throw may not be as controlled as the pitcher's throw. Unlike the pitcher, an infielder may not begin and end his or her throw in the same manner every time (1).

The amount of ball handling also must be considered in order to assess the differences between a pitcher and infielder. Neither infield nor outfield position players were involved in repetitive throwing, therefore no differences were indicated between infield and outfield position players.

External rotation of the shoulder at 90° abduction. The greater external rotation at 90° abduction among pitchers when compared to that of infield position players may be attributed to the influences of repetitive throwing described previously. Also, other studies have indicated that pitchers possess greater flexibility in the dominant arm in comparison to other players, because the arm is fully cocked in order to impart the greatest force on the ball (4,10). One also may conclude that this action might contribute to the tendency toward greater external rotation at 90° abduction in pitchers than in outfielders.

Conclusion

The results of this study indicate that increases and decreases in ROM may occur in the shoulder complex as a result of throwing. Evidence suggests that alterations in the mechanism of throwing can lead to a difference in ROM between pitchers and other players. Because proper flexibility may enhance performance and minimize potential for injury, athletic trainers, coaches, and athletes can use this study as a baseline for preparticipation screening and as objective evidence of potential injury risk.

Acknowledgements

Thanks to Craig Mackail, Herb Amato, Johanna Sowder, Wendy Crump, and Dr. Jean Dalton for their help and encouragement with this study. I also thank the coaching staff and players of the James Madison University and Eastern Mennonite College baseball teams for their participation in this study. A special thanks to Becky Salter, Susan Detwiler, and Heather Watts for their assistance with the photography and graphics.

References

1. Amato H. Sports medicine: managing injuries. In: Kindall J, ed. *Science of Coaching Baseball.* Champaign: Human Kinetics Publishers; 1991: 125-154.
2. American Academy of Orthopaedic Surgeons. *Joint Motion Method of Measuring and Recording.* Chicago: AAOS; 1965: 10-43.
3. Andrews JR, Gillogy S. Physical examination of the shoulder in throwing athletes. In: Zarins B, Andrews JR, Larson WG: *Injuries to the Throwing Arm.* Philadelphia: WB Saunders; 1985: 51-52.
4. Brown L, Niehues S, Harrah A, Brown LP, Niehues SL, Harrah A, Yavorsky P, Hirshman HP. Upper extremity range of motion and isokinetic strength of the internal and external shoulder rotators in major league baseball players. *Am J Sports Med.* 1988; 16:577-585.
5. Gowan I, Jobe FW, Tibone J, Gowan ID, Jobe FW, Tibone JE, Perry J, Moynes DR. A comparative electromyographic analysis of the shoulder during pitching. Professional versus amateur players. *Am J Sports Med.* 1987; 15:586-590.
6. Jobe FW, Moynes DR, Tibone JE, Perry J. An EMG analysis of the shoulder in pitching. A second report. *Am J Sports Med.* 1984; 12:218-220.
7. Jobe FW, Tibone JE, Perry J, Moynes DR. An EMG analysis of the shoulder in pitching. A preliminary report. *Am J Sports Med.* 1983; 11:3-5.
8. Norkin CC, and White DJ. *Measurement of Joint Motion: A Guide to Goniometry.* Philadelphia: FA Davis Company; 1985: 26-36.
9. Pappas AM, Zawacki RM, McCarthy CF. Rehabilitation of the pitching shoulder. *Am J Sports Medicine.* 1985; 13: 216-222.
10. Pappas AM, Zawacki RM, Sullivan TJ. Biomechanics of baseball pitching. A preliminary report. *Am J Sports Med.* 1985; 13:216-222.
11. Tullos HS, King JW. Throwing mechanism in sports. *Orthop Clinic North Am.* 1973; 4:709-720.

NATA's 43RD Annual Meeting & Clinical Symposium

★ ★ ★ ★

Clinical sessions and workshops include:

★ NACDA Seminar:
Anabolic Steroids and Drug Use by Athletes
Student Athletes at Risk: Developing an Effective Student Athlete Assistance Program

★ McNeil/Tylenol Symposium:
Transmission of Potentially Lethal Infectious Agents During Athletic Competition

★ Gatorade Workshop:
Teaching Athletes How to Eat to Compete

★ Clinical Sessions:
Sports-Related Injuries of the Low Back
Overuse and Stress-Related Injuries of the Throwing Arm
Professional Issues in Athletic Training
Functional Rehabilitation of the Injured Athlete
Legal Considerations in Sports Injury Management

★ PFATS Seminar ★ NCAA Seminar
★ Workshop on Medical and Scientific Publishing
★ NATA's Awards Luncheon
★ Student Athletic Trainer Banquet

and more.....

June 3 - 6, 1992
Colorado Convention Center
Denver, Colorado