



ORIGINAL ARTICLE

Lower shoulder abduction during throwing motion may cause forceful internal impingement and decreased anterior stability

Masaki Akeda, MD^{a,b}, Teruhisa Mihata, MD, PhD^c, Woong Kyo Jeong, MD, PhD^{b,d}, Michelle H. McGarry, MS^b, Tetsuya Yamazaki, MD^a, Thay Q. Lee, PhD^{a,b,e,*}

^aDepartment of Sports Orthopaedic Center, Yokohama Minami Kyosai Hospital, Yokohama, Japan

^bOrthopaedic Biomechanics Laboratory, Tibor Rubin VA Medical Center, Long Beach, CA, USA

^cDepartment of Orthopedic Surgery, Osaka Medical College, Takatsuki, Osaka, Japan

^dDepartment of Orthopaedic Surgery, College of Medicine, Korea University, Seoul, Republic of Korea

^eDepartment of Orthopaedic Surgery, University of California, Irvine, CA, USA

Background: Internal impingement and decreased anterior stability, which result from shoulder capsular loosening, are common shoulder pathologies in throwing athletes. The purpose of this study was to assess the effect of shoulder abduction angle on shoulder internal impingement and anterior shoulder stability during the simulated throwing motion.

Methods: Eight cadaveric shoulders were tested by simulating the late-cocking and acceleration phases of the throwing motion for intact and thrower's shoulder conditions. The maximal glenohumeral external rotation, anterior translation, location of the rotator cuff insertion with respect to the glenoid, length and site of internal impingement, and glenohumeral contact pressure were measured. All data were compared between shoulder abduction angles of 80°, 90°, and 100°.

Results: Decreasing shoulder abduction in the simulated late-cocking phase shifted the humeral head posteriorly ($P < .03$) and superiorly ($P < .001$), decreasing the total internal impingement area between the greater tuberosity and glenoid ($P = .04$) and increasing the glenohumeral contact pressure during internal impingement ($P = .02$). In the simulated acceleration phase, anterior glenohumeral translation significantly increased as the shoulder abduction angle decreased ($P < .001$).

Conclusion: Decreasing shoulder abduction significantly increased the contact pressure during internal impingement in the simulated late-cocking phase of the throwing motion. During the simulated acceleration phase of the throwing motion, anterior glenohumeral translation significantly increased as shoulder abduction decreased.

Level of evidence: Basic Science Study; Biomechanics

Published by Elsevier Inc. on behalf of Journal of Shoulder and Elbow Surgery Board of Trustees.

Keywords: Abduction angle; internal impingement; laxity; rotator cuff; throwing; contact pressure

*Reprint requests: Thay Q. Lee, PhD, Orthopaedic Biomechanics Laboratory, Tibor Rubin VA Medical Center (09/151), 5901 E Seventh St, Long Beach, CA 90822, USA.

E-mail address: tqlee@uci.edu (T.Q. Lee).

During internal impingement, the undersurfaces of the supraspinatus and infraspinatus tendons contact the posterosuperior glenoid when the shoulder is abducted and externally rotated. Increased repetition and intensity of contact during the late-cocking phase of the throwing motion are thought to cause injuries to the throwing shoulder, including labral and rotator cuff damage.^{4,10,11,16-18,21,22,36} Previous cadaveric studies have shown that excessive anterior capsular laxity²² and posterior capsular tightness¹⁷ increase the glenohumeral contact pressure during internal impingement. These results suggest that these capsular properties affect the severity of the internal impingement.

Anterior shoulder instability caused by dysfunction of the anterior capsular ligaments (eg, their repeated stretching during the throwing motion) or anterior labral or capsular tears due to traumatic anterior subluxation^{28,32} leads to disability of the throwing shoulder.^{12,13,19,22,31,32} A previous cadaveric study has shown that decreased glenohumeral abduction increases anterior translation through loosening of the anterior band of the inferior glenohumeral ligament, which is the primary static restraint to anterior force in the glenohumeral joint during the throwing motion.^{15,27} Therefore, the glenohumeral abduction angle may affect capsular laxity, thereby altering shoulder biomechanics and shoulder stability during throwing.

Our objective was to assess the effect of the shoulder abduction angle on shoulder internal impingement and anterior shoulder stability during the simulated throwing motion. Our hypothesis was that decreasing shoulder abduction increases the glenohumeral contact pressure during internal impingement in the simulated late-cocking position and increases anterior translation in the simulated acceleration position.

Materials and methods

Eight fresh-frozen cadaveric shoulders (1 female and 7 male specimens) from donors with an average age of 60.5 years (range, 36-76 years) at the time of death were thawed overnight at room temperature before dissection and experimentation. The shoulders were screened macroscopically and were free of signs of anatomic abnormality and pathologic change. Each specimen was dissected free of skin, subcutaneous tissue, and muscles and then placed in the shoulder testing system (Fig. 1). The capsule, coracoacromial ligament, deltoid tendon, pectoralis major tendon, latissimus dorsi tendon, and all rotator cuff tendons were preserved.

The scapula was fixed to a mounting plate using 3 screws to securely align the medial border of the scapula parallel to the plate. A rotatory saw was used to transect the humeral shaft 2 cm distal to the deltoid tuberosity; an aluminum rod inserted into the medullary canal of the humeral shaft was secured with several interlocking screws to avoid unintentional rotation of the humerus. The aluminum rod was mounted to a custom device that enabled axial rotation of the humerus and glenohumeral abduction and was attached to an arc that allowed controlled horizontal and vertical abduction. The neutral position of humeral external and internal rotation was referenced to anatomic landmarks on the basis of the anatomic

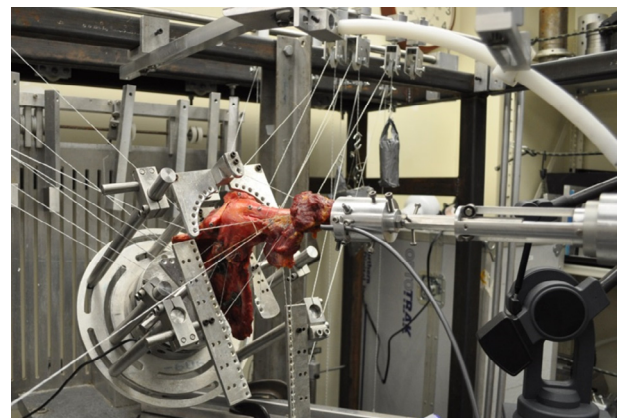


Figure 1 Shoulder testing system.

relationship between the bicipital groove and the anterolateral corner of the acromion, as established in previous studies.^{1,16-23,29,33}

Shoulder position

It is generally considered that throwers maintain 90° of shoulder abduction throughout the throwing motion^{7,30,34} and, in the late-cocking and acceleration phases of throwing, that the arm is in the coronal plane. To simulate this shoulder position, the scapular plate was mounted in 30° of scapulothoracic abduction in the vertical plane with the humerus parallel to the floor for 90° of shoulder abduction. The arc was locked in 30° of horizontal abduction, posterior to the scapular plane, to simulate the coronal plane. To assess the effect of shoulder abduction, we then chose to test in 100°, 90°, and 80° of shoulder abduction for both the acceleration position and the late-cocking position. For the acceleration position, 60° and 90° of external rotation were tested, and for the late-cocking position, 90° of external rotation and maximal external rotation were tested.²⁰

Muscle loading

Adjustable pulleys and fishing lines were tied to all tendons and used to create anatomic force vectors in each muscle. Proportional shoulder muscle forces in the late-cocking and acceleration phases were calculated by multiplying the maximal potential muscle force from the physiological cross-sectional area of each muscle by the shoulder muscle activity during throwing, as determined in previous studies.^{8,9,20} For the simulated late-cocking phase, the force applied to each muscle was 7 N for the supraspinatus, 30 N for the subscapularis, 20 N for the infraspinatus, 6 N for the teres minor, 10 N for the anterior and middle deltoids, 4 N for the posterior deltoid, 20 N for the pectoralis major, 12 N for the latissimus dorsi, and 2 N for the long head of the biceps. For the simulated acceleration phase, muscle loading was only applied to the rotator cuff as loading all muscles provided too much joint force to measure anterior glenohumeral translation. The force on the rotator cuff muscles was 8 N for the infraspinatus, 4 N for the teres minor, 7 N for the supraspinatus, and 30 N for the subscapularis.

Download English Version:

<https://daneshyari.com/en/article/8800820>

Download Persian Version:

<https://daneshyari.com/article/8800820>

[Daneshyari.com](https://daneshyari.com)