Effect of Posteroinferior Capsule Tightness on Subacromial Impingement during Pitching Motion

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INTRODUCTION:
Loss of internal rotation as well as excessive external rotation has been recognized as adaptive changes in baseball pitchers who continue to play baseball for a long period of time. Tightness of the posteroinferior capsule including the posterior band of the inferior glenohumeral ligament (PIGHL) is assumed to be a cause of this loss. Previously, the posterior capsule tightness was also speculated to lead to subacromial impingement during shoulder flexion and horizontal adduction (Harryman, 1990). Although intra-articular (internal) impingement during the pitching motion is well accepted, the relationship between the posterior capsule tightness and subacromial (external) impingement is unclear. The purpose of this study was to determine the effect of posteroinferior capsule tightness on contact pressure and area of the coracoacromial arch and humeral head during the pitching motion.

METHODS:
Eight fresh cadaveric glenohumeral joints were harvested and used for the study. Specimens with rotator cuff tears or radiographic evidence of acromial spurs and glenohumeral osteoarthritis were excluded. All tissues except the rotator cuff muscles and coracohumeral ligament were removed. The specimen was secured in a custom-designed shoulder experimental device which allows 6 degree-of-freedom motion of the glenohumeral joint.

Flexible tactile force sensors (K-SCAN model 4000; Tekscan Inc, South Boston, Mass) were utilized to measure the contact pressure and area on the undersurface of the acromion and coracoacromial ligament (Figure 1). Simultaneously, an electromagnetic tracking device (FASTRAK, Colchester, VT) and motion capture software (MotionMonitor, Innovative Sports Training, Chicago, IL) were used to measure the range of shoulder motion during the pitching motion. These were also used to digitize and animate the surfaces of the scapula and humeral head after measurement and disarticulation of the glenohumeral joint in order to observe the contact site of peak contact pressure on them from various angles.

The posteroinferior capsule tightness was simulated by plicating the capsule in the region from 6 to 8 o’clock in the right shoulder (4 to 6 o’clock in the left shoulder, Figure 2). The static testing positions in the study correlated to the early cocking, late cocking, acceleration, deceleration, and follow-through phases of the pitching motion. These positions were defined based on previous analyses of the pitching motion. In each phase, the forces applied through the rotator cuff muscles were based on the muscle’s cross-sectional areas and muscle activations during pitching. A paired t-test was used to compare all the parameters between the intact and posterior capsule tightness (tight) conditions.

RESULTS:
In 3, 6, and 5 of the all 8 specimens, the range of motion was restricted during the late cocking, deceleration, and follow-through phases, respectively. Internal rotation was restricted by 14° to 20° during the deceleration and follow-through phases, whereas external rotation was restricted little during the late cocking.

In the tight condition, the peak contact pressure during the follow-through phases was significantly higher than that in the intact condition (P<0.05), whereas there was no significant difference in the other phases (Figure 3). After plicating the posteroinferior capsule, the contact area on the coracoacromial arch during the follow-through phase was also higher than before the plication (P<0.001) (Figure 4). The contact site of peak contact pressure was on either of the acromion or coracoacromial ligament during the follow-through phase and changed little after the plication. For the humeral head, the peak contact pressure was also located on either of the greater and lesser tuberosity.

DISCUSSION:
Posteroinferior capsule tightness is a cause of internal rotation loss in baseball pitchers. In this study, plication of the posteroinferior capsule restricted internal rotation as suggested in previous studies (Burkhart, 2003; Meister, 2000).

Posteroinferior capsule tightness has been recognized as a factor which causes SLAP lesion in the late cocking phase (Burkhart, 2003) and subacromial impingement during the elevation motion (Meister, 2000). However, our findings demonstrate an increase in contact pressure and area on the subacromial arch during the follow-through phase. These findings could be explained by anterior translation of the humeral head with horizontal adduction due to posterior capsule tightness (Harryman, 1990) because shoulder was positioned in maximum internal rotation at 60 ° of horizontal adduction during this phase. Although internal impingement during the late cocking phase has been recognized to be a cause of injury of the rotator cuff and its surrounding tissues, posteroinferior capsule tightness could also lead to higher pressure on the coracoacromial arch and increase risk of injury in the rotator cuff and its surrounding tissues.

REFERENCES:
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