The Role of the Biceps Brachii in Overhead Throwing: A Biomechanical Study

INTRODUCTION:
The biceps brachii is a fusiform muscle typically thought of as an elbow flexor. However, further biomechanical testing has complicated its role at the glenohumeral joint, especially the long head (LHB). The LHB has been described as a humeral head depressor as well as a compression and as both an anterior and posterior stabilizer of the glenohumeral joint. In addition, it has been described as a constraint to external rotation and as a stress-shield to the inferior glenohumeral ligament in the abduction-external rotation position. The short head of the biceps (SHB) has not been studied as in-depth as the LHB. The objective of this study was to examine the roles of each individual head of the biceps and its effects in glenohumeral kinematics and contact characteristics in the throwing shoulder.

METHODS:
Eight human cadaveric shoulders were used for this study. All tissue was removed except for the tendinous insertions of the rotator cuff, deltoid, pectoralis major, latissimus dorsi and coracoacromial ligament. The LHB and SHB were transected at their proximal musculotendinous junctions and connected to a custom clamp on the humerus to permit loading of each head individually to simulate its natural line of pull. Each specimen was attached to a custom shoulder testing system. Two different muscle loading conditions were used for the rotator cuff, deltoid, pectoralis major and latissimus dorsi: late-cocking loads and deceleration loads based on electromyographic studies of throwing athletes. The LHB and SHB were loaded with increasing loads of 10-, 20-, and 40N each. For the late-cocking position, the shoulders were placed in 90° degrees of abduction in the scapular plane and maximum external rotation. To simulate the deceleration phase, the shoulder was placed at 90° degrees of abduction in the scapular plane and maximum internal rotation. To evaluate the role of the LHB, the LHB was unloaded, and to evaluate the role of the SHB, the SHB was unloaded. Range of motion and the humeral head apex (HHA) position were measured using a manual goniometer and a 3-D digitizing system, respectively for all positions and loading conditions. A Tekscan pressure sensor was then placed in the glenohumeral joint through an incision in the rotator interval to examine contact characteristics. Glenohumeral contact area, pressure and peak pressure were measured for all positions and loading conditions. Statistical analysis was performed using a paired t-test with Bonferroni correction. Significance was set at P < 0.05.

RESULTS:
In the late-cocking loads and position, loading the LHB decreased maximal external rotation and moved the humeral head apex (HHA) anteriorly. With deceleration loads and position, loading the LHB resulted in a significant decrease in maximal internal rotation, and the HHA moved posteriorly, inferiorly and medially. Contact data showed no difference in contact characteristics whether the LHB was loaded or unloaded in the late-cocking or deceleration positions.

In the late-cocking load and position, loading the SHB significantly moved the HHA superiorly and there was a trend towards moving the HHA posteriorly. There was a significant decrease in maximum external rotation and increase in peak pressure with the SHB loaded. In the deceleration load and position, loading the SHB tended to move the HHA posterior, inferior and medial; however, none of these values reached significance. Loading the SHB also decreased maximum internal rotation and increased both contact pressure and peak pressure.

DISCUSSION:
This study shows that loading the LHB and SHB has significant effects on glenohumeral kinematics and contact characteristics in the throwing shoulder. According to this study, unloading the LHB moves the humerus posteriorly during late-cocking, which may lead to higher rates of internal impingement and articular-sided partial thickness rotator cuff tears. While it did not reach significance, the SHB tended to act as a restraint to anterior translation of the humerus in both the late-cocking and deceleration positions. Our results showed that increased load on the SHB increased glenohumeral contact pressures and limited excessive rotation which appears to give the glenohumeral joint more stability.

SIGNIFICANCE:
Throwing athletes who undergo biceps tenodesis for superior labral lesions could have a higher incidence of partial-thickness articular-sided rotator cuff tears due to superior migration of the humeral head. The SHB appears to stabilize the glenohumeral joint by limiting excessive rotation and increasing compressive forces.

Custom Biceps Testing System

Effect of the Long Head of Biceps Brachii

Effect of the Short Head of Biceps Brachii