INTRODUCTION
Total shoulder arthroplasty (TSA) for conditions affecting the glenohumeral joint (GHJ) has proven to be successful in relieving pain and preserving range of motion. Yet, the longevity of TSA has not met with the success of arthroplasty in other joints such as the hip or knee, often due to glenoid failure. As posterior glenoid wear is a common finding in shoulders affected by osteoarthritis, it has been theorized that unappreciated, concentric reaming of the glenoid may result in a retroverted glenoid component and contribute to TSA failure. Furthermore, when posterior glenoid wear results in greater than twenty degrees of retroversion, many have advocated the technically demanding procedure of glenoid bone grafting. (1,2) To evaluate the importance of glenoid version, we evaluated the GHJ forces, contact pressures and areas in intact shoulders, and following total shoulder arthroplasty with the glenoid components placed in neutral and retroversion.

MATERIALS & METHODS
Eight fresh-frozen shoulders were sectioned at the mid-humerus and dissected free of skin, and subcutaneous tissue. The muscles and insertions of the rotator cuff, deltoit, pectoralis major and latissimus dorsi, were all preserved. For biomechanical testing, a custom shoulder testing system that permits anatomic loading of the muscles was used. (3) (Figure 1) Each individual muscle was loaded with computer controlled pneumatic cylinders, applying 60N of force to the supraspinatus, subscapularis and infraspinatus/teres minor, pectoralis major, and latissimus muscles while 120N was applied to the deltoid. Testing was performed in three separate positions under 3 separate major, and latissimus muscles while 120N was applied to the deltoid.

RESULTS
PlACEMENT OF THE GLENOID COMPONENT IN FIFTEEN DEGREES OF RETROVERSION

Glenohumeral abduction of 60 degrees and external rotation of 60 degrees was maintained throughout the test while glenohumeral horizontal adduction was varied to 0, 30 and 60 degrees with respect to the scapula plane. Each shoulder was tested intact (intact), after total shoulder arthroplasty with the components in neutral (neutral) and with the glenoid component retroverted 15 degrees (retroverted). TSA was performed using the Osteonics Howmedica prosthesis. Glenoid retroversion was controlled with a custom made shim which was cemented into the glenoid neck. The shim held the glenoid component in either neutral or 15 degrees of retroversion. Specimens were trialed at least four times in each position under each condition. Forces upon the glenoid were measured with a six degree-of-freedom load cell. Measured GHJ forces were resolved into anterior-posterior, superior-inferior and compressive components. GHJ contact pressures and areas were measured with Fuji pressure sensitive film inserted into the GHJ. Fuji super low film was used to analyze differences between the intact and arthroplasty groups while Fuji low film was used to analyze differences between the neutral and arthroplasty groups. The contact pressure images were then analyzed using NIH Image 1.62. Statistical analysis of force measurements, contact pressures and contact areas was performed with paired students t-test with a p value less than 0.05 as the level of significance.

DISCUSSION
The shoulder model presented in this study simulates the muscles of the rotator cuff, deltoid, pectoralis major and latissimus dorsi and predicts changes that occur with TSA after retroverting the glenoid component. Placement of the glenoid component in fifteen degrees of retroversion significantly changes GHJ forces, contact pressures, and contact areas which may contribute to glenoid loosening. This study provides biomechanical data that supports the importance of appropriate glenoid version during total shoulder arthroplasty.

REFERENCES:

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Figure 1. Photograph of the custom shoulder testing system.

Figure 2. Contact pressures at 0, 30 and 60 degrees of horizontal adduction. (* p<0.05)

Figure 3. Glenohumeral joint forces in the scapular plane. (* p<0.05)