INTRODUCTION

Rotator cuff tears, the most common injury in shoulder joints, are often accompanied by secondary tears in the superior glenoid labrum [1]. While this high incidence of superior labral pathology has been described in association with rotator cuff pathology, the significance and mechanism of this finding is unclear.

Because the long head of the biceps tendon (LHB) forms a continuous structure with the superior labrum, the LHB has been implicated in the pathogenesis of superior labral injuries [2]. Therefore, we hypothesize that superior humeral head translation, as can be seen in rotator cuff disease, combined with loading on the LHB tendon leads to increased displacement and strain of the superior labrum.

METHODS

Mechanical tests were performed using six shoulders obtained from fresh-frozen cadavers (avg. age=51.7 years, range=47-55) having no evidence of shoulder pathology. Specimens were dissected free of all soft tissue, except for the labrum-LHB complex and articular cartilages. The humerus was positioned in 30° of abduction in the scapular plane with 0° humeral rotation. A compressive force of 50N in the medial direction was applied to seat the humeral head in the glenoid cavity [3]. Next, a tension load of either 0N or 22N was applied to the LHB tendon. A 22N load was chosen because this magnitude was shown to affect glenohumeral range of motion and kinematics [4]. The humerus was translated relative to the glenoid by 5mm in the superior direction at a rate of 1mm/sec. This amount of displacement encompasses the range of humeral head translations encountered in patients with rotator cuff disease (excluding massive tears) [5]. Paired beads were affixed to the superior labrum and the glenoid surface, according to the six angular positions (Fig. 1, inset), but the beads on both AB and PB had the same reference bead. Serial radiographs captured the position of the beads to determine the displacement of the superior labrum.

RESULTS AND DISCUSSION

The tension on the LHB significantly affected the magnitude of the labral displacement (P=0.0002) and the location of the peak displacement. The predicted FE data fell within 1 standard deviation of experimental data. Both the mechanical test and the model showed when the LHB load increased from 0N to 22N, there was a posterior shift in the location...
of the greatest displacement from the AB to the PB location (Fig. 1). Similarly, the 55N and 88N LHB loading conditions caused both an increase and a posterior shift in the predicted displacements.

Figure 1: The displacement profile of the superior labrum determined from the FE model and experiments (average ± 1 standard deviation) for 5mm of superior humeral head displacement with 0N and 22N LHB tension.

Increasing LHB tension also increased the strain in the superior labrum by a factor of 43% (Fig 2). The region of the labrum with the highest strain occurred in the origin of LHB (0°, Fig. 2, inset) in the superior labrum and it was independent of the magnitude of the LHB. The high strain around the 20° location is explained by the small cross-sectional area in that portion of the labrum.

Figure 2: The average strain through the cross section of the labrum on the labral location.

The strain in the PB and AB locations were relatively low in the ON case compared to the 88N case (Fig. 3). The high strain pathway from the origin of the LHB to the interface between the glenoid bone and cartilage was demonstrated in the labrum with 88N of LHB tension. The strain distributions in the 22N and 55N tension conditions were similar to that in the 88N case.

Figure 3: The strain plots for 5mm of superior humeral head displacement with (a) 0N and (b) 88N of LHB tension.

CONCLUSIONS

This study supports the hypothesis that tension on the LHB increases displacement and strain of the glenoid labrum in shoulders with rotator cuff disease. Increasing the LHB tension caused a posterior shift in the location of peak displacement and strain. Additionally, the area of the highest predicted strain in the labrum with LHB tension correlated well with the clinical presentation of the most common superior labral pathology. Therefore, high LHB tension may contribute to injuries of the superior labrum in patients with rotator cuff disease.

REFERENCES