INTRODUCTION:
Patients with anterior shoulder instability often develop glenohumeral defects at the time of shoulder dislocation. Clinical and cadaveric research has demonstrated that glenoid bone defects have a significant impact on shoulder stability. 1, 2 Humeral head bone defects occur with a similar high rate of frequency, and unlike glenoid bone defects, these defects tend to get larger with multiple dislocations. 3, 5 Clinical research has suggested that humeral head defects have an effect on recurrence of glenohumeral dislocation even after soft-tissue repair. 6 However, no cadaveric study has evaluated the contribution of humeral head defect size to recurrent shoulder dislocation.

The purpose of this study was to investigate the relationship between humeral head defect size and glenohumeral joint stability. We hypothesized that glenohumeral joint stability will decrease with increasingly larger humeral head defects. The specific aims were (1) to correlate defect size with anterior shoulder stability, (2) to identify the critical defect size which leads to dislocation, and (3) to determine how humeral abduction angle and rotation affect stability.

METHODS:
Nine fresh-frozen cadaveric shoulder specimens had all soft tissues superficial to the rotator cuff muscles removed and the rotator cuff muscles elevated from the scapula. The tendinous portions of the rotator cuff were bluntly separated from the capsule in a medial to lateral direction ending at a level one centimeter lateral to the glenohumeral joint. For each specimen, the humeral shaft was mounted to a rigidly fixed six degree-of-freedom load cell and the scapula was mounted to a six degree-of-freedom robot.

Progressively larger humeral head defects were created in the posterior superolateral humeral head to simulate Hill Sachs defects. The defects represented 1/8, 3/8, 5/8, and 7/8 of the radius of the humeral head. Secondary experimental factors included humeral abduction angles of 45° and 90°, and humeral rotations of 40° internal rotation, neutral, and 40° external rotation. These two factors were randomly applied for each defect size. Each specimen was tested twice prior to the creation of defects, before (native) and after detaching and repairing the subscapularis and at each defect size sequentially from smallest to largest. Testing was done at each of the conditions for all of the abduction and rotation combinations. Preconditioning of the intact specimens was performed with 5 trials to dislocation.

For each test a reference position, where the humeral head was most medial, was defined for each testing configuration by translating the humeral head 6 mm both along the superior-inferior and anterior-posterior axes. A constant axial load relative to the glenoid of 50 N was applied throughout each trial to center the humeral head in the glenoid fossa.

Each experimental trial was performed by translating the humeral head at 0.5 mm per second until dislocation in the anteroinferior direction at 45° to the horizontal glenoid fossa axis. The distance to dislocation was recorded and defined as the distance translated in the anteroinferior direction until dislocation.

RESULTS:
The outcome of interest was defined as the normalized distance to dislocation. This is defined as the distance between the reference position and the point of dislocation along the anteroinferior axis, and was normalized to this distance from the intact test for each configuration. An ANOVA was used to identify the significance of each factor (defect state, abdication angle, rotation angle) on the normalized distance to dislocation. Results of the analysis of variance demonstrated significant factors to include the amount of humeral rotation (p<0.001) and the size of the defect (p<0.001). A Tukey post hoc analysis was used to determine significance of differences between factor levels. In 40° external rotation, there was a significant reduction in distance to dislocation compared with both neutral and 40° internal rotation (p<0.001). The 5/8 radius osteotomy had a decreased distance to dislocation compared to the intact state (p<0.05), as did the 7/8 radius osteotomy (p<0.001). There was no significant difference found between the 2 abduction angles.

DISCUSSION:
The findings of this study support the clinical exam findings commonly seen with anterior glenohumeral instability, including those with humeral head defects. This includes patients feeling more unstable on exam in higher degrees of external rotation and abduction. It also supports the clinical finding that large humeral head defects may require repair. Our results indicate that humeral head defects corresponding to 5/8 of the humeral head radius would be the threshold above which repairing a defect is indicated.

REFERENCES: