The Influence of Glenoid Retroversion on Posterior Shoulder Instability: A Cadaveric Study (214)

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Objectives: Increased glenoid retroversion has been associated with an increased risk of posterior glenohumeral instability. Normal mean glenoid version is between 0-7° of retroversion depending on the population and measurement method. Retroversion can range above 20°, notably in patients with glenoid dysplasia. Increased glenoid retroversion has also been proposed as a risk factor for failure after primary soft tissue repair. Arthroscopic repair is the most common surgical treatment; however, this does not address cases of increased glenoid retroversion. What has not been identified is the degree of glenoid retroversion associated with recurrent instability or failed repair. The goal of our work is to (1) measure how resistance to posterior translation changes as retroversion increases, (2) examine if labral tear results in a greater decrease to resistance at increasing degrees of retroversion, and (3) to determine the degree of retroversion at which labral repair fails to restore the resistance of the intact, neutral version state.

Methods: Eight fresh frozen cadaveric shoulder specimens (age 50-64, 4 male) were prepared, maintaining bone and capsulolabral tissue. The scapula and humerus were potted using quick-set polyurethane. CT scans were obtained to establish a scapular 3D coordinate system relative to the potting. Specimens were mounted on a 6 degree of freedom musculoskeletal simulation robotic arm (KUKA KR 6 R700, Augsburg, Germany) and referenced to the coordinate system. The humeral head was centered on the glenoid using a 50N compressive force, and the humerus was translated posterior-inferiorly (30° inferior to the midline) at 1mm/sec in neutral rotation for 10mm. The shoulder was positioned in 30° of abduction and 30° of flexion, based on prior protocol. Custom simVITRO (Cleveland Clinic, Ohio, US) labview-based control software measured peak resistance at 0° of version and then in 5° increments of retroversion until the specimen dislocated, up to 30° of retroversion. Version was adjusted through use of a multiplanar vice. A posterior labral tear was created from the 2 to 6 o'clock position on a left shoulder, and the same testing parameters were performed. Vertical mattress sutures using 4 independent bone tunnels were used to repair the labrum and the same version iterations were tested.
Generalized estimating equations were used to compare the peak resistance to translation for each degree of version in the intact, cut and repaired states. The maximum likelihood estimators of the model were adjusted for any model misspecification using classical sandwich estimation. Post hoc pairwise comparisons between conditions were conducted via orthogonal contrasts. The Holm-test was used to calculate adjusted p-values and confidence intervals. Statistical significance was established at the $P<0.05$ level and all interval estimates were calculated for 95% confidence.

Results: The mean peak resistance for the intact labral state decreased significantly for each interval increase in retroversion when the humerus was translated posterior-inferiorly (Figure 1). On average, a 1° increase in retroversion correlated with a 3.5% decrease in resistance to translation. Dislocation with an intact labrum without any posterior force occurred at a mean of 22.7° (range 15-30°) of retroversion.

After labral tear, resistance forces to posterior-inferior translation decreased but not significantly from the intact state. However, the percent change of resistance force decreased 41% at 25° of retroversion; this was notably higher than the percent change at 0-15° of retroversion (range 2.7-6.5% decrease) but was not statistically significant (Figure 2).

Compared to the intact state at 0° version, there was a 45% and 81% decrease in resistance after labral repair at 20° and 25° of retroversion, respectively ($p=0.04$ and $p=0.004$).

Conclusions: Glenoid retroversion has a significant effect on resistance to posterior humeral head translation, with each degree increase accounting for 3.5% of resistance to translation. Cutting the labrum at 0-15° of retroversion does not have a significant effect on resistance to posterior inferior humeral translation; however, at 25° of retroversion cutting the labrum results in a 41% decrease in resistance. Similarly, labral repair at 20-25° of retroversion does not recreate peak resistance values of the intact state at 0-5° of retroversion. These findings point to the bony anatomy (retroversion) playing a larger role in preventing posterior instability than the labrum. It also provides evidence that the labrum plays a more significant role in stability at higher degrees of retroversion, and labral repair in patients with >20° of retroversion may be subjected to a relatively greater percentage of force than those at lesser degrees of retroversion.

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