THE EFFECTS OF ZONE-SPECIFIC SUPERIOR LABRAL DETACHMENT ON BICEPS ANCHOR STABILITY

Megan E. Gates, Joseph X. Kou M.D., Constantine K. Demetropoulos Ph.D., Kenneth A. Jurist M.D., Joseph H. Guettler M.D.
Gehring Center for Biomechanics and Implant Analysis, William Beaumont Hospital Royal Oak, MI, cdemetropoulos@beaumont.edu

INTRODUCTION
Lesions of the superior labrum anterior posterior (SLAP) lesions are a known cause of shoulder pain and dysfunction. Diagnostic arthroscopy is ultimately the tool utilized to assess and treat SLAP tears. Vertical lift-off of the labrum, displacement of an unstable anchor into the joint, and ‘posterior peel-back’ are parameters used to assess for biceps anchor instability at the time of arthroscopy. The current literature provides no scientific guidelines for the evaluation of superior glenolabral separation as it relates to biceps anchor stability. This study aimed to elucidate the degree of biceps anchor instability that occurs when specific zones of the superior labrum are detached from the glenoid.

MATERIALS AND METHODS
For this study 16 cadaveric scapula, 8 left and 8 right, were obtained from the International Institute for the Advancement of Medicine. During preparation, specimens were examined to assure that the superior labrum was intact. Of the 16 specimens, 12 were accepted for further testing. The average age of death was 52.5 years (range, 45-60 years).

The scapulas were prepared by removing the surrounding musculature and in some circumstances, the acromial and coracoid processes. The labrum, biceps anchor and biceps tendon were carefully preserved. A suture was looped and secured to the biceps tendon. Specimens were wrapped in saline soaked towels and stored in plastic bags at -20 ºC, then thawed in a 5 ºC refrigerator for testing.

The testing apparatus consisted of a large aluminum frame with a wood-mount for the specimen. The frame contained several pulleys of adjustable position. Multiple infrared Optotrak markers fixed to the aluminum frame to serve as a reference for displacement measurements.

The scapulas were mounted in the testing apparatus with the glenoid surface facing upwards using two 1.5” wood screws. An infrared Optotrak sensor was attached to the bone. A suture was inserted to the biceps anchor proximal to the glenoid. A cable and pulley system with a hanging weight was attached to the suture loop at the end of the biceps tendon. This weight applied a constant 2.5 lbs of traction. Pulleys were arranged to enable traction in three different directions: superior (to simulate vertical lift-off), lateral (to simulate displacement into the joint), and combined posterior/superior/lateral (to simulate the ‘peelback’ test).

For each direction of pull, 2.5 lbs of traction was applied for 10 seconds while the displacement of the biceps anchor was measured relative to the reference frame using the Optotrak system. Data were collected at 10 Hz. The first 6 seconds and last 1 second of data from each test were not used for analysis. This was repeated three times for each direction with the traction removed in between trials.

The superior glenoid labrum was divided into three zones: zone 1 (the portion of the superior labrum anterior to the biceps anchor), zone 2 (the portion of the superior labrum including the biceps anchor), and zone 3 (the portion of the superior labrum posterior to the biceps anchor). Each specimen was put through four sets of three repetitions in each direction: first with an intact superior labrum, then with single zone labral detachment (zone 1, 2 or 3), third with consecutive zone detachments (zones 1 and 2 or zones 2 and 3) and finally with all three zones detached. Zone detachments were performed by sharp dissection and were meant to simulate SLAP lesions in various locations.

RESULTS
The greatest degree of instability, in general, occurred with the sectioning of all three zones followed by the sectioning of two adjacent zones. Single zone sectioning proved to be the least unstable. When comparing single zone sectioning, isolated zone 1 sectioning produced slightly more instability than that associated with isolated zone 2 or zone 3 sectioning. When comparing zone-sectioning combinations, combined zone 1/zone 2 or zone 1/zone 3 lesions demonstrated more displacement than combined zone 1/zone 2 lesions when evaluating for vertical displacement and lateral displacement into the joint. However, with the simulated ‘peelback’ test, combined zone 1/zone 2 lesions demonstrated more displacement than combined zone 1/zone 3 lesions. When comparing displacement methods, superior traction (vertical displacement) created the least displacement in all combinations, while lateral traction (displacement into the joint) created maximal displacement - with one exception: in the setting of zone 1/zone 2 lesions, increased displacement was observed using the ‘peelback’ simulation.

DISCUSSION
Concepts relating to the clinical diagnosis, imaging, and ultimate treatment of SLAP lesions have continued to evolve over the past decade as the literature has accumulated. Significant attention has been paid to the physical exam tests and imaging modalities as they relate to the diagnosis of SLAP tears. Although these tools are essential in the work-up of these lesions, diagnostic arthroscopy is ultimately the tool utilized to assess and treat SLAP lesions.

At the time of arthroscopic surgery, findings often dictate treatment. In the case of a significant SLAP tear, the decision to repair or debride is often quite easy. However, in many situations, the tearing and amount of labral detachment is subtle, and the arthroscopist is confronted with the following dilemma: ‘to repair, or not to repair.’ To aid in the decision making, the arthroscopist utilizes three parameters to assess the degree of biceps anchor instability: vertical lift-off of the labrum, displacement into the joint, and ‘posterior peel-back.’

The current literature provides no scientific guideline for the evaluation of superior glenolabral separation as it relates to biceps anchor stability. The findings of this study are important, not only as they relate to the assessment of SLAP lesions at the time of arthroscopy, but also as the displacement of certain lesion patterns relates to certain clinical situations: lateral displacement into the joint replicates a loading scenario that might be encountered in a heavy, forward-lifting laborer; ‘posterior peel-back’ replicates a loading situation that might very well be encountered in an overhead athlete, and vertical displacement replicates a situation encountered in an athlete or laborer who places a superiorly directed force on the humeral head (decline bench press or operating a press at waste level).

Assessment of the glenoid labrum is also complicated by the normal anatomic variants that are encountered. The sublabral foramen and sublabral recess are anatomic variants that are particularly problematic when assessing for the true degree of labral detachment and biceps anchor instability. In addition, the literature has pointed to the antero-superior labrum (zone 2 in the current study), because of its anatomic variability, as having a less significant role in biceps anchor integrity. Our current study indicates that this region not only contributes, but also has a significant biomechanical role in the stability of the biceps anchor. Indeed, all three zones contribute to the biomechanical stability of the superior labrum/biceps anchor complex.

CONCLUSION AND CLINICAL SIGNIFICANCE
All three labral zones assessed in this study have important biomechanical contributions to biceps anchor stability. Biceps anchor displacement, particularly the degree and direction of displacement, is affected by the labral detachment pattern.

The study’s findings have important implications relating to the clinician’s arthroscopic assessment of SLAP tears, as well as the determination of need for stabilization. The information obtained from this study can be used to aid the clinician in determining whether or not a SLAP lesion should be repaired, and which intra-operative maneuvers can be used to determine this. This information is particularly useful when treating SLAP tears in certain laborers and athletes, whose activities may cause specific biceps anchor displacement patterns.

REFERENCES

ACKNOWLEDGEMENTS:
The authors thank Stryker Corporation for project support.