Capsulorrhaphy to Repair Central Humeral Avulsion of the Glenohumeral Ligament: Biomechanical Study

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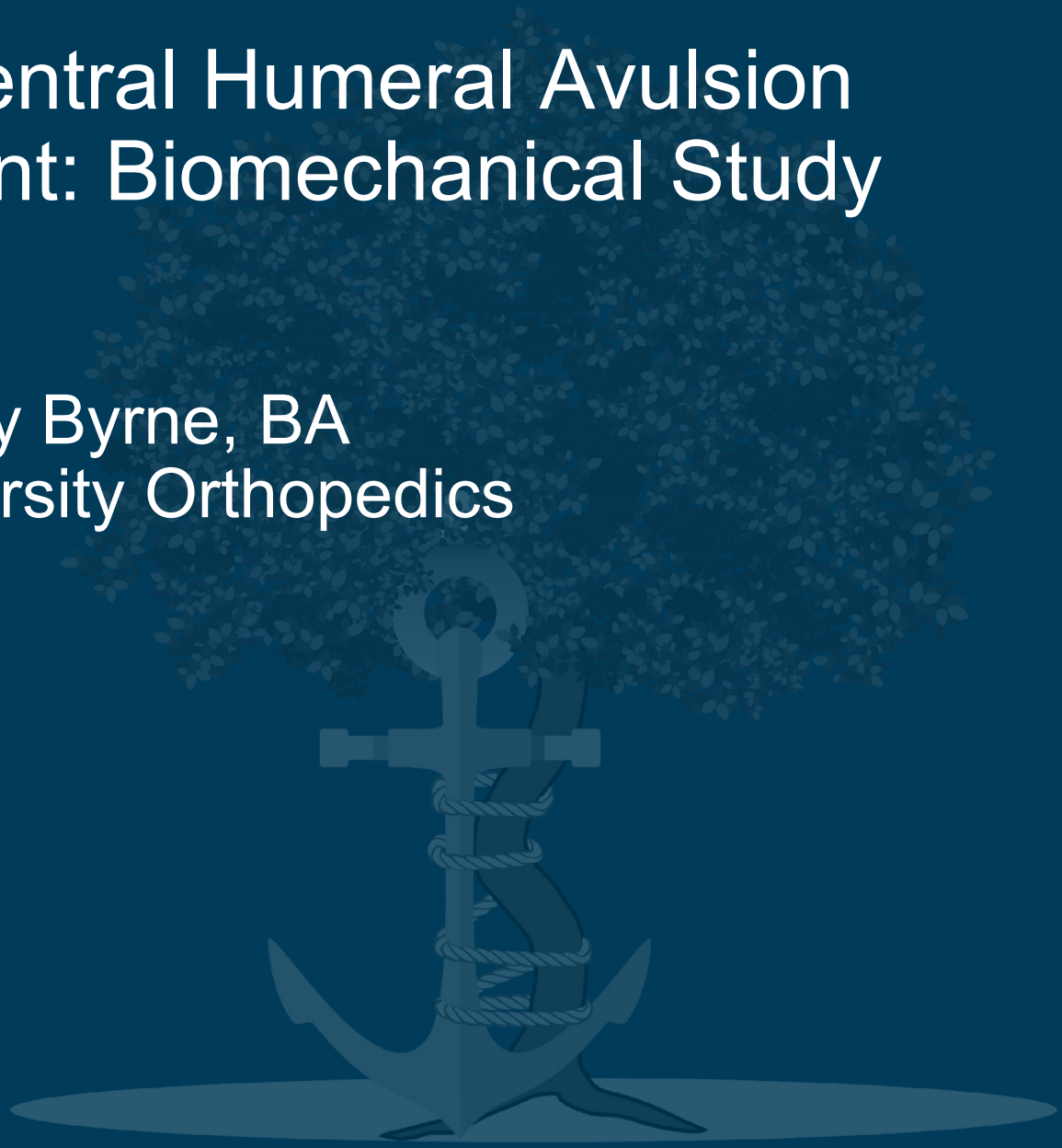

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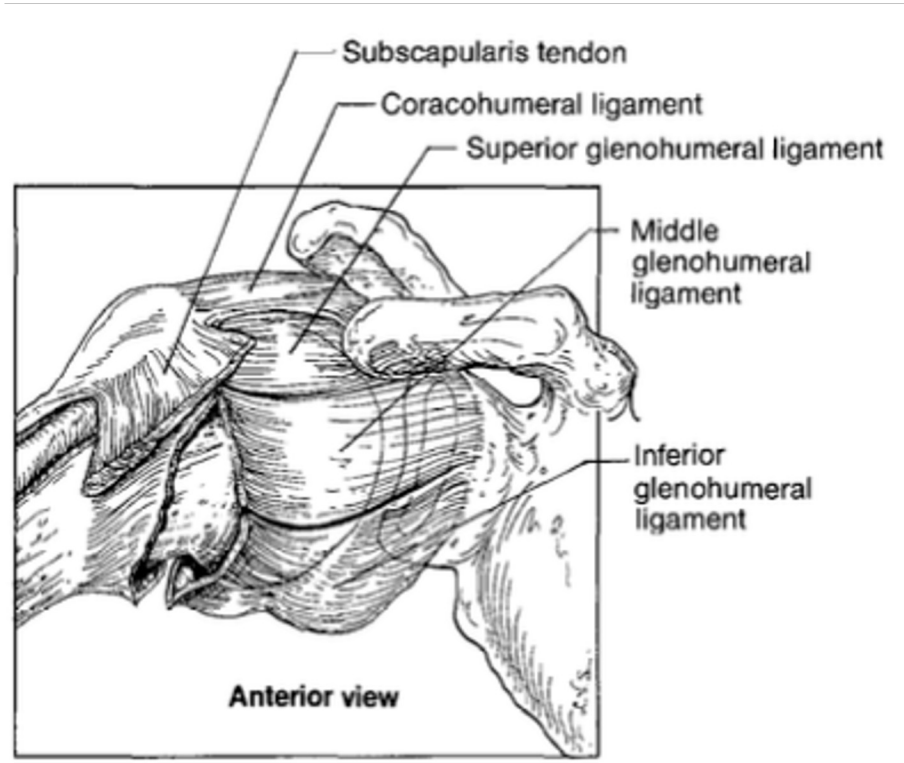
Overview

- Introduction
- Objectives
- Materials & Methods
- Results
- Conclusions
- Significance of the of Findings
- Future Ideas

Introduction

- HAGL = Humeral avulsion of the glenohumeral ligament
- First described by Dr. Nicola in JBJS in 1942 as the anterior “capsule tear(ing) away from the neck of the humerus”
- In 1995 Wolf et al. coined the term “HAGL” in Arthroscopy



Wolf, EM, Cheng, JC, Dickson, K: Humeral avulsion of glenohumeral ligaments as a cause of anterior shoulder instability. *Arthroscopy: The Journal of Arthroscopic & Related Surgery* 1995;11:600–607

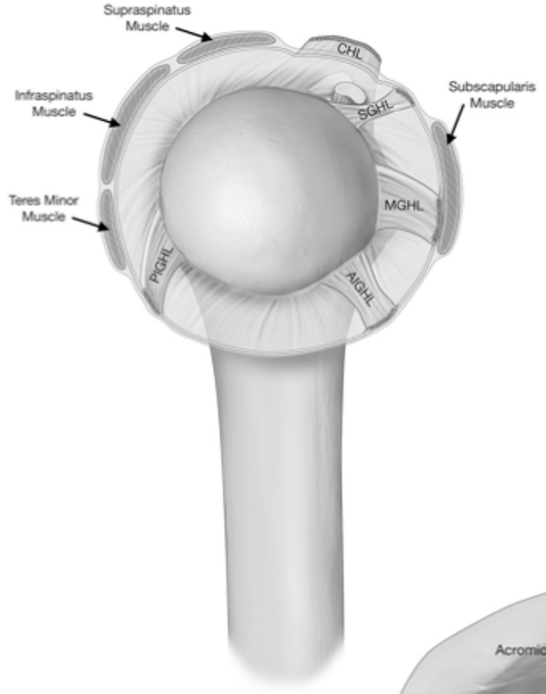
Anatomy

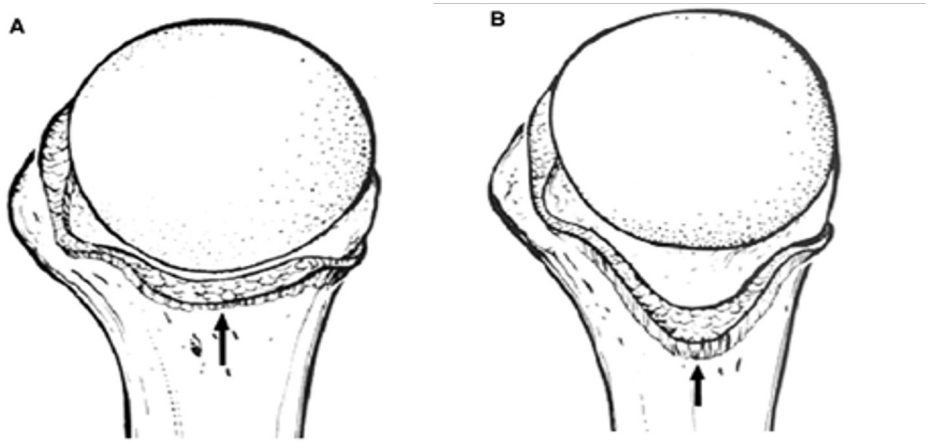
- Glenohumeral joint most mobile joint in the body
- Dynamic stabilizers: deltoid, rotator cuff, biceps
- Static stabilizers
  - Articulation of humeral head within glenoid cavity
  - Fibrocartilaginous labrum
  - Joint capsule and glenohumeral ligaments

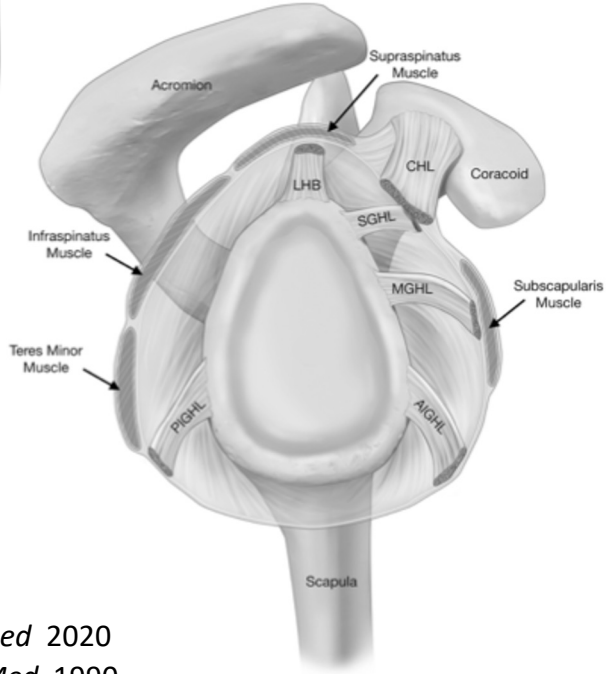
Anatomy cont.

Glenohumeral ligaments

- Superior glenohumeral ligament (SGHL)
- Middle glenohumeral ligament (MGHL)
- Inferior glenohumeral ligament complex (IGHL)
  - Anterior band
  - Posterior band
  - Axillary pouch







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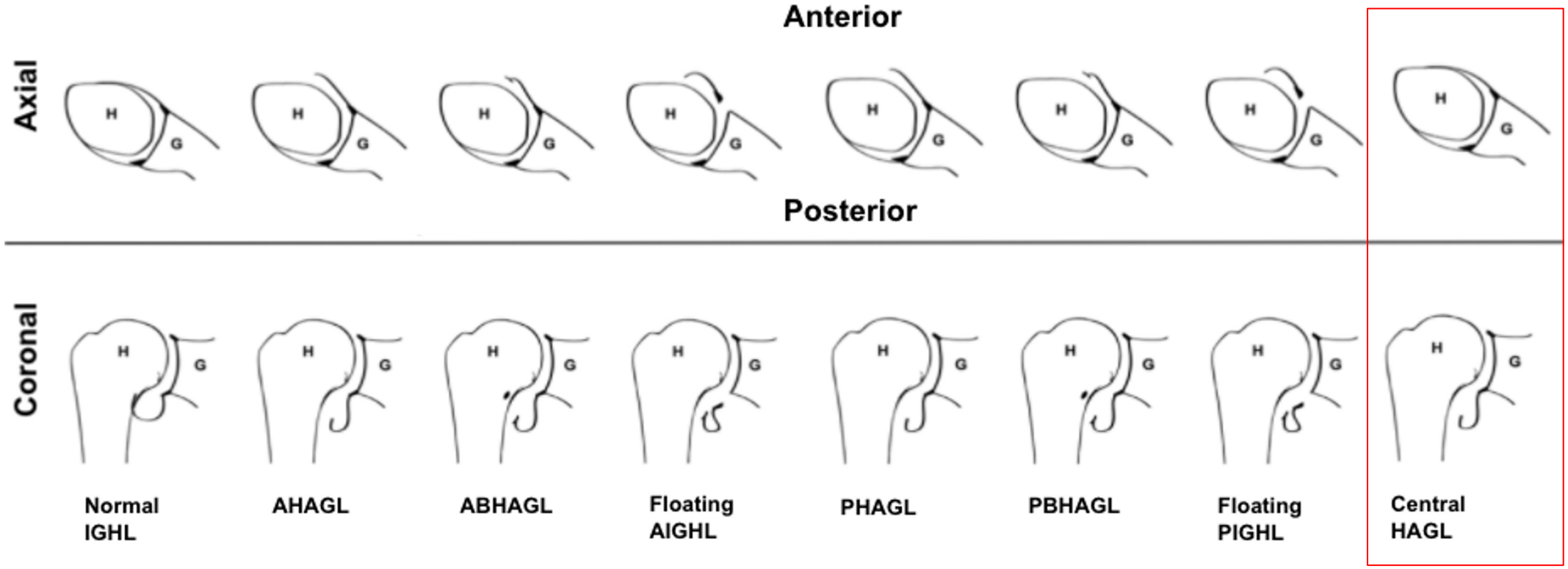
O'Brien et al.: The anatomy and histology of the inferior glenohumeral ligament complex of the shoulder. *Am J Sports Med* 1990

Modified West Point Classification



Krueger, Van S., et al. "Humeral avulsion of the glenohumeral ligament: Diagnosis and management." *JBJS reviews* 10.2 (2022): e21.

Objectives

- Hypothesis: Anterior inferior capsulorrhaphy will restore native stability to central HAGL lesions
- Biomechanical study
- Aim 1: To create a reproducible HAGL lesion in a cadaver model that simulates anterior instability
- Aim 2: To perform an anterior-inferior capsulorrhaphy which restores a cadaver model with anterior laxity due to a central HAGL lesion to native stability

Materials & Methods

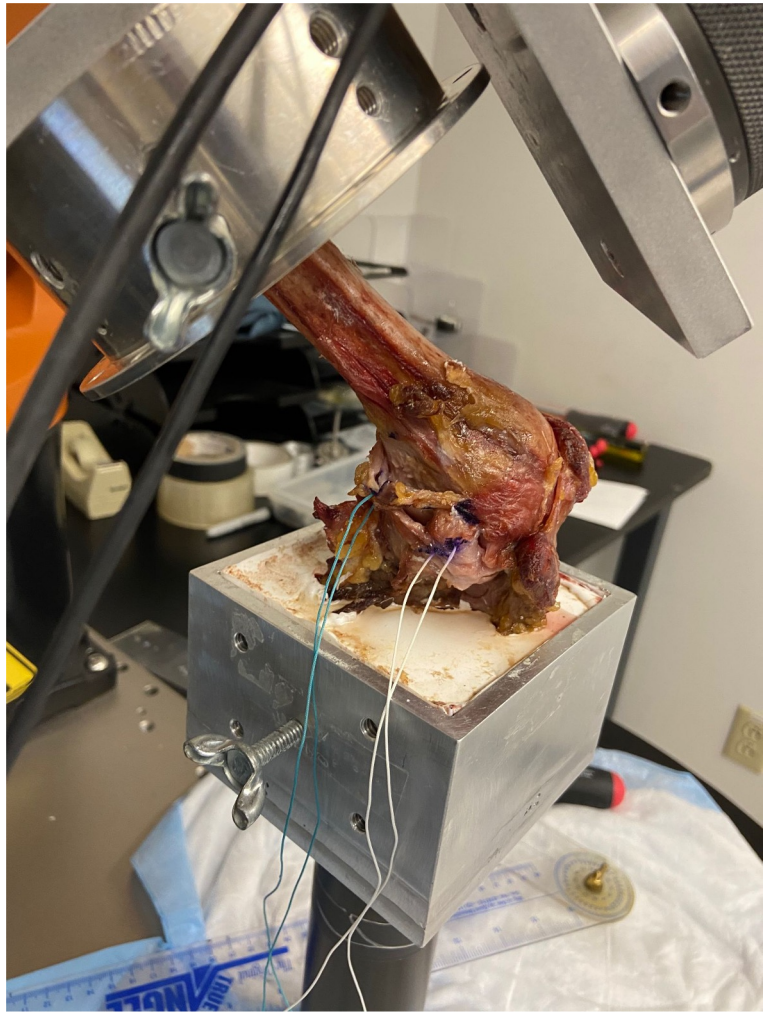
- 7 fresh frozen cadaveric shoulders (average age 36.8 yrs, all < 45 yo) dissected down to the glenohumeral joint capsule and ligaments
- CT scan performed to define reference coordinates
- Mounted on 6-*df* robotic musculoskeletal simulator (KR 6 R700; KUKA)
- 5-N compressive force applied to humerus
- Humeral head was displaced 15 mm in anterior inferior direction
- Using multi-axis load cell, peak resistive force against anterior inferior humeral head translation was recorded

Materials & Methods

- 5 states
  - Intact (capsule and glenohumeral ligaments)
  - Central HAGL (5:30 to 6:30 o'clock)
  - Central HAGL with anterior-inferior capsulorrhaphy
  - Large Anterior HAGL (3:30 to 6:30 o'clock)
  - Large Anterior HAGL with anterior-inferior capsulorrhaphy
- Anterior inferior capsulorrhaphy= figure-of-8 stitch in capsule with #2 nonabsorbable suture, one throw then clamped in order to release and reclamp

Intact capsule- mounted on robot

Small HAGL with capsulorrhaphy



Large HAGL without capsulorrhaphy

Results

Table 1. Median and Interquartile Range for Peak Resistive Force per Experimental Condition

Experimental condition	Force
Intact	26.71 (17.32, 33.60)
Central HAGL	13.59 (2.44, 33.82)
Central HAGL with capsulorrhaphy	26.35 (4.17, 71.28)
Large Anterior HAGL	8.96 (2.03, 19.59)
Large Anterior HAGL with capsulorrhaphy	5.55 (2.26, 42.72)

HAGL, Humeral avulsion of glenohumeral ligaments

* p<0.01: Intact vs. Central HAGL
# p<0.001: Intact vs. Large Anterior HAGL
^ p=0.27: Intact vs. Central HAGL with capsulorrhaphy
& p=0.25: Central HAGL vs. Central HAGL with capsulorrhaphy
+ p<0.0012: Intact vs. Large Anterior HAGL with capsulorrhaphy
% p=0.76: Anterior Large HAGL vs. Large Anterior HAGL with capsulorrhaphy

Conclusion

- The central HAGL and large anterior HAGL defects resulted in less peak force required to translate than the intact condition ($p<0.01$ and $p<0.0001$ respectively)
- Central HAGL repaired with a capsulorrhaphy restored the shoulder to similar intact peak force as there was no significant difference between the two conditions ($p=0.27$)
- The median peak force for central HAGL and central HAGL with capsulorrhaphy (13.59 vs. 26.35) trended toward significance ($p=0.25$).
- Large anterior HAGL repaired with capsulorrhaphy failed to restore stability to the intact state ($p<0.0012$).

Significance of Findings

- These results demonstrate that a central HAGL lesion between the AIGHL and PIGHL leads to abnormal biomechanics of the glenohumeral capsule.
- Repair with glenoid-based capsulorrhaphy restores the resistance to anteroinferior displacement comparable to the intact state.
- Extension of the HAGL injury to include the AIGHL results in impaired mechanics, which are not restorable with a capsulorrhaphy alone.
- Capsulorrhaphy may be a viable option for non anatomic repair of central HAGL lesions reducing the risk profile of traditional anatomic HAGL repair, but likely not adequate for large anterior HAGL lesions.

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