Using Optical Tracking to Calculate Non-Recoverable Strain in the Glenohumeral Capsule Following a Severe dislocation

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Introduction

Anterior shoulder dislocations can result in non-recoverable strain of the glenohumeral capsule, increasing the chances of recurrent shoulder instability. Optical tracking can be used to determine non-recoverable strain, which indicates injury, by recording the position of markers adhered to the capsule before and after a dislocation. This method has not been assessed following a severe anterior shoulder dislocation.

Objective

Assess ability to determine non-recoverable strain via optical tracking in the glenohumeral capsule following a severe anterior shoulder dislocation

1) Tissue pathomorphology 2) Intra-observer repeatability 3) Inter-observer repeatability

Materials & Methods

- 2 fresh-frozen shoulders, dissected of all tissue except glenohumeral capsule
- 7x11 Grid of strain markers adhered to inferior glenohumeral ligament
- 6 DOF Robotic testing system (FRS2010, Chino, Japan) performed 3 severe dislocations by applying force to anteriorly translate humerus across entire width of glenoid (Figure 1)
- 3D position of strain markers recorded by motion tracking system (Spica technology corporation, HI) before and after dislocation in reference configuration
- Max principal strain calculated on humeral side of anterior band using ABAQUS (Simulia, Providence RI)
- Tissue pathomorphology observed

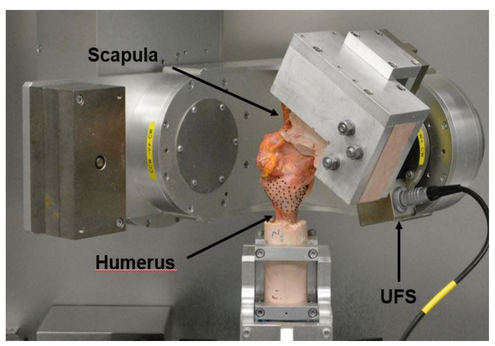

Figure 1: Setup for optical tracking.

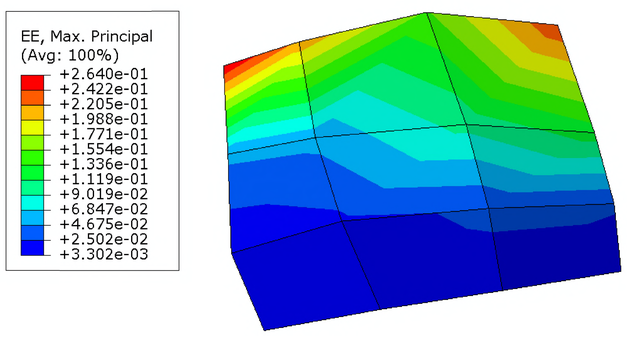

Figure 2: Strain map of humeral side of anterior band of glenohumeral capsule after severe dislocation

Repeatability

- Average non-recoverable strain of nine elements on humeral side of anterior band of glenohumeral capsule (Figure 2)
- Intra-observer repeatability: Tracked 3 times, 1 day apart
- Inter-observer repeatability: Tracked 3 times each by two observers

Results

Tissue Pathomorphology

- Specimen 1: capsular tearing- strain analysis not possible (Figure 3)
- Specimen 2: no capsular tearing, marker visibility affected by new folds in tissue- strain analysis possible

Repeatability

- Good intra- and inter-observer repeatability
- Inter-observer repeatability slightly better

Table 1. Intra- and inter-observer repeatability

	STD (% Strain)
Observer 1	0.2%
Observer 2	0.2%
Inter-Observer	0.3%

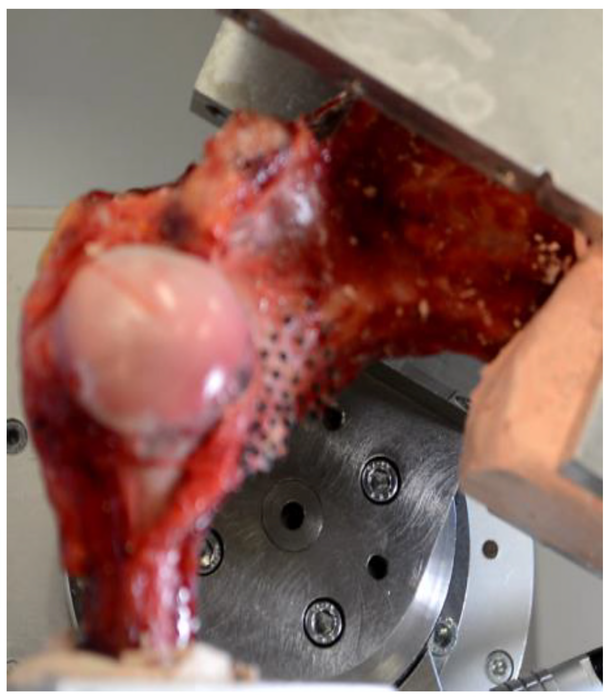

Figure 3: Glenohumeral capsule tearing during severe dislocation

Discussion

- Capsule plication- common procedure to reduce recurrent shoulder instability after a dislocation
  - Quantify non-recoverable strain Ÿ improve accuracy of capsular plication
- Capsular tearing
  - Humeral head tore through capsule, with tear starting near anterior portal
  - Non-recoverable strain analysis not possible
- Better repeatability than previous studies [3]
  - Strain averaged across region instead of measuring each element
  - All tracking done from one recording- effect of entire experimental procedure not assessed

Future directions

- Study surgical repair of capsule tear

Significance

- Optical tracking has good repeatability for determining non-recoverable strain, but limited by tissue pathomorphology caused by severe dislocation

Acknowledgements
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References
[1] Abrams et al. JBJS. 2014 [2] Malicky et al. JSES 2002 [3] Moore et al. Ann Biomed Eng, 2010