Biomechanical Analysis of Capsular vs Transosseous Ulnar Tunnel Repair for Unstable TFCC Tears

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Introduction

Injury to the triangular fibrocartilage complex (TFCC) can cause ulnar sided wrist pain that can decrease quality of life as evidenced with higher patient reported scores on the Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaire[1, 2]. To our knowledge no study has directly compared arthroscopic capsular repair with arthroscopic trans-osseous fixation. We hypothesize that using a biomechanical model that represents physiologic loading, combined with sensitive optical tracking devices will demonstrate increased displacement and reduced stiffness of the peripheral capsular repair when compared to a trans-osseous repair.

Objectives

- Determine the absolute difference in translational stability as measured with optical markers in a biomechanical model of TFCC loading, with and without an unstable peripheral TFCC tear
- Determine the effect of trans-osseous ulnar tunnel repair compared to peripheral capsule repair on stiffness and maximal displacement of the DRUJ

Methods:

- Eight matched pairs (16 specimens) of fresh frozen cadaveric forearms were tested with an Instron 8821s servo-hydraulic load frame.
- Ulna was cycled (5 cycles) between ±30-40N in the A-P direction and translational displacement tracked with 3D optical trackers (NDI Certus)
- Specimens were tested in supination and pronation to establish baseline values
- Each specimen then underwent a standard diagnostic wrist arthroscopy and sectioning of the TFCC's deep and superficial radio-ulnar ligaments
- Specimens were then re-tested to assess instability secondary to the tear.
- TFCC was then repaired with either a peripheral capsular repair using three 2-0 PDS sutures, or a trans-osseous ulnar tunnel repair using a 2-0 Fiberwire.
- Specimens underwent final testing. A student's t-test was used to determine statistical significance with a $p<0.05$ considered significant.

Discussion

- Arthroscopic sectioning of the TFCC resulted in DRUJ instability
- TUR effectively restored DRUJ stability - no significant difference in post-operative stiffness or maximal displacement when compared to the intact specimen
  - supination ($p=0.95$ and $p = 0.89$ respectively)
  - pronation ($p=0.40$ and $p = 0.09$ respectively).
- stiffness and maximal displacement of CR specimens continued to be significantly different than the intact state
  - $p<0.01$ for stiffness and displacement in both supination and pronation
- Previous studies have shown no difference in ulnar displacement after TUR or CR through an open approach[3], but these did not utilize optical tracking methods.
- Current standard of care for repair of a TFCC with an unstable DRUJ is an open approach with repair of the TFCC utilizing a suture anchor
  - significantly more scarring
  - potentially greater morbidity compared to arthroscopic repairs.
- Arthroscopic peripheral capsular repairs are commonly employed in TFCC repairs (typically peripheral tears without evidence of instability)
- This study provides the first biomechanical evidence than an ulnar tunnel technique could restore stability to the DRUJ, increasing the surgical options for the patient.

Conclusions

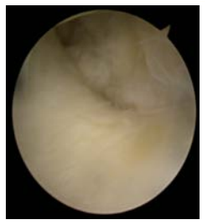
- **Trans-osseous ulnar tunnel repair of unstable TFCC tears resulted in DRUJ stiffness and translation comparable to the native state.**
- **Peripheral capsular repair demonstrated decreased stiffness in pronation and supination when compared to the native state and trans-osseous repair.**

Figure 1: Experimental Set-Up

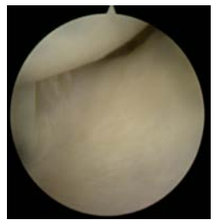
A) Specimen mounted with optical trackers attached to pelvic screws inserted in radius and ulna. Instron ram loaded ulna with 5 cycles +/-40 Newtons.

B) Wrist arthroscopy was performed in each specimen. An unstable TFCC lesion was made arthroscopically using a scalpel

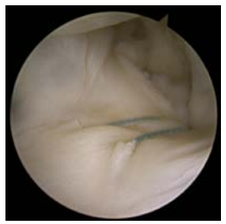
Figure 2 : TFCC Sectioning & Repair



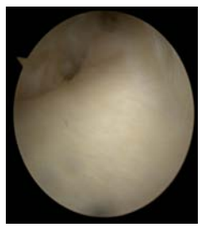
A) Native TFCC for matched specimens16 (above) and 15 (below)

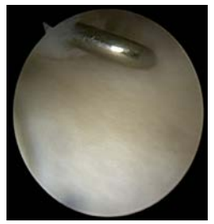


B) After Sectioning – note patulous nature of TFCC



C) Ulnar Tunnel repair (above) and peripheral capsule (below)





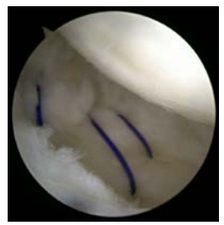
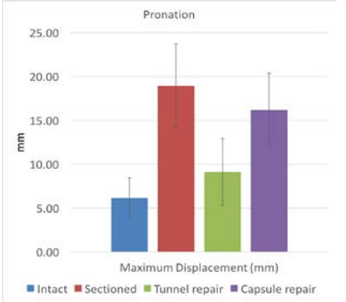
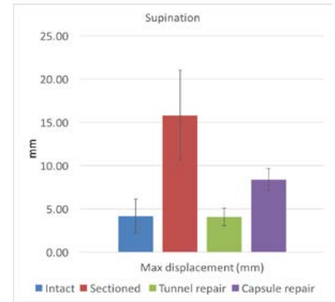


Figure 3: Maximal Displacement

A. Pronation



B. Supination

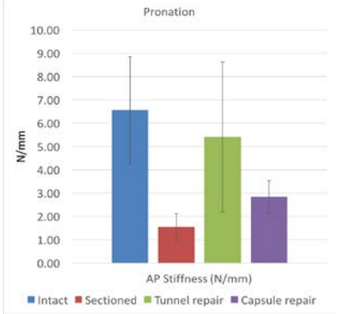


A) After sectioning, all specimens showed significant increase in translation, consistent with instability. Repair of TFCC with trans-osseous technique resulted in displacement similar to the native tissue ($p=0.09$) Capsular repair specimens were found to have displacement significantly greater than the intact state ($p<0.01$).

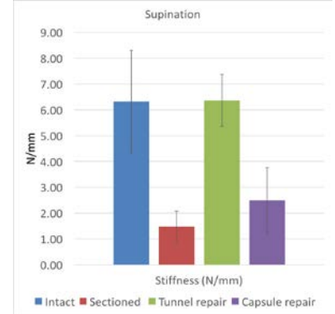
B) Testing in supination again demonstrated decreased maximal displacement with trans-osseous technique.

Figure 4: Stiffness

A. Pronation



B. Supination



A) After sectioning, specimens showed significant decrease in stiffness. Trans-osseous technique restored stiffness to the native levels ($p=0.40$), while capsular repair showed little improvement in stiffness compared to the sectioned state.

B) Supination is thought to increase stability of the DRUJ, but testing of stiffness showed similar findings in comparing trans-osseous and peripheral capsular repair in both positions.

References:

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2. Cardenas-Montemayor, E., et al., *Subjective and objective results of arthroscopic debridement of ulnar-sided TFCC (Palmer type 1B) lesions with stable distal radio-ulnar joint.* Archives of orthopaedic and trauma surgery, 2013. **133**(2): p. 287-293.
3. Ruch, D.S., S.R. Anderson, and M.R. Ritter, *Biomechanical comparison of transosseous and capsular repair of peripheral triangular fibrocartilage tears.* Arthroscopy: The Journal of Arthroscopic & Related Surgery, 2003. **19**(4): p. 391-396.