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Pullout strength and stiffness of a non-metallic suture anchoring system for repair of the central slip of the extensor mechanism at the proximal interphalangeal joint

Aaron Hoblet

Christina Salas

Justin Brantley

James Clark

Deana Mercer

See next page for additional authors

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Authors
Aaron Hoblet, Christina Salas, Justin Brantley, James Clark, Deana Mercer, and Elizabeth Mikola

Pullout Strength and Stiffness of a Non-Metallic Suture Anchoring System for Repair of the Central Slip of the Extensor Mechanism at the Proximal Interphalangeal Joint

Aaron Hoblet, MD[1]; Christina Salas, MS[1,2]; Justin Brantley, BS[1,2]; James Clark, MD[1]; Deana Mercer, MD[1]; Elizabeth Mikola, MD[1]

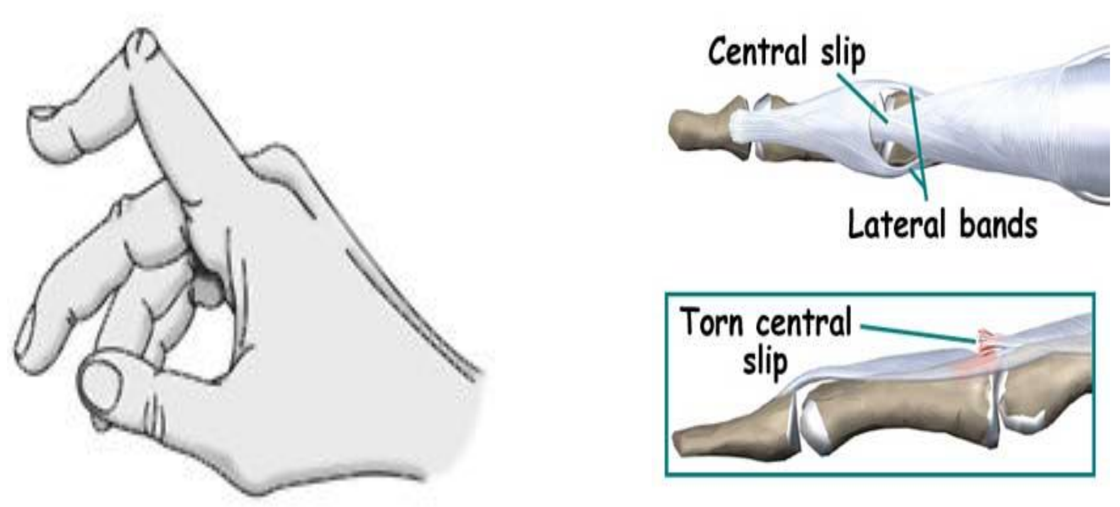
UNM SCHOOL of ENGINEERING

1. Department of Orthopaedics and Rehabilitation
2. Center for Biomedical Engineering
The University of New Mexico, Albuquerque, USA

UNM SCHOOL of MEDICINE Department of Orthopaedics & Rehabilitation

INTRODUCTION

- **Studies have used metallic bone anchors and suturing techniques to repair acute rupture of the central slip of the extensor mechanism at the proximal interphalangeal joint of the hand which can lead to Boutonnière deformity. (Fig. 1)**



A B

Figure 1: A. Boutonnière deformity preventing full extension of the finger. B. Top image shows normal central slip attachment to proximal interphalangeal joint. Bottom image shows torn central slip.

PURPOSE

- **We present a biomechanical study investigating pullout strength and stiffness of the non-metallic JuggerKnot™ Soft Anchor system with MaxBraid™ suture for repair of the central slip of the extensor mechanism at the proximal interphalangeal joint. We compare our results with pure tensile testing of MaxBraid™ suture as controls on the contralateral limb.**

METHODS

- **Ten matched pairs of cadaveric hands were used in this study:**
  - **Two fingers (index, middle) from each hand were used**
  - **One hand from each donor was randomized to Group 1; the contralateral limb from the same donor assigned to Group 2**
  - **Group 1: Prepared with 1.0mm mini JuggerKnot anchor with #2-0 MaxBraid suture (n=20) (Fig. 2)**
  - **Group 2: Prepared with #2-0 MaxBraid suture through transverse bone tunnel (n=20) in the contralateral limb**
- **Prior to testing, areal bone mineral density (BMD) of the distal radius was obtained using dual-energy X-ray absorptiometry**
- **The distal phalanx is potted in bone cement and fixed to the base of the servohydraulic testing machine**
- **The suture is fixed to the linear actuator using flat grips (Fig. 3)**
- **Specimens are loaded using a displacement controlled protocol at a rate of 100mm/min until failure**

METHODS

A B C

Figure 2: A. JuggerKnot™ Soft Anchor System. Anchor sleeve is made from polyester suture loaded with MaxBraid™ polyethylene suture. B. Anchor is seated with a custom guide and inserter. C. Once fully seated, suture is pulled until the anchor sleeve is fully engaged against the cortical surface.

Figure 3: Experimental testing fixture showing specimen in bone cement fixed to the base of the testing machine. Suture attached to vertical actuator grips for tensile loading at a rate of 100mm/min.

- **A paired t-test was used to analyze ultimate load to failure and construct stiffness between fingers (index vs. middle) and between fixation group (anchor vs. suture)**
- **Regression analysis was used to determine whether BMD was a predictor of ultimate load**

RESULTS

- **No significant difference in ultimate load (UL) or stiffness was found between index and middle finger specimens for the anchor (p=0.68 UL and 0.62 stiffness) or suture groups (p=0.38 UL and p=0.64 stiffness)**
- **Mean UL and stiffness for the anchor group was 52.6+-18.3N and 10.4+-2.6N/mm, respectively**
- **Mean UL and stiffness for the suture group was 90.5+-18.7N and 16.2+-3.1N/mm, respectively**
- **All anchors failed by pullout and all sutures failed by breakage**
- **Regression analysis showed no correlation between anchor pullout and BMD**

RESULTS

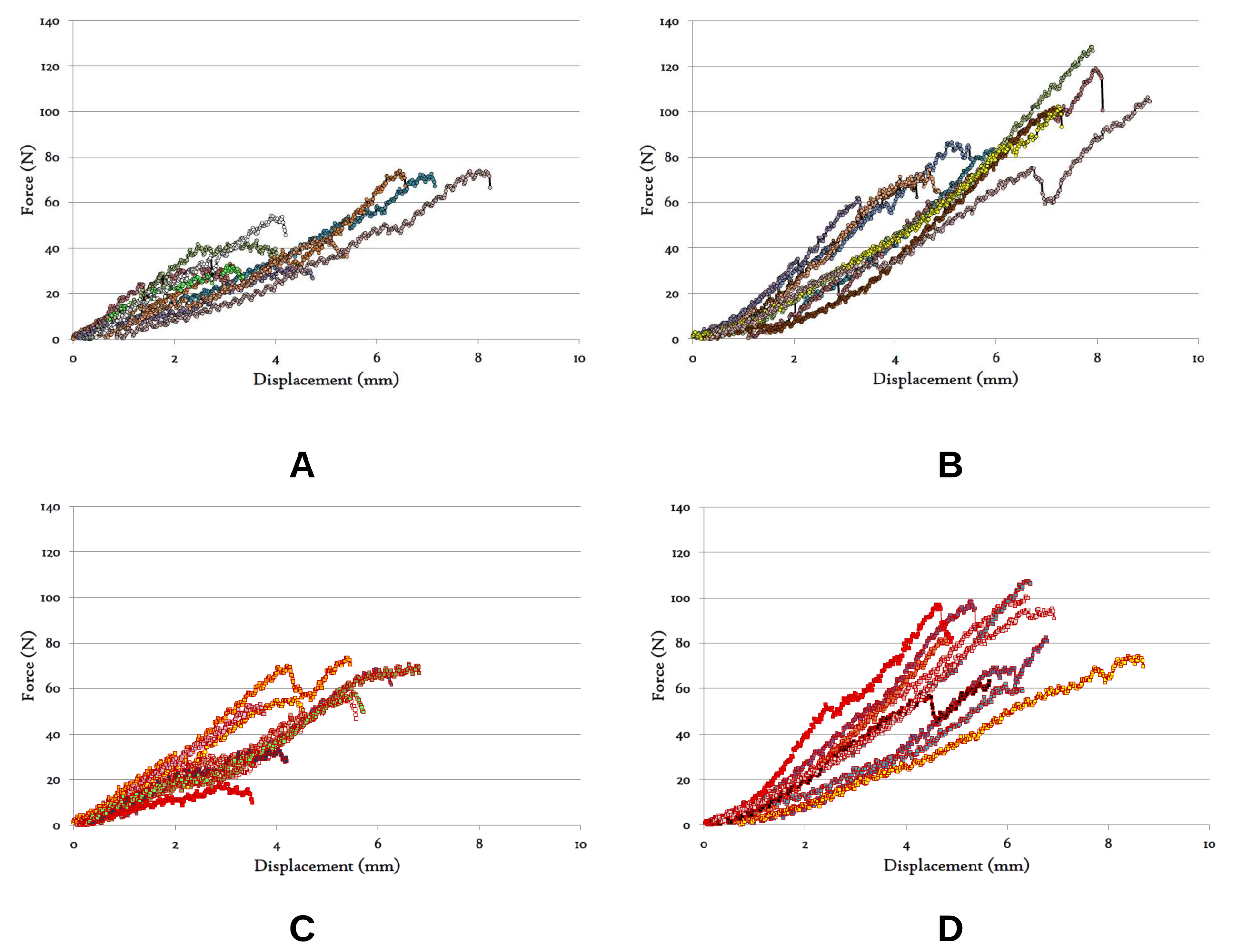


Figure 4: Force-displacement plots of middle and index fingers prepared with JuggerKnot anchor plus suture (anchor) and suture only (suture) through transverse bone tunnels. A. anchor middle, B. suture middle, C. anchor index, and D. suture index.

CONCLUSIONS

- **Failure of the soft anchor system would occur through pullout from bone prior to suture breakage**
- **Suture repair through bone tunnels provide higher strength and stiffness than the soft anchor system, but require more bone and soft tissue disruption**
- **Results of this study are favorable when compared with published results of ultimate load using metallic anchors (UL=22.3+-4.7N) or horizontal mattress suture (UL=24.7+-5.5N) techniques[1]**

CLINICAL RELEVANCE

- **UL of the soft anchor is higher than the UL found in published studies which show failure is likely to occur at the suture/tendon interface before soft anchor pullout occurs – making it a viable alternative to metallic anchor repair**

REFERENCES

- **[1] Cluett J, Milne AD, Yang D, Morris SF. J Hand Surg Br. 1999;24(6):679-682.**

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