Isolated Thumb Carpometacarpal Joint Dislocations With and Without Suture Augmentation: A Biomechanical Study

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Background

- Optimal management of dislocations remains unclear
- Biomechanics surrounding the injury are more obscure
- Treatment options include immobilization, immediate ligament reconstruction, suture anchor repair, and K-wire stabilization

Methods

1. 12 CMC joints were dissected of bony and soft-tissue structures expect: trapezium and ligamentous/capsular structures
2. Ligamentous structures were measured with a caliper
3. First metacarpal potted in PVC with Bondo
4. Loaded metacarpal perpendicular to the long axis of an Instron E10000
5. Cyclic loading at 1 mm/s, hold for 2 seconds, five times to avoid exceeding 20% of failure load
6. 30 N Pre-load applied to mimic posteriorly-directed hyperflexion through the CMC joint
7. Load to failure applied at 1 mm/s until posterior CMC dislocation was achieved
8. Native ligament repaired using 1.3 mm flat suture tape with 3.5 mm X 8.5 mm DX Swivel lock anchor (Arthex, Naples Florida)
9. Repeat steps 4 - 7 on reconstructed ligament

Objectives

- Provide anatomical data of the dorsal ligamentous complex of the CMC joint
- Achieve a laboratory produced dorsal thumb CMC dislocation to accurately describe injury pattern
- Analyze biomechanics of ligamentous complex of the CMC joint as well as a ligament repair with a suture augmentation technique

Results

Table 1: Anatomical Measurements

	Length (mm)	Mid-Substance Width (mm)	Proximal Attachment Distance to CMC joint (mm)	Distal Attachment to CMC Joint (mm)
Dorsal Radial Ligament	14.3 ± 2.41	8.02 ± 1.77	7.63 mm ± 2.10	6.18 mm ± 1.24
Posterior Oblique Ligament	16.2 ± 2.54	3.69 ± 0.80	7.20 mm ± 3.14	7.03 mm ± 1.76

Table 2: Biomechanical Measurements

	Native Ligament	Reconstructed Ligament	P value
15 N Cyclic Load Displacement	2.84 mm ± 0.12	3.47 mm ± 0.22	0.202
Load to Failure	217.76 N ± 66.03	94.62 N ± 39.77	<0.001
Displacement	14.48 mm ± 6.54	11.92 mm ± 4.33	0.068
Stiffness	19.36 N/mm ± 9.56	8.66 N/mm ± 3.41	0.002

Figure 1: Native ligament mid-substance failure n=12

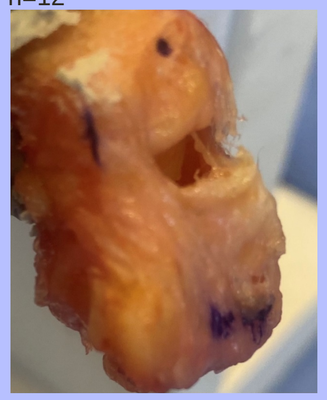


Figure 2: Reconstruction failure - suture stretched without rupturing n=11

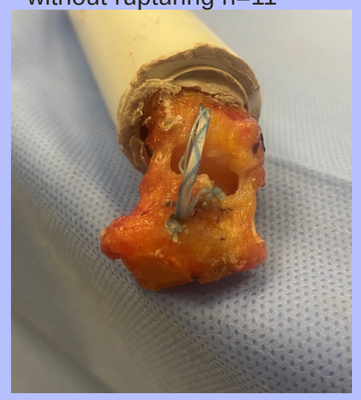
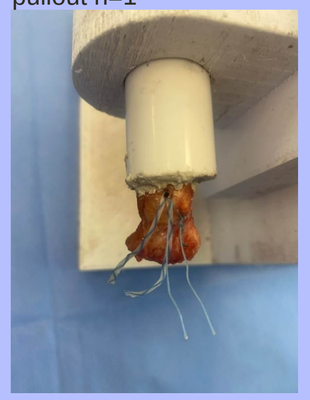


Figure 3: Reconstruction failure - distal anchor pullout n=1



Discussion

- CMC joint dislocations account for less than 1% of hand injuries
- The CMC joint is unstable due to its saddle shape and surrounding ligaments/capsule
- Our anatomical results were comparable to previous reported findings by Ladd and Bettinger
- This research describes a reconstruction technique using two suture anchors which yielded some return of biomechanical strength to the CMC joint

Conclusions

- The ultimate failure load of the repaired ligaments with suture augmentation was about half of that of the native ligaments
- Native ligaments were twice as stiff as reconstructed ligaments
- Ligament reconstruction and the dynamic stabilizers provide enough stability in the post-repair period to reduce the need for k-wire fixation or complete immobilization

Limitations and Future Work

- Limitations include: cadaver age, not testing dynamic stabilizers, inability to directly measure stiffness
- Future work includes research on younger specimen and clinical trial of suture augmentation

References

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