

Biomechanical comparative study of the JuggerKnot™ soft anchor technique with other common mallet finger fracture fixation techniques

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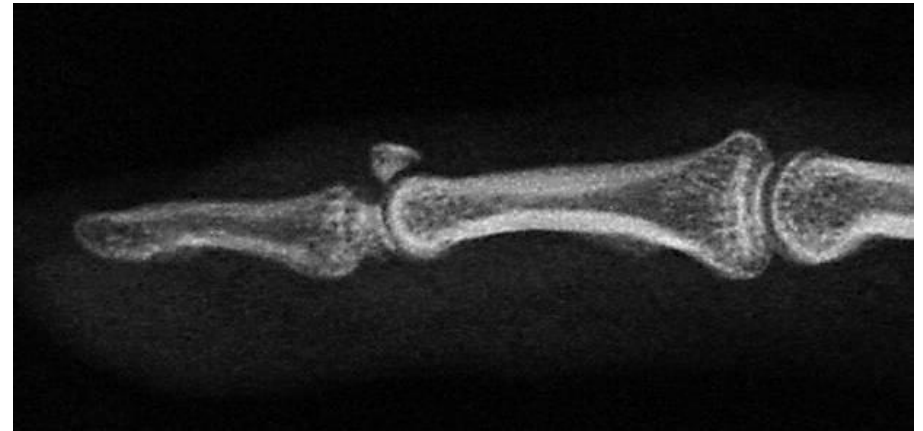


Study Disclosures

- I have no financial disclosures to report



Mallet Finger Deformity



Splinting

- Cumbersome
- Compliance issue



Operative

- Open injury
- Cannot tolerate splinting
- Large avulsion fracture
 - >30% of articulation

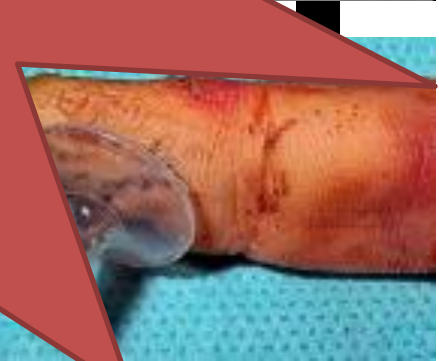
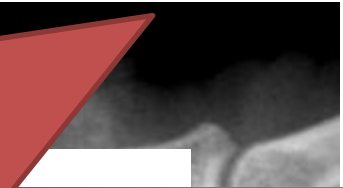


Fixation Methods

- Kirshenbaum
- extensile

All Methods Require
Immobilization!

- He
- P
- Tension band
- Umbrella handle



Study Aims

- A biomechanically sound device
 - Early mobilization without protection
 - DIPJ mobilization has force of 5.6N (Husain JHSA 2008)
- Less soft tissue complications
- Biomechanical study
 - Peak load resistance to flexion of DIPJ
 - How do suture anchors compare?



Methods

- 32 specimens (8 fresh frozen cadaveric human hands)
 - 8 of each finger
 - No thumbs
- 8 specimens for trial of procedure
- 24 specimens for analysis



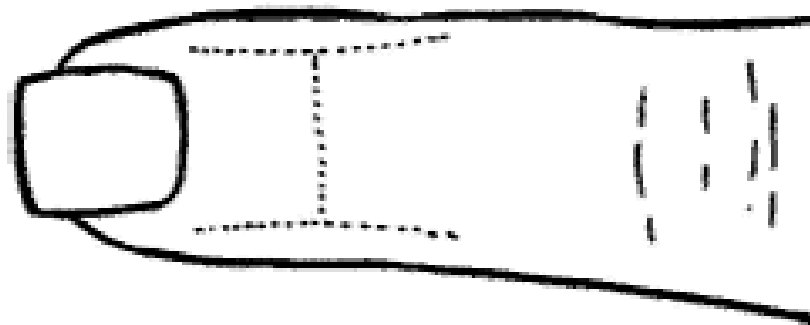
Preparation

- Thawed to room temperature (24°C)
- Amputated at PIPJ
- Sparing of extensor tendon to wrist level
- Nails intact
- None had OA joints and bone defects

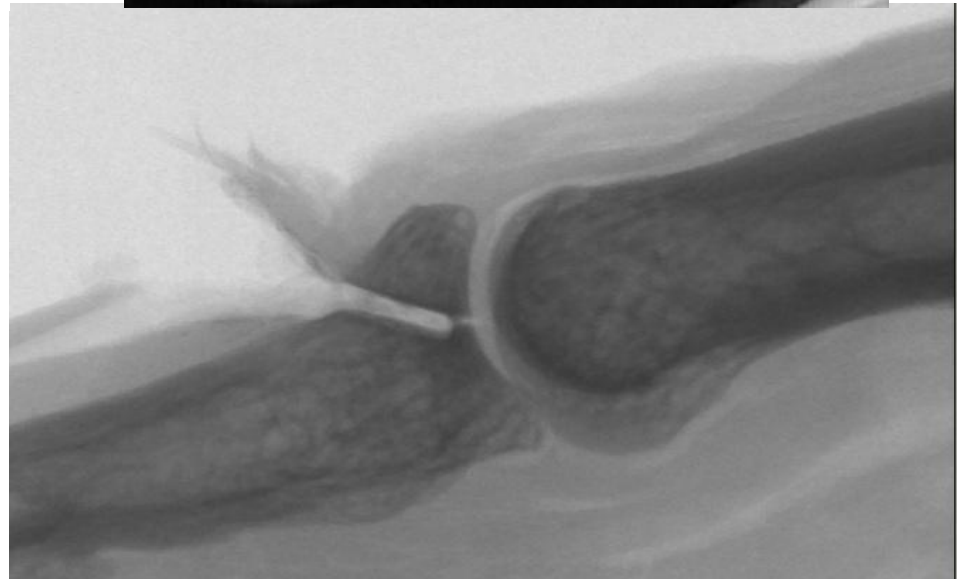
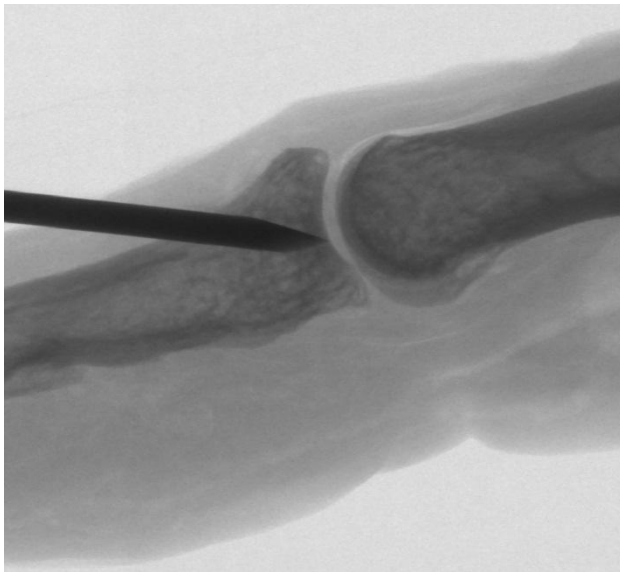


Preparation

- H-shaped skin incision at dorsal of DIPJ
 - Osteotomy
 - Fixation
- Fluoroscopic guidance



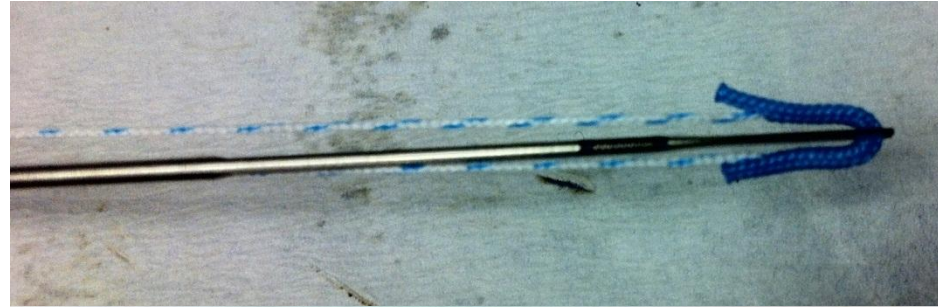
Fragment Sizing



Fixation Methods

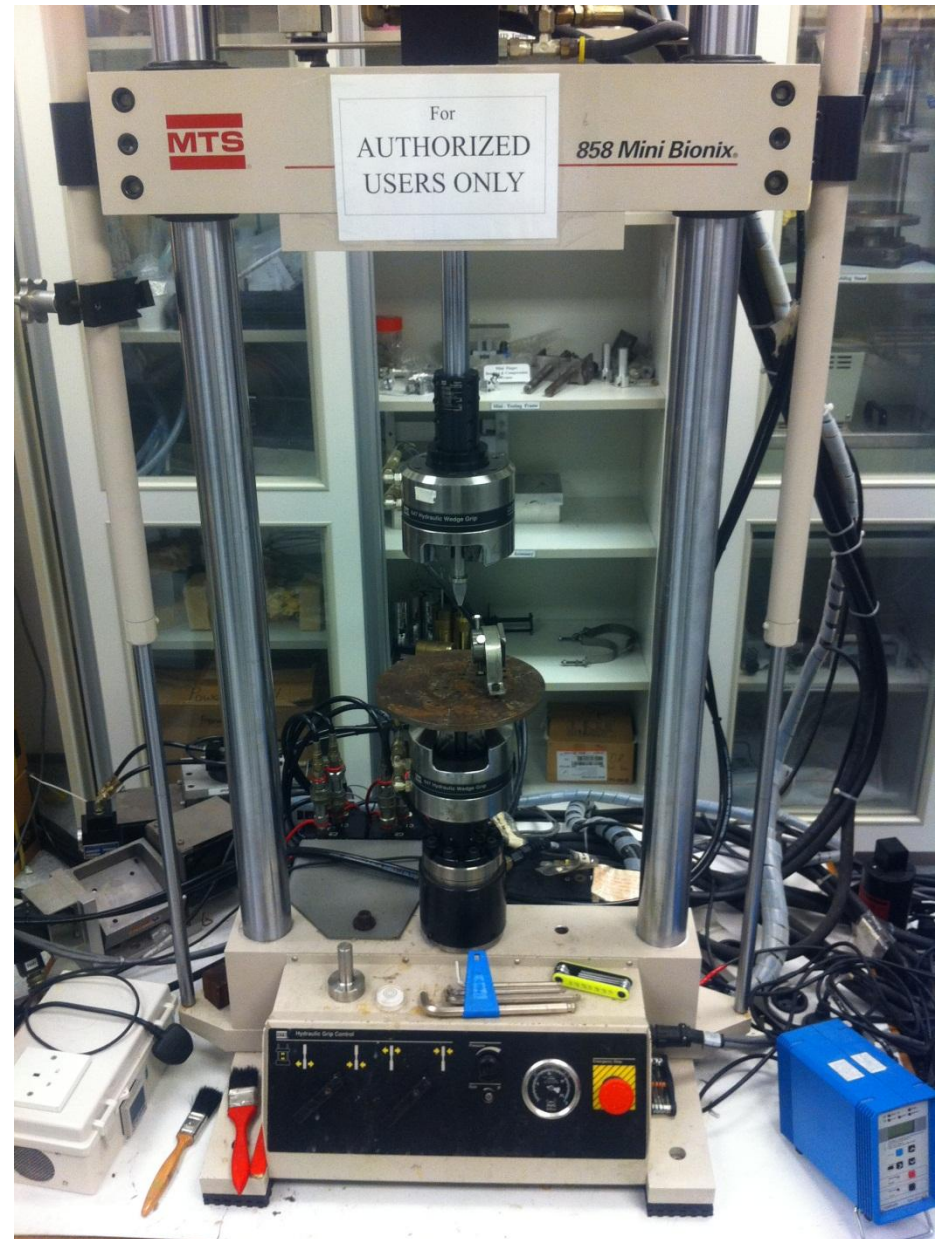
- Kirschner wire
- Pull-out wire
- Tension-band wiring
- Suture Anchor
 - JuggerKnot™

- Randomized block pattern distribution



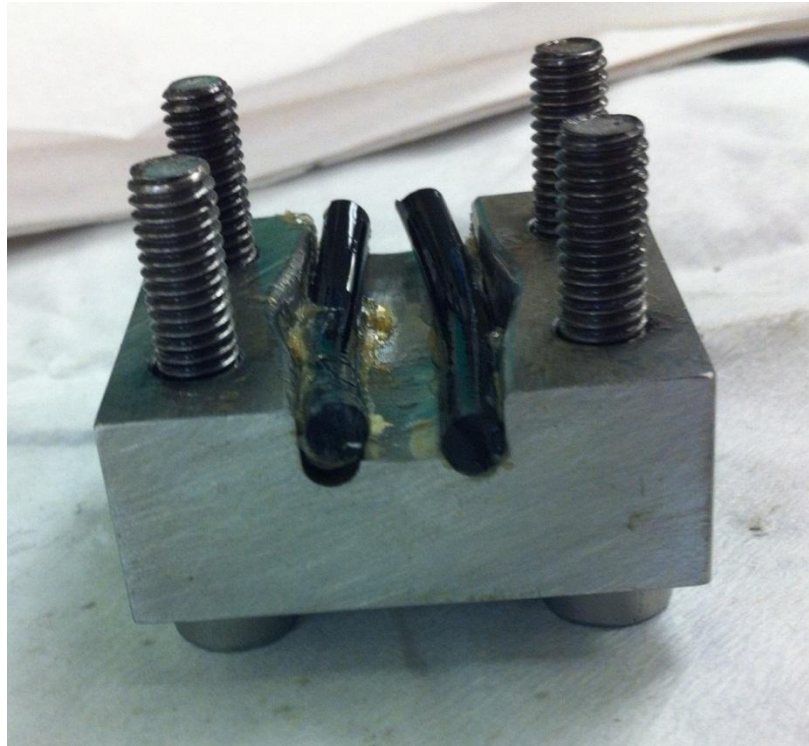
Biomechanical Testing

- MTS 858 Mini Bionix servo-hydraulic load frame



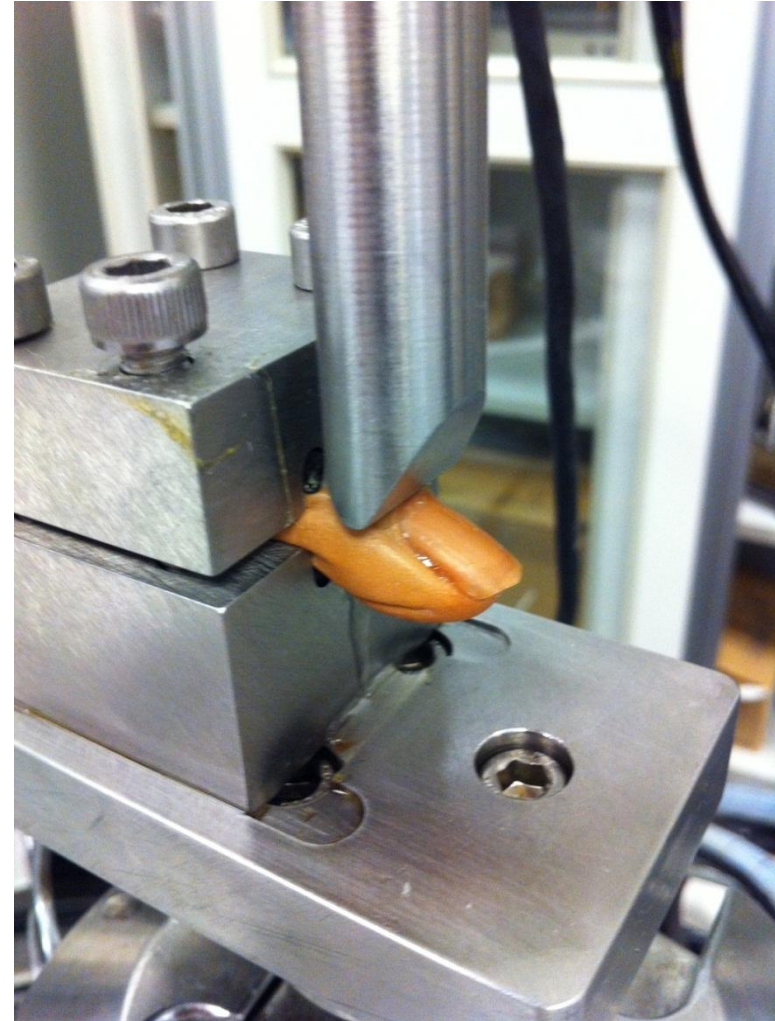
Mounting Device

- 4N torque screws
- 10N preloaded extensor tendon
- Testing apparatus with clamping device



Biomechanical Testing

- Peak load resistance
- Load testing at DIPJ flexion
 - 30 degrees
 - 45 degrees
 - 60 degrees
- Speed: 10cm/s
- Load distance: $\tan \theta$ of mount to nail fold



Biomechanical Testing

- Complications
 - Implant failure
 - Loosening of knot, pull-out of implant, implant fracture
 - Fixation failure
 - >1mm widening of fracture site



Comparability between Digits

Average Peak Load



No differences between Digits

		Mean (N)	Range (N)	Standard Deviation	p-value
Before osteotomy	30°	16.45	8.45-31.25	1.14	0.370
	45°	31.32	16.39-52.50	8.79	0.342
	60°	57.01	24.26-88.47	19.52	0.450
After fixation	30°	18.88	7.10-50.18	11.03	0.549
	45°	30.48	11.70-80.80	17.66	0.505
	60°	44.27	17.50-98.80	21.25	0.515



Comparison between Fixation Methods

Peak Load Analysis



TBW Strongest Fixation

Suture Anchor Strong Enough to Resist Normal DIPJ forces

Fixation method	Before osteotomy: N (\pm SD)			After fixation: N (\pm SD)		
	30°	45°	60°	30°	45°	60°
Kirschner wire	12.37 (\pm 2.67)	23.73 (\pm 6.67)	45.75 (\pm 22.14)	11.86 (\pm 3.07)	21.13 (\pm 5.41)	39.42 (\pm 16.60)
Pull-out wire	19.01 (\pm 6.27)	34.80 (\pm 9.20)	58.41 (\pm 19.29)	18.40 (\pm 7.91)	25.60 (\pm 7.73)	36.92 (\pm 9.07)
Tension-band wire	17.51 (\pm 4.41)	33.75 (\pm 6.71)	62.71 (\pm 19.23)	31.91 (\pm 12.81)	52.69 (\pm 21.52)	67.80 (\pm 25.00)
Suture Anchor	16.93 (\pm 6.11)	32.99 (\pm 9.35)	61.17 (\pm 17.52)	13.35 (\pm 4.91)	22.51 (\pm 4.91)	32.96 (\pm 13.55)
p-value	0.161	0.099	0.446	0.001	0.001	0.008



Complications

- Dorsal skin impingement with TBW in 3 digits
- No implant failure
- No fixation failure



Discussion

- **Only** biomechanical study using suture anchors for mallet injuries
- **Randomization**
- **Standardized** biomechanical testing
- All fixation methods can withstand normal DIPJ movement in terms of peak load resistance



Future Studies

- Information on fatigue failure?
- Animal studies for healing potential
- Clinical trials for applicability in clinical setting



Thank You

