

Efficacy of common stabilization techniques to protect the ulnar collateral ligament of the thumb: a cadaveric study

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INTRODUCTION

- The thumb accounts for 40-50% of total hand function and is important for everyday activities, especially those involving grip or pinching motions.¹
- Common injuries to the thumb involve the ulnar collateral ligament (UCL), located at the 1st metacarpophalangeal (MCP) joint (Figure 1).²
- 86% of injuries occurring at the MCP joint involve the UCL.^{2,3}
- Injury is often referred to as Gamekeeper's or Skier's thumb.
 - Accounts for up to 32% of all skiing injuries²
 - Prevalent in football and other contact sports
- Mechanism of injury involves forceful abduction of the thumb at the MCP joint and can be chronic or acute.^{1,2}
- Return to play often involves some type of protection with taping or bracing.
- The primary objective of this study was to evaluate the effectiveness of various stabilization techniques for the UCL of the thumb in fresh cadaveric specimens.
- A secondary objective of this was to quantitatively analyze the anatomical differences between male and female UCLs.

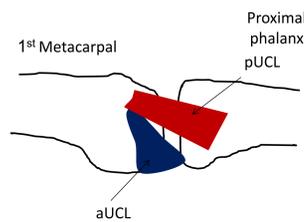


Figure 1: Structure of the UCL of the thumb; proper ulnar collateral ligament (pUCL) and accessory ulnar collateral ligament (aUCL)

MATERIALS & METHODS

- 8 fresh cadaveric specimens were obtained from the Division of Anatomy Body Donor Program at The Ohio State University.
- Anthropometry measurements were taken first, which included hand, palm, and thumb lengths, hand breadths, thumb and circumference, and range of motion at the MCP joint.
- Next, Four conditions were assigned in random order for each specimen:
 - (1) Control (no stabilization device), (2) Thumb spica tape job, (3) Thumb abduction tape job, (4) Over the counter spica brace
- Test set-up:
 - The forearm and hand were stabilized using a custom wood apparatus (Figure 2a).
 - A hose clamp was positioned on the thumb 15 mm distal to the MCP joint.
 - A cable was connected from the hose clamp and was attached to a Teflon rail guided drop tower (Figure 2b).
 - 131 N of force was applied through the impact load transfer system, resulting in a direct and forced thumb abduction.
 - Previous studies determined load to failure to range from 111 N to 166 N³ and is heavily debated in the literature
- Force, velocity, acceleration, and energy were recorded for each test using TDAS control and a g5 block.
- Abduction angles were measured using TEMA software (Figure 2c).

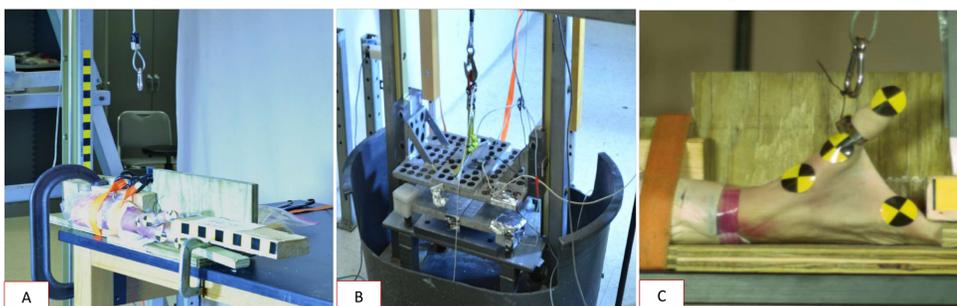


Figure 2: A) Custom wooden splint apparatus B) Teflon rail guided drop tower C) measurement of maximum abduction angle at impact (TEMA)

- Each fresh specimen was dissected (Figures 3 & 4).
- The UCL was located and the ligament length and width was measured.



Figure 3: Fresh cadaveric specimen dissection



Figure 4: Close-up of UCL dissection

RESULTS

- 8 fresh cadaveric specimens (4 males, 4 females) with a mean age of 79 ± 8 years were evaluated.
- Prior to testing, range of motion at the MCP joint measured 32° ± 8°
- Mean rate of abduction for each trial was 1,100 mm/s and mean time between trials 11 min ± 3.
- Each stabilization condition significantly reduced mean thumb abduction angles compared to the control (Figure 5).
 - Thumb spica tape job = 59.9% reduction in abduction
 - Thumb abduction tape job = 78.8% reduction in abduction
 - Over the counter brace = 57.7% reduction in abduction

Specimen	Age	Sex	Hand Length (mm)	Palm Length (mm)	Hand Breadth (mm)	Thumb Length (mm)	Thumb Circumference (mm)	Range of Motion (MCP) (degrees)	UCL Length (mm)	UCL Width (mm)
1	76	M	18.9	9.8	9.1	6.5	7.9	23	11.6	3.5
2	64	M	18.5	10.9	7.8	6.9	6.9	34	14.5	5.1
3	89	F	18.6	10.5	7.2	7	5.5	34	13.6	6.8
4	81	F	18.0	9.8	7.9	6	7.2	42	11.9	5.1
5	86	M	19.4	10.6	8.3	7.6	7.1	24	11.2	4.0
6	84	F	16.5	9.8	7.1	5.7	7.0	46	11.7	4.7
7	74	F	15.8	9.0	6.8	5.8	21	25	8.8	3.6
8	76	M	18.8	10.9	7.8	7.4	6.5	30	12.0	5.0
Mean	79		18.1	10.2	7.8	6.6	6.7	32	11.9	4.7
Std. Dev.	8		1.3	0.7	0.7	0.7	0.8	8	1.7	1.1

Table 1: Anthropometric measurements

- Anthropometry measurements of the male specimens were significantly larger than the females (p<0.05) (Table 1).
 - Hand length, palm breadth, thumb length, hand breadth, thumb length, thumb circumference, ROM
- However, no significant difference in UCL dimensions were found between males and females in both the embalmed and fresh cadaveric specimens (p<0.05) (Figure 6).

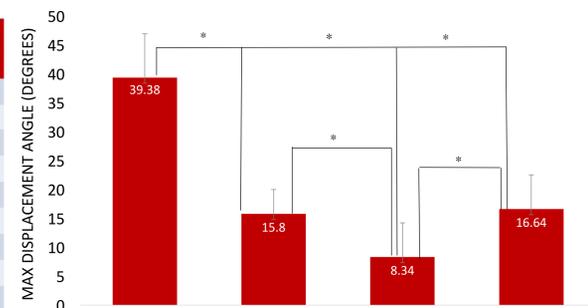


Figure 5: Fresh cadaveric abduction angles for each stabilization condition

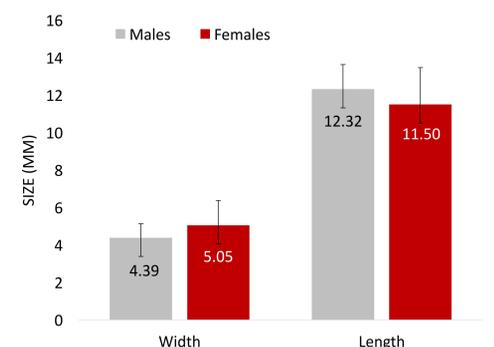


Figure 6: UCL dimension comparison (length and width) between males and females

DISCUSSION & CONCLUSIONS

- The primary objective of this study was to evaluate the efficacy of common stabilization techniques to decrease abduction angles of the thumb, ultimately protecting the UCL at the MCP joint.
- The most effective stabilization condition was the abduction tape job, followed by the spica tape job, Mueller brace, and the control.
- Embalmed specimens provided pilot data to guide fresh specimen test set-up.
- The mean abduction angle during dynamic testing for the control condition (39.38°) was similar to previous literature (32.6°).¹
- The mean abduction angle of all the stabilization techniques (13.59°) demonstrated a greater reduction of thumb abduction than with a custom orthosis (24.0°).¹
- The abduction rate in the current study was more realistic to the acute injury mechanism at 1,100 mm/s, in comparison to previous literature at 1.0 mm/s and 0.1 mm/s.^{1,3}
- Limitations include the sample size, fit of the over the counter brace, exact tension and placement of tape, including the distance past the MCP joint of the thumb.
- The UCL is vulnerable to injury and poorly protected. Protection is critical to return to activity following injury.
- We successfully designed a dynamic model that evaluate thumb abduction at over 1,100 mm/s consistently.
- Understanding the overall efficacy of these common stabilization techniques may aid clinicians in further understanding how to best protect the UCL from injury.

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