

Biomechanics of Thumb Metacarpophalangeal Joint Ulnar Collateral Ligament Injury: A Cadaveric Study

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Disclosures:

INTRODUCTION: Injury to the ulnar collateral ligament (UCL) of the thumb can result in pain, instability, and loss of function. This cadaveric study evaluated injury patterns, force requirements, and demographic differences in UCL disruption secondary to valgus loading in effort to better understand this injury.

METHODS: 24 fresh frozen cadaveric upper extremity specimens (12 matched pairs) without prior musculoskeletal pathology were obtained from an accredited tissue bank. Demographic data including sex and age at time of donation were obtained. Specimens were disarticulated at the carpometacarpal (CMC) joint; the MP joint was isolated and the UCL exposed. The metacarpal was stabilized and the proximal phalanx was loaded with valgus force at a rate of 0.1 mm/s until both clinical and structural failure occurred. Clinical failure was defined as 30-degree angular valgus deflection across the MP joint or approximately 11.5 mm of vertical displacement across the MP joint. Structural failure was identified by a decrease in resistance to applied load. After testing, two independent reviewers evaluated each specimen to determine failure characteristics (anatomical failure location, ligamentous rupture vs fracture). Student's t test and Pearson correlation were used to compare subgroups based on demographic data (significance <0.05).

RESULTS: Ligamentous rupture at the distal UCL insertion occurred in 58% (14/24) of specimens compared to 21% (5/24) at the proximal UCL origin, and 8% (2/24) within mid-substance. Fractures at the proximal phalanx base occurred in 13% (3/24). Mean valgus force to induce clinical failure and mechanical failure were 137.2 +/- 44.1 N and 189.2 +/- 59.3 N, respectively. Mean angular displacement across the joint at the time of mechanical failure was 36.8 +/- 9.9 degrees. Increasing age of specimen at time of donation demonstrated a strong-to-moderate inverse correlation with force required to cause both clinical (R = -0.60, p = 0.004) and mechanical failure (R = -0.46, p = 0.024). Increasing BMI demonstrated a moderate direct correlation with force to clinical failure (R = 0.44, p = 0.031), but not mechanical failure (R = 0.21, p = 0.330). Specimens from female donors exhibited mechanical failure under less valgus force compared to male specimens (mean 154.5 +/- 32.4 N vs 200.8 +/- 62.3 N; p = 0.031).

DISCUSSION: Traumatic injury to the UCL from valgus force most commonly results in ligamentous injury at its distal insertion, followed by its proximal origin. These injuries occur when approximately 190 N of valgus load is applied. Female sex and increasing age may be risk factors for UCL injury due to inherent differences in ligament laxity and tensile strength.

SIGNIFICANCE/CLINICAL RELEVANCE: These findings help characterize biomechanical properties of the thumb UCL and elucidate epidemiologic risk factors that may predispose certain populations, such as women and older individuals, to UCL injury.

IMAGES/TABLES:

Figure 1: Decreasing Loads to Failure with Increasing Age

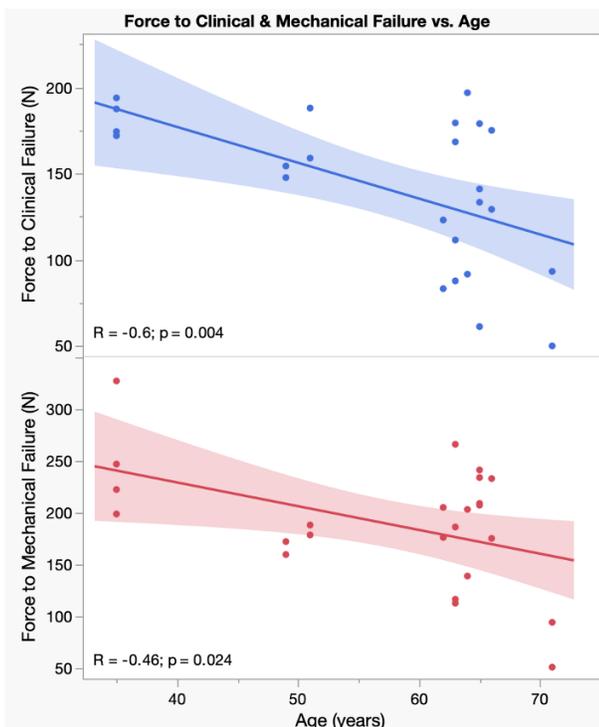


Figure 2: Decreasing Loads to Failure with Increasing BMI

