Morphometric Evaluation of Collateral Ligaments of the First Metacarpophalangeal Joint

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Abstract

Introduction The collateral ligaments of the first metacarpophalangeal (MCP) joint provide stability to the thumb. Injury to these collateral ligaments occurs more commonly in sports accidents leading to joint instability, weakness in pinch and grip strength. Normal morphometric measurements of collateral ligaments are essential for primary repair or reconstruction of the injured ligament. Hence, the objective of the study is to give the detailed morphometric profile of the proper collateral ligaments of the MCP joint of the thumb.

Materials and Methods A total of 55 adult cadaveric hands were included in the study taken from 18 male (36 hands) and 10 female (19 hands) cadavers. Out of 55 hands, 28 belonged to the left side, while 27 were of the right side. The MCP joints were dissected to expose the collateral ligament complex. The length and width of the proper ligaments were measured.

Results Both the proper collateral ligament attachments and the direction of the fibers were defined. Overall length and the width of both the proper collateral ligaments showed no statistically significant difference of mean between the left and the right sides. However, the length of both the proper collateral ligaments is significantly less in females compared with the males.

Conclusion The morphometric details of the proper collateral ligaments obtained from this study would be useful for hand surgeons during surgical correction of the injured collateral ligaments either by primary repair or reconstruction with a tendon graft.

Keywords

- collateral ligaments
- thumb
- morphometry
- reconstruction

Introduction

Thumb injuries comprise 5% of cases treated in emergencies. One-fifth of these injuries involve the ligament of the metacarpophalangeal (MCP) joint.¹ This MCP joint is a diarthrodial ginglymoid type which provides stability to the thumb. It helps perform movements such as flexion and extension predominantly with limited abduction and adduction. The interphalangeal and the carpometacarpal joints enable mobility of the thumb.^{2,3} The static support to first MCP joint is provided by the radial collateral ligament (RCL), ulnar collateral ligament (UCL),

extensor hood, and the volar plate.⁴ Of these, the RCL and the UCL provide the mediolateral stability as well as dorsal support to the joint. Both the collateral ligaments consist of a proper ligament and accessory ligament. Stability of MCP joint in flexion is provided by the proper collateral ligaments which become taut with concurrent laxity of the accessory ligament and the reverse occurs during extension with stability being provided by the accessory collateral ligament.⁵ Injuries to the proper collateral ligaments lead to symptomatic joint instability with subsequent pain and weakness of the joint resulting in diminished pinch and grip strength.⁵ Primary osteoarthritis of the first

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MCP joint is not common but secondary osteoarthritis following trauma to collateral ligaments is common if left untreated.⁶ Injury to the UCL is more common than RCL and accounting for 60 to 90% collateral ligament injury of the MCP joint.² Incidence of RCL injuries reported in all cases of collateral ligament injury is around 10 to 33%.⁴ Acute injuries of the collateral ligament resulting in partial laceration or complete rupture presenting early are treated by cast immobilization or immediate repair. However, in case of the instability of the MCP joint due to chronic laxity of the ligaments, inadequate treatment after acute injury, failed primary repair, or complete ligament tear presenting lately with unidentifiable and shrunken stumps, either local repair in conjunction with tendon advancement or ligament reconstruction with the tendon graft is done.^{4,6,7} Nonanatomic reconstruction techniques often lead to a compromised range of motion or joint instability.^{2,8-10} There is paucity of literature regarding the morphometry of these ligaments in detail. Hence, we have taken up the study to document the morphometry of both proper UCL and RCL which could be used in the reconstruction or tendon graft to stabilize the MCP joint.

Materials and Methods

The study includes 55 fresh frozen adult cadaveric thumbs of both sexes (18 males and 10 females). It was conducted from the cadavers donated to the department of anatomy, Jawaharlal Institute of Postgraduate Medical Education and Research, Pondicherry through the institutional body donation program following the ethical guidelines. The clearance was obtained from the institute ethics committee. The study has been conducted ethically according to set international standards and meets the ethical standards of the journal.¹¹ Thumb was kept in extended position and a midline longitudinal skin incision was made in the palmar aspect of the thumb from its tip to the base at carpometacarpal joint. Deep dissection was performed and the superficial fascia, the digital nerves, and arteries were retracted to expose the MCP joint. The distal attachment of the thenar muscles is detached from the base of the radial side of the proximal phalanx. The adductor pollicis and the first palmar interosseous insertion in the ulnar side of the thumb are also detached. The extensor hood over the dorsal aspect of the MCP joint was cleared from the ligaments. After distinguishing both the RCL and the UCL from the joint capsule, the capsule is excised and removed. The overall length and the breadth of the proper collateral ligaments were measured using Mitutoyo digital vernier caliper to the nearest millimeters in the extended position of the joint (►Figs. 1 and 2). The length was measured along the long axis of the ligaments and the breadth was measured in the middle of the ligament.

Statistical Analysis

The variables measured were expressed in mean, standard deviation, and range. Comparison of the significant difference in the mean between both sides was tested using paired sample *t*-test and between the genders were done using independent sample *t*-test. The *p*-value of less than 0.05 was considered statistically significant at 5% α error with 95% confidence interval. The statistical analysis was performed using SPSS software version 19.

Results

A total of 55 thumbs were dissected and the attachment of the proper collateral ligament was studied. The attachment of the proper RCL was from the dorsolateral aspect of the lateral condyle of the metacarpal head to the palmar aspect of the lateral tubercle of the proximal phalanx, whereas the proper UCL was attached from dorsomedial aspect of the metacarpal head to the palmar aspect of the medial tubercle of the proximal phalanx. Both the collateral ligaments were rectangular in shape and the fibers are directed from proximal dorsal to the distal palmar aspect. The overall length and width of the proper UCL and RCL are given in ►Table 1. The overall length of the UCL was comparatively lower than that of the RCL. The length of both the RCL and the UCL was significantly lower in

Fig. 1 Measurement of the proper radial collateral ligament. Blue star, accessory radial collateral ligament; L, length; red star, proper radial collateral ligament; W, width; yellow arrow, the gap between the proper and accessory radial collateral ligaments.

Fig. 2 Measurement of the proper ulnar collateral ligament. The accessory ulnar collateral ligament has been removed. L, length; W, width.

Table 1 Overall length and width of the proper RCL and UCL

Proper collateral ligament	Overall length (mean $\pm$ standard deviation) (mm)	Range (mm)	Overall width (mean $\pm$ standard deviation) (mm)	Range (mm)
RCL	13.52 $\pm$ 1.62	10.24–16.67	4.87 $\pm$ 0.64	3.81–6.42
UCL	12.51 $\pm$ 1.41	7.42–15.59	4.29 $\pm$ 0.56	2.71–5.84

Abbreviations: RCL, radial collateral ligament; UCL, ulnar collateral ligament.

Table 2 Comparison of length and width of the proper collateral ligaments between male and female

Ligament	Measurement	Male (36) Mean $\pm$ standard deviation (mm)	Female (19) Mean $\pm$ standard deviation (mm)	Independent sample <i>t</i> -test (<i>p</i> -Value)
Radial collateral ligament	Length	13.84 $\pm$ 1.58	12.90 $\pm$ 1.54	0.038
	Width	4.89 $\pm$ 0.65	4.82 $\pm$ 0.62	0.715
Ulnar collateral ligament	Length	12.88 $\pm$ 1.16	11.81 $\pm$ 1.6	0.006
	Width	4.28 $\pm$ 0.58	4.29 $\pm$ 0.50	0.965

Table 3 Comparison of length and width of the proper collateral ligaments between both sides

Ligament	Measurement	Left side (28) Mean $\pm$ standard deviation (mm)	Right side (27) Mean $\pm$ standard deviation (mm)	Paired sample <i>t</i> -test (<i>p</i> -Value)
Radial collateral ligament	Length	13.43 $\pm$ 1.64	13.61 $\pm$ 1.61	0.50
	Width	4.77 $\pm$ 0.59	4.96 $\pm$ 0.68	0.21
Ulnar collateral ligament	Length	12.50 $\pm$ 1.63	12.53 $\pm$ 1.17	0.90
	Width	4.31 $\pm$ 0.43	4.26 $\pm$ 0.66	0.73

females than males (**Table 2**). However, there was no significant difference of mean of both the UCL and RCL between the left and the right sides (**Table 3**).

Discussion

The collateral ligaments are the strong, round cords that support the joints. The proper UCL originates from dorsoulnar aspect of posterior tubercle on the metacarpal head and travel in distal palmar direction to the medial tubercle of proximal phalanx, whereas the proper RCL originates from dorsoradial aspect of the center of the lateral condyle on the metacarpal head and travel in a distal palmar direction to the lateral tubercle of the proximal phalanx. The UCL is strengthened by the thin layer of adductor pollicis aponeurosis and the RCL by abductor pollicis brevis and flexor pollicis brevis. Both the UCL and the RCL including the proper and the accessory ligaments have been measured to be 4 to 8 mm in width and 8 to 12 mm in length. Ladd et al documented the length and width of UCL as 9.36 ± 0.60 and 4.27 ± 0.26 , respectively.¹²⁻¹⁵

Thumb UCL injury is more common than the RCL injury. Since the intrinsic anatomy of the radial side of the MCP joint differs from that of the ulnar side, injury to these ligaments results in distinctive instability pattern. Rupture of UCL result in addition to dorsal capsule tear results in radial and palmar subluxation, whereas disruption of the RCL rupture with unopposed pull of adductor pollicis is prone to ulnar and palmar subluxation.¹⁶

Acute UCL rupture occurs frequently at distal attachment site with or without interposition of adductor pollicis aponeurosis. The former is termed as Stener lesion. However, proximal avulsion, proximal or distal bony avulsions, and midsubstance tear with or without bony avulsion of both the attachment sites do also occur. Acute UCL ligament rupture is commonly called as skier's thumb as it was reported frequently in the skiing sports accident. Supportive treatment

has been advised for acute injuries with a mild sprain, partial ligament tear, and nondisplaced or minimally displaced avulsion fractures of the UCL either with functional bracing or via thumb spica casting or splinting. However, for the Stener lesion, surgical repair is done. Various surgical options are available for treating acute injuries such as primary repair by direct suturing of the ligament at the point of rupture, bony tunnels and pullout sutures for distal avulsion, tension band fixation of the bony avulsion, and direct repair using various bony anchors.^{1,17} Adequate length and quality of the native tissue are essential for acute ligament repair. If there is either lack in length of stump of the ligament or quality, reconstruction with tendon graft should be considered.¹⁸

Chronic instability of the UCL could be due to the failure or lack of treatment of an acute injury or progressive attenuation of the remnant ligament. Reconstruction is a better option for these older injuries if the tissue quality or length is inappropriate for primary repair.¹⁸ In other chronic cases, ligament reconstruction with tendon graft and/or adductor advancement is done.¹⁷ The repetitive valgus strain to the thumb MCP joint leads to chronic laxity of the UCL. Campbell observed this type of lesion in British gamekeepers and coined the term gamekeeper thumb. This stretched and lax ligament is treated by shortening and plication.¹ In this condition, excessive shortening may lead to decrease in joint motion or inadequate shortening may lead to persistence of the laxity.

Similar to UCL, the RCL tear can also occur at any site of the ligament with proximal tear, more common. Because of the absence of a Stener-like lesion in RCL injury, immediate open repair is not indicated. Cast immobilization is recommended for partial rupture. Controversies exist in the treatment of acute complete RCL rupture regarding cast immobilization or direct repair. Treatment for chronic RCL injuries includes direct repair or RCL free tendon graft with or without soft tissue reconstruction.^{19,20} Tendons that have been harvested for reconstruction of both the proper UCL and RCL are palmaris longus, abductor pollicis longus, abductor pollicis

brevis, extensor pollicis brevis, extensor indicis proprius, flexor carpi radialis, and adductor pollicis for either as a free graft or as local tissue advancement.⁵

Factors that affect the normal mechanics of the joint after ligament reconstruction are ligament attachment site, ligament stretch, eccentric lay within a bone tunnel, and direction. Bean et al have shown the isometric attachment point for the UCL, to optimize MCP range of motion. However, this technique resulted in the limitation of the joint movement in flexion.⁸ Carlson et al have proved that native anatomic reconstruction of both the collateral ligaments restored the joint function without significant loss of MCP flexion. They generalized their results such that the attachment site of both the proper collateral ligaments 3 to 5 mm proximal to the articular surface of the metacarpal bone and 3 mm distal to the articular surface of the proximal bone.²

After knowing both the proper collateral ligament native attachment sites, maintenance of the appropriate dimension of the ligaments should be ensured to maintain accurate ligament stretch and also to decrease the complication of joint instability after reconstruction or repair. The dimension of the proper UCL and RCL as per the present study may also help the surgeon in taking the appropriate size of the graft that has to be harvested for repair or reconstructive procedures and to overcome the problem of inadequate length to complete the transfer.

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Conflict of Interest

None declared.

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