Rev Bras Ortop. 2013;48(1):52-56

RBO REVISTA BRASILEIRA DE ORTOPEDIA
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Original Article

Anatomical parameters in the lateral ulnar collateral ligament reconstruction: a cadaver study

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ARTICLE INFO

Article history:
Received January 26 2012
Approved May 8 2012

Keywords:
Elbow/anatomy&histology
Elbow/surgery
Elbow Joint
Cadaver

ABSTRACT

Introduction: The purpose of this study was to indentify the ulnar insertion of the LUCL using the olecranon tip and the radial head as parameters to guide the ligament reconstruction surgery. *Methods*: Thirteen elbows of eight fresh cadavers were dissected for the study of the LUCL. The distances between the proximal and distal insertion of the LUCL (footprint), between the radial head and the footprint and between the olecranon tip and the footprint were measure with a digital pachimeter. *Results*: The average distance from the radial head to the proximal and distal ulnar insertion of the LUCL was 13.6 and 22.99 mm, respectively. The average distance between the olecranon tip and the proximal and distal ulnar insertion of the LUCL was 38.25 and 47.6 respectively. The mean length of the LUCL footprint was 9.35 mm. *Conclusions*: The LUCL insertion has a wide footprint with average 9.3 mm (7.5-11 mm). Ulnar insertion half point be located at 18.2 mm of the radial head and at 42.9 mm of olecranon tip.

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ISSN/$–see front matter
doi: 10.1016/j.rboe.2012.05.001

Introduction

The elbow has inherent bone stability due to its anatomical characteristics, but the structures of the adjacent soft tissues also contribute. The statistic stabilizers are the anterior and posterior capsules and the medial and lateral collateral ligaments, while the dynamic stabilizers are the muscles that cross the joint and compress the bone surfaces.[1]

Although acute dislocation of the elbow occurs frequently and is the second commonest among the major joints, chronic instability and recurrent dislocation have been less reported.[1,2] The commonest form of symptomatic chronic instability of the elbow is posterolateral rotatory instability (PLRI), in which the radius and ulnar rotate externally in relation to the distal humerus, leading to posterior dislocation of the radial head in relation to the capitellum.[3] According to O'Driscoll et al.,[4] the main factor responsible for this displacement is injury to the lateral ulnar collateral ligament (LUCL).

The lateral ligament complex may become injured consequent to trauma, iatrogenically or through chronic mechanical overload. Acute dislocation of the elbow is the main traumatic cause, through the axial overload mechanism and through supination and valgus, in which the capsule-ligament lesion progresses from lateral to medial locations.[5] Lesions of the lateral complex may occur iatrogenically following open or arthroscopic surgical release for lateral epicondylitis, through approaches to the radial head and even through serial infiltrations into the lateral compartment.[3,6,7] Chronic overloading of the elbow may also cause instability, such as in cases of cubitus varus and in patients who use crutches.[3,8]

In most cases, the symptoms of posterolateral chronic rotatory instability do not improve with conservative treatment and require surgical treatment involving repair, retensioning or reconstruction.[3,9]

Contrary to the medial complex, for which observations regarding its anatomical description have been concordant, there have been divergences in descriptions of the lateral complex, with regard to: the ligaments that form it, the types of insertion of the LUCL, its annular ligament (conjoined or separated) and the exact location of its insertion.[1,2,10-12] The lack of published studies and the low degree of unanimity regarding the location the ulnar insertion in reconstructions of the LUCL create difficulties in conducting procedures aimed towards achieving anatomical positioning.[9,13-16]

This study had the aim of identifying the ulnar insertion of the LUCL through using the olecranon tip and radial head as fixed parameters, thereby aiming to guide the positioning of the ulnar tunnel in ligament reconstruction surgical procedures.

Methodology

Fourteen elbows from seven chilled recent adult cadavers were studied. The cadavers did not have any congenital abnormalities, advanced arthrosis or signs of trauma or previous surgery. One of the elbows was rejected because it presented signs of an old fracture in the olecranon, thus resulting in 13 elbows, from six men and one woman, with a mean age of 66.4 years, ranging from 55 to 92 years. There were seven right elbows and six left elbows.

The dissections were performed by a single researcher. A pilot study had previously been conducted on four elbows from two cadavers, before any data-gathering, so as to gain better knowledge of the local anatomy and to study it. An incision was made in the skin of the lateral face of the elbow, to reveal tissues down to the muscle fascia. The interval between the anconeus muscle (which was released from its ulnar insertion and subsequently folded back) and the ulnar extensor muscle of the carpus was accessed. The conjoined tendon, composed of the origin of the supinating extensor musculature, was dissected until the lateral ligament complex and the joint capsule had been revealed proximally, along with the supinator muscle distally. Following this, the origin of the supinator muscle was released in order to isolate the insertion of the LUCL (Fig. 1).

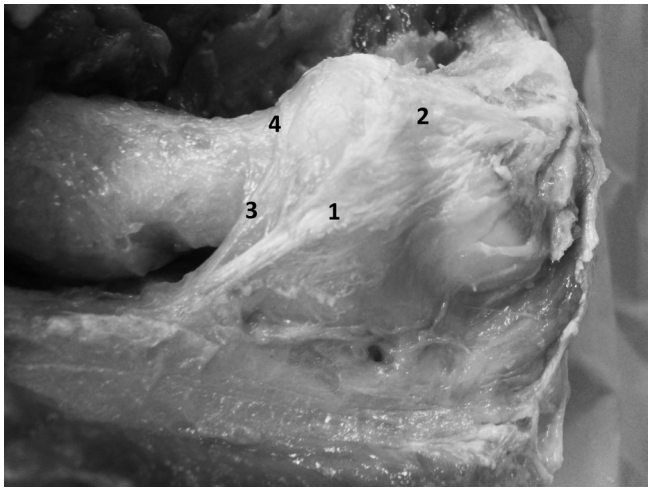

Fig. 1 - (1) Lateral ulnar collateral ligament, (2) radial collateral ligament, (3) accessory ligament, (4) annular ligament.

Measurements were made using a Mistainless® digital pachymeter, with the elbow on the dissection table at 90 degrees of flexion and without varus and valgus stress. To demarcate the limits of the segments measured, 40 x 1.2 mm needles were used.

The following measurements of the elbows studied were recorded: the insertion footprint of the LUCL; the distance from the proximal edge of the cartilage of the radial head to the proximal and distal insertion of the LUCL; the distance from

the proximal edge of the olecranon to the proximal and distal insertion of the LUCL; and the distance from the proximal edge of the cartilage of the radial head to the distal edge of the annular ligament (Fig. 2). The gender, side, age and height of the cadavers were also recorded.

The ligaments forming the lateral ligament complex were identified, along with observing whether the insertion patterns of the LUCL and the annular ligament were conjoined or separated.

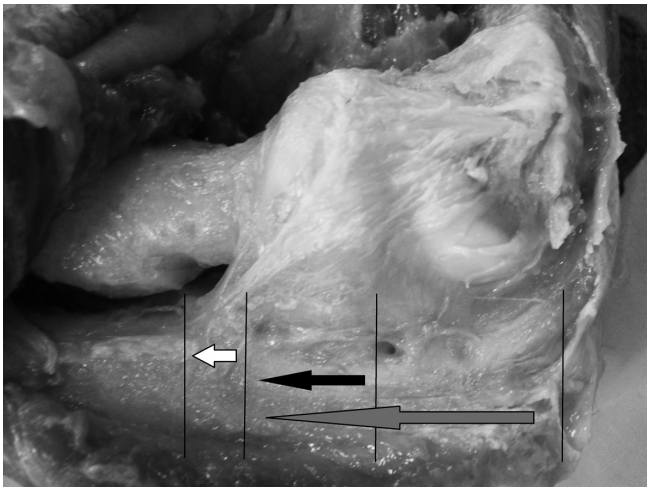

Fig. 2 - The white arrow shows the footprint of the LUCL. The black arrow shows the distance from the radial head to the start of the footprint, and the grey arrow shows the olecranon tip at the start of the footprint.

Result

In 10 cases, the lateral ligament complex was composed of four ligaments (annular, lateral ulnar collateral, lateral radial collateral and accessory), while in three cases the accessory ligament was not observed. The insertion of the LUCL was conjoined with the annular ligament in two elbows, while in 11 of them it was possible to differentiate the insertion of the LUCL through the presence of a foramen filled with adipose tissue (Figs. 3 and 4).

The mean distance between the edge of the radial head and the proximal insertion of the LUCL was 13.6 mm (11.7-16.2 mm); the mean distance between the edge of the radial head and the distal insertion of the LUCL was 22.9 mm (20.2-26.4 mm); and the midpoint between the proximal and distal insertions was 18.2 mm from the radial head.

The mean distance between the olecranon tip and the proximal insertion of the LUCL was 38.2 mm (33.6-43.9 mm) and the mean distance between the olecranon tip and the distance between the olecranon tip and the distal insertion of the LUCL was 47.6 mm (42.6-55 mm). The midpoint was 42.9 mm from the olecranon tip (Fig. 5).

In the two cases in which the insertion of the LUCL was conjoined with the annular ligament, the distance between

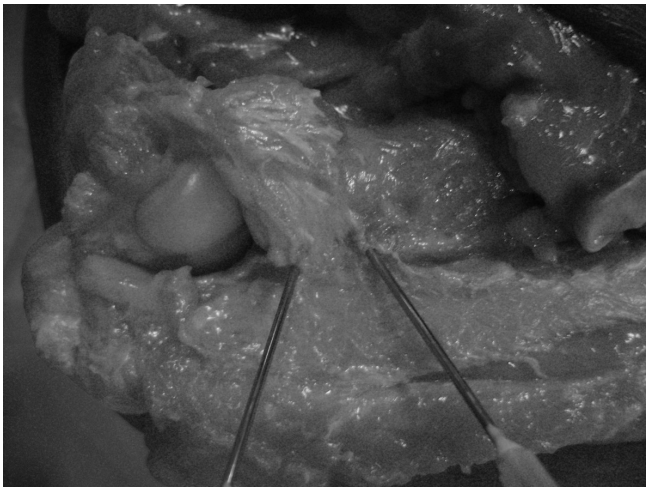

Fig. 3 - Conjoined insertion of the LUCL and annular ligament.

Fig. 4 - Single insertion of the LUCL: the arrow shows the foramen that separates the ligaments.

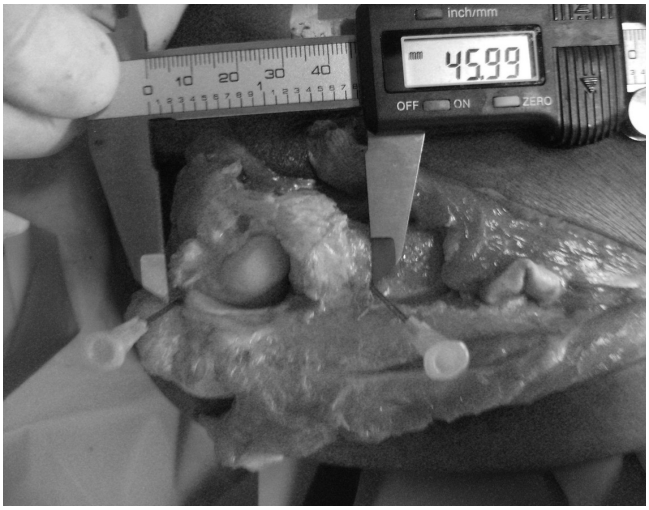

Fig. 5 - Distance between the olecranon tip and the distal insertion of the LUCL.

the edge of the radial head and the distal edge of the annular ligament was measured in the anterior region of the radius, where the LUCL was not present. By subtracting the length of the insertion of the annular ligament from the total value for the conjoined insertion, we obtained the footprint. The measurement of the footprint of the LUCL in the ulna ranged from 7.5 to 11 mm (mean length of 9.3 mm).

Discussion

In 1985, Morrey and An[10] conducted an anatomical study in which they gave the name lateral ulnar collateral ligament to a structure posterior to the radial collateral ligament that extended to the annular ligament and was inserted into the crest of the supinator. This structure was observed in five of the ten elbows dissected and, at that time, no importance was attributed to this structure with regard to elbow stabilization. Beckett et al.[10] studied 39 elbows from cadavers in order to describe the anatomical variations of the lateral ligament complex and found that the LUCL was present in only 50% of the cases.

Olsen et al.[17] observed that the LUCL was present in all the cases in their study, like in our study, in which this ligament was identified in 100% of the elbows dissected (Fig. 3). A histological and anatomical analysis conducted by Imatani et al.[12] also recognized the LUCL in 100% of the elbows studied. Furthermore, they showed that this ligament was related to the fascia of the ulnar extensor muscles of the carpus and supinator in their medial portion and with the lateral radial collateral ligament in its proximal portion. This would cause difficulty in identifying it macroscopically in anatomical studies, thereby causing the mistaken belief that it did not exist. In 1999, Vieira and Caetano[18] published an anatomical study in which they described the lateral ligament complex in detail, such that it was composed of the lateral ulnar collateral ligament, radial collateral ligament, accessory ligament and annular ligament.

In our dissection, we observed that there was a close relationship between the conjoined tendon of the extensor-supinator muscles, the origin of the lateral ligament complex and the joint capsule, which made it difficult to separate these elements. At the origin of the lateral ligament complex, the ulnar and radial bands could not be differentiated from the lateral collateral ligament, which is concordant with the literature.[10,12,17,18] At the insertion of the lateral ligament complex, it was possible to identify the LUCL separated from the annular ligament in 11 elbows. This type of insertion of the LUCL alone was observed by Olsen et al.[17] in 100% of the cases and by Cohen and Hastings 2nd [19] in 22 of the 40 elbows studied.

Since posterolateral rotatory instability was described by O'Driscoll et al.,[4] the LUCL has been indicated as the main restrictor for this displacement. However, the importance of the entire lateral ligament complex, septa, fasciae and extensor-supinator has been emphasized,[2,19-21] thus showing that the LUCL is not the only factor responsible. Cohen and Hastings 2nd [19] conducted an anatomical study in which they serially sectioned the lateral stabilizing structures of the elbow and observed that injury to the fibers of the LUCL only resulted in 15% of the total displacement. Thus, they suggested that more than one structure must have been comprised for a substantial displacement of the radial head to have been caused.[19] Likewise, Dunning et al.[20] observed that the pivot shift test was negative and there was no difference in the magnitude of the pronation-supination and varus-valgus lassitude when only the LUCL was sectioned, in comparison with the intact elbow. This evidence was confirmed by the studies of McAdams et al.[21] and Olsen et al.[2]

Nevertheless, surgery to correct the PLRI still has the sole aim of reconstructing the LUCL. On the other hand, there is a lack of precision in the literature regarding the insertion site for the ulnar tunnel.[9,13-16] In 1992, Nestor et al.[13] published an article in which they described the region just posteriorly to the tubercle of the supinator as the point for the ulnar tunnel. Lee and Teo[9] described the location of the ulnar tunnel as posterior to the crest of the supinator. Rizzio[14] reported on a case of reconstruction in a patient with an immature skeleton and also only cited the crest of the supinator, as also seen in the biomechanical study by King et al.[15] and the study by Olsen and Söjbjerg.[16]

The ulnar insertion point should reproduce the original anatomy of the lateral ligament complex for the best result.[22] However, the conjoined insertion of the annular ligament and LUCL into the ulna measures 2 cm on average and there have not been any reports on the length of the LUCL insertion alone.[1,15,23] In our study, we were able to measure this footprint (mean value of 9.3 mm), thereby facilitating the measurement of the site of LUCL insertion.

Goren et al.[23] conducted a biomechanical study with the aim of identifying the best location for the humeral and ulnar tunnels, by means of a software program that measured the variations in distances between the points chosen during flexion-extension. At the end of the study, they found that there was no true universal isometric point for the LUCL and that the individual variation in tunnel insertion was statistically significant. However, the point of greatest isometry would be 16-20 mm distally to the joint face of the radial head. This information is concordant with the results from our study, in which we found that the midpoint of LUCL insertion was 18.2 mm from the radial head. On the other hand, Moritomo et al.[24] investigated the isometric point of the LUCL *in vivo* and established three insertion points for testing in the ulna, at 5, 15 and 25 mm distally to the joint face of the radial head, and were unable to identify it, thus showing that the LUCL is not isometric.

In addition to using the radial head, as described in the literature,[23,24] the present study added the olecranon tip as a reference point and fixed parameter, since it is located in the same bone, in order to increase the precision of the correct location for LUCL insertion (mean of 42.9 mm). No similar studies with measurements made from the olecranon tip (of the same bone) to the insertion zone of the LUCL were found in the literature that we consulted LUCL (Fig. 4).

Conclusion

We conclude that the insertion of the LUCL has a wide footprint, of 9.3 mm on average (range: 7.5-11 mm). The midpoint of the ulnar insertion is located 18.2 mm from the radial head and 42.9 mm from the olecranon tip.

Conflicts of interest

The authors declare that there was no conflict of interests in conducting this study.

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