FUNCTIONAL ANATOMY OF THE LATERAL COLLATERAL LIGAMENT COMPLEX OF THE ELBOW: MORPHOLOGY AND STRAIN

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The anatomy of the lateral ulnar collateral ligament (LUCL) of the elbow was investigated in 26 fresh frozen cadavers. Two types of insertion of the LUCL were originally described but we found another type which is characterized by a broad single expansion along with a thin membranous fibre. Strain on the LUCL was measured in situ during extension and flexion with the forearm in supination, pronation and neutral. Strain in the proximal fibres started to occur at around 32° flexion and peaked at between 50° and 60° flexion. Strains measured in the distal fibres were smaller in magnitude. Forearm rotation had little effect on strain during extension to flexion. Based on these results, we conclude that the LUCL functions in unison with the annular ligament.

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INTRODUCTION

O'Driscoll's et al. (1991) work put a new perspective on posterolateral rotatory instability (PLRI) of the elbow. Since that report, several anatomical and biomechanical studies on PLRI have been published, but the structure and function of the lateral collateral ligament of the elbow remain unclear. The lateral collateral ligament complex of the elbow is composed of four elements: the radial collateral ligament, the annular ligament, the lateral ulnar collateral ligament (LUCL) and the accessory posterior annular ligament (Morrey and An, 1985).

Cohen and Hastings (1997) reported that the lateral collateral and annular ligaments formed a broad conjoined insertion onto the proximal aspect of the ulna in all specimens and that there were two types of conjoined lateral collateral and annular ligamentous insertions. In their serial sectioning study, they reported that the LUCL, the annular ligament, and extensor muscle origin provide stability through fascial bands and intermuscular septa. Imatani et al. (1999) later performed a histological study which concluded that the LUCL existed in all specimens, but was only slender and ill defined capsuloligamentous structure. The purpose of the present study was to clarify the anatomy and function of the LUCL in order to determine the best position of the elbow for suturing and postoperative immobilization after reconstruction procedures for PLRI.

MATERIALS AND METHODS

Twenty-six elbows from fresh frozen cadavers (21 from men and 5 from women) with no pathology around the elbow were studied. The average age at death was 72 years (range 40–88 years).

The elbow joints were approached through a posterolateral incision between the extensor carpi ulnaris and the anconeus muscles. The anconeus was released from its ulnar insertion and reflected proximally to reveal the underlying supinator muscle and the lateral ligament complex of the elbow. Using a 2.6X loupe magnification, the supinator was released from the complex to expose its ulnar insertion. The LUCL was visualized and Vernier calipers were used to measure the lengths and widths of its origins and insertions. The complex consists of the radial collateral ligament, the annular ligament and the LUCL. The LUCL runs from the lateral epicondyle to the spinator crest of the ulna and is divided into two parts for the purpose of analysis of functional differences: the proximal fibres extends from the lateral epicondyle to the annular ligament, while the distal fibres run from the annular ligament to the supinator crest of the ulna (Fig 1). Distal fibres arrangements were classified according to Cohen and Hastings (1997).

Following the anatomical study, five specimens from younger male cadavers (mean age = 58 years) were selected for the strain study. Two right and three left elbows were examined. Each specimen was sectioned 25 cm proximal to the elbow and mounted on a custom-designed frame with screws through the humerus (Fig 2). Soft tissues were removed for 5 cm proximal to the screw insertion. An electrogoniometer manufactured by Penny and Giles (Blackwood Gwent, UK) was fixed to each specimen in order to measure the angle of flexion.

Two ultra-miniature differential variable reluctance transformers (DVRTs) manufactured by Microstrain (Burlington, VT) were calibrated in the laboratory before use. With the aid of microsurgical instruments the devices were secured with 4-0 polypropylene sutures to the proximal and distal fibres of the LUCL under 2.6X loupe magnification (Fig 2). Since there were three

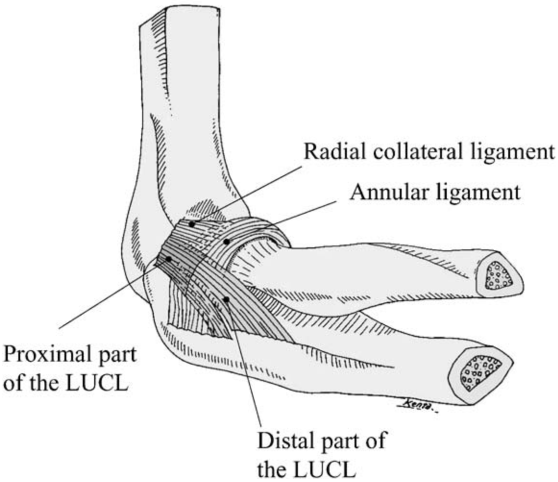

Fig 1 The lateral ulnar collateral ligament. Its proximal fibres run from the lateral epicondyle to the annular ligament and its distal fibres from the annular ligament to the supinator crest.

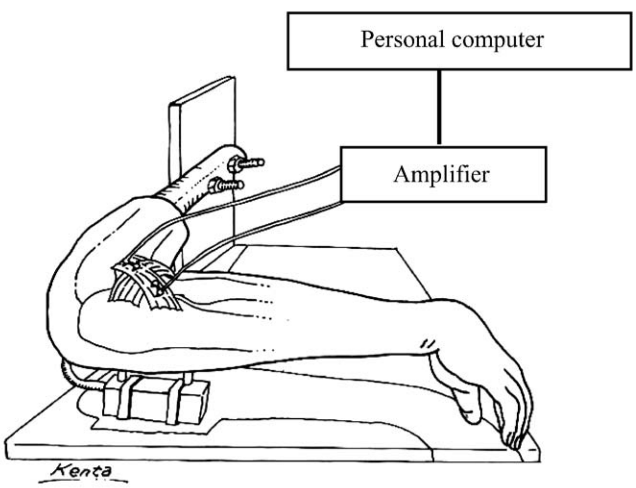

Fig 2 The specimen testing apparatus with two DVRTs attached to it to measure strain.

types of conjoined lateral and annular ligamentous insertions, strain measurement was performed in the proximal anterior and distal posterior region in three types of specimens (Fig 3). Prior to suturing, elbow specimens were fixed at 90° flexion. For testing, the elbows were positioned in maximum extension with the weight of the specimen providing a varus load. The elbows were then moved manually at a constant rate through their full arc of flexion/extension with the forearm held in supination, pronation or neutral rotation. Data were sampled from extension to flexion using a Dash-16 computer board (MetraByte Corporation, Stoughton, MA) housed in a personal computer

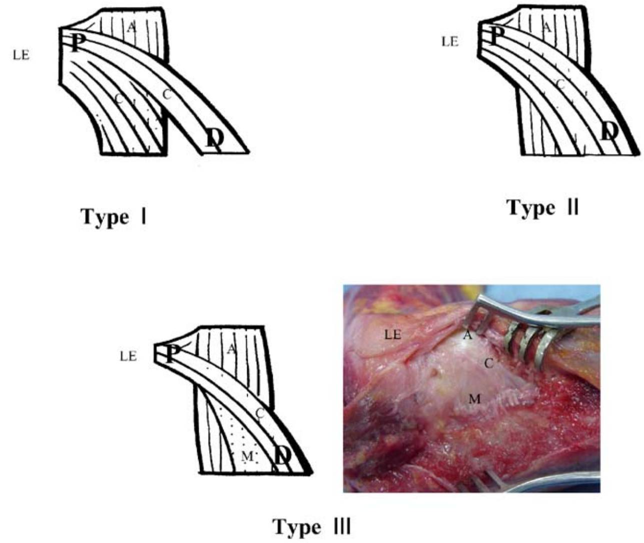

Fig 3 The three types of LUCL. LE: lateral epicondyle, A: annular ligament, C: cord, M: membranous fibre, **P**: proximal set up region of strain measurement, **D**: distal set up region of strain measurement.

(Kansas City, MO) controlled by Labtech Notebook software (Wilmington, MA).

Differences in maximum strain between proximal and distal fibres with the forearm held in supination, pronation or neutral rotation were analysed by Student's *t*-tests for paired results using Statview statistical software (SAS institute, Cary, North Carolina). Values of $P<0.05$ were considered statistically significant.

RESULTS

The lateral collateral ligament complex is composed of three main fibre bundles. The radial collateral ligament is a fan-shaped structure which runs from the inferior part of the lateral epicondyle and blends with the annular ligament. The annular ligament runs around the radial head and is confluent with the radial collateral ligament and the LUCL. The LUCL is a thin and slender structure, but it was found in all 26 specimens. The proximal fibre bundles of the LUCL had a similar anatomical appearance in all specimens; they run from the more inferior part of the lateral epicondyle and blend with the annular ligament. The distal fibre bundles, which run from the annular ligament to the supinator crest, had three configurations. Width and length measurement data for the three types of LUCL are provided in Table 1. Eight specimens were bilobed (Cohen's type I) with longitudinal fibres inserting onto the annular ligament and a second bundle inserting distally along the ulna. Nine specimens were conjoined