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The extended medial elbow approach—a cadaveric study

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Background: The two most commonly used approaches to expose medial elbow structures are the flexor carpi ulnaris split and the Hotchkiss over-the-top approach. The aim of this study was to define the extended medial approach to the elbow, featuring advantages of over-the-top (proximal exposure) and additional complete exposure of the coronoid and proximal medial ulna, while respecting the internervous plane between the flexor pronator mass and flexor carpi ulnaris muscle.

Methods: In this comparative anatomic study, 12 fresh frozen cadaveric elbows were dissected alternately to study the distal limitation and exposed area of the extended medial elbow approach compared with splitting the flexor carpi ulnaris.

Results: Proximal ulna exposure area was comparable between the extended medial elbow approach (average, 840 mm^2) and the flexor carpi ulnaris split (average, 810 mm^2; $P = .44$). The extended medial approach was limited distally by the posterior recurrent ulnar artery (mean 68 mm from medial epicondyle), whereas the first motor branch for the flexor carpi ulnaris muscle limited the second approach in 75% of the specimens (mean 29 mm from medial epicondyle, $P < .001$).

Conclusions: The extended medial elbow approach is a single approach allowing full exposure of the medial elbow and combining the advantages of the over-the-top approach with a safe distal extension to the medial ulna. In contrast to the flexor carpi ulnaris split, our approach respects the internervous plane.

Level of evidence: Anatomy Study, Cadaver Dissection.

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Keywords: Elbow; surgical exposure; coronoid fractures; Hotchkiss over-the-top; flexor carpi ulnaris split; sublime tubercle

Complex trauma and ligament reconstruction of the elbow have been in the focus of recent literature. Reconstructive surgery on the medial side of the elbow has led to more technically demanding operative procedures and drawn attention to surgical exposure of medial elbow structures. Several approaches to the medial elbow have been described, including osteotomy of the medial epicondyle or splitting the flexor carpi ulnaris muscle to expose the proximal, medial ulna.[7,8,12] In a cadaveric study, Hotchkiss and Kasparyan[2] describe the over-the-top approach, claiming excellent exposure of the joint without need for osteotomy of the medial epicondyle. This approach can also be extended proximally to expose the distal medial aspect of the humerus. However, the approach

The Ethical Committee of Kanton St. Gallen, Switzerland, being our local authority in this respect, approved this study (Ref. EKSG 14/95, August 18, 2014).

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is limited distally by the median nerve lying on the ulnar head of the pronator teres muscle. Jobe et al[4] described splitting the flexor muscle to approach the anterior bundle of the medial collateral ligament directly. Smith et al[12] modified this approach and described a safe zone between the flexor pronator mass and the flexor carpi ulnaris. Alternatively, flexor carpi ulnaris splitting (FCUS) has been proposed[3,9,10] because each head of this muscle has separate innervation and blood supply.[5] A recent study showed FCUS allowed for a better view of the sublime tubercle compared with the over-the-top approach.[3] FCUS separates 2 apparently independent muscle heads but does not completely respect the internervous plane. Furthermore, the distal approach is limited by the first motor branch of the ulnar nerve to either head.

In this study, we describe a new approach to the medial elbow: the extended medial elbow approach (EMEA). EMEA is based on the over-the-top approach and involves distal extension by detaching the ulnar head of the pronator teres muscle. Apart from protecting the median nerve, this allows extended exposure through the internervous plane as described by Smith et al[12] (an interval between the flexor pronator mass and the flexor carpi ulnaris muscle). Such an extension combines advantages of the over-the-top approach (access to the joint) and the distal muscle split (medial collateral ligament and sublime tubercle exposure) while respecting the internervous plane. The first author (B.J.) has been using EMEA successfully for reconstruction of the medial collateral ligament and for sagittal coronoid fractures. In this cadaveric study, we examined the safety and distal limitations of EMEA and compared the exposed area of the ulna between EMEA and FCUS.

Materials and methods

For this comparative anatomic study, we dissected 12 fresh frozen arms (6 left and 6 right elbows) from 6 deceased Caucasian adult donors (5 women, 1 man). The arms were amputated in the middle of the upper arm, and the specimens proven to be intact and free of any signs of prior elbow surgery or injury. The specimens were randomly assigned to 2 groups. The first group, EMEA first, was dissected as follows: EMEA first, followed by FCUS. The second group, FCUS first, was dissected the other way around: FCUS approach first, followed by EMEA. This resulted 24 dissections performed by the first (B.J.) or the last author (C.S.).

Surgical procedure

The cadaveric limbs were positioned with the elbow at 30° and the medial epicondyle facing toward the surgeon. This position was used for all dissections and measurements. The incision was the same for both approaches and ranged from 50 mm above to 100 mm below the medial epicondyle, which was passed 10 mm in front (Fig. 1).

The medial antebrachial cutaneous nerve, crossing this incision between 3 and 60 mm distal to the medial epicondyle,[12] was preserved and retracted radially. Proximal to the elbow joint, the ulnar nerve was found dorsally to the medial intermuscular septum in all specimens. It was dissected further distally until entering the cubital tunnel. The order of subsequent preparation was determined by whether the specimen was assigned to EMEA first or FCUS first.

EMEA

The incision of the fascia crosses the humeral head of the pronator muscle 10 mm distal to its humeral origin (for later adaptation of the flexor pronator mass). The fascia raphe, described by Smith et al,[12] can be identified distally between the flexor carpi ulnaris and the flexor pronator mass (Fig. 2, *A* and *B*), and incised longitudinally (Fig. 2, *C* and *D*).[2]

Deep proximal dissection was performed according to the over-the-top approach by lifting off the flexor pronator mass from the capsule, which is thin at this location and can be opened longitudinally. Next, the brachialis tendon with its insertion distal to the coronoid process was identified and the plane between the brachialis tendon and the flexor pronator mass developed.

As a next step, the anterior bundle of the medial collateral ligament was identified and the insertion of the flexor digitorum superficialis lifted off anteriorly to it by sharp dissection. At this point, care must be taken not to dissect into the tendon of the brachialis muscle. Lifting off the flexor digitorum superficialis exposes the ulnar head of the pronator teres, which crosses a part of the brachialis tendon (Fig. 3). Distal to the ulnar head of the pronator teres, the posterior recurrent ulnar artery that supplies the flexor carpi ulnaris[5,6] crosses the exposed area (Fig. 4). The ulnar head of the pronator teres is dissected sharply from its ulnar origin and lifted off radially to protect the median nerve, which is found lying on it (Fig. 5). This vascular bundle is the distal limitation of the EMEA and needs to be preserved.

The flexor carpi ulnaris was finally lifted off the medial ulna, dissecting directly on the bone with a blunt instrument. The ulnar nerve stays embedded in the mass of the flexor carpi ulnaris, which can be gently retracted dorsally.

A Hohmann retractor was placed into the joint onto the coronoid and another one behind the olecranon to lift off the flexor carpi ulnaris and the ulnar nerve. One Langenbeck retractor was used to protect the median nerve in the flexor pronator mass radially, and another was placed distally to hold the posterior recurrent ulnar artery away from the exposure. By placing the retractors in this way, full exposure of the proximal, medial ulna, including the sublime tubercle and the medial collateral ligament, was possible (Fig. 6).

FCUS

The ulnar nerve was dissected out of the cubital tunnel by splitting the 2 heads of the flexor carpi ulnaris. The nerve was mobilized, sacrificing the articular branches. The motor branches of the ulnar nerve to the flexor carpi ulnaris heads were identified, and the first motor branch was dissected out of the muscle belly as far distally as possible. By blunt dissection, the interval between the humeral and ulnar heads of the flexor carpi ulnaris was completed down to the bone. The anterior portion (humeral head) of the flexor carpi ulnaris was elevated off the medial, proximal ulna by blunt dissection and retracted anteriorly. The entire medial ulna was prepared by lifting off the ulnar head of the flexor carpi ulnaris

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