



Anatomic study of the flexor carpi ulnaris muscle and its application to soft tissue coverage of the elbow with clinical correlation

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Background: The posterior elbow is prone to soft tissue loss that may require reconstructive methods for wound healing to be achieved. The flexor carpi ulnaris (FCU) muscle has been described for coverage in case reports and small series. Previous studies give conflicting anatomic findings about the dominant vascular pedicle for the FCU.

Methods: Twenty-five cadaveric specimens were dissected. Pedicle location, number, and distance from the medial epicondyle were recorded along with the extent of posterior elbow coverage. Chart review was conducted during a 4-year period. Eight patients who underwent FCU rotational flap coverage were identified. Those flaps relied entirely on a single proximal pedicle.

Results: The vascular pedicles from the ulnar artery or recurrent ulnar artery were identified in 24 of 25 specimens. The average distance from the tip of the medial epicondyle to the first pedicle was 5.7 cm (range, 3 to 10 cm). The length of muscle coverage proximal to the olecranon tip averaged 9.3 cm. The clinical follow-up of 7 patients requiring FCU rotational flaps for coverage of the posterior elbow showed that all flaps survived and provided adequate coverage for the defect.

Conclusions: The FCU rotational pedicle flap provides predictable coverage of small to medium-sized defects about the posterior elbow. Although it is relatively consistent, the proximal vascular pedicle does demonstrate some variability, which should be considered in planning surgery. The consistent distal extent of the FCU muscle belly provides wider proximal coverage of defects.

Level of evidence: Level IV, Case Series, Treatment Study.

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Soft tissue loss at the posterior elbow remains a difficult clinical problem, particularly when it is compounded by exposed implants or infection. The olecranon is covered by

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skin, subcutaneous tissue, and the triceps insertion. This thin soft tissue envelope is prone to development of complications of wound dehiscence, prominent or exposed hardware, unstable scar, and infection.

There are multiple options for soft tissue coverage of the elbow. These include local fasciocutaneous flaps, axial fasciocutaneous flaps (such as the radial forearm flap), two-stage distant pedicle flaps, local muscle rotational flaps (anconeus, brachioradialis, and flexor carpi ulnaris), distant pedicled muscle or musculocutaneous flaps (latissimus

dorsi), and free flaps.^{17,20-22} Familiarity with various surgical options is useful in tailoring coverage to the zone of injury, defect size, and functional deficits.

The flexor carpi ulnaris (FCU) is a bipennate muscle innervated by the ulnar nerve and supplied by the ulnar artery. Several case reports have described the use of this muscle for soft tissue coverage of the elbow.^{5,7,8,16} More recent studies have described the dual innervation of the humeral and ulnar heads of origin and possible sparing of the humeral head of origin to retain FCU function while using the ulnar origin head for local soft tissue coverage.^{7,23}

As a local rotational flap, the FCU can be readily dissected; it requires no microvascular anastomosis and can provide excellent coverage for small to medium-sized defects about the elbow. It has previously been shown to have acceptable donor site morbidity.^{14,25}

The purpose of our study is to describe the vascular anatomy of the FCU and the range of muscle coverage when it is rotated on its proximal vascular pedicles. We also present our clinical experience with use of this muscle flap for coverage of posterior elbow defects.

Methods

Anatomic dissections

Twenty-five fresh-frozen cadaveric specimens were used. We had 10 paired and 5 unpaired specimens. One of the paired specimens had a unilateral absent ulnar artery, and no pedicle data were recorded for this side of the cadaver. The skin and subcutaneous tissues were removed to the level of the antebrachial fascia. The FCU was identified, and the center of the medial epicondyle was marked (all measurements were made in reference to this point). The length of the muscle was measured from the medial epicondyle to the wrist flexion crease. The fascia on the radial aspect of the FCU was released, starting at the wrist crease and continuing to the humeral origin at the medial epicondyle. The ulnar fascia was then released from the wrist flexion crease to 6 cm from the olecranon tip. The tendon was transected at the wrist crease. Meticulous care was taken to preserve the muscle belly at the distal aspect of the tendon (Fig. 1). The muscle was carefully elevated off of the forearm from distal to proximal. Data were collected for all pedicles encountered. All pedicle measurements were recorded as the distance from the center of the medial epicondyle to its entry site in the muscle belly. The 2 most proximal pedicles were identified, and the more distal pedicles were transected (Fig. 2). The FCU was then rotated 180° over the olecranon, leaving 2 proximal pedicles intact. The extent of muscle coverage proximal to the olecranon tip was measured with the elbow flexed at 90° (Fig. 3).

Clinical cases

Through chart review of surgical cases undertaken by the hand service between 2006 and 2010, we identified 8 patients treated with an FCU rotational flap for soft tissue defects at the elbow. Charts were reviewed for indications for coverage, defect size if it was listed in the operative report, and estimated surgical time

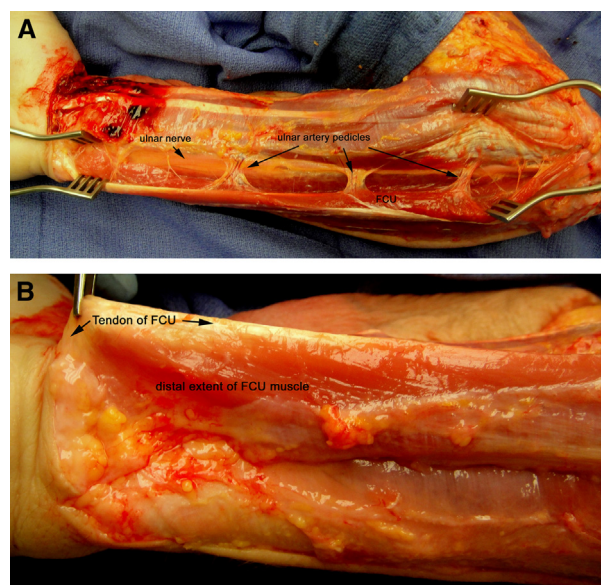


Figure 1 (A) The dissected flexor carpi ulnaris (FCU) muscle and its vascular pedicles. (B) The distal extent of the muscle belly to the wrist flexion crease is demonstrated.

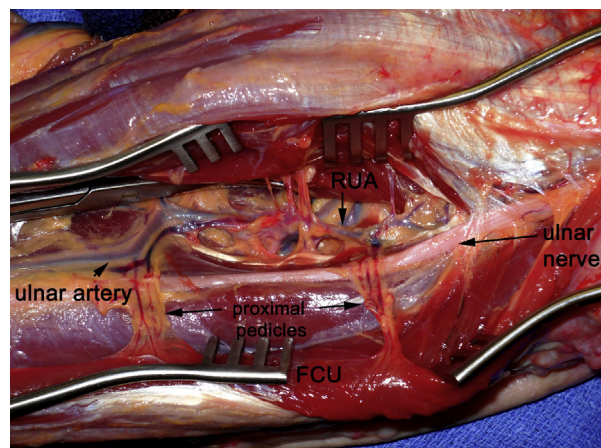


Figure 2 The relationship of the proximal pedicles to the flexor carpi ulnaris (FCU) is shown. The most proximal pedicle in this specimen arises from the recurrent ulnar artery (RUA), and the second pedicle arises from the ulnar artery.

related to harvesting of the FCU (based on the listed tourniquet time). Outpatient charts were reviewed for complications related to soft tissue healing. Clinical follow-up of all patients was carried out until soft tissue healing was complete and free range of motion was allowed. Patients were contacted at a minimum of 2 years after their index procedure to determine if any additional surgeries related to soft tissue complications had been required.

Operative technique

The operation was performed under tourniquet control and general anesthesia. A longitudinal incision starting from the wrist flexion crease on the lateral (anterior) side of the FCU was taken proximally toward the medial epicondyle. The surgical incision was

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