(i) Anatomy of the carpus and surgical approaches

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Abstract
Anatomy and surgical approaches are intimately related. In this article the authors describe the anatomy of the wrist in detail — vascular, neural, osseous, articular and ligamentous. This is followed by description of the surgical approaches to the distal radio-ulnar joint, distal radius, scaphoid and the universal dorsal approach to the carpus. The article is supported by illustrations throughout.

Keywords anatomy; carpus; surgical approach; wrist

Distal radio-ulnar joint anatomy

Bone

The sigmoid notch of the radius articulates with the ulnar head. Because there is a different centre of rotation of the head and notch there is some glide in the antero-posterior plane. The distal dome of the head articulates with the underside of the lunate and triquetrum; the central part of the TFCC acting as a cushion. The ulna is relatively longer than the radius ("*ulnar variance*") with the forearm pronated; ulnar variance shortens in supination. About 20% of load across the wrist passes through ulno-carpal joint and 80% through the radio-carpal joint. Increasing ulnar variance by 2.5 mm increases ulno-carpal load to 40% whilst decreasing variance by 2.5 mm decreases ulno-carpal load to 5%. A long ulna is associated with *ulno-carpal impaction* (central TFCC perforation and luno-triquetral degeneration); a short ulna is associated with *Kienbock's disease* (spontaneous avascular necrosis of the lunate).

Triangular Fibrocartilage Complex

The Triangular Fibrocartilage Complex (TFCC) is a complex conglomeration that acts as the major soft tissue stabilizer of the distal radio-ulnar joint (DRUJ) (Figure 1). The components of the TFCC include:

- dorsal radio-ulnar ligament
- anterior radio-ulnar ligament
- central articular disc

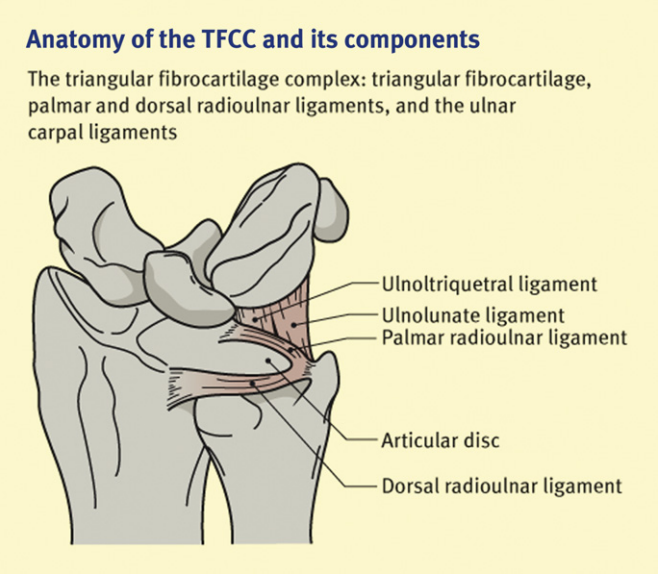

Figure 1 Anatomy of the TFCC and its components. The triangular fibrocartilage complex: triangular fibrocartilage, palmar and dorsal radioulnar ligaments, and the ulnar carpal ligaments.

- meniscus homologue
- ulnar collateral ligament
- extensor carpi ulnaris subsheath
- origins of the ulno-lunate and luno-triquetral ligaments

The TFCC arises along the ulnar aspect of the distal articular surface of the radius at the distal margin of the sigmoid notch. The anterior radio-ulnar ligament emerges from the anterior ulnar-distal corner of the notch and the posterior radio-ulnar ligament from the dorsal-ulnar-distal corner. The ligaments, which blend with the central disc, attach to the fovea which is a pit at the radial edge of the base of the ulnar styloid. If these ligaments are avulsed distally, the DRUJ becomes unstable; surgical reconstruction involves either re-attachment with a bone anchor via the surgical approach described below, or with a tendon graft mimicking the anatomical pathway as described by Adams.

In addition to stabilizing the DRUJ, the TFCC allows the transmission of 20% of the axial load at the wrist (neutral ulnar variance). The periphery of the TFCC is well vascularized, whereas the central radial portion remains relatively avascular. Injuries to the peripheral aspect of this triangular plate heal better than the central portion. Central portion perforations, due to natural degeneration, traumatic impaction or erosion by a long ulnar head (impaction syndrome) are treated arthroscopically with the approach described below.

Tendons

The ***ECU*** acts as a secondary stabilizer of the DRUJ and resists dorsal and ulnar translation of the ulnar head. It runs through a groove in the ulnar head and has its own subsheath (which is a component of the TFCC) (Figure 2). The retinaculum over the 6th compartment runs ulnarwards and palmarwards, blending into the anterior fascia and is separate from the subsheath. ECU is a pure ulnar deviator with the wrist in pronation and a pure extensor with the forearm in supination. The ECU is the only long extensor tendon which is *not*

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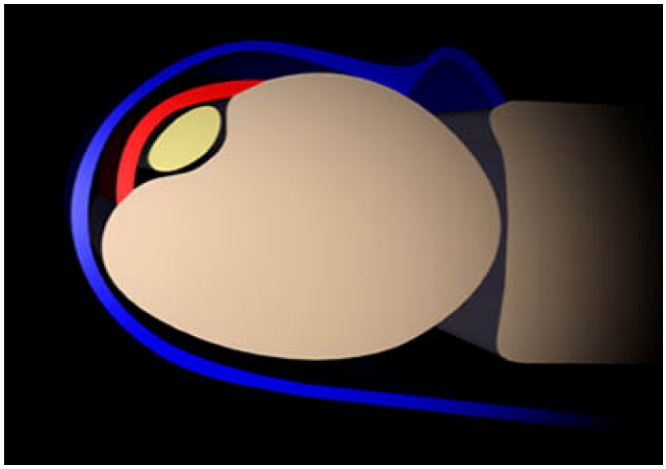

Figure 2 Schematic of the ECU subsheath (in red) (axial view). It is a component of the TFCC and houses the ECU tendon which acts as a secondary stabilizer of the DRUJ. The extensor retinaculum (in blue) courses over the ECU and distal ulna attaching to the pisiform and triquetrum.

contained by the extensor retinaculum; if it was then the forearm could not supinate and pronate because the distance between the 5th compartment (attached to the radius) and 6th compartment (ECU) would be fixed.

The **FCU** (flexor carpi ulnaris) is an ulnar deviator and flexor of the wrist. It stabilizes the wrist in grip and hammering. Its insertion is augmented through the pisiform bone which acts in the same way as the patella of the knee.

The **EDM** (Extensor Digiti Minimi) is the direct dorsal relation of the DRUJ capsule and runs within the 5th retinacular compartment (Figure 3).

Surgical approach to the distal radio-ulnar joint

Indications

- Open TFCC attachment
- Open wafer excision
- TFCC anatomical reconstruction
- Ulnar head deletion (Darrach's, Sauve–Kapandji, matched ulnar resection). *NB these operations are to be avoided whenever possible due to the risk of incurable instability*!
- Ulnar head replacement
- Fracture reconstruction

Procedure

An incision is made over the dorsum of the distal radio-ulnar joint, extending distally and slightly ulnarwards towards the styloid process of the 5th metacarpal (Figure 4). *Take great care to avoid cutting or stretching the dorsal branches of the ulnar nerve which traverse this plane and which are vulnerable*. The

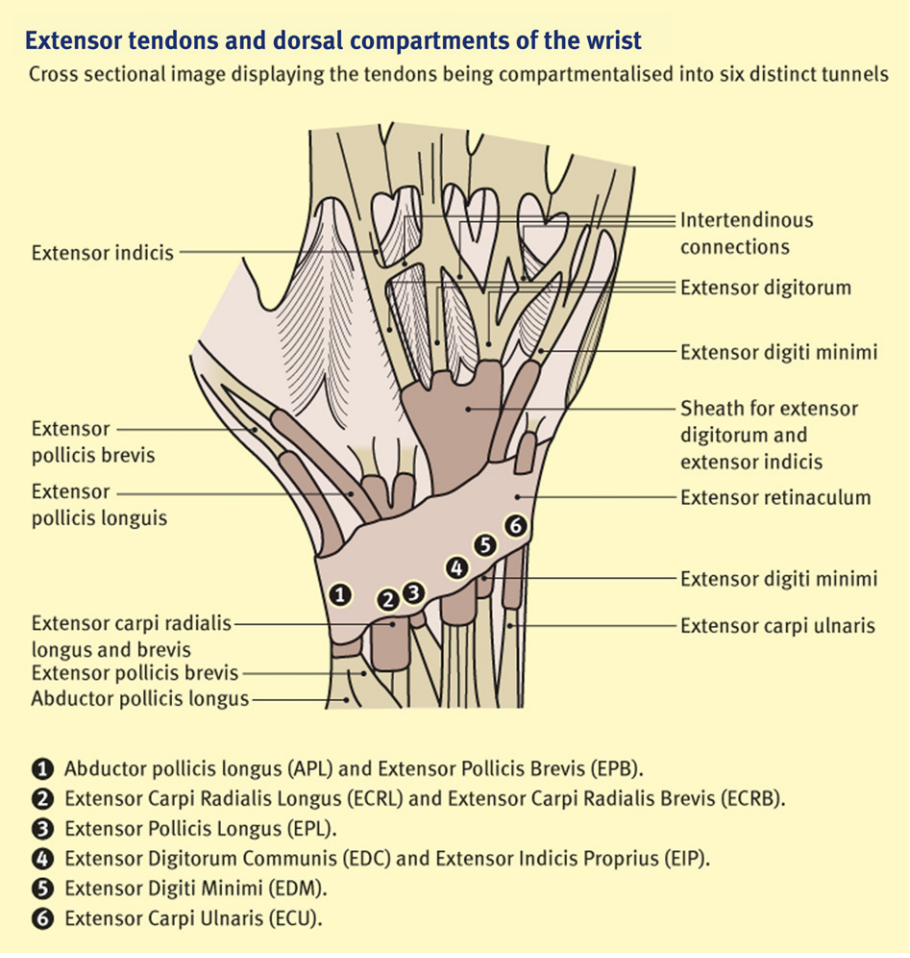

Figure 3