Renato Fricker | Jesse Jupiter | Matej Kastelec

8 Distal forearm

Table of contents

Executive Editor: **Steve Krikler**
Authors: **Renato Fricker, Jesse Jupiter, Matej Kastelec**

8.1 Anatomy of the distal forearm

Surgical apporach

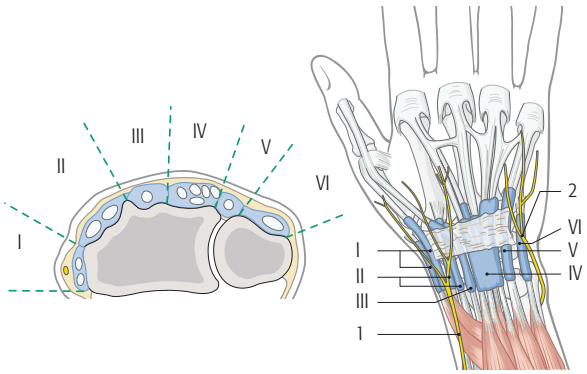
A thorough knowledge of the anatomy around the wrist is essential. The following images give a short introduction.

Anatomy

Soft tissue anatomy - dorsal Extensor compartments:

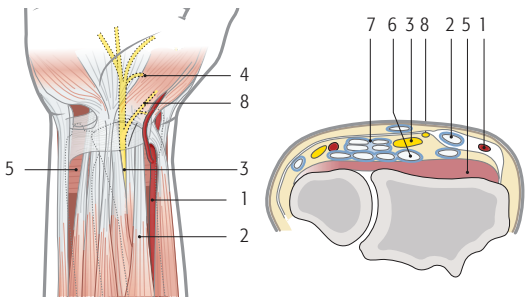
I. Abductor pollicis longus and extensor pollicis brevis
II. Extensor carpi radialis longus and brevis
III. Extensor pollicis longus
IV. Extensor digitorum communis and extensor indicis proprius
V. Extensor digiti minimi
VI. Extensor carpi ulnaris

Nerves:
1 Superficial radial nerve
2 Dorsal branch of ulnar nerve



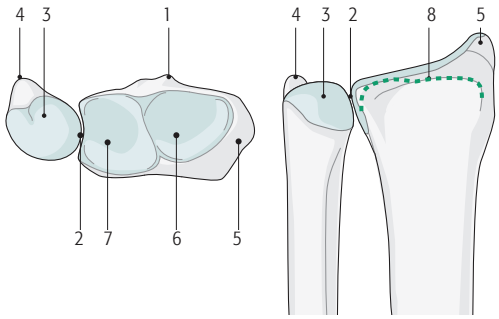
Soft tissue anatomy - palmar

Radial arteryFlexor carpi radialis tendonMedian nerve-Motor branch of the median nervePronator quadratus muscleFlexor digitorum profundus tendonsFlexor digitorum superficialis tendonsPalmar cutaneous branch of the median nerve



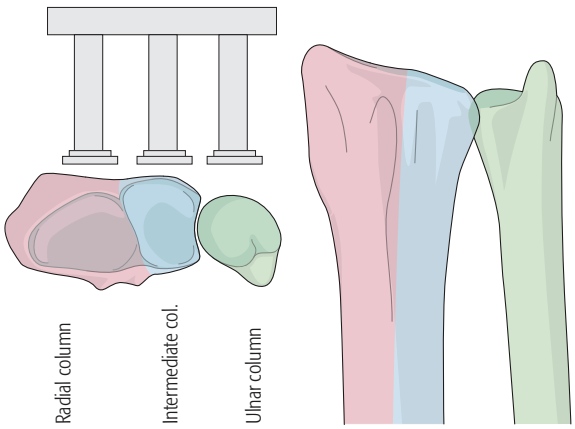
Bony anatomy

Lister's tubercleSigmoid notchUlnar headUlnar styloidRadial styloidScaphoid facetLunate facetWatershed line



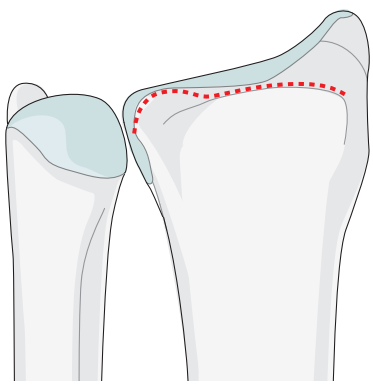
Principle of columns

The distal forearm may be thought of in terms of three columns. The ulna forms one column. The radius may be thought of as an intermediate and a radial column.
Distally at the wrist joint, the radial column articulates with the scaphoid and the intermediate column articulates with the lunate.
The ulnar column terminates distally at the TFCC.



Watershed line

The watershed line represents the margin between the structures which may be elevated proximally and the capsule of the wrist joint which should be respected.



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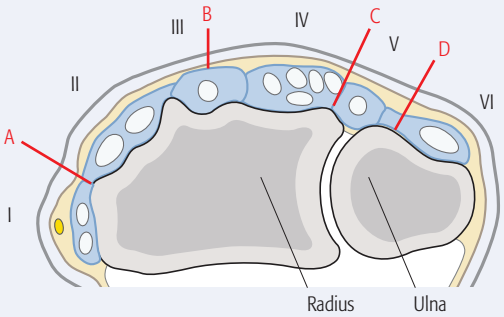
8.2 Direct approach to the radial styloid

Surgical apporach

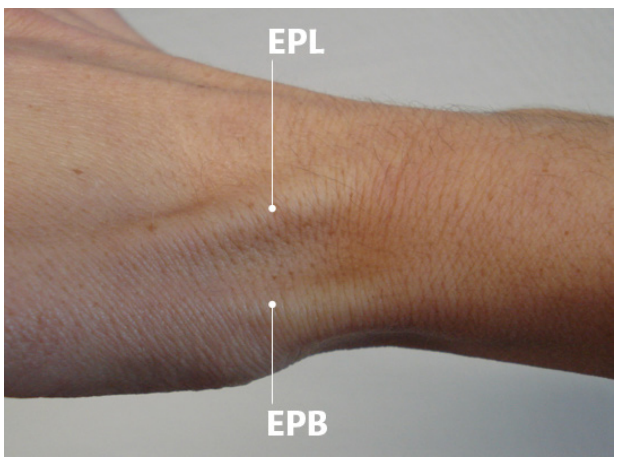
Dorsal approaches (as illustrated A-D) can be chosen between the different extensor compartments (as illustrated I-VI), as dictated by the specific fracture pattern.
Here an approach between the first and second extensor compartments (A) is described in detail..



I Extensor pollicis brevis & Abductor pollicis longus
II Extensor carpi radialis brevis and longus
III Extensor pollicis longus
IV Extensor indicis & Extensor digitorum communis
V Extensor digiti minimi
VI Extensor carpi ulnaris

Anatomical snuffbox

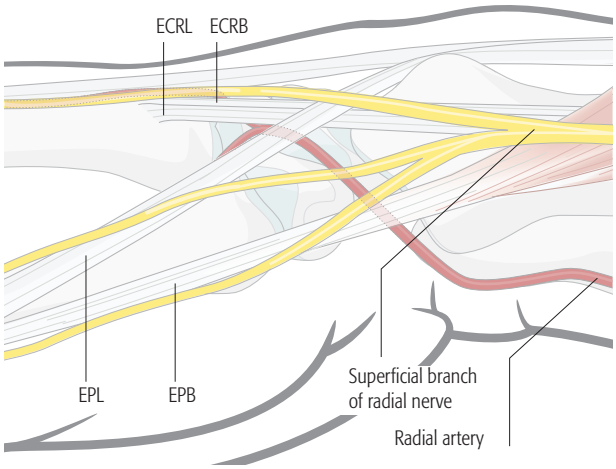
Extensor pollicis longus (EPL) and Extensor Pollicis Brevis (EPB) are the landmark for anatomical snuffbox, with the tip of the radial styloid forming the floor.



Nerves and arteries

Important structures around the anatomical snuffbox are the superficial branches of the radial nerve, which should be carefully protected during different percutaneous fixation techniques.

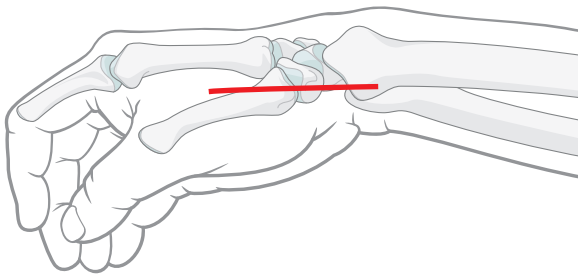
The radial artery crosses the floor of the anatomic snuffbox and should be protected as well.



Skin incision

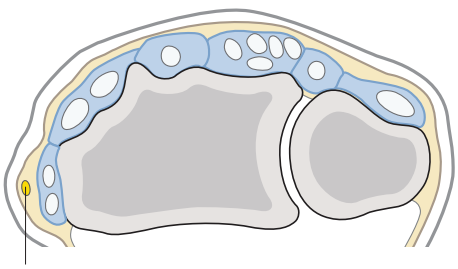
A straight incision is made over the anatomical snuffbox, and then extended distally and proximally, to the necessary extent, as illustrated.

The two resultant skin/subcutaneous flaps are raised, by blunt dissection, from the underlying deep fascial and extensor retinaculum.

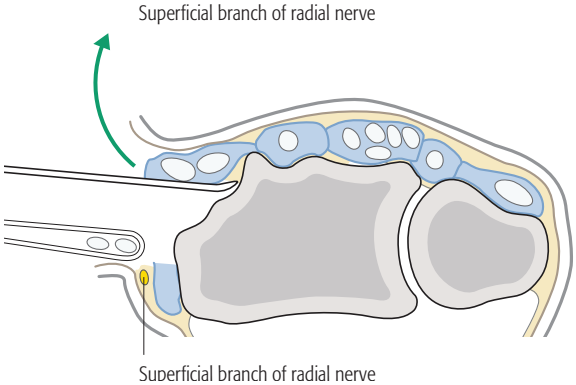


Exposure

The superficial cutaneous branch of the radial nerve is identified and protected. The radial styloid is then exposed by sharp dissection.



The first and second compartments may be elevated as necessary.



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8.3 Ulnar palmar approach to distal radius

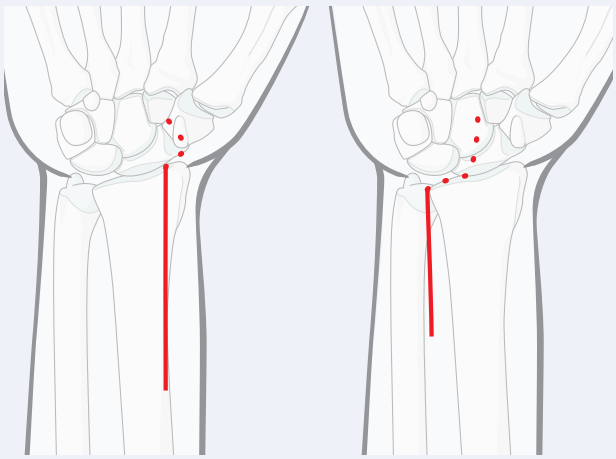
Surgical apporach

In general, there are two palmar surgical approaches to the distal radius– a modified Henry approach to the radius and a more ulnar approach, designed to expose the median nerve as well as the distal radius.
Themodified Henry approachis suitable for most fractures of the distal radius.

If it is desired to decompress the carpal tunnel, this may be performed either through one ulnar extensile approach or two separate approaches.

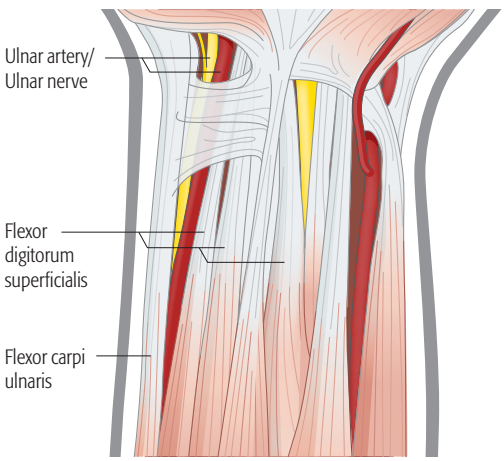
An ulnar palmar approach facilitates exposure of the sigmoid notch, the lunate facet, the palmar wrist capsule, the distal radioulnar joint and distal ulna. It is less suitable for the radial part of the distal radius.

For high energy fractures an extended ulnar approach may be used.



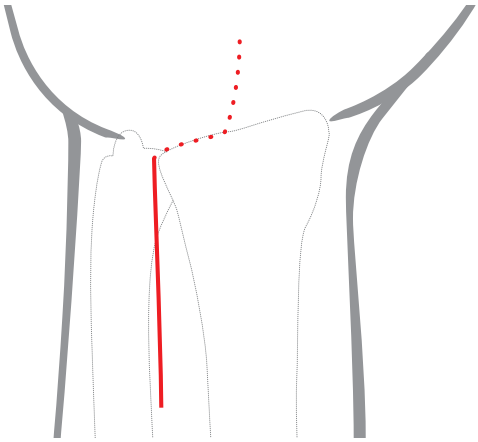
Ulnar Palmar approach - Introduction

The ulnar palmar approach uses the plane between the ulnar artery and nerve on one side and the flexor tendons on the other side.



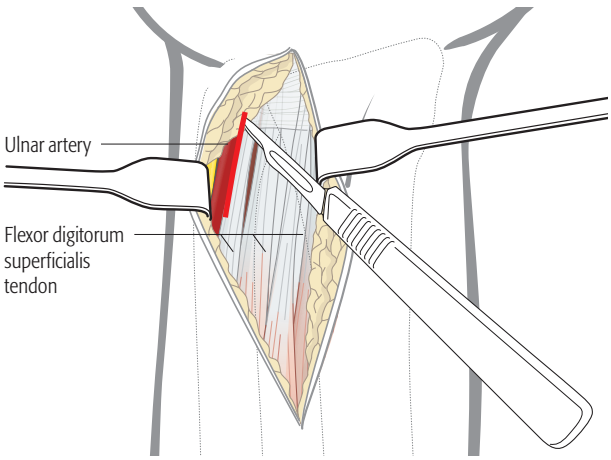
Skin Incision

The incision starts at the wrist crease, and runs proximally parallel to the ulna. It can be extended along the wrist crease and distally into the palm.

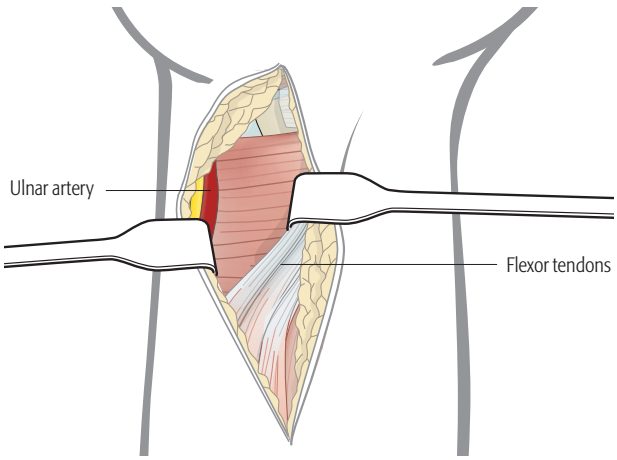


Dissection

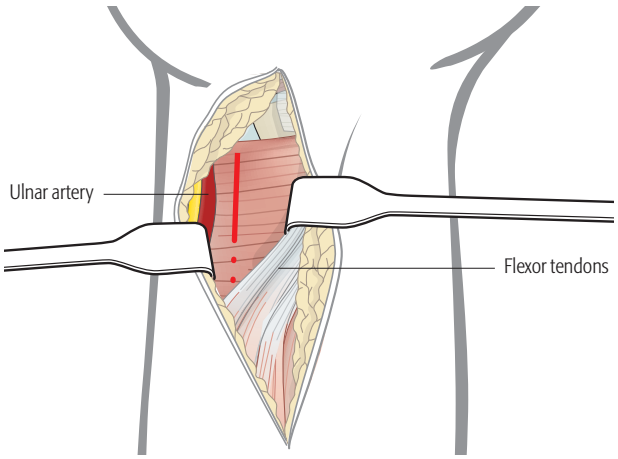
The interval is developed between the ulnar artery and nerve on one side and flexor tendons on the other side.



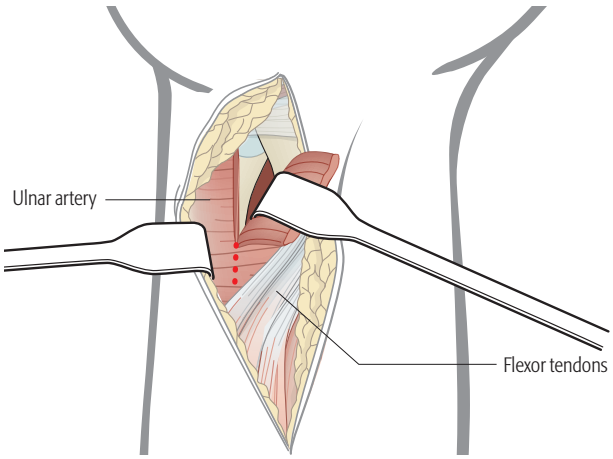
The flexor tendons and median nerve are retracted towards the radius to provide excellent exposure of the pronator quadratus.



The pronator quadratus is incised as much as necessary.

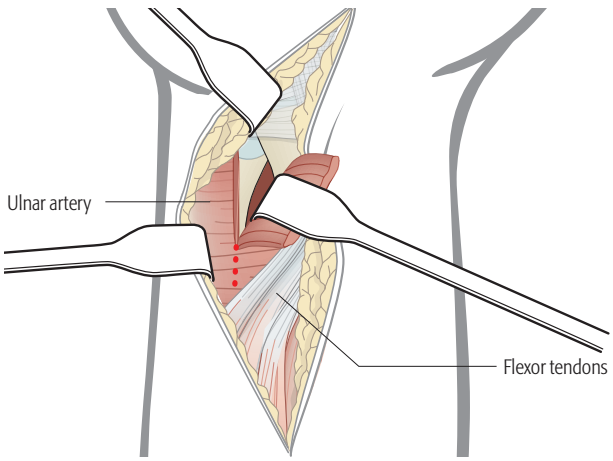


Expose the ulnar side of the distal radius by elevating the incised portion of the pronator quadratus.



Extension of ulnar palmar approach

The ulnar palmar approach may be extended distally. This allows decompression of the carpal tunnel and gives good access to the radiocarpal structures in high energy injures.



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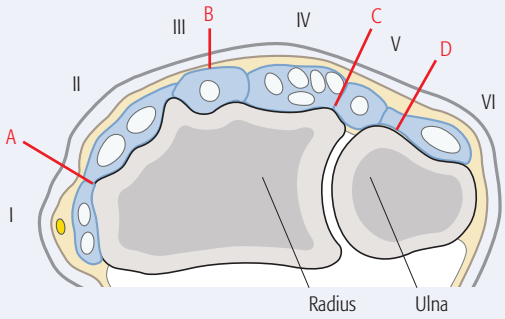
8.4 Dorsal approach

Preliminary remark

Dorsal approaches (as illustrated A-D) can be chosen between the different extensor compartments (as illustrated I-VI), as dictated by the specific fracture pattern. In this module the dorsal approach through the third extensor compartment (B) is described in detail.

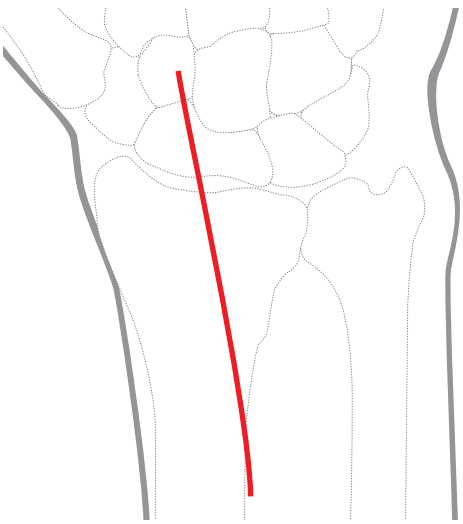
Combined approaches may be used through a single skin incision.



I Extensor pollicis brevis & Abductor pollicis longus
II Extensor carpi radialis brevis and longus
III Extensor pollicis longus
IV Extensor indicis & Extensor digitorum communis
V Extensor digiti minimi
VI Extensor carpi ulnaris

Skin incision

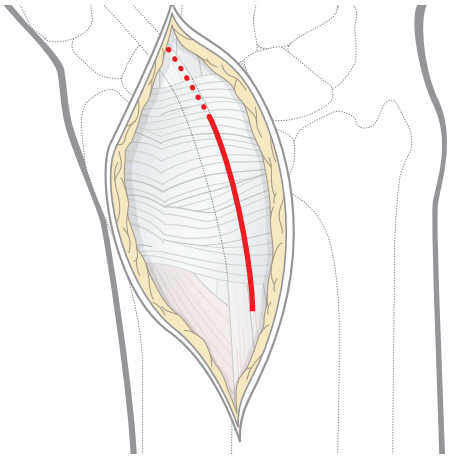
The intermediate and the radial columns may be approached separately using a single dorsal skin incision.



Approach to the intermediate column

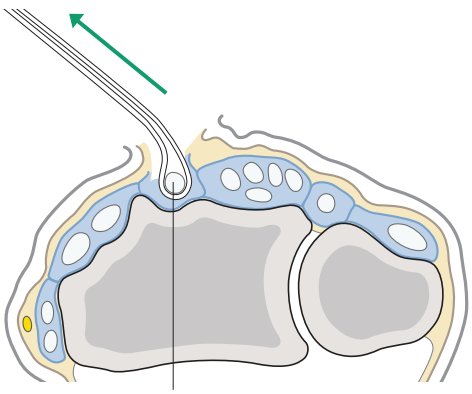
Incision of retinaculum

The third compartment is opened in line with the EPL tendon in the extensor retinaculum.
When opening the tendon sheath, be careful not to cut the tendon.
The incision is extended proximally in line with the EPL tendon.
Distally, open the extensor retinaculum as far as needed. It is recommended to preserve the distal part, so the tendon still glides towards the thumb.
Alternatively, the sheath may be opened distally, and the tendon elevated and retracted radially.



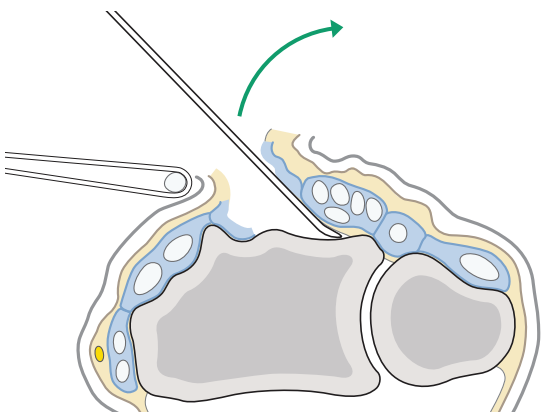
Mobilization of extensor pollicis longus tendon

The extensor pollicis longus tendon is freed and a vessel loop is passed around it.



Subperiosteal elevation of 4th compartment

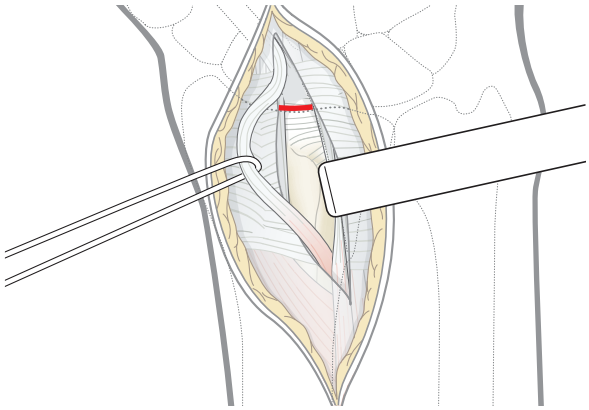
The fourth compartment is elevated subperiosteally, leaving the compartment itself intact. The intermediate column is now exposed.



Arthrotomy (optional)

To expose the distal articular surface, for example in die punch injuries or associated carpal injuries, the capsule is incised in the line of the distal radial articular surface as much as needed to identify and deal with the articular injury.

One mm of the capsule should be left on the distal radius for reattachment.

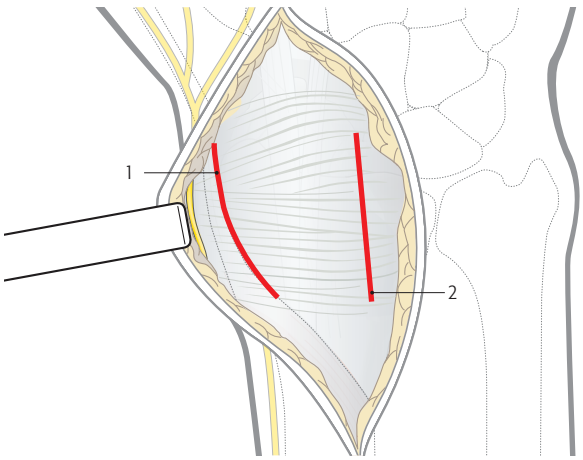


Approaches to the radial column

Depending on the fracture configuration, further retinacular incisions may be required to deal with the radial column fracture. Either of the following options may be chosen.

Option 1: Extraarticular approach to the radial column using a separate retinacular incision between the first and second compartment. This is used in extraarticular and simple articular fractures.

Option 2: Approach to radial column through the same retinacular incision as described above and developed under the second extensor compartment. This gives better access for intraarticular fractures of the scaphoid facet.



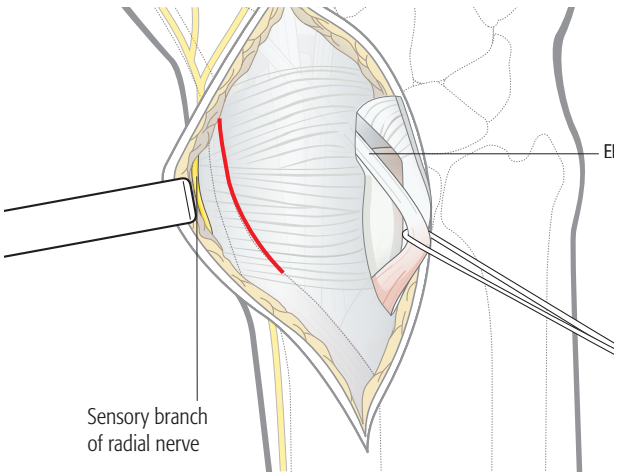
Option 1: Extraarticular dorsal approach to the radial column between extensor compartments I & II

This approach allows plate positioning on the radial side of the radial column, when it is not necessary to expose the articular surface.

The radial column is approached with subcutaneous dissection towards the radial side.

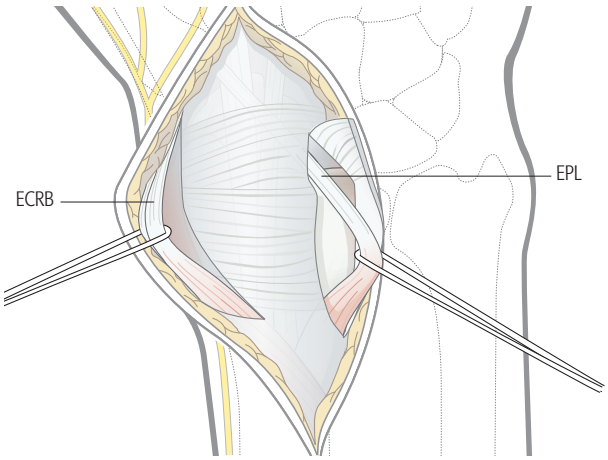
As a first step, identify the sensory branch of the radial nerve, which lies in the subcutaneous flap above the first compartment and must be protected.

If it is difficult to obtain satisfactory reduction of a radial styloid fracture, it may be helpful to release the brachioradialis tendon.



Incision through 1st compartment

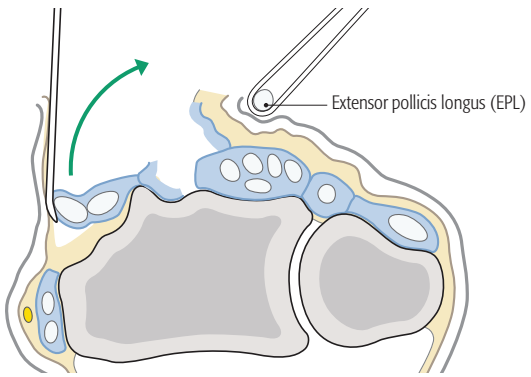
The 1st compartment is incised at the level of the musculotendinous transition and is released up to the tip of the radial styloid.
The tendons of the first extensor compartment are released and mobilized.



Subperiosteal elevation of 2nd compartment

The second compartment is elevated subperiosteally, leaving the compartment itself intact.

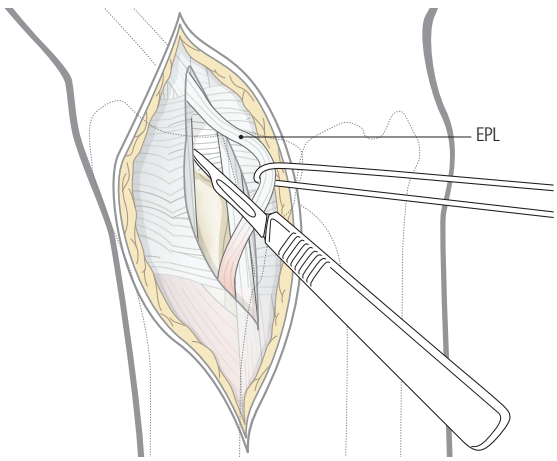
The radial styloid is now exposed.



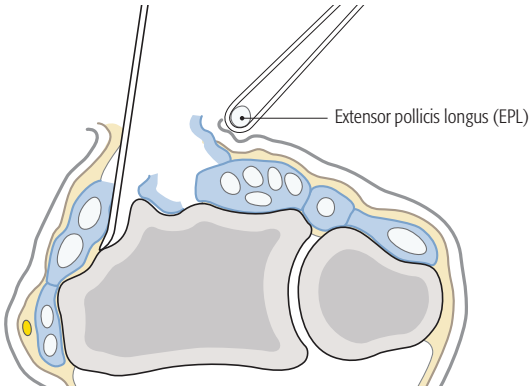
Option 2: Approach to radial column under the second extensor compartment

Lister's tubercle is identified on the radial side and the second compartment is partially elevated.

The EPL tendon can be retracted to the ulnar side.

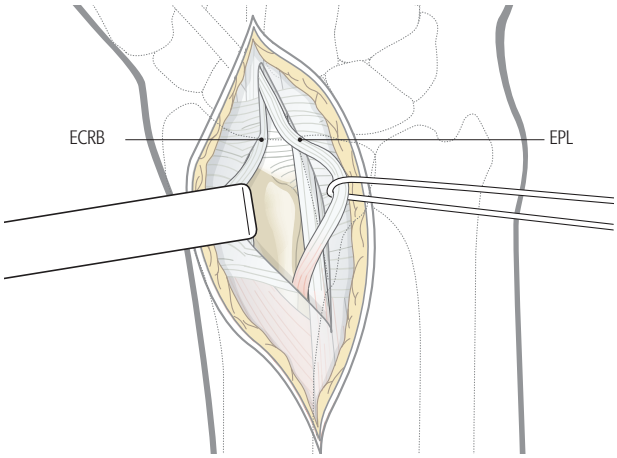


The second compartment and its contents are elevated from the distal radius by sharp dissection.



The tendon of the Extensor Carpal Radialis Brevis (ECRB) is retracted from the floor of the compartment.

This allows access to the radiocarpal articular surface on the radial column.

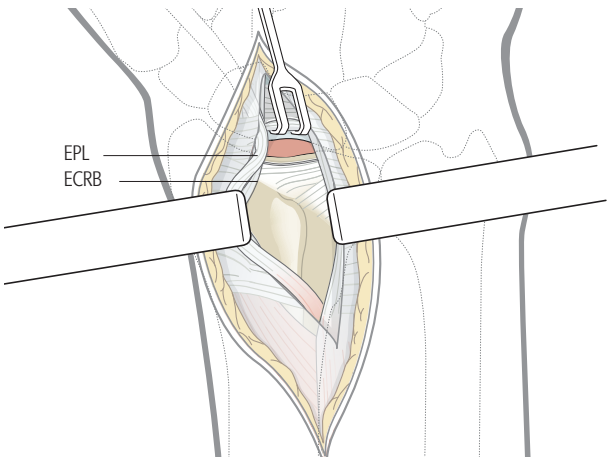


Once the compartments have been elevated and the distal radius exposed, the capsule may be opened to expose the articular surfaces.

A plate may be applied to the radial column through this approach.

The EPL tendon may be retracted in either direction, as dictated by the fracture configuration.

The capsular incision should be big enough to see the lunate facet and a part of the scaphoid facet in case of distal radial articular compression or carpal bone injuries.



Wound closure

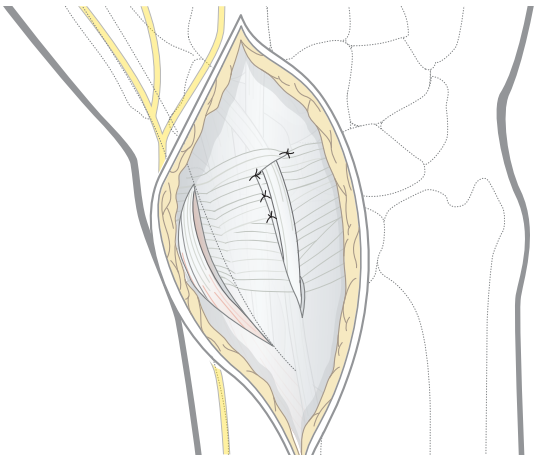
The second and fourth compartment are sutured back underneath the EPL tendon without any tension.

The distal part of the tendon sheath is left intact, so the tendon still lies in its anatomical position.

The first and second compartments are not closed.
If the brachioradialis tendon has been released it does not need to be reattached.

If a plate has been applied with the EPL lying over it, the V-shaped retinacular flap should be drawn underneath the EPL tendon to prevent contact with the plate. Leaving the EPL tendon in a subcutaneous position is also acceptable.

The skin is then closed.



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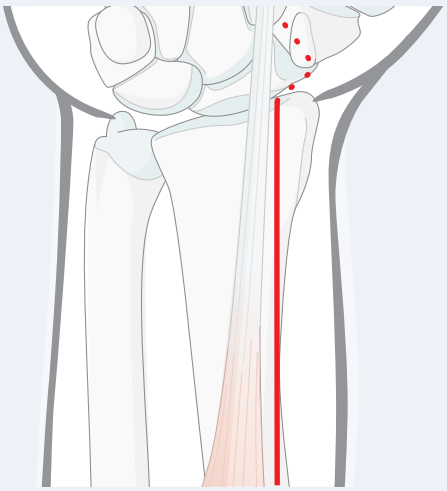
8.5 Palmar approach – The modified Henry approach

Preliminary remark

The modified Henry approach uses the plane between flexor carpi radialis tendon and the radial artery



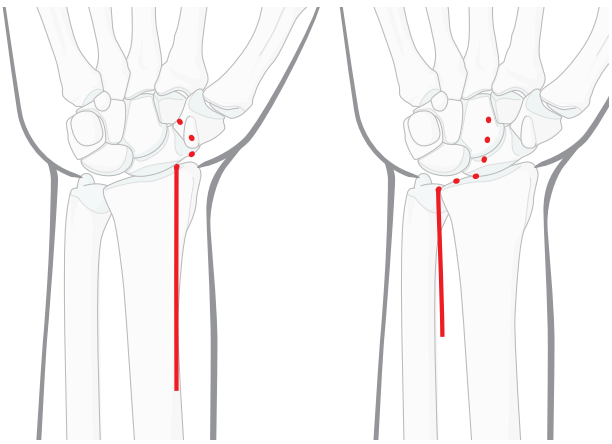
Palmar approaches

In general, there are two palmar surgical approaches to the distal radius– a modified Henry approach to the radius and a more ulnar approach, designed to expose the median nerve as well as the distal radius.
The modified Henry approach is suitable for most fractures of the distal radius.

If it is desired to decompress the carpal tunnel, this may be performed either through one ulnarextensile approachor two separate approaches.

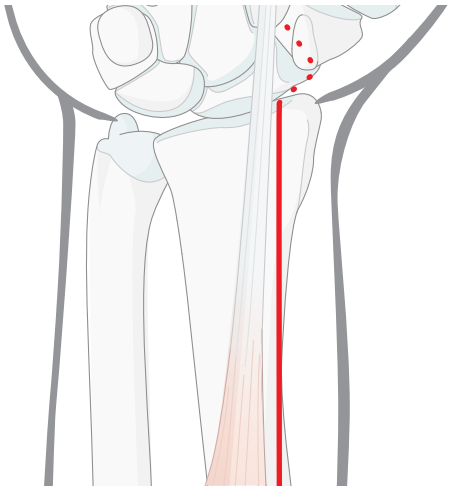
For isolated lunate facet fractures an ulnar approach is more useful.

For high energy fractures an extended ulnar approach may be used.

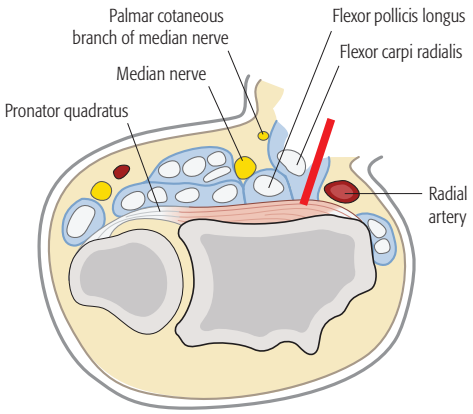


Modified Henry approach

The modified Henry approach uses the plane between flexor carpi radialis tendon and the radial artery.
The classical Henry approach goes between brachioradialis and the radial artery, i.e., radial to the radial artery. The modified approach is ulnar to the radial artery.
The flexor carpi radialis tendon is palpated, before making the skin incision to the radial side.



Pitfall The radial artery and the palmar cutaneous branch of the median nerve are at risk during this approach.

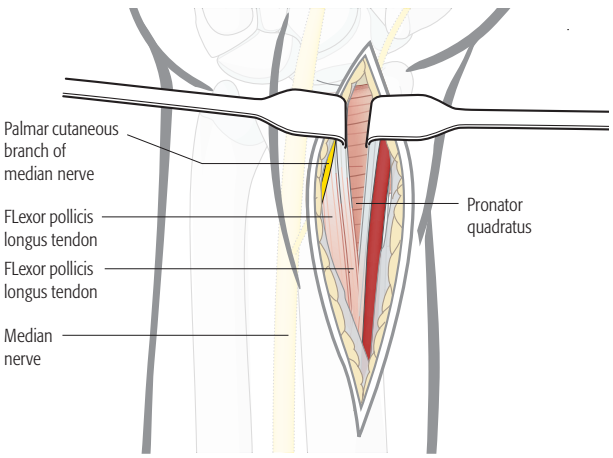


Skin incision and exposure

Make the skin incision along the radial border of the flexor carpi radialis tendon.

The sheath is opened and the tendon retracted towards the ulna.

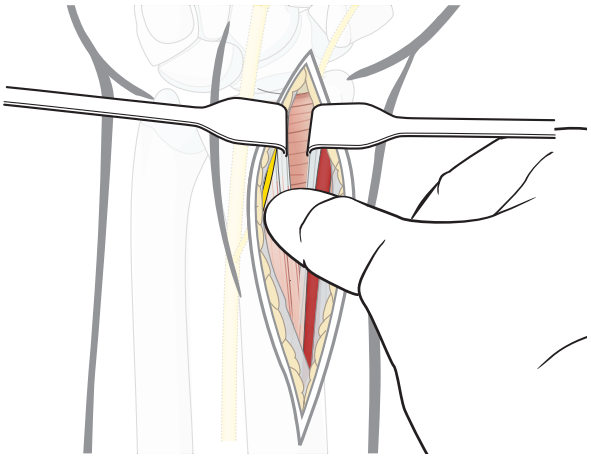
Deepen the incision between the flexor pollicis longus and the radial artery.



Care must be taken to avoid damaging the radial artery on the radial side and the palmar cutaneous branch of the median nerve on the ulnar side.

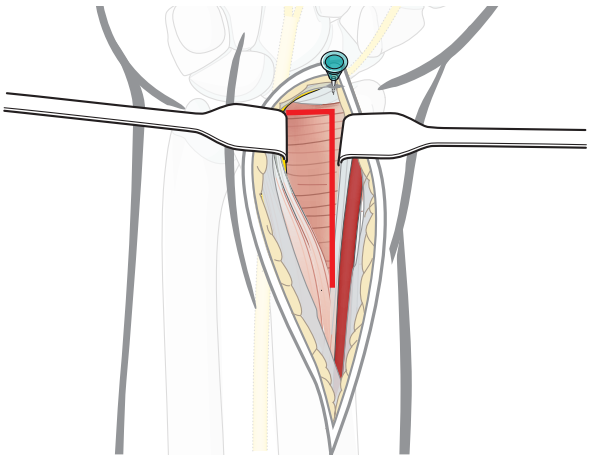
A finger is used to sweep the flexor pollicis longus muscle belly towards the ulna.

This increases the space and exposes the pronator quadratus muscle.

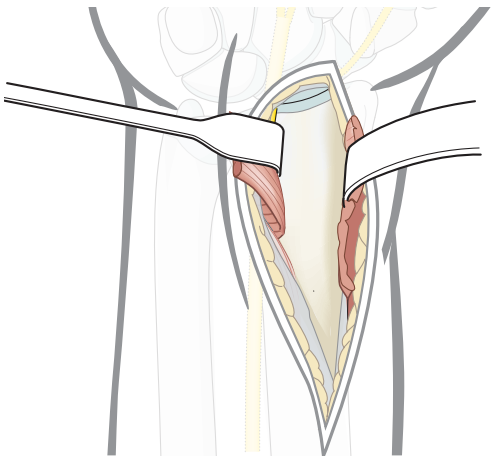


Pearl The pronator quadratus muscle should be elevated using an L-shaped incision.

The horizontal limb is placed at the watershed line. This lies a few mm proximal to the joint line; the position of the joint line can be determined by a hypodermic needle placed in the joint.

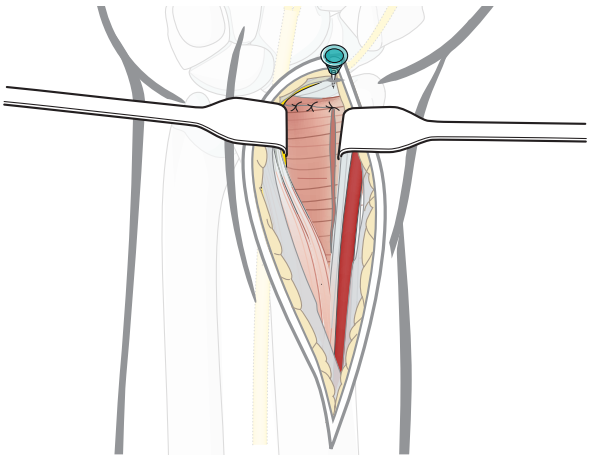


The pronator quadratus muscle is incised on its radial border, exposing the distal radius. It is stripped off the distal radius together with the periosteum.



Wound Closure

The pronator quadratus should be placed over the plate. Every attempt should be made to reattach the horizontal limb of the pronator quadratus elevation to the capsule. If possible, it should be reattached to its radial insertion. The tendon sheath may be closed, but care must be taken to avoid catching the cutaneous branch of the median nerve. The skin is closed.



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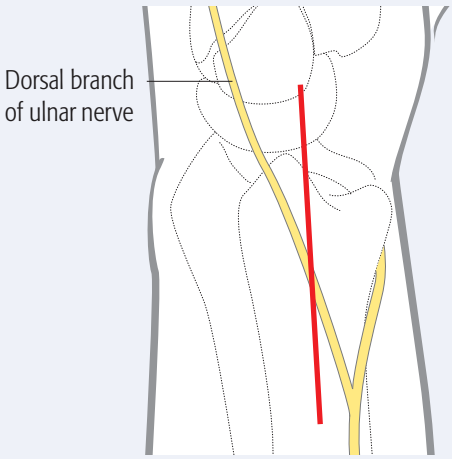
8.6 Ulnar approach to the distal ulna

Surgical apporach

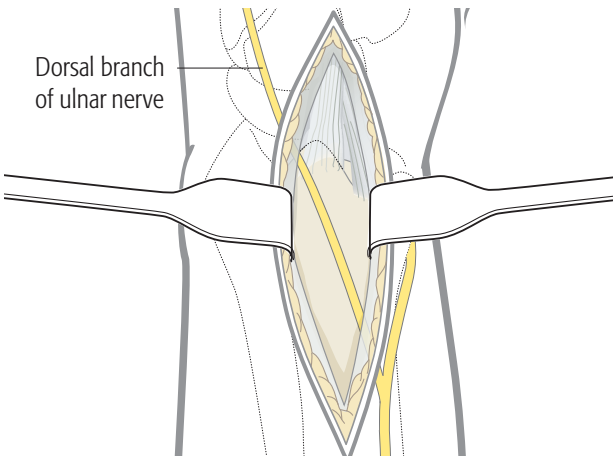
The ulnar shaft and the fracture gap between the ulnar styloid and the distal metaphysis are usually easily palpated.

A straight, longitudinal incision is made over the distal ulna, between the tendons of the extensor and flexor carpi ulnaris.



Surgical dissection

The dorsal branch of the ulnar nerve may be seen. Care should be taken to avoid injury to this nerve.
The fracture site is then exposed, if necessary, releasing the ulnar attachment of the extensor retinaculum.



Wound closure

The extensor retinaculum is repaired, as necessary, and the wound is closed in layers.

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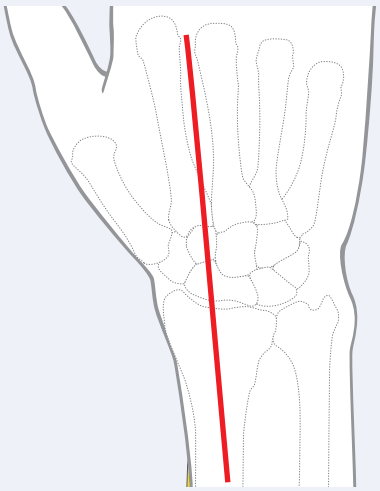
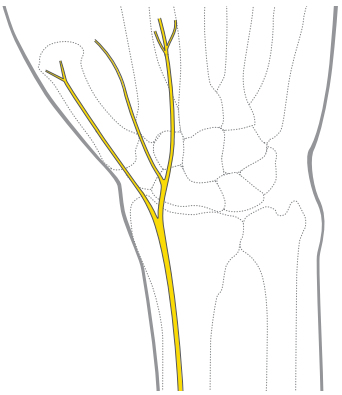
8.7 Dorsal approach for joint spanning plate

Surgical apporach

This extended dorsal approach can be used for wrist fusions or for joint-spanning plate fixation of comminuted intra-articular distal radius fractures.



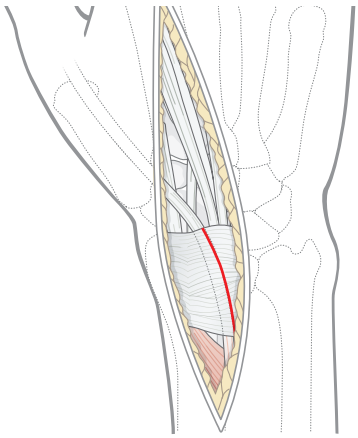
When mobilizing the skin flaps, make sure not to injure the superficial radial nerve.



3 Incision of retinaculum

The third compartment is opened completely in line with the EPL tendon in the extensor retinaculum.
When opening the tendon sheath, be careful not to cut the tendon.

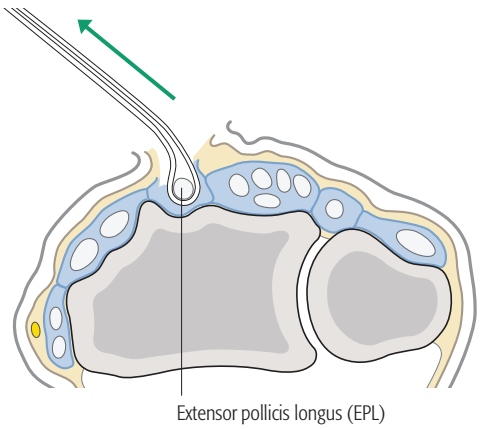
The incision is extended proximally in line with the EPL tendon.



4 Mobilization of extensor pollicis longus tendon

The extensor pollicis longus tendon (EPL) is freed and a vessel loop is passed around it.

The tendon is pulled towards the radial side.

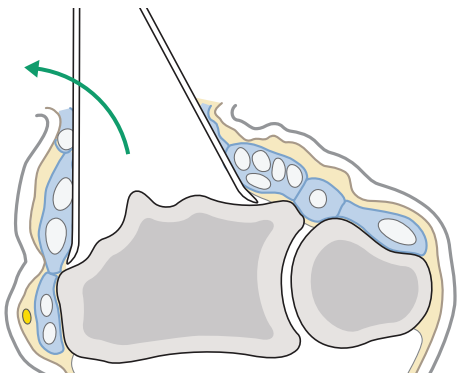


5 Subperiosteal elevation of 4th compartment

The fourth compartment is elevated subperiosteally, leaving the compartment itself intact. The intermediate column is now exposed.

The tendons of the 4th extensor compartment are held to the ulnar side.

If necessary, the tendons of the second extensor compartment are mobilized to the radial side.



The periosteum is incised on the dorsal side of the third metacarpal and the interosseous muscles elevated subperiostally if necessary.