PLEASE CLICK ON THE FOLLOWING LINK TO WATCH THE LECTURE ONLINE:-

https://www.youtube.com/watch?v=m2gmTCEtOf4&list=PLuBRb5B7fa_fRRpcuUO-I1JFGuAGVF9Qy&index=2

Compressive Neuropathies

Compression neuropathy : nerve is compressed against an adjacent structure.

In fact, ischemia of the nerve is likely the underlying cause for the symptoms of pain, numbness, and weakness

- Nerves have segmental circulation, which enters via the epineurium

- With increasing pressure, breakdown of the blood-nerve barrier occurs, followed by endoneurial thickening and then perineurial thickening

Table 16–1: Pathophysiologic Basis for Peripheral Nerve Grading Scale

DEGREE OF SEVERITY	PATHOPHYSIOLOGY	CLINICAL
Mild	Blood-nerve barrier breakdown	Symptoms, no signs on PEX
Moderate	Demyelination abnormal threshold	Symptoms, signs of elevated cutaneous pressure or vibratory thresholds, and/or of weakness
Severe	Axonal loss decreased innervation, density	Symptoms, signs of decreased innervation density (abnormal two point discrimination), and/or muscle wasting

- continued pressure causes localized demyelization and eventual axonal degeneration with collapse at the nodes of Ranvier

- External pressure has been correlated with symptoms of compression neuropathy

- pressure in excess of 30 mmHg is associated with carpal tunnel syndrome (CTS). Pressures greater than 60 mmHg are associated with a complete motor and sensory conduction block.

The goal of treatment for compressive neuropathies is to relieve the external pressure, thereby restoring blood supply to the nerve, providing a bed for the nerve that is free of adhesions, and permitting the normal gliding and elongation of the nerve that occurs with joint motion

Systemic Disorders

- Obesity, aging, and female gender have each been associated especially with CTS.

- Diabetes, alcoholism, hypothyroidism, and exposure to industrial solvents have all been associated with a reduction in peripheral nerve function, which lowers the threshold for developing a compression neuropathy.

Box 16–3 Systemic Diseases Predisposing to Nerve Compression in the United States

- Diabetes
- Thyroid disease
- Collagen vascular disease (vasculitis)
  - Most common: rheumatoid arthritis, lupus erythematosus, scleroderma
- Chemotherapy-induced neuropathy
  - Most common: vincristine, cisplatin (carboplatin), paclitaxel (Taxol), thalidomide
- Alcoholism
- Vitamin deficiency (folate, B_{12}, B_6)
- Heavy metal toxicity (Pb, Hg, Ar, Cd)
- Lyme disease
- Multiple myeloma (protein immunoelectrophoresis)
- AIDS (secondary to protease inhibitors)

- Prolonged exposure to vibration has been clearly shown to increase the risk of neuropathy.

- There is no clear conclusive evidence that occupational factors such as typing and repetitive hand motions are associated with developing compressive neuropathies

Electrodiagnostic Studies

NCV measurements have limitations:

(1) they only measure large myelinated fibers, which are the most severely involved portion of the nerves;

(2) it is difficult to measure the most distal or proximal portions of a peripheral nerve

(3) there is no way to measure dynamic changes in a given nerve

(4) it is typically 3 to 6 weeks before significant changes are seen after an acute injury

(5) the results are operator dependent.

- It has been shown that patients with symptoms and physical exam findings consistent with compressive neuropathies, especially cubital tunnel syndrome, can still benefit from surgical release despite normal electrodiagnostic studies

- normal values for ruling out clinically significant CTS as less than 4 milliseconds for motor latency and less than 3.5 milliseconds for sensory latency
- Ulnar nerve latencies are generally lower than median nerve latencies. At the elbow, ulnar nerve conduction velocities (NCVs) average 60 m/s, and a 10-m/s decrease is considered clinically significant

AREAS OF COMPRESSION

- Carpal tunnel syndrome is by far the most common peripheral nerve compression site and consists of compression of the median nerve beneath the transverse carpal ligament

- . The median nerve may also be compressed proximally in the forearm or elbow, causing either a pronator or anterior interosseous syndrome

- Compression of the ulnar nerve at the level of the elbow is termed cubital tunnel syndrome, and is the second most common site of compressive neuropathy

- The ulnar nerve may also be compressed at the level of the wrist, which is known as ulnar tunnel syndrome

- The radial nerve may be compressed in the proximal forearm, leading to either radial tunnel syndrome or posterior interosseous nerve (PIN) syndrome.

- Compression of the radial sensory nerve across the distal forearm is known as Wartenberg’s syndrome.

- compression of the brachial plexus or subclavian artery across the supraclavicular region can produce thoracic outlet syndrome (TOS)

- Carpal tunnel syndrome is approximately 20 times more common than cubital tunnel syndrome, and both of these conditions are much more common than the other compression neuropathies.

Carpal Tunnel Syndrome

- The average age of patients undergoing carpal tunnel release (CTR) is 54 years; approximately 70% of the patients are female

- The majority of cases are idiopathic, but an increased incidence of CTS is seen in patients with diabetes as well as thyroid disorders, alcoholism, amyloidosis, inflammatory arthritis, cigarette smoking, and pregnancy

- Some work-related activities, such as use of vibrating tools, have been consistently shown to increase the risk of developing CTS

- Some work-related activities, such as use of vibrating tools, have been consistently shown to increase the risk of developing CTS

Anatomy and Pathology

- The carpal canal functions as an enclosed space and pressure in the carpal canal exceeding 30 mmHg will produce symptoms of median nerve compression.
- The roof of the carpal canal is the flexor retinaculum, which

extends from the hamate and triquetrum on the ulnar side to

the scaphoid and trapezium on the radial side

- There are several possible anatomic variations from normal for the motor branch of the median nerve

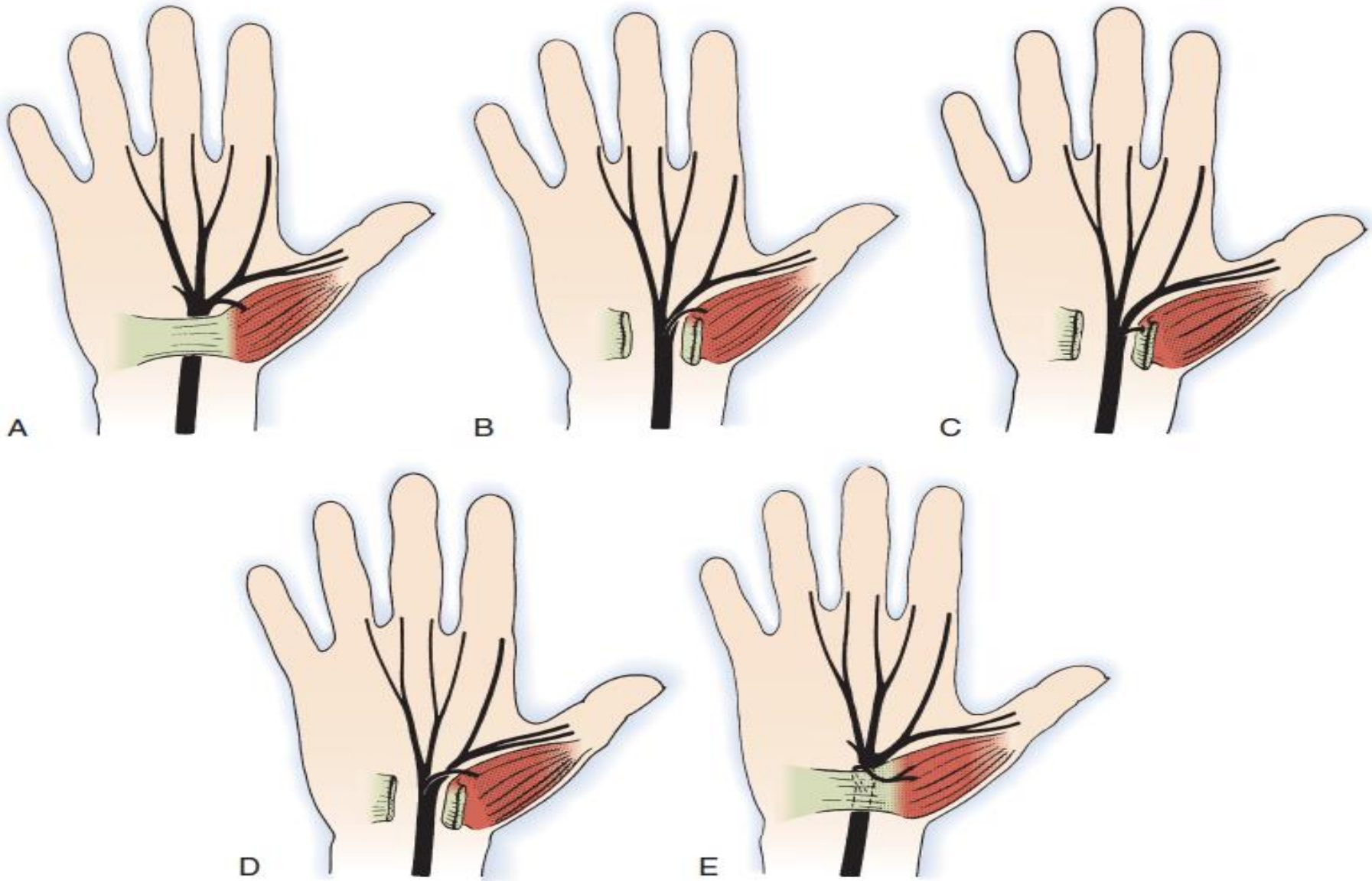


FIGURE 28.5 Variations in median nerve anatomy in the carpal tunnel. **A,** The most common pattern of the motor branch is extraligamentous and recurrent. **B,** Subligamentous branching of a recurrent median nerve. **C,** Transligamentous course of the recurrent branch of the median nerve. **D,** The motor branch can uncommonly originate from the ulnar border of the median nerve. **E,** The motor branch can lie on top of the transverse carpal ligament. (From Lanz U: Anatomical variations of the median nerve in the carpal tunnel, *J Hand Surg [Am]* 2:44–53, 1977.)

Symptoms

- Patients with CTS note numbness in the median nerve distribution, which typically involves the radial three and one-half digits

- Worsening discomfort at night

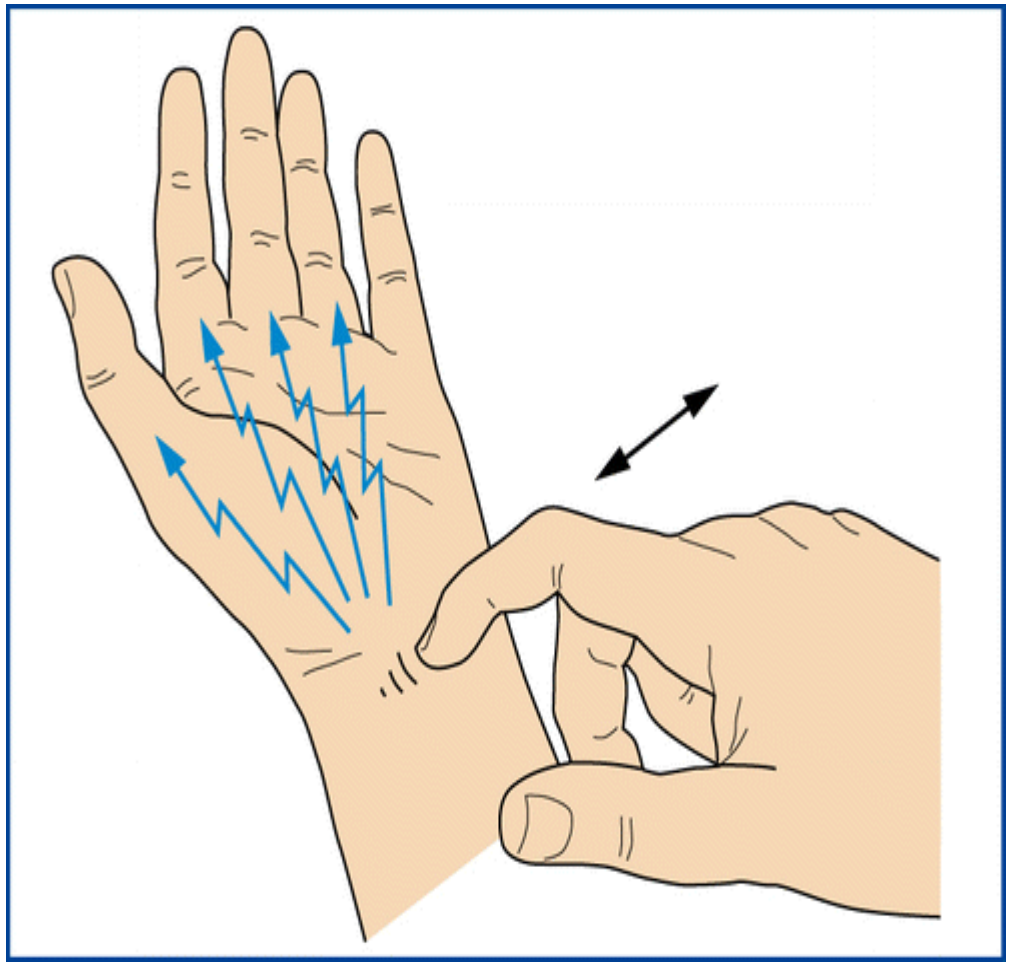
- Occasionally, patients will report weakness in the hand, dropping objects
- shake hand or hang it down by side or off the side of bed at night to relieve the numbness

Examination

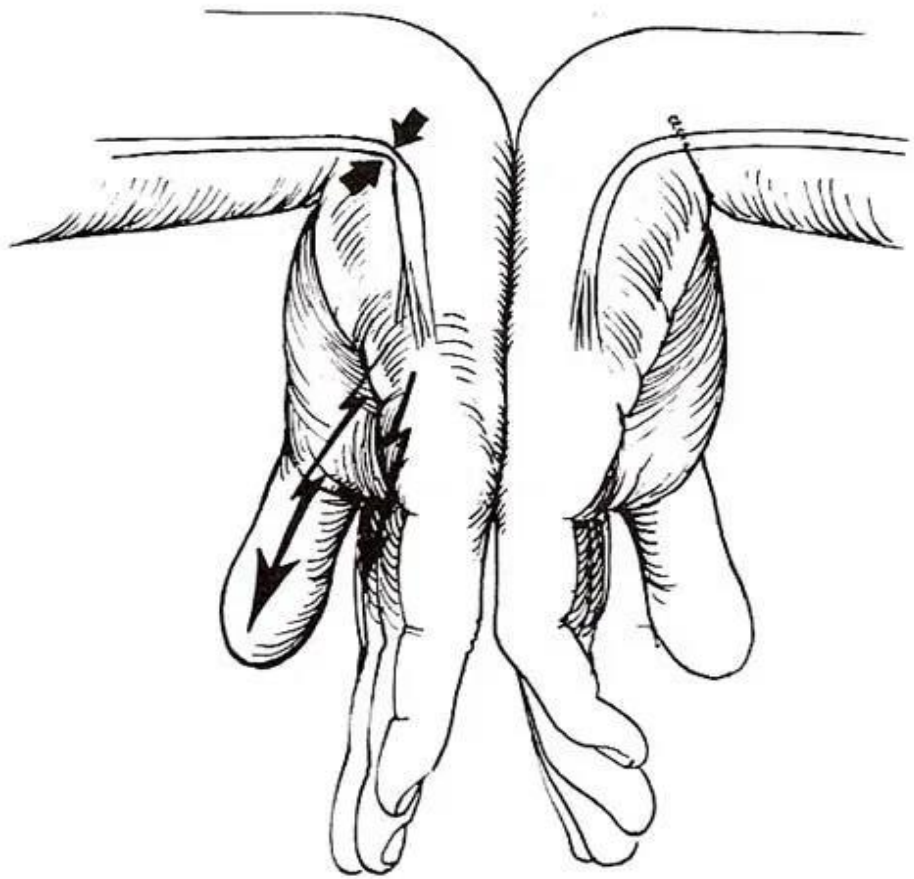
- Tinel’s test strictly refers to distal paresthesias over a site of nerve regeneration when the nerve is tapped

- . Phalen’s test is performed by asking the patient to let their wrist drop (not forced) into flexion

- The compression test is considered positive when the examiner applies direct digital pressure over the carpal canal
- scratch collapse test



Phalen's test



Carpal compression test

Durkan's test

Apply direct pressure with thumb on carpal tunnel for 1 min

Paresthesia in median nerve distribution is considered positive

Sensibility: 64% – Specificity: 83%

In: Carpal tunnel syndrome and related median neuropathies: Challenges and complications. S. Duncan & R. Kakinoki (Eds), Springer International Publishing, 2017.

Diagnostic Tests

- The standard method for confirming the diagnosis of CTS and eliminating other causes of symptoms remains the EMG/NCV study

- A motor latency greater than 4 milliseconds and sensory latency greater than 3.5 milliseconds are consistent with the diagnosis.

- Fibrillation potentials noted in the abductor pollicis brevis muscle may be seen in EMG testing and suggest muscle denervation secondary to axonal dropout
- highresolution ultrasound is now being described for the evaluation of peripheral nerves

Treatment

- Nonoperative treatments of CTS include, but are not limited to, splinting, nonsteroidal antiinflammatory drugs (NSAIDs), and corticosteroid injections.

- CTR surgery can be divided into open and endoscopic procedures

Endoscopic CTR

- . Overall studies have shown that short- and long-term outcomes of open and endoscopic CTR are similar with regard to major complications, the need for revision surgery, and symptomatic relief

Advantages:

less scar sensitivity, earlier return to work, and increased pinch strength in the early postoperative period

Disadvantages:

more expensive because of additional cost of the equipment

Open CTR

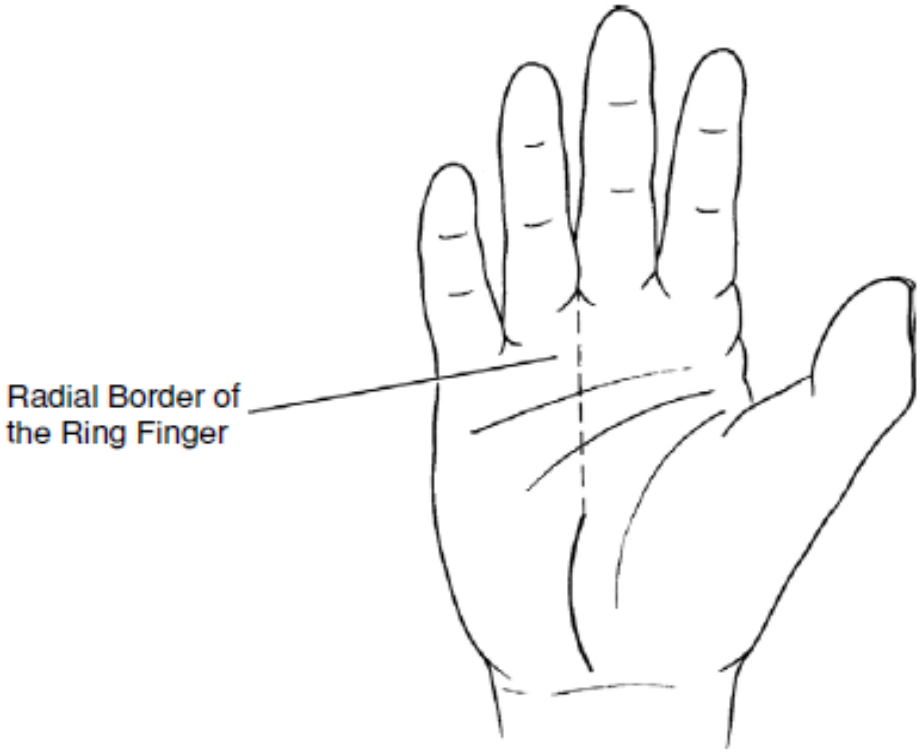
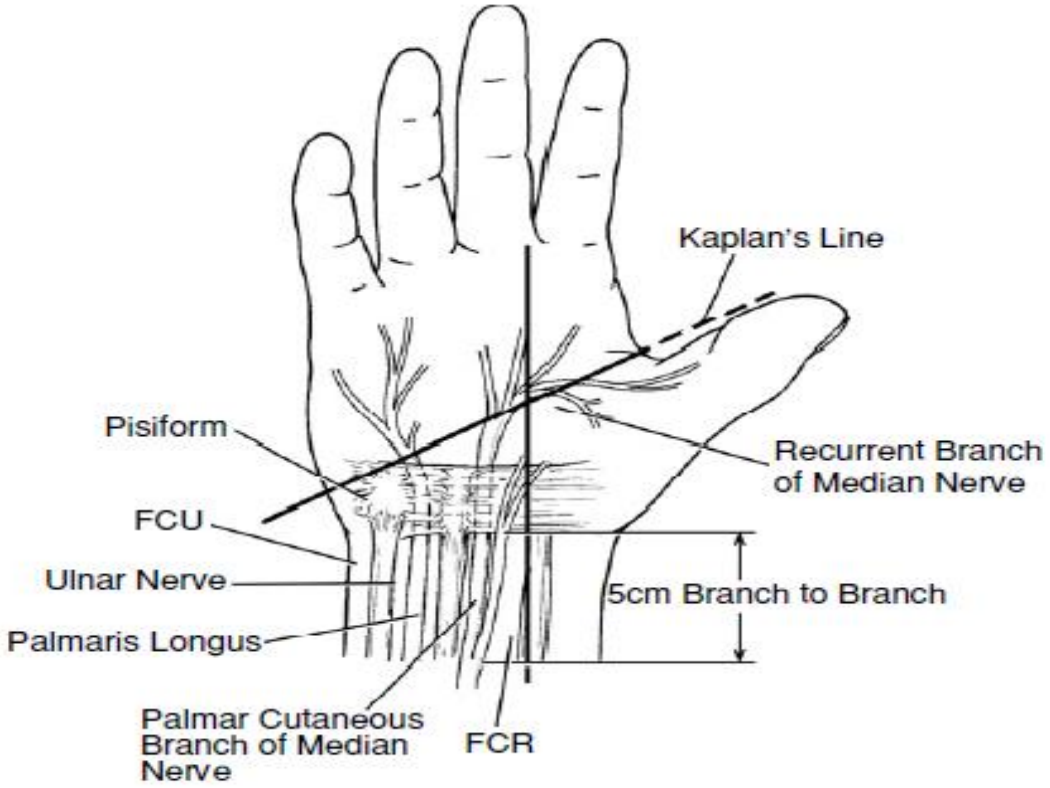


Figure 16–3:
A carpal tunnel incision made along a line drawn proximally from the radial border of the ring finger avoids injury to the recurrent motor branch and the palmar cutaneous motor branch of the median nerve.



CTS-Important Landmarks

Figure 16–2:
Kaplan's line is drawn along the ulna border of the abducted thumb. The motor branch is identified as the intersection of Kaplan's line in a line drawn longitudinally in the web space of the index and middle fingers.

Complications

- excellent outcomes reported in 75% to 93% of patients
- nerve injury to both the ulnar and median nerves has been reported for all CTR techniques
- Scar sensitivity occurs in nearly all patients
- Complex regional pain syndrome
- pillar pain, which weakens grip

- Recurrent CTS is also a more commonly reported complication with rates ranging from 3% to 24%
- Persistent or recurrent symptoms may have a number of different etiologies:

  incomplete TCL release

  incomplete distal forearm fascia release,

  TCL scarring or even reconstitution

  perineural fibrosis

Box 16–7 Differential Diagnosis of Failed Carpal Tunnel Surgery

- Recurrent or persistent carpal tunnel syndrome
- Proximal median nerve compression in the forearm
- Radial sensory nerve entrapment in the forearm
- Upper trunk brachial plexus compression
- Cervical radiculopathy (C5/C6)

Postoperative Rehabilitation

- Finger range-of-motion exercises are started immediately after surgery
- Immobilization?!
- Scar massage and gentle strengthening may be started 2 weeks
- full recovery using objective and subjective measures may take up to 4 months

Compression of the Ulnar Nerve at the Elbow (Cubital Tunnel Syndrome)

- The overall incidence of cubital tunnel syndrome is approximately 1%
- Approximately 10% to 15% of all adults experience nighttime numbness in the ulnar border of the hand on an intermittent basis
- There is an increased incidence of cubital tunnel syndrome in patients with:

  cubitus valgus

  idiopathic subluxation of the ulnar nerve,

  elbow arthritis

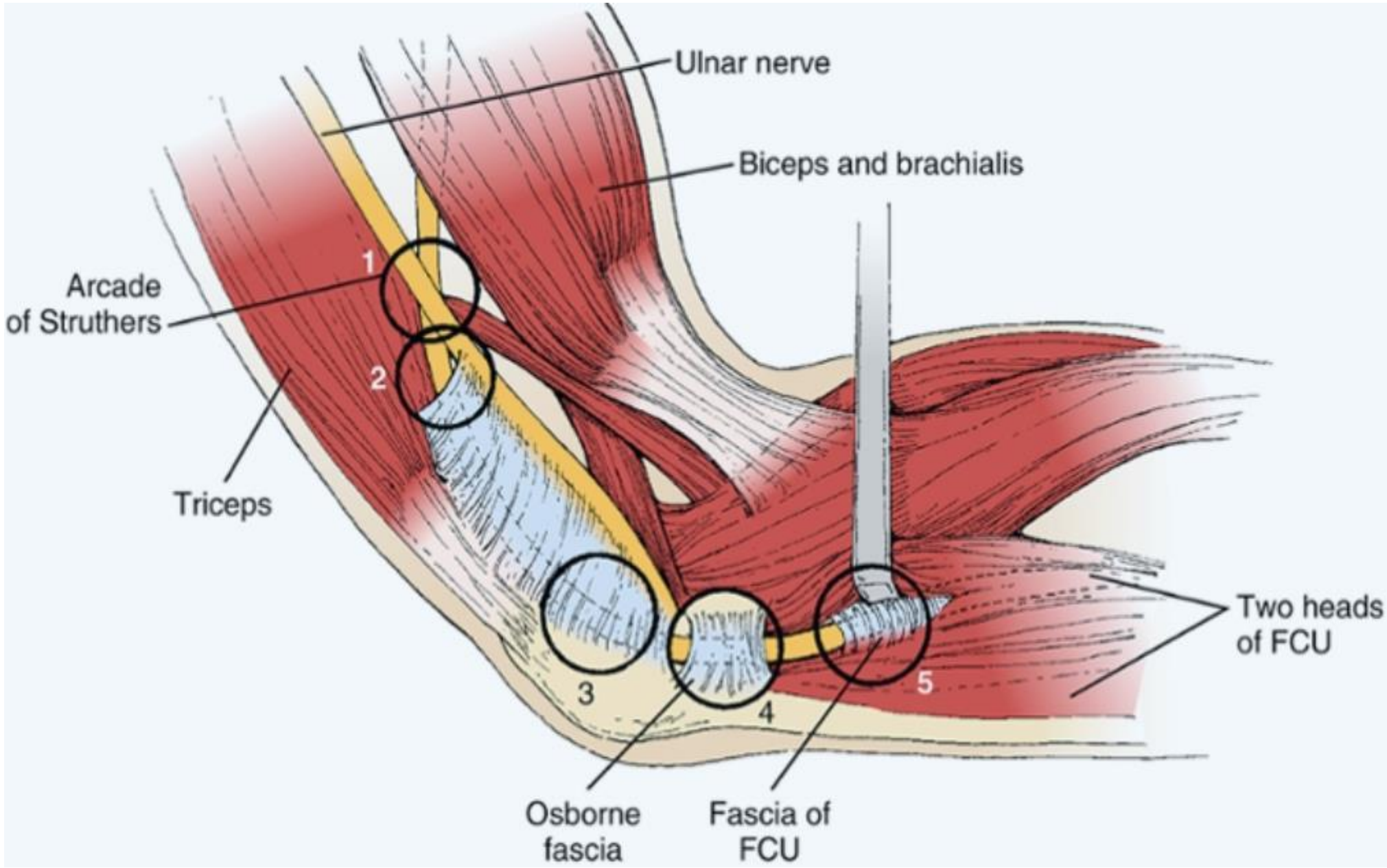
  ganglion medial to the elbow joint.

Anatomy

- At the level of the elbow :

The ulnar nerve passes posterior to the medial epicondyle and medial to the olecranon.

The ulnar nerve then enters the cubital tunnel, which is defined by a taut fascial layer extending from the flexor carpi ulnaris muscle and the arcuate ligament of Osborne. After passing through the cubital tunnel, the ulnar nerve travels deep into the forearm between the ulnar and humeral heads of the flexor carpi ulnaris muscle.


Ulnar nerve
Biceps and brachialis
Arcade
of Struthers
1
2
Triceps
3
4
5
Two heads
of FCU
Osborne
fascia
Fascia of
FCU

Sites of compression :

- between the two heads of the flexor carpi ulnaris (FCU)
- the arcade of Struthers (a fascial extension of the medial intermuscular septum and is essentially a thickening of the medial arm fascia on top of the ulnar nerve)
- the space between Osborne’s fascia (the proximal fibrous bands of the FCU origin)and the medial collateral ligament (MCL).

- medial head of the triceps
- the fascia over the cubital tunnel
- the anconeus epitrochlearis muscle(an anomalous muscle that extends from the medial border of the olecranon and inserts on the medial epicondyle).

Table 16–5: Critical Anatomic Structures that Must be Treated to Prevent Recurrent Ulnar Nerve Compression at the Elbow

ANATOMIC STRUCTURE	INITIAL SURGICAL TREATMENT
Roof of cubital tunnel	Incision of entire length
Fascia of flexor carpi ulnaris	Incision of 3-cm length distally
Medial intermuscular septum	Excision of 2-cm segment
Fascia from medial head of triceps	Incision from medial intermuscular septum
Anomalous origins of triceps	Divide medial head if above to ulnar nerve
Epitrochlearis anconeus	Divide if this anomalous muscle is present
Arcade of Struthers	(There is no arcade of Struthers)

Symptoms

- numbness along the ring and small fingers as well as the dorsal ulnar aspect of the hand.

- Elbow flexion worsens the symptoms and exacerbation often occurs at night when patients sleep with their elbows in a flexed position
- snapping on the medial aspect of the elbow with range of motion

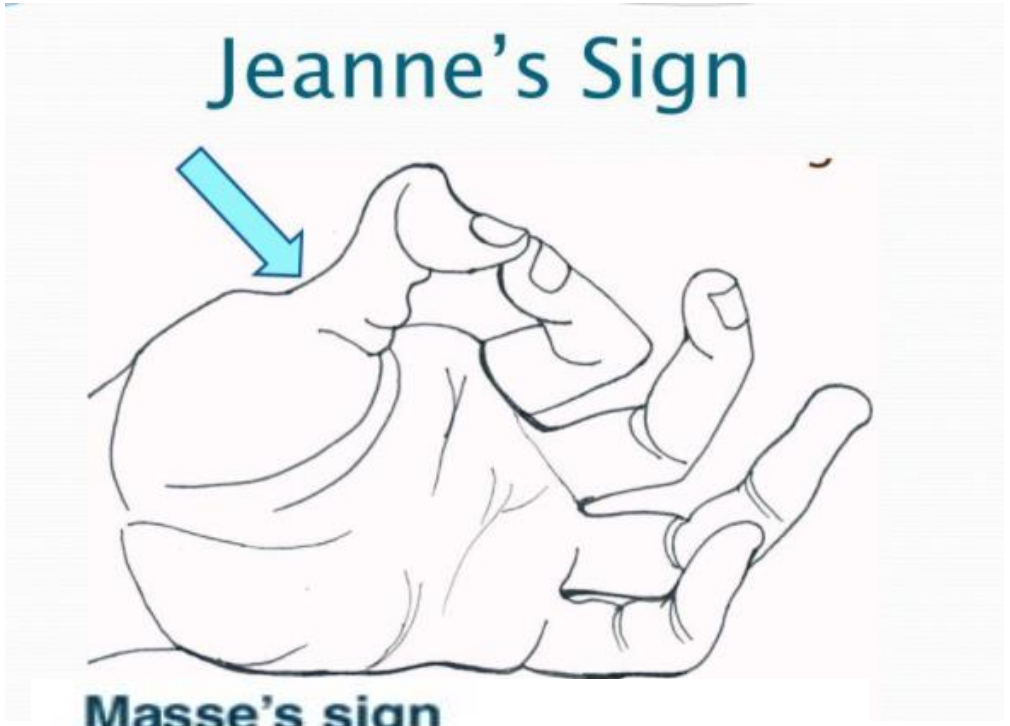
Examination

- a positive Tinel’s sign at the cubital tunnel.
- abnormal two-point discrimination
- . In severe cases, patients have weakness of the intrinsic muscles of the hand with wasting in the thumb-index web space
- . The most severe chronic cases may exhibit clawing of the ring and small fingers

- Froment’s sign

- Wartenberg’s sign

- Jeanne’s sign
- Masse’s sign



Treatment

- nonoperative treatment :
- Indications :

  pain and numbness are not severe

  patient does not have constant nerve symptoms

  there is no muscular weakness or atrophy

  Modalities :

medial elbow pad

 avoiding excessive flexion of the elbow, especially at night.

A night splint or anterior elbow pad

Surgical indications :

Surgery is typically recommended as the initial treatment when the patient has

muscular involvement clinically or

neurodiagnostically, or when the NCV is less than 40 m/s.

Surgery is also indicated for patients with a subluxating ulnar nerve

- In Situ Release in uncomplicated cubital tunnel syndrome except:

nerve subluxation,

recurrent symptoms following previous decompression, or concomitant medical epicondylitis.

decreased operative time, allows for faster recovery, and has a decreased risk of disturbing the blood supply to the nerve

Anterior Submuscular Ulnar Nerve Transposition

- nerve subluxation or recurrent symptoms following simple decompression, and some surgeons still choose this as their primary surgical recommendation.
- . Approximately 8 to 10 cm of the intermuscular septum is excised to prevent pressure and angulation of the nerve
- following transposition Care is taken to ensure that there is no kinking of the nerve

- Anterior Subcutaneous Transfer of the Ulnar Nerve.

- Medial Epicondylectomy.

MEDIAN NERVE COMPRESSION IN THE ELBOW AND FOREARM

• Median nerve compression in the forearm has been subdivided into

the *anterior interosseous nerve compression syndrome* and *the pronator syndrome*

Symptoms

- Classically, the pronator syndrome has little motor deficit and primarily results in symptoms of numbness in the hand with the median-innervated fingers.[23]

- .Classically, the anterior interosseous nerve syndrome results in weakness and/or paralysis of the flexor pollicis longus and the flexor profundus to the index finger and no sensory symptoms

Sites of compression :

Box 16–8 Anatomic Structures Causally Related to Median Nerve Compression in the Forearm

- Ligament of Struthers (humerus to medial humeral epicondyle)
- Lacertus fibrosis
- Deep head of the pronator teres
- Fibrous arch between heads of the superficialis muscles

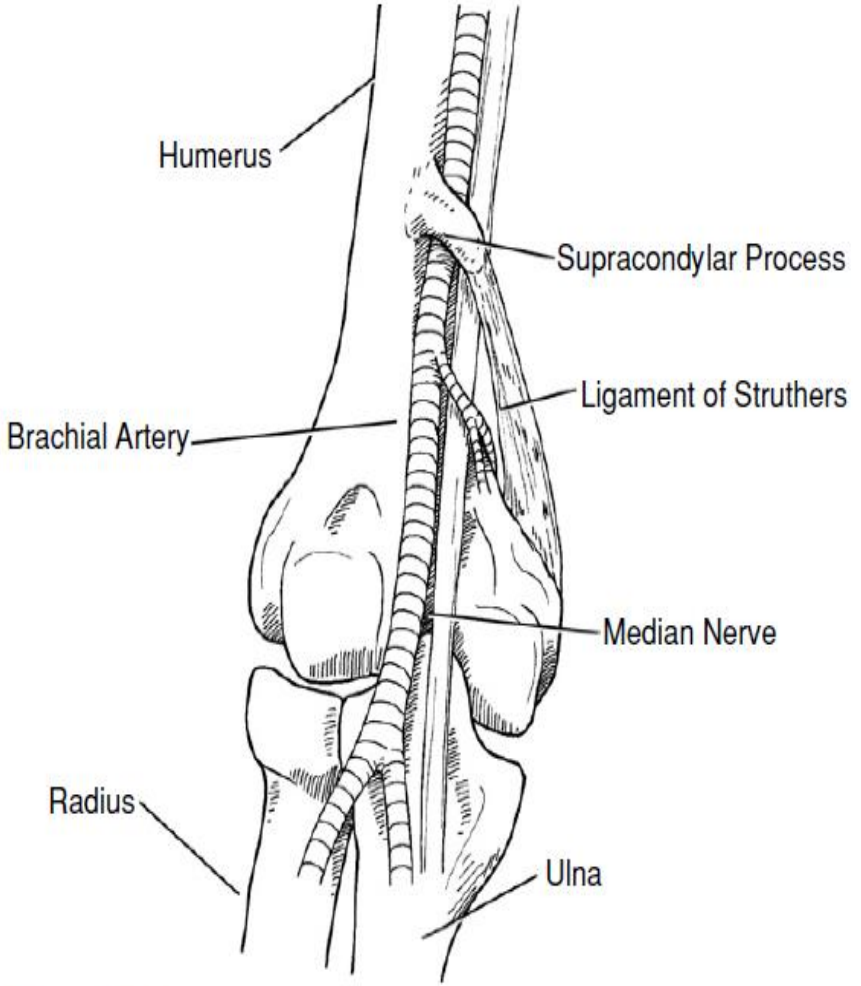


Figure 16–6:
The ligament of Struthers bridges the supracondylar process of the humerus to the medial epicondyle or the origin of the humeral head of the pronator teres.

Treatment

- Nonoperative management includes changing activities of daily living and, in the work environment, may require an ergonomic evaluation and job rotation.
- Splinting and cortisone injections usually are not helpful.
- Surgical approach should permit exposure from the medial elbow to the midforearm but does not have to incorporate a long zigzag incision, except where crossing the antecubital crease is necessary.
- With the surgical approach, care should be taken not to injure either the medial or the lateral antebrachial cutaneous nerve, which can be a source of a painful scar

Ulnar Nerve Compression at the Wrist ulnar tunnel syndrome

- Anatomy :
- The ulnar nerve and ulnar artery plus a collection of fat occupy a space described by Guyon.There is a thin but firm roof bridging from the palmar fascia, the palmaris brevis muscle (present in 20%), and the hamate toward the pisiform.The deep surface of the ulnar tunnel is the pisohamate ligament.[26]

Floor : TCL, Hypothenar muscle

Roof : volar carpal ligament

Ulnary : Pisiform, Pisohamate lig.

Radially : Hook of hamate

Zones :

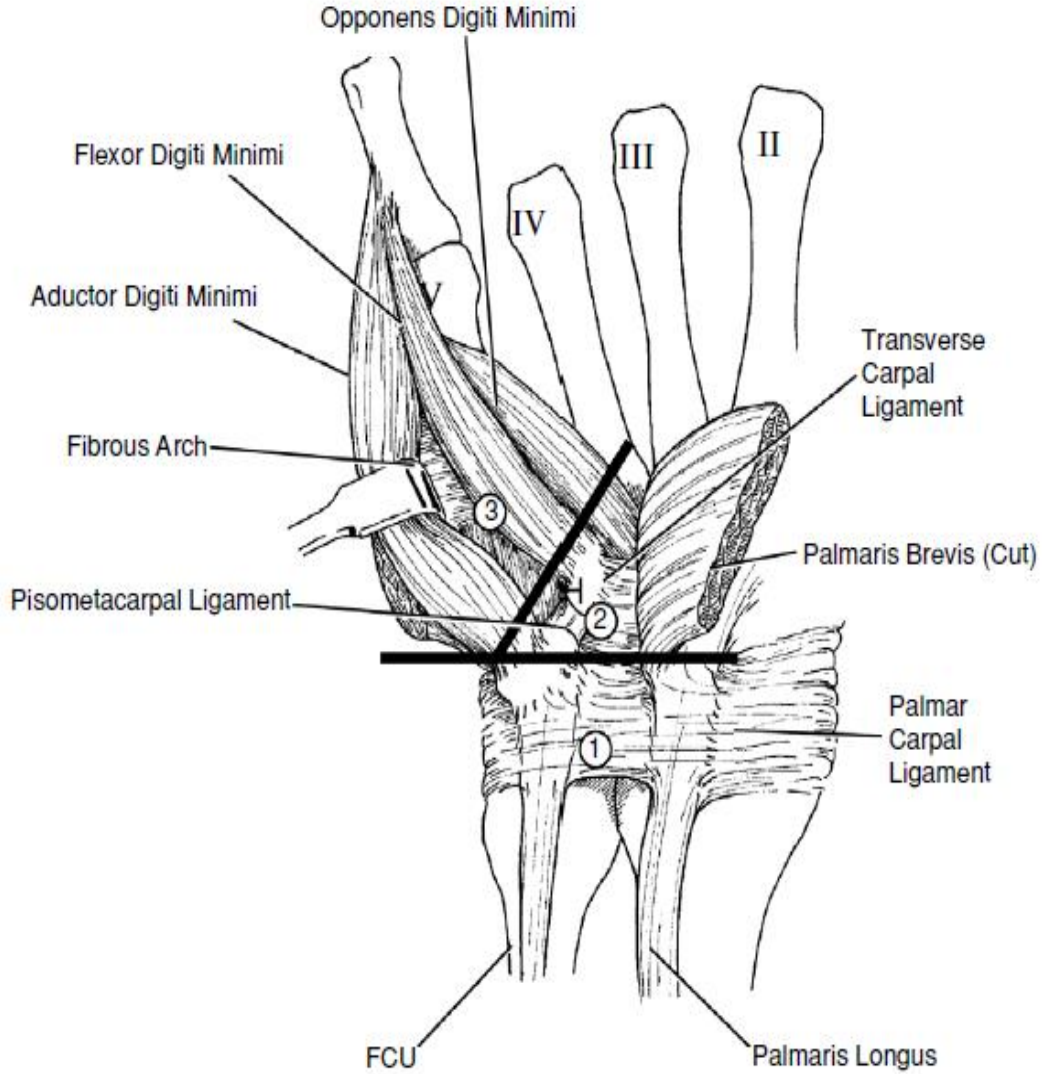


Figure 16–8:
The ulna tunnel can be divided into three sections: Lesions in zone I often produce a combined sensory and motor deficit. Lesions in zone II, cause a pure motor deficit. Lesions in zone III cause pure sensory deficits. (This is from Figure 18–10 on page 330 in the textbook.)

Causes :

- The most common cause of compression of the ulnarnerve at the wrist level is a **lipoma or a ganglion**
- Twenty-five percent of patients have **a fibrous origin of the hypothenar muscles** that can cause compression of the deep motor branch.
- Inflammation of the pisotriquetral joint may cause ulnar nerve symptoms, as may **occlusion of the ulnar artery or an ulnar artery aneurysm**
- **classic sports injuries** can cause fractures of the **hook of the hamate**

Symptoms and treatment :

- Symptoms related to ulnar nerve compression at the wrist always include numbness of the little finger pulp and sometimes the ring pulp, but not the dorsum of the hand, and variable degrees of intrinsic muscle weakness or loss of coordination of the fingers

- Surgical decompression of the ulnar nerve at the wrist can be performed through the typical incision for carpal tunnel decompression. Care should be taken to trace out the course of the motor branch to make sure that the decompression is complete.

Radial Sensory Nerve Compression

Wartenberg Syndrome

- The radial sensory nerve is compressed in pronation by the movement of the extensor carpi radialis longus toward the brachioradialis tendon, at the site where the nerve transits from deep to superficial. Sometimes there is a small sheath binding the radial sensory nerve to the deep surface of the brachioradialis. Sometimes the nerve exits through the brachioradialis tendon

- Risk factors :

setting of trauma, with crush injury, or with use of an external fixation device in the forearm.

Symptoms

- Symptoms are just sensory and consist of a burning, paresthesia, or numbness along the dorsoradial aspect of the hand.
- .*These symptoms can be described simply as numbness in the thumb and index finger, leading to a misdiagnosis of carpal tunnel syndrome*.
- .Radial sensory nerve crosses the wrist joint while being tethered proximally. Ulnar wrist deviation, especially if the thumb is grasped, causes a shooting dorsoradial pain.
- .The physical examination should identify the Tinel sign just posterior (lateral) to the insertion of the brachioradialis into the radius

Treatment

- The surgical technique consists of releasing the fascia from the exit point of the radial sensory nerve as far proximal as necessary so that the nerve is no longer compressed with forearm pronation.
- .During the dissection, care should be taken to not injure the overlying lateral antebrachial cutaneous nerve

Radial Nerve Compression at the Elbow

- *posterior interosseous nerve compression* and the *radial tunnel syndrome*

- Anatomic structures that may compress the radial nerve at the elbow are fibrous or muscular connections from the biceps to the brachioradialis that form the roof of the radial tunnel, a fibrous edge to the extensor carpi radialis brevis muscle, and the fibrous covering of the supinator muscle (arcade of Frohse).

Symptoms

- Radial tunnel syndrome symptoms consist primarily of aching in the region of the lateral elbow and can be confused with epicondylitis. *The critical difference on physical examination is that with epicondylitis the tender site is at the lateral humeral epicondyle, at the extensor muscle origin, but with compressive neuropathy of the radial nerve the nerve itself is tender approximately 1.5 cm anterior and distal to the epicondyle.*
- Physical examination for radial tunnel syndrome should include resisted middle finger extension.This action forces the extensor carpi radialis brevis to contract to maintain the third metacarpal position, causing pressure on the radial nerve. Pain is referred to the region of the radial tunnel.

Symptoms

- *The symptoms of posterior interosseous nerve "palsy" all are motor, with the exception of aching in the dorsal wrist, because the terminal branches of this nerve innervate the dorsal wrist capsule.*
- The motor symptoms of posterior interosseous nerve palsy range from weakness of grasp to paralysis of individual or all muscles that extend the wrist and fingers.
- Surgical exposure for decompression of the radial nerve can either be anterior or posterior.

Brachial Plexus Compression (Thoracic Outlet Syndrome)

- The symptoms of brachial plexus compression can be so universal in the neck, shoulder, and entire hand and arm
- Symptoms can extend to facial pain and temporomandibular joint pain, presumably because of secondary effects on the cervical plexus
- Headaches can be a common feature because of tightness in the scalene muscles.
- Symptoms of hand swelling reflect compression of the subclavian vein, whereas symptoms of coldness may reflect either lower trunk compression with involvement of the sympathetic inflow or subclavian artery compression.

Causes

- Pancoast tumour
- cervical rib.
- *Congenital anomalies*

Table 16–6: Anatomic Anomalies in the Thoracic Inlet

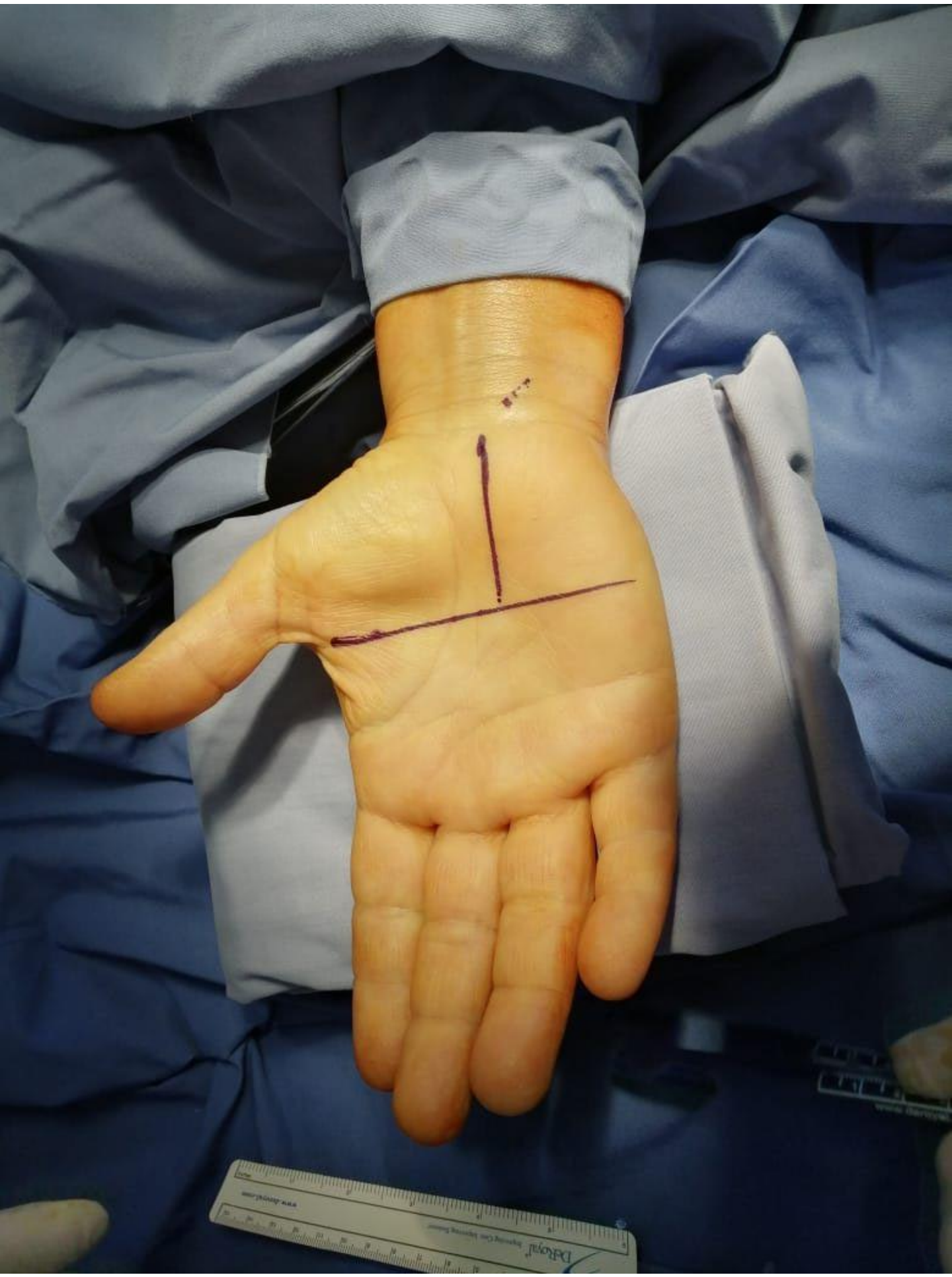
Cervical rib
Fibrous bands from C7 transverse process
Extra origins for scalene muscles
Prefixed or postfixed brachial plexus
Intraplexus anomalous connections
Elevated position of subclavian artery
Muscle of Albinus (scalenus minimus)
Fibrous edges of scalene muscles
Anomalous vessels crossing plexus
Sibson fascia crossing T1 nerve root
Proximal junction of T1 to C8

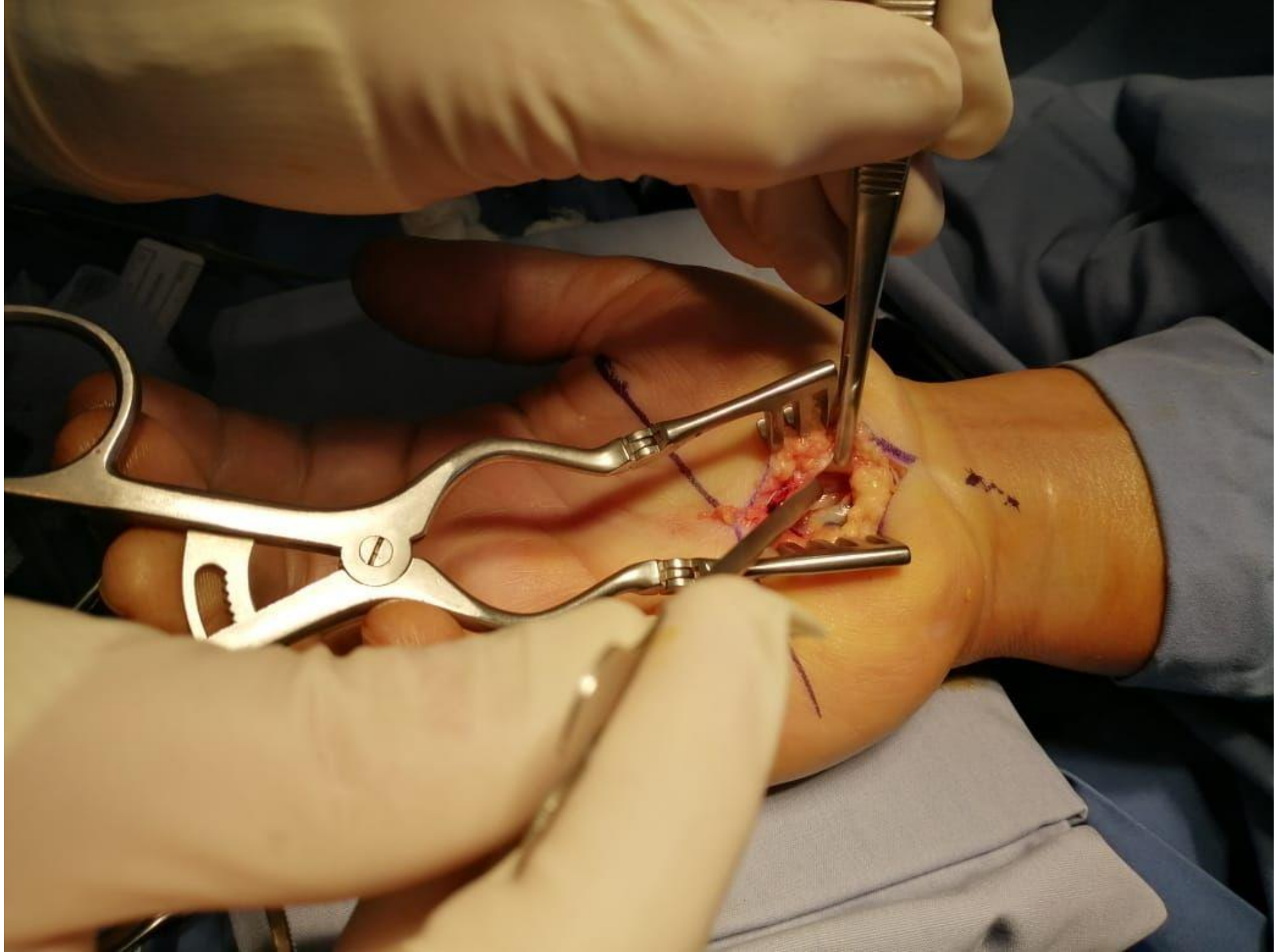
Treatment

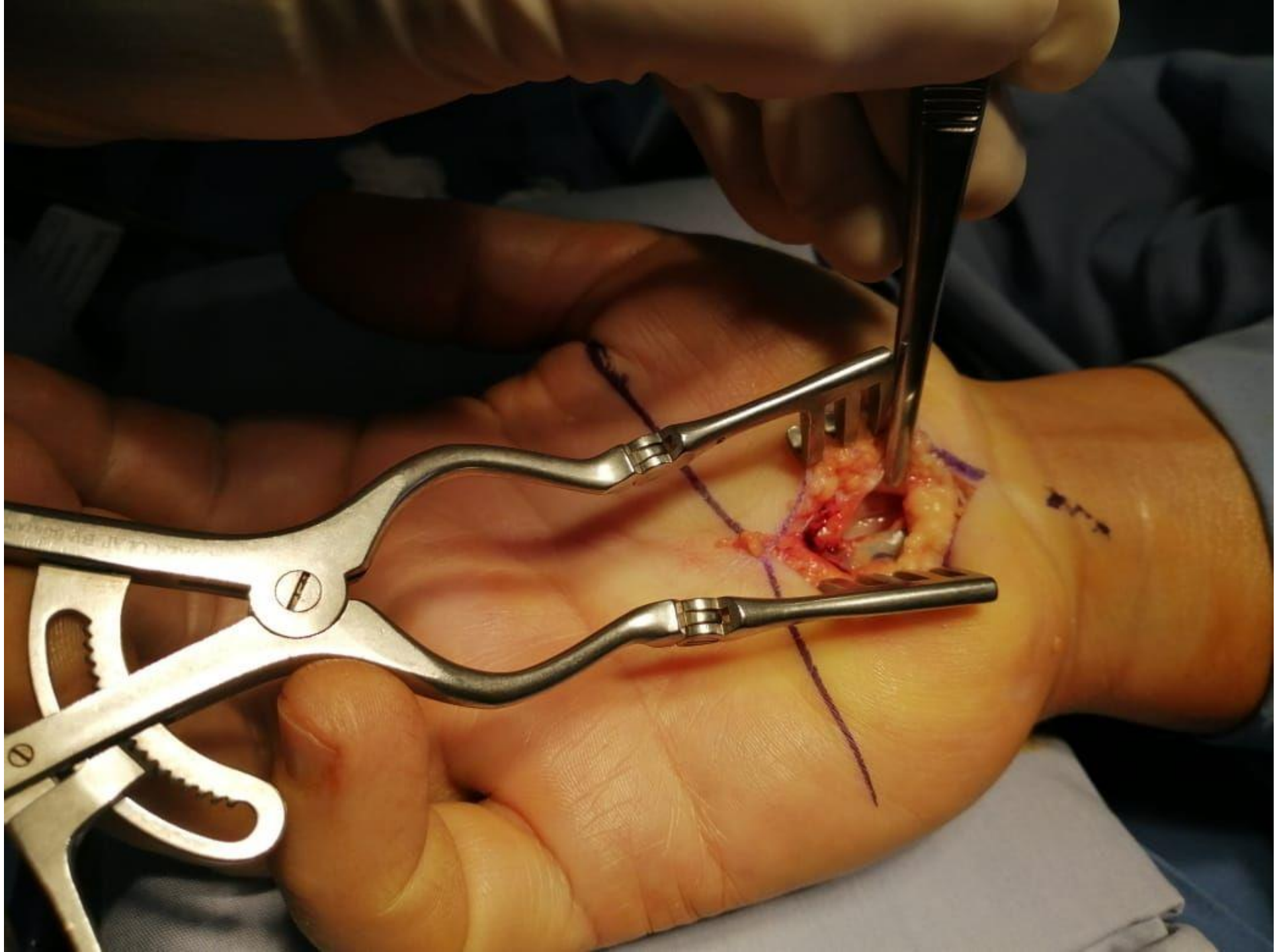
- *No surgery should be contemplated until the patient has undergone at least 6 months of special exercises designed to stretch the scalene muscles and strengthen other shoulder muscles*

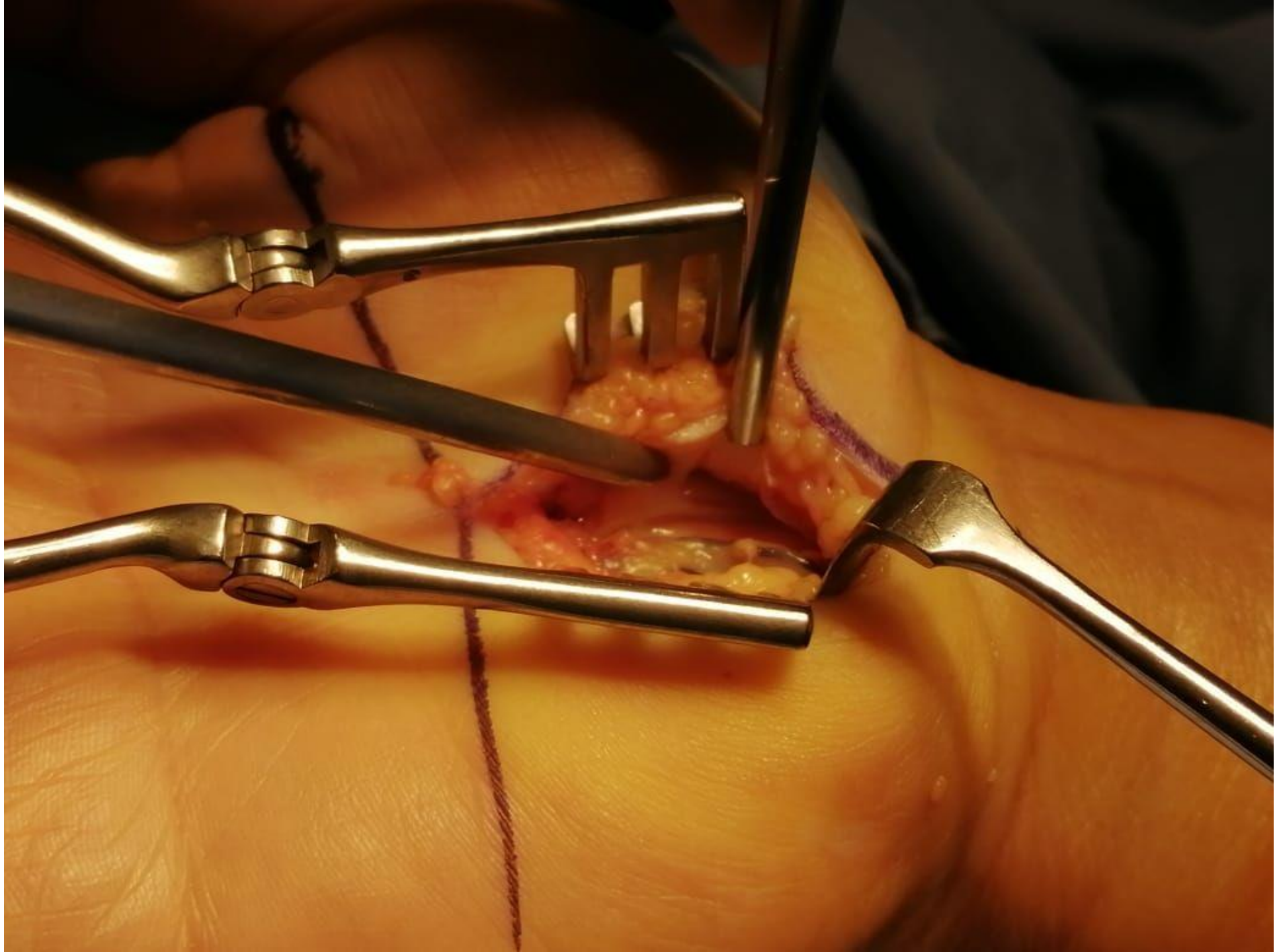
Discussion

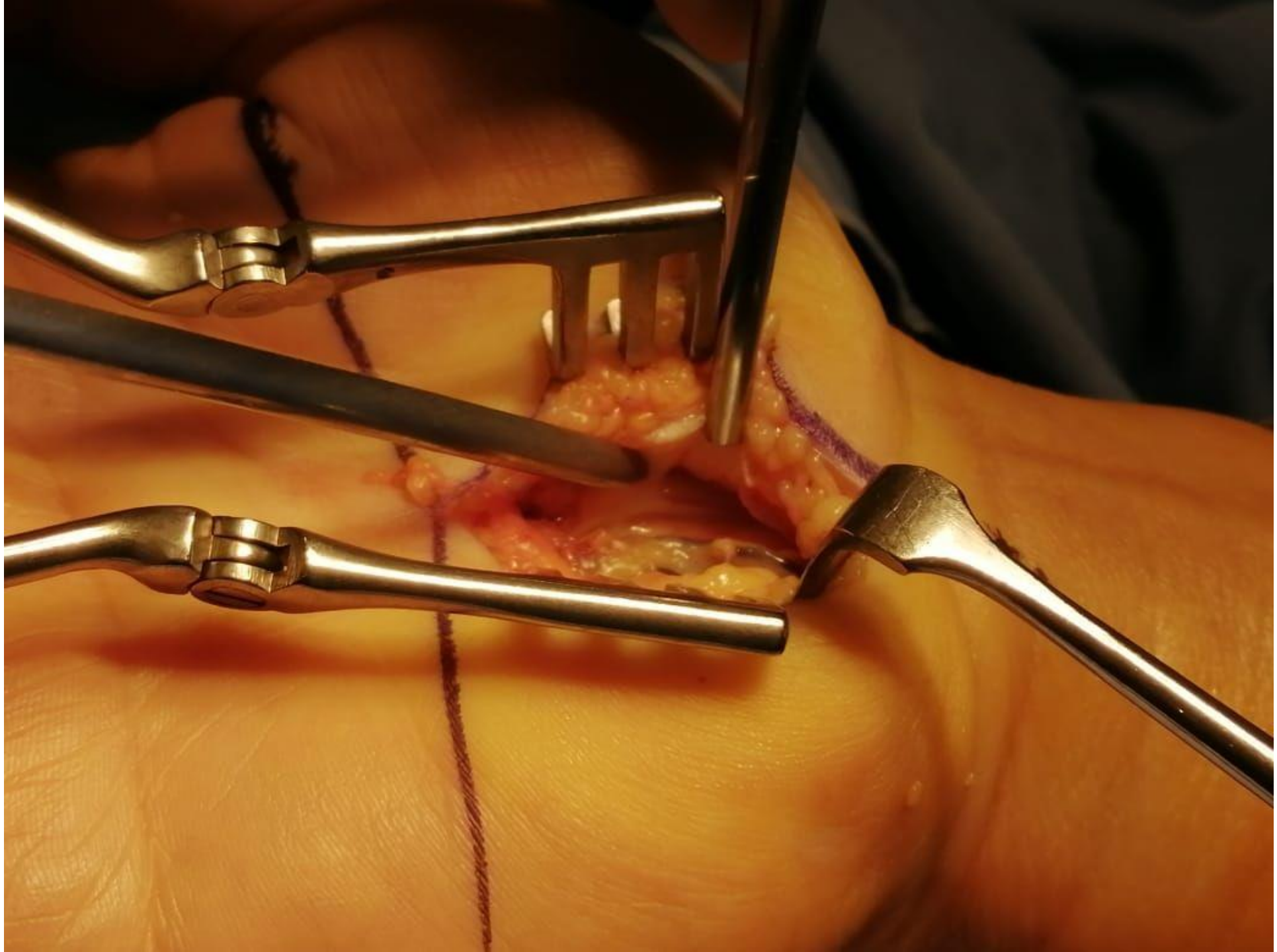
- Hand innervation , motor and sensory
- How to perform Open CTR

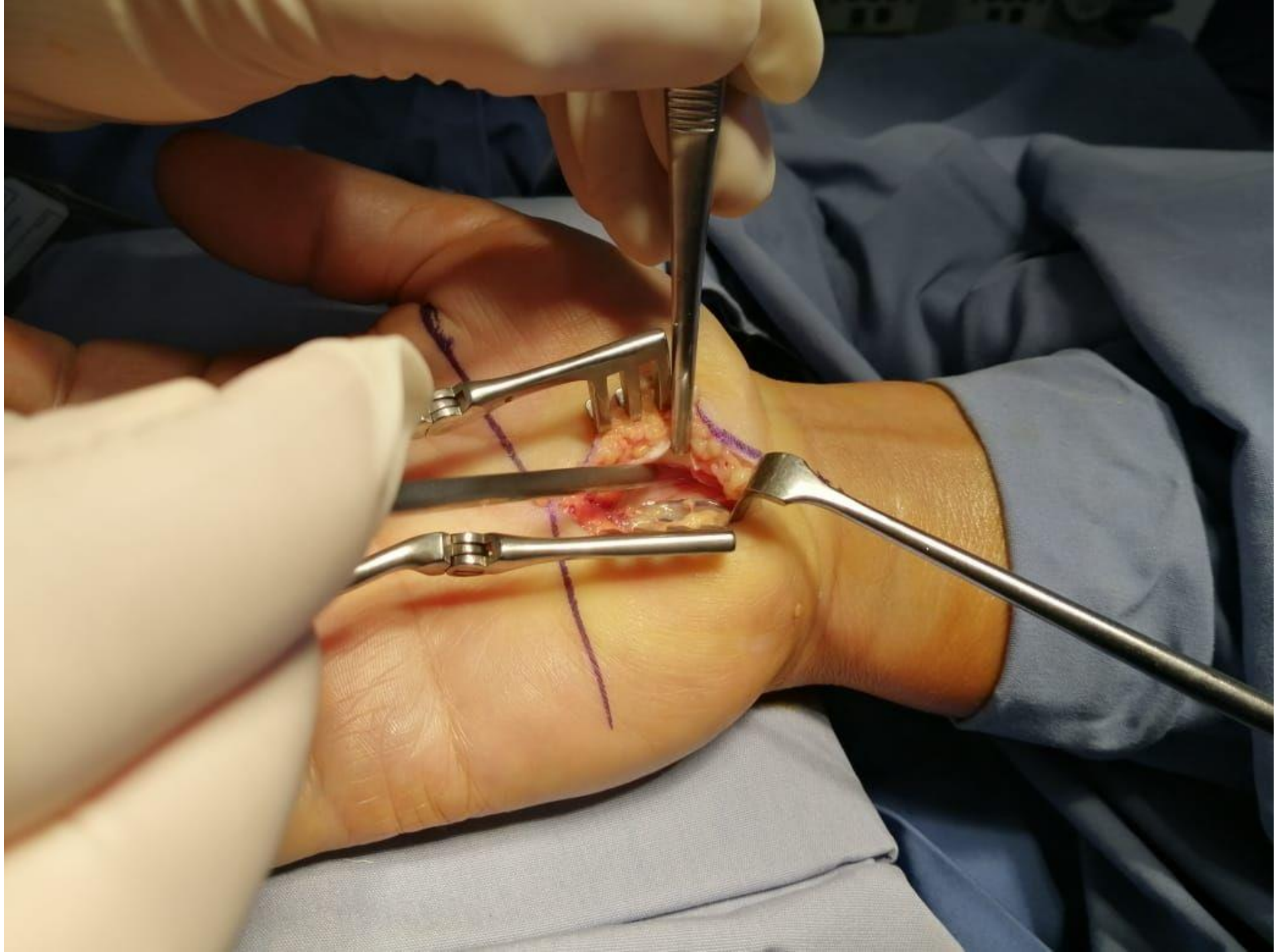












- Thank you all