Carpal Tunnel Syndrome

Epidemiology

- Most common entrapment neuropathy
- Incidence: 125:100,000
- Affects1-3% in general population
  - Usually people who use their hands extensively in their jobs or daily activities with repetitive movements
- Female:Male = 2.5:1
- >50% between ages 40 & 60
- Dominant hand most often affected
  - Bilateral in10% of patients

Symptoms

- Insidious onset
- Sensory complaints
  - 80-100% of patients
  - Numbness or paraesthesias in radial half of hand & lateral 3 ½ digits
  - Nocturnal numbness, parathesiae and (burning) pain that awakens patient
  - May occasionally present with forearm, arm, and shoulder pain radiating from wrist
- Symptoms usually aggravated by activity or repeated wrist flexion
- Patient characteristically shakes or rubs hand or uses cold water to obtain relief

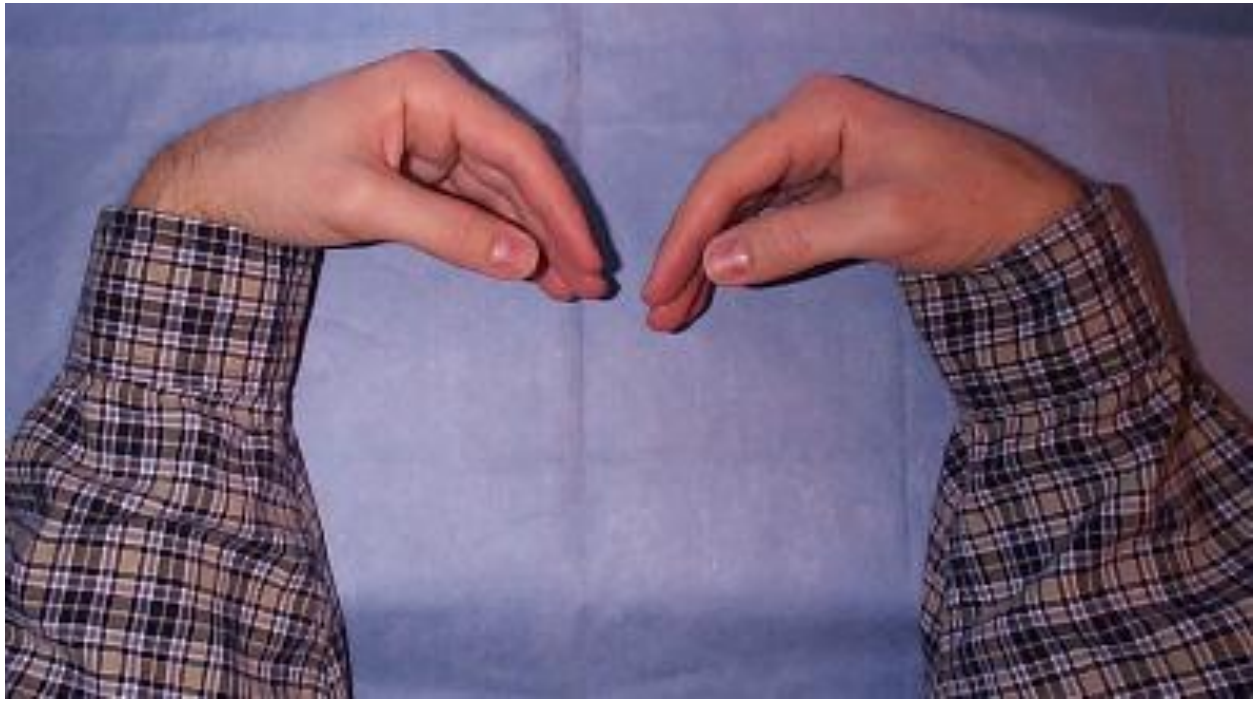
Symptoms

- Motor complaints
  - Clumsiness or weakness of the involved hand
  - Problems grasping or pinching

- Acute carpal tunnel syndrome
  - Severe pain, wrist or hand swelling, cold hand, or decreased finger motion.

Signs

- Thenar atrophy
- Abductor pollicis brevis weakness
- Sensory examination
  - Decreased sensation to light touch and pinprick in the lateral three digits and in the radial palm



Signs

- Phalen sign
  - Seek to reproduce pain or paresthesias in the median nerve's distribution within 30-60 seconds
  - Maximal flexion of the wrist
  - 60-80% sensitivity, 80% specificity
- Tinel sign
  - Tapping wrist produces paresthesias
  - 45-80% sensitivity, 91% specificity

- Positive Phalen & Tinel signs with objective sensory findings in median nerve distribution are 85% diagnostic

Signs

- Durkan test:
  - Examiner presses on carpal tunnel with his/her thumbs in an attempt to reproduce paresthesias within 30 seconds
  - Pressure of 20 Kpa (150 mmHg)
  - 89% sensitivity
- Wormser's test (reverse Phalen's)
  - Hyperextension of the wrist.
- Tourniquet
  - Significant damage if paresthesias appear in 15 seconds.
  - Sensitivity 83%.

Signs

- Advanced disease
  - Decreased sensation to pain or light touch in radial half of hand and lateral 3 ½ digits
  - Thenar muscle atrophy and weakness, especially abductor pollicis brevis
    - Unable to abduct thumb against resistance or oppose pads of thumb & index finger
  - Phalen sign may be absent in patient with profound sensory loss

Associated Conditions

- CTS is idiopathic and there are no predisposing entities in most patients

- Traumatic
  - Distal radius fracture
  - Malunion of Colles / carpal fracture
  - Unreduced dislocation of wrist
  - Compression by cast
  - Improper immobilization of wrist
  - Burns at wrist

Associated Conditions

- Metabolic/Endocrine
  - Diabetes mellitus
    - 15% of CTS patients have DM
  - Hypothyroidism
  - Vitamin B6 deficiency
  - Acromegaly
  - Renal failure/dialysis
  - BCP
  - Gout
  - Pregnancy / lactation
    - Fluid retention in the connective tissue due to the hormone relaxin
    - Symptoms are transient and improve after delivery.
    - 62% of pregnant women report symptoms

Associated Conditions

- Neoplastic / Mass Lesions
  - Ganglion cyst
  - Hemangioma
  - Lipoma
  - Xanthoma
  - Neurofibroma
  - Schwannoma
- Infectious
  - Septic arthritis
  - Palmar space infections
  - Lyme disease
  - Tuberculosis
  - Tenosynovitis
  - Histoplasmosis

Associated Conditions

- Systemic
  - Rheumatoid arthritis
    - Synovial overgrowth and alterations in carpal bone alignment.
  - Amyloidosis
  - Obesity
  - Mucolipidoses
  - Chondrocalcinosis
  - Multiple myeloma
  - Hemophilia
  - Alcoholism
  - Sarcoidosis
- Congenital
  - Narrow carpal canal

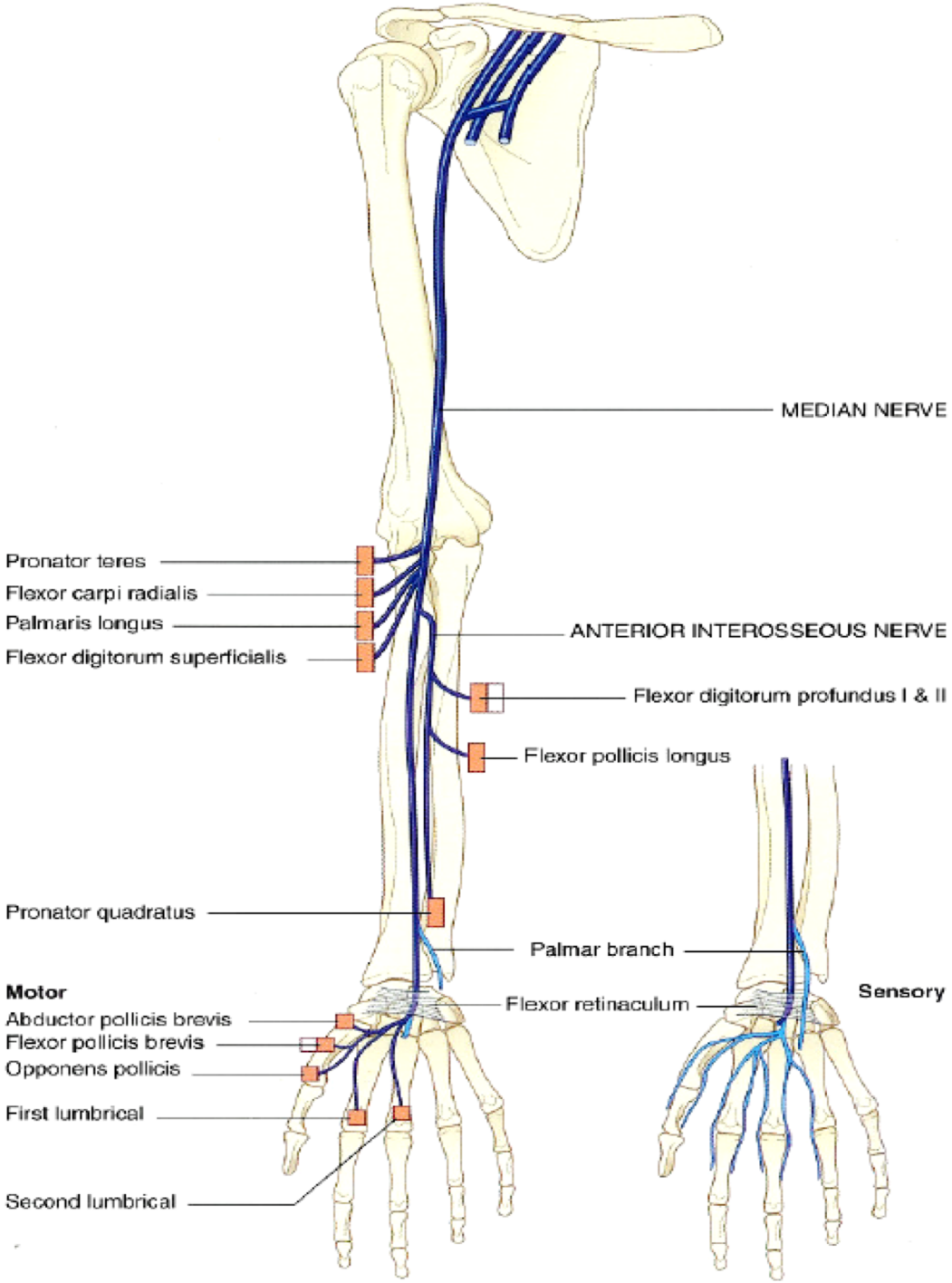
Associated Conditions

- Anatomical
  - Persistent medial artery
    - May be thrombosed
    - AVM
  - Anomalous tendons or muscles
    - Palmaris profundus
    - Lumbricals
    - Flexor digitorum superficialis
- Acquired
  - Repetitive wrist motion
    - Typing, knitting, scrubbing

Differential diagnosis

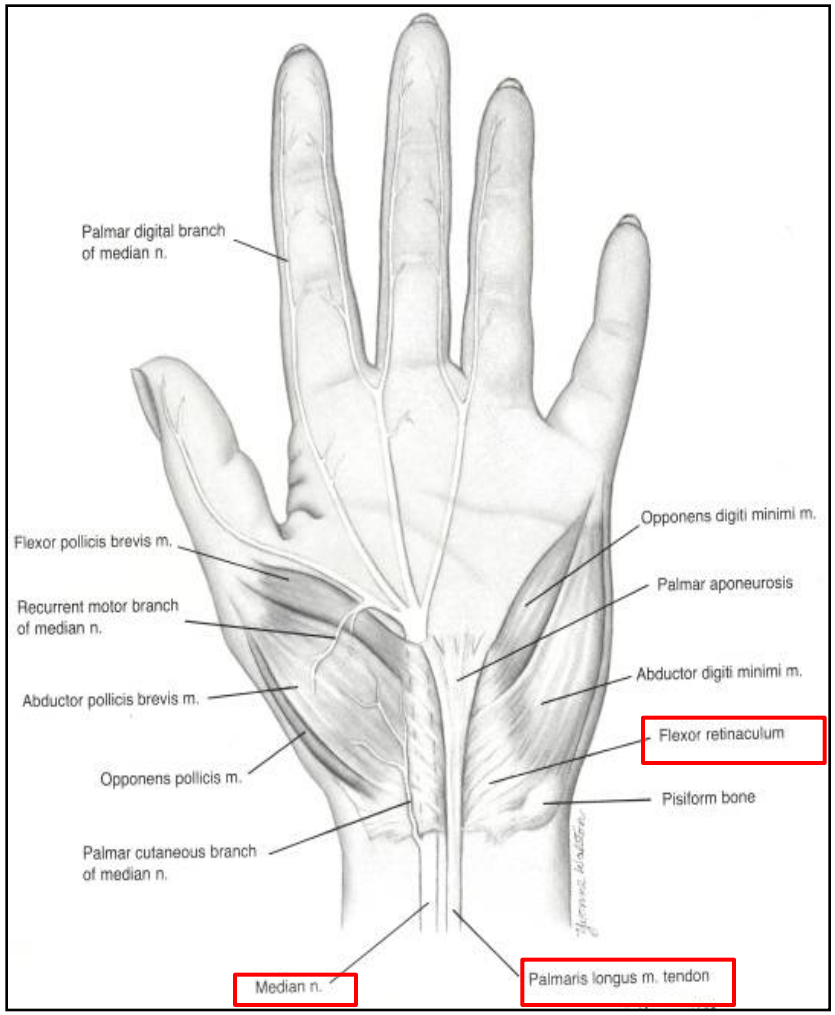
- Thoracic outlet syndrome
  - Diffuse hand weakness, numbness
- Tenosynovitis
- Anterior interosseus nerve entrapment
- Pronator teres syndromes
- Double-crush
  - CTS with cervical radiculopathy (esp. C6)
- DeQuervain's syndrome
  - Tendonitis of APL
  - Tenderness at base of thumb with abduction (Finkelstein's test)
  - Associated with pregnancy.
  - NCV normal

Anatomy


MEDIAN NERVE
Pronator teres
Flexor carpi radialis
Palmaris longus
Flexor digitorum superficialis
ANTERIOR INTEROSSEOUS NERVE
Flexor digitorum profundus I & II
Flexor pollicis longus
Pronator quadratus
Palmar branch
Motor
Abductor pollicis brevis
Flexor pollicis brevis
Opponens pollicis
First lumbrical
Second lumbrical
Flexor retinaculum
Sensory

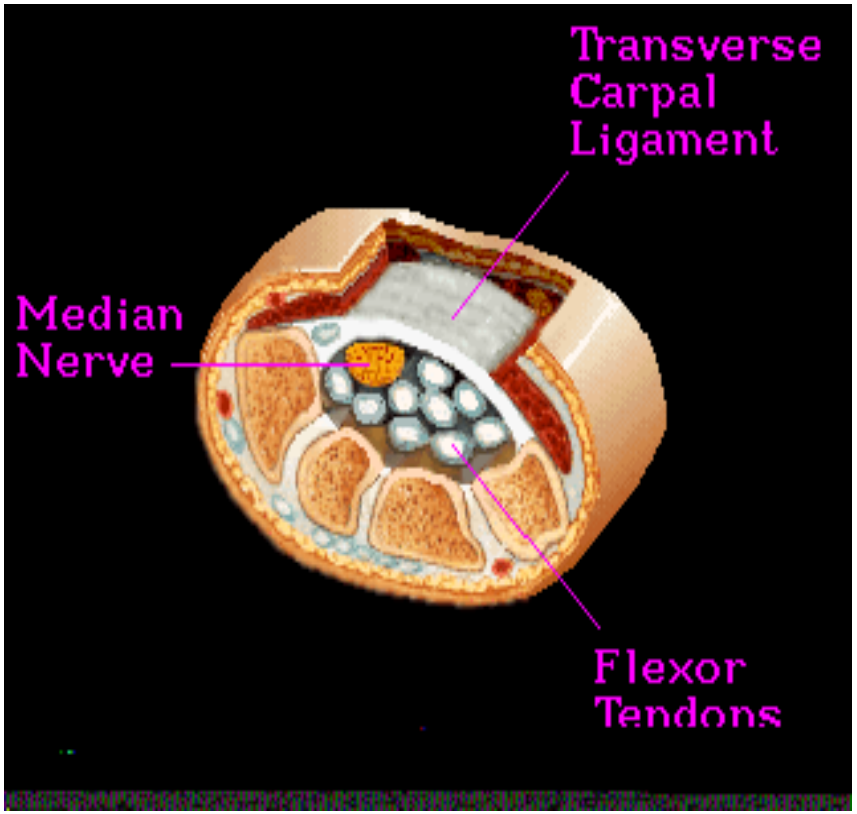
Entrance to carpal tunnel

- Median nerve enters the wrist under the tendon of the palmaris longus and under the transverse carpal ligament (flexor retinaculum)



Carpal Tunnel Anatomy

- Fibro-osseus tunnel bounded by
  - the carpal bones
  - the interosseus ligaments
  - the transverse carpal ligament



Floor

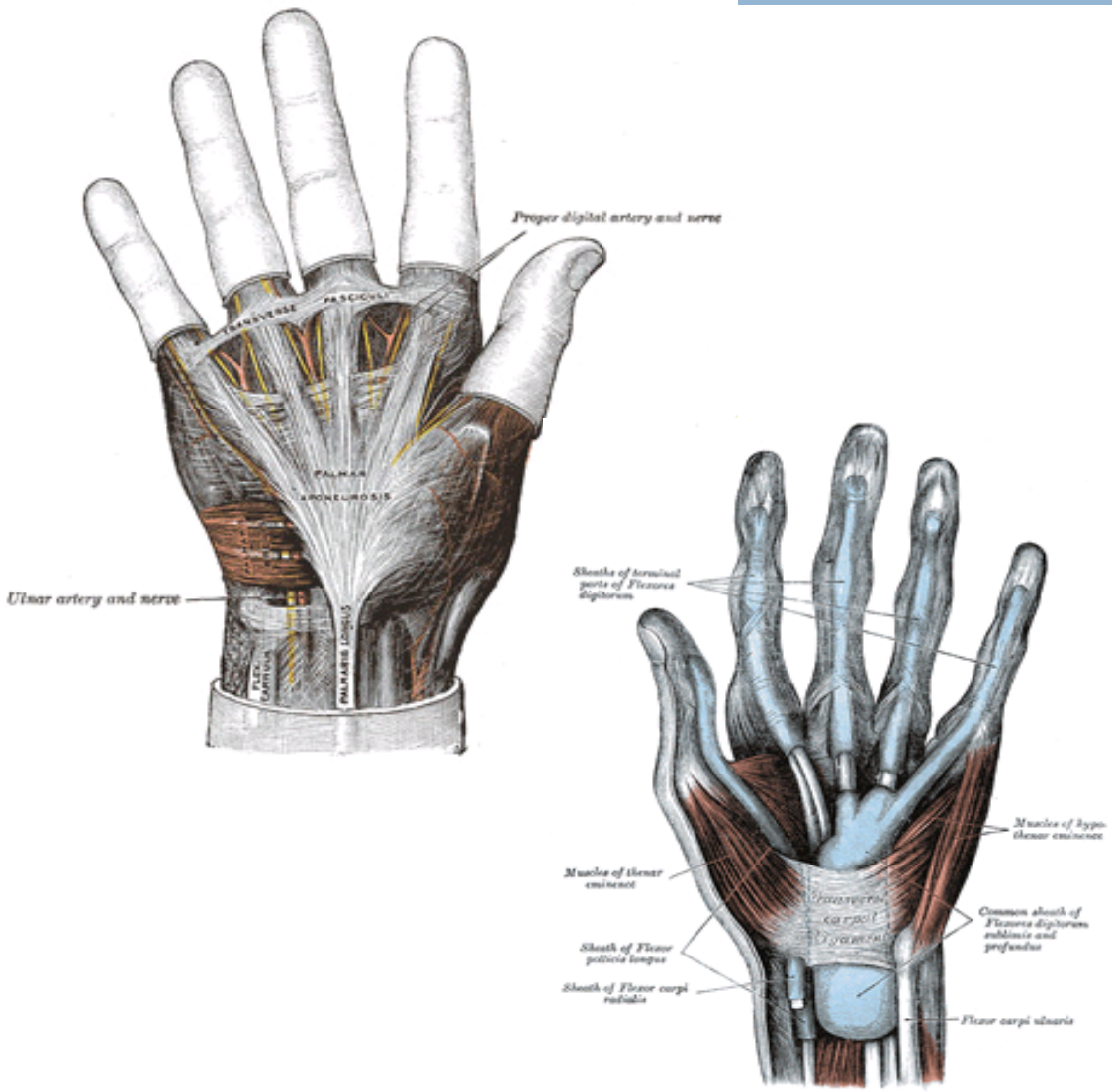
- Carpal bones: Scaphoid, lunate, hamate, pisiform
- Bridging ligaments between the carpal bones
- Volar radiocarpal ligament

Roof

- Transverse carpal ligament
  - An annular pulley of the flexor mechanism
  - A thick fibrous band arching over the carpal bones
    - Radial attachment: trapezium and scaphoid tuberosity
    - Ulnar attachment: pisiform and hook of the hamate
  - Blends proximally antebrachial fascia and distally palmar aponeurosis

Transverse carpal ligament

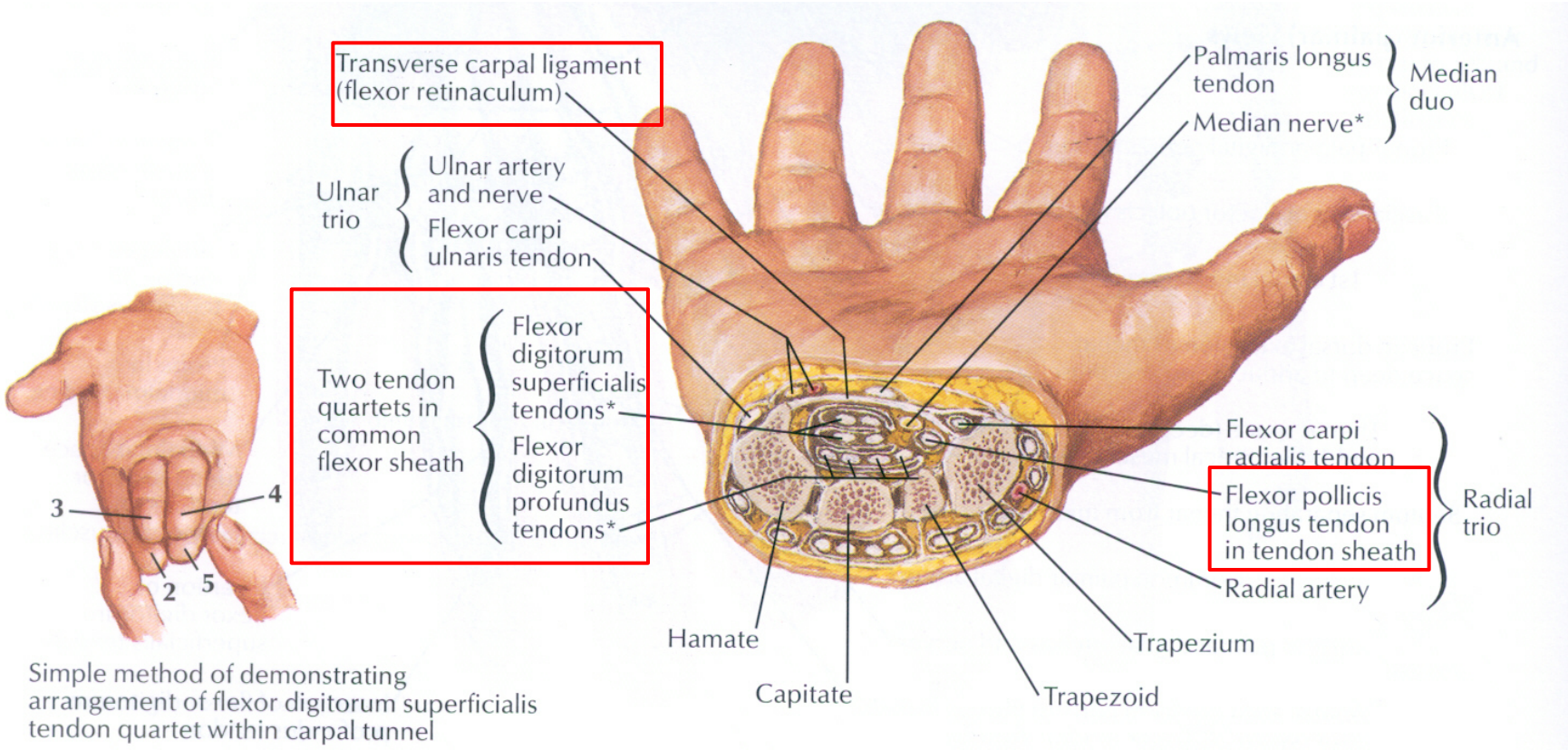
- Extends 1 cm or more proximal to the most distal wrist crease distally at least 3 to 4 cm into the palm.



Carpal Tunnel contents

- Contents of the carpal tunnel
  - Median nerve
  - nine long flexor tendons
    - flexor digitorum superficialis (FDS)
    - flexor digitorum profundus (FDP)
    - flexor pollicis longus (FPL).
  - synovium beneath the TCL
  - median nerve vascular bundle.

Carpal Tunnel contents



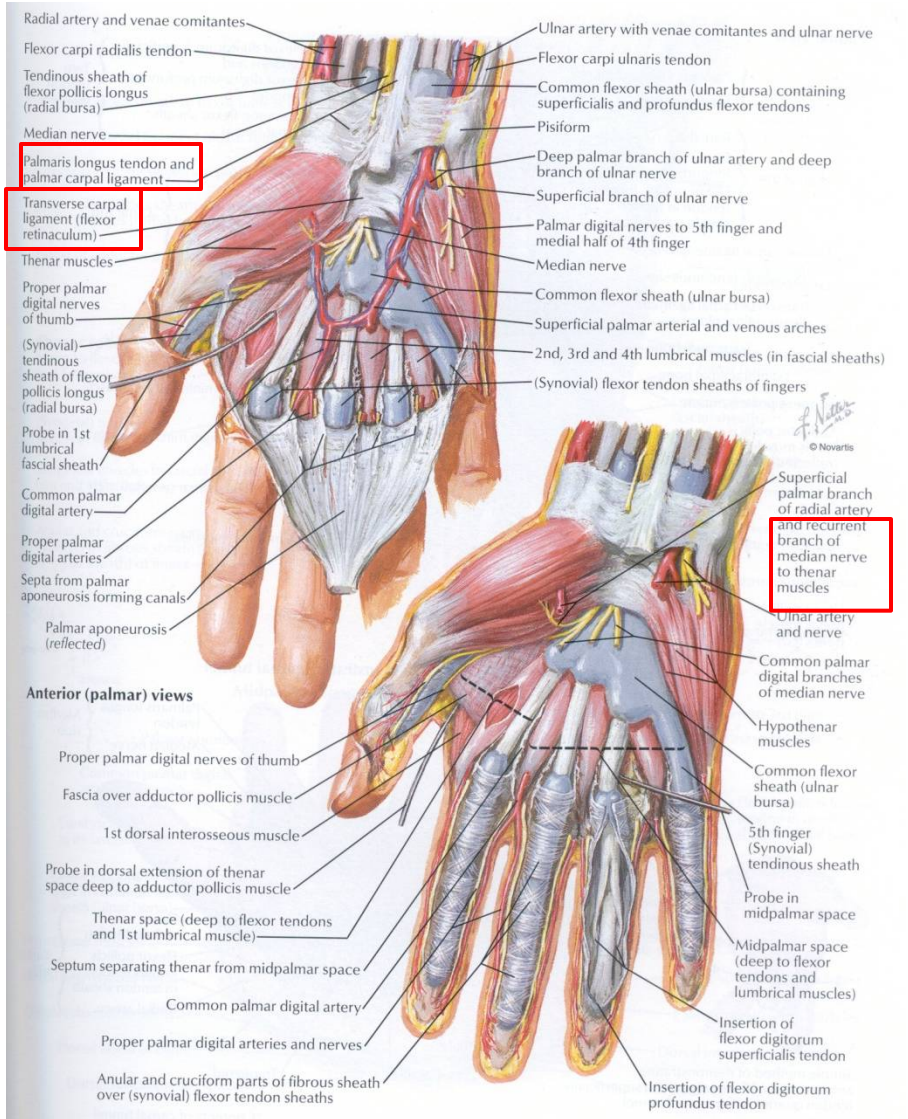
Simple method of demonstrating arrangement of flexor digitorum superficialis tendon quartet within carpal tunnel

- The median nerve is located radial to palmaris longus tendon

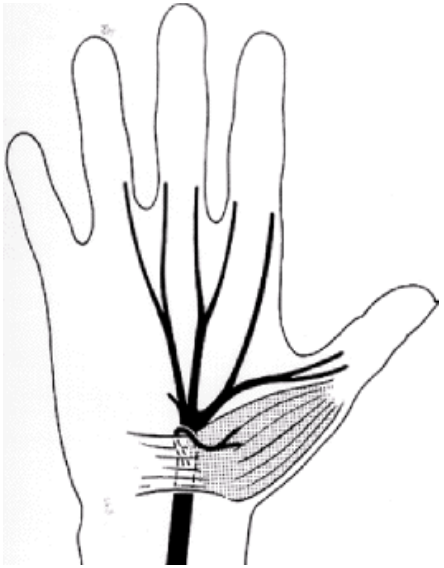
Distal border of the TCL

- Recurrent motor branch
  - Recurrent motor branch usually exits distal to ligament but may pierce it.
  - Innervate the thenar muscles
  - Must be aware of the anatomical variations
  - 70% arise from radial side
  - Lanz classification of the branching variants
    - Extraligamentous and recurrent (50%)
    - Subligamentous (30%)
    - Transligamentous (20%)
    - Multiple accessory motor branches may also occur

Recurrent Motor Branch

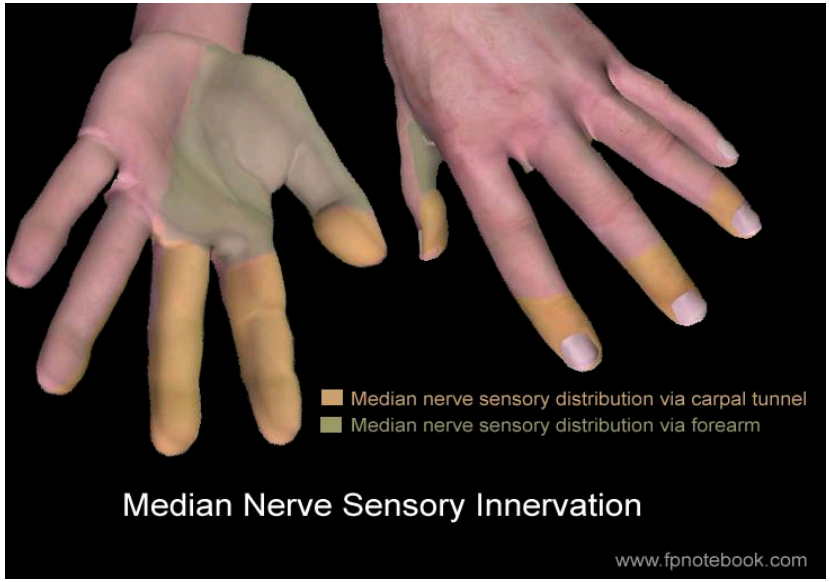


- Supplies:
  - Abductor pollicis brevis
  - Opponens pollicis
  - Superficial head of flexor pollicis brevis
- Usually arises 3 cm distal to distal wrist crease

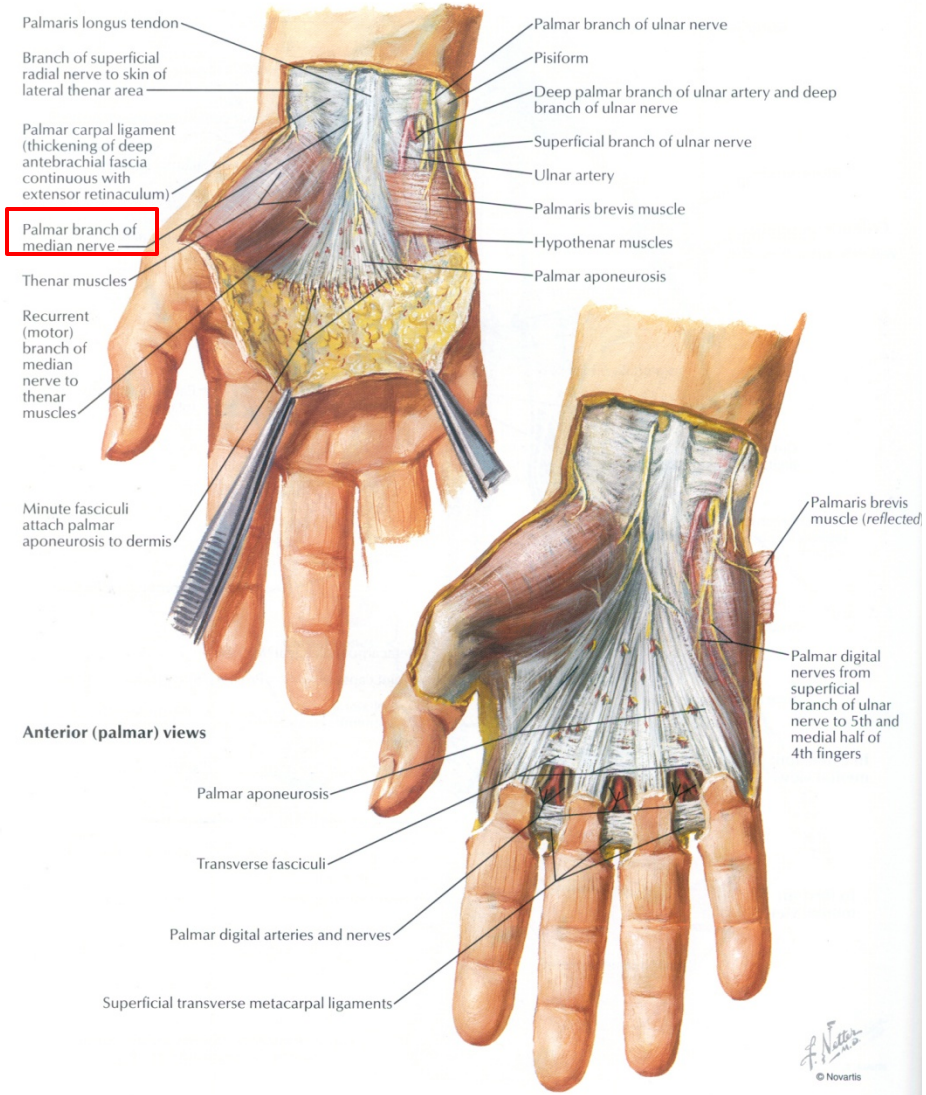


Sensory innervation

- Sensory branches of the median nerve
  - Lateral three digits and the radial half of the fourth digit
  - Dorsal aspect of these digits beyond the distal interphalangeal (DIP) joint
  - Radial palm.

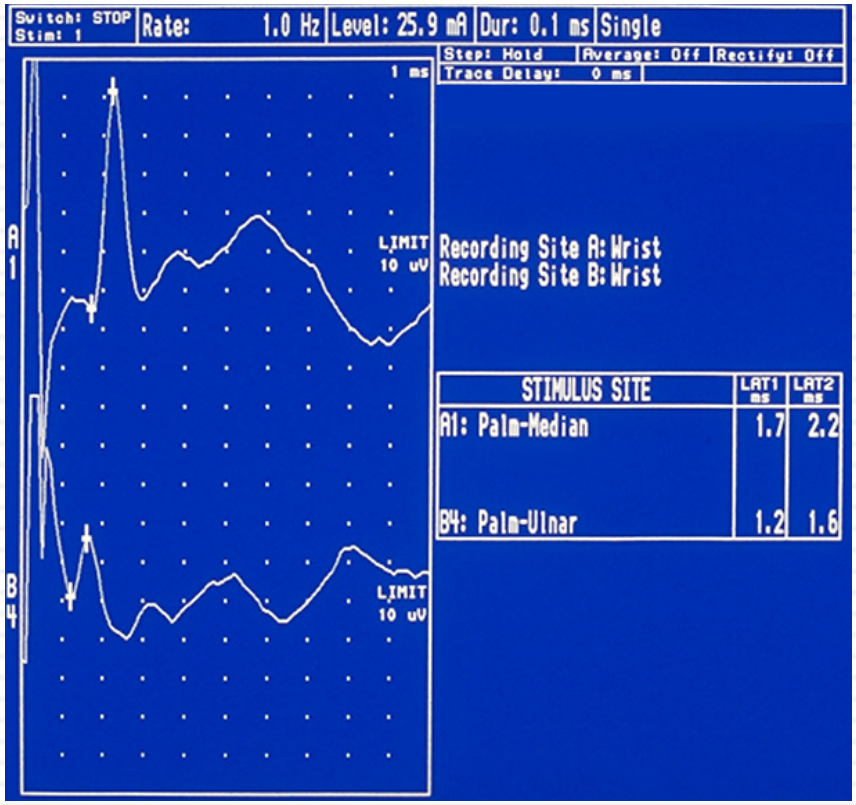


Palmar Cutaneous Branch



- Originates from the median nerve before it enters to the carpal tunnel
- Exits the median nerve along its anterolateral quadrant
  - 3 to 4 cm above the distal wrist crease.
  - 2 cm proximal to TCL
- Passes superficial to the TCL and radial to palmaris longus tendon.
- Supplies sensation to the proximal surface of the thenar eminence.
- If numbness in the distribution of the palmar cutaneous branch occurs
  - Neuropathy is almost always above the level of the TCL
  - CTS can be excluded

Diagnostic Tests



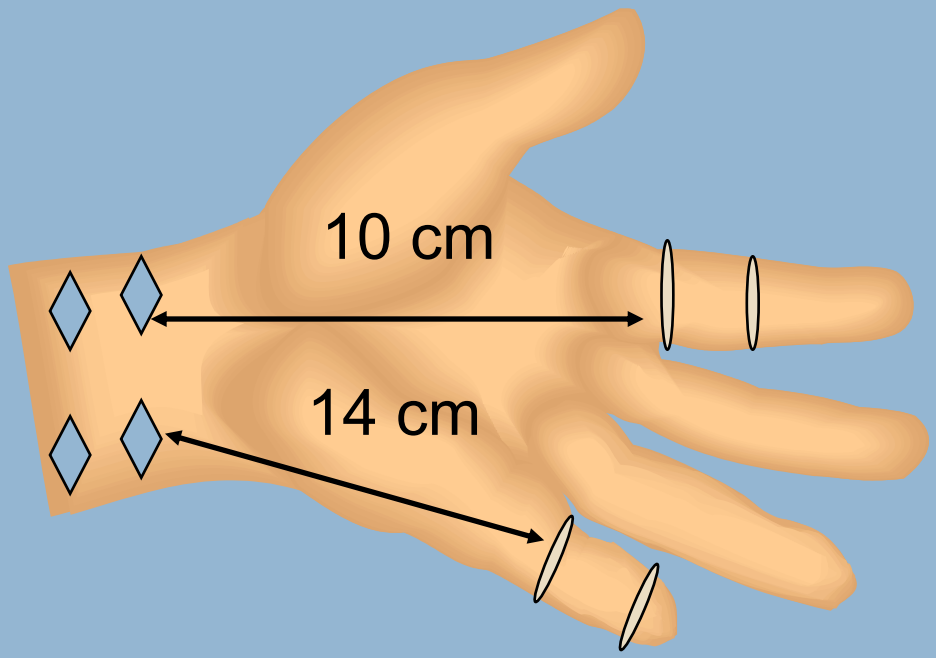
Electrodiagnostic studies

- Localizing the site of compression
  - Sensitivity and specificity of 90%
- Uncertain clinical diagnosis
  - Confirm CTS
  - Rule out other neuropathies
  - Detect or exclude coexisting conditions
  - Important role in the differentiation among the possible affected areas such as roots in the cervical spine, brachial plexus, or along the arm.
- Monitor conservative treatment of patients
- Pre-operative to confirm diagnosis and collect baseline for post operative comparison of nerve function
  - Abnormal in 90% with clinical diagnosis of CTS

Nerve conduction studies

- Demonstrate conduction block or slowing
  - Signifies demyelination at the site of compression.
- Sensory evoked response
  - Recorded from stimuli applied to the finger via ring electrodes
  - Earliest & most sensitive
  - Prolonged distal sensory latency with decreased amplitude or absent altogether
    - Increase in distal latency due to focal slowing of conduction across the carpal tunnel.
    - Normal latency <3.7 msec
    - Increased median sensory (> motor) latency
  - May be influenced by various factors e.g. age, obesity, edema, & temperature

Sensory evoked response



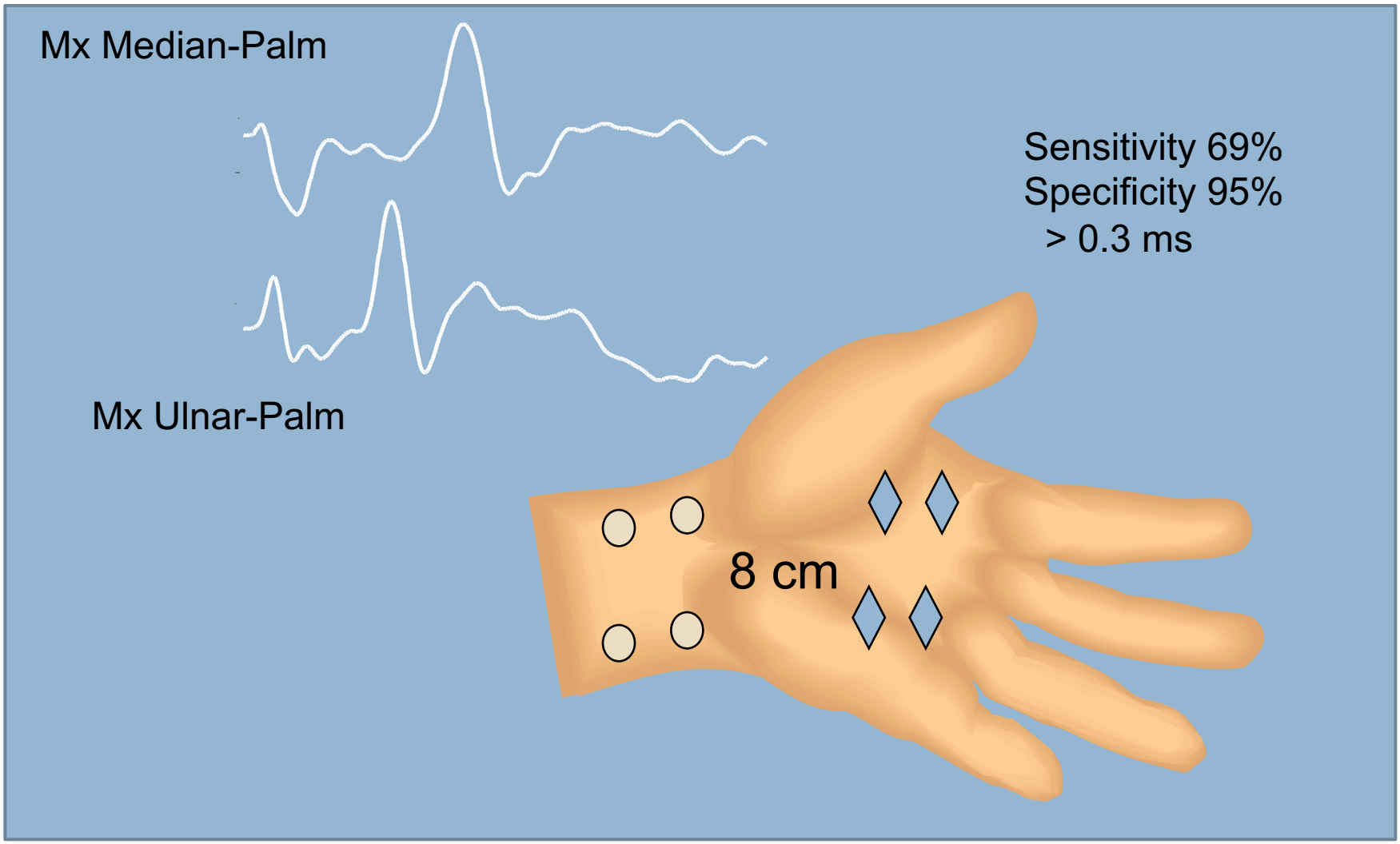
Med II - Uln V SNAP
if > 0.5 msec II/V
Sensitivity 70 - 80%

Nerve conduction studies

- Motor
  - Recorded from surface electrodes overlying the thenar muscles after electrical stimulation of the nerve
  - latency across carpal tunnel of >4 msec diagnostic

- Comparison studies
  - median nerve conduction is compared with that of another nerve
  - Internal control for age, obesity, edema, and& temperature

Motor response



EMG

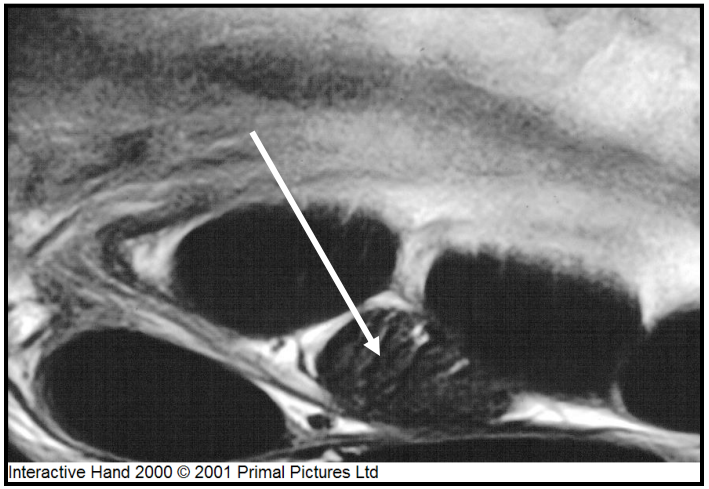
- EMG usually not necessary
  - Normal in 30%
- Can help differentiate CTS from high median neuropathies, C6-C7 radiculopathies, or brachial plexus lesions
- Advanced cases
  - loss of motor units & denervation potentials (fibrillations & positive sharp waves) in thenar muscles

Negative tests

- Condition is too mild, affects too few fibers
- Intermittent ischemia, fully reversible
- Small, slowly conducting fibers which do not contribute to latency or velocity
- Coexisting peripheral neuropathy
- Another condition (radiculopathy, overuse)

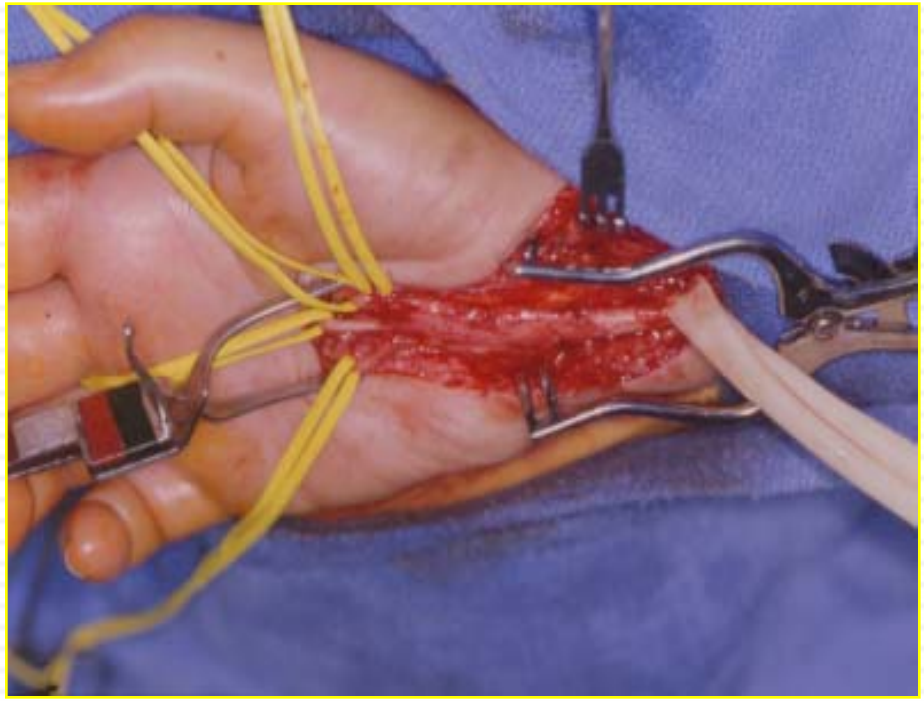
Other Methods of Assessment

- MRI
  - neurography - median n. does not move
  - useful in recurrent CTS




Interactive Hand 2000 © 2001 Primal Pictures Ltd

Management



Conservative Treatment

- Underlying condition is self-limited
  - E.g. pregnancy
- Mild symptoms
- Occupational factor that could be modified

Conservative Treatment

- Conservative
  - Activity modifications
    - rest
    - avoidance of repetitive stressful motion of the hands such as use of vibratory tools
  - Splinting of wrist in neutral position
    - Relief in 80% of patients
    - symptoms may return once splints removed
    - During sleep
  - Oral NSAIDs or steroids
  - Corticosteroid injections into carpal tunnel
    - Short-term response 76%, but only 6%–33% long-term relief
    - No trial-based evidence to support repeat injections.
    - Intraneural injection must be avoided.

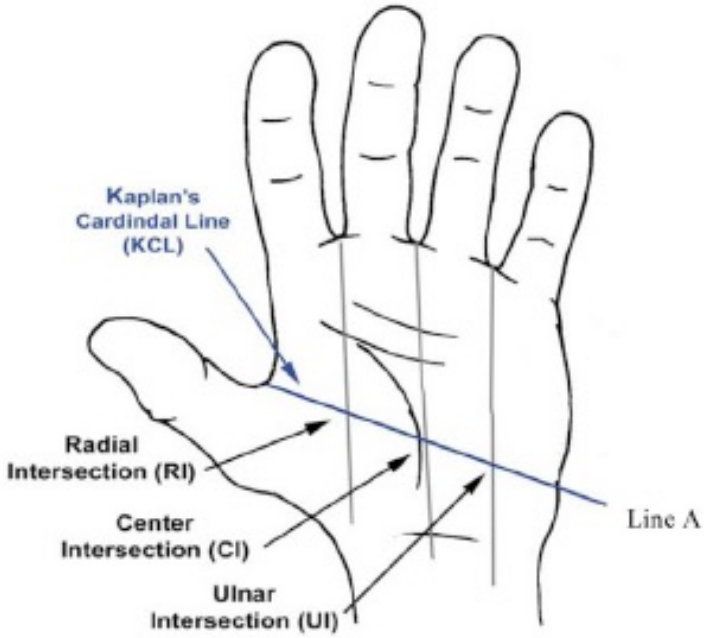
Surgical Treatment

- Surgical
  - Transverse carpal ligament release
    - Open
    - Endoscopic
  - Most effective when offered early
    - Less than 3 years from the initial time of diagnosis
  - Indications:
    - Failure of conservative management
    - Continued or disabling symptoms with
      - progressive or unremitting sensory loss with increased two point discrimination
      - evidence of thenar muscle weakness or atrophy
      - abnormal electrical studies with electrophysiological evidence of axonal loss

Surgical Anatomy

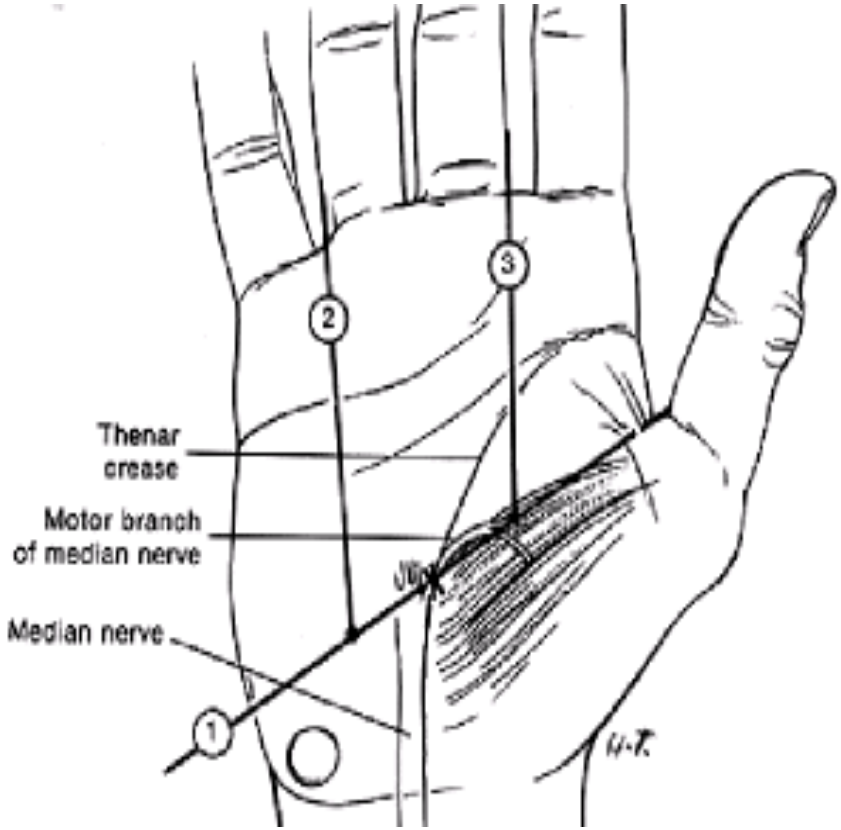
Kaplan's Cardinal Line:

- Apex of the First web space (between the thumb and index finger)
- Parallel with the proximal palmar crease.
- Intersects a line drawn as a continuation of the ulnar border of the ring finger at the hook of hamate.



Surgical Anatomy

- Recurrent motor branch of median nerve
  - Emerges at the intersection of the KCL with a line drawn through the axis of the long finger.
  - Enters into the thenar musculature at the intersection of KCL with the proximal continuation of the radial border of the long finger.



Carpal tunnel release

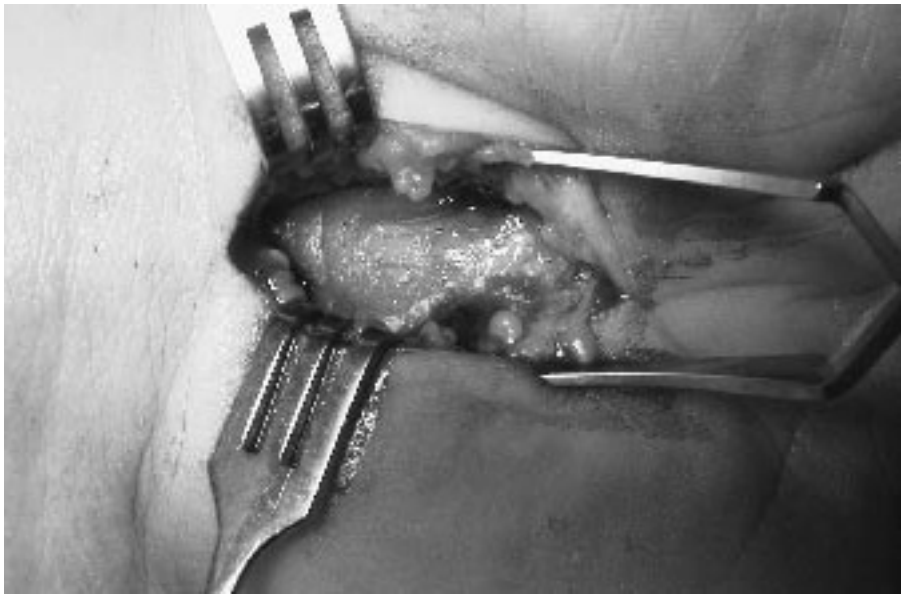
- Incision
  - Local anesthetic
    - 1% lidocaine with epinephrine
  - Begins at the distal wrist crease at the base of the palm
  - Extends 3 to 5 cm ulnar to the palmar crease to a point inline with the distal border of the extended thumb
  - The incision should be placed at the ulnar side of the palmar crease and palmaris longus tendon, in line with the long axis of the ring finger, to avoid the palmar cutaneous branch of the median and ulnar nerves
  - Should be at ulnar edge of median nerve

Carpal tunnel release

- Layers divided
  - skin & subcutaneous fat
  - palmar fascia (aponeurosis) / palmar carpal ligament
  - transverse carpal ligament
- Use mosquito to gently dissect under TCL & incise TCL with tonotomy scissors or scalpel – distally & then proximally
  - Distally – enter palmar fat space and avoid injury of the vascular arch
  - Proximally – divide TCL 2 cm proximal to wrist crease – enter deep fascia of forearm
- Identify anomalous position of the motor branch
- Inspect median nerve and explore carpal tunnel for tumor, ganglion cysts, muscle anomalies, or synovitis
  - May need to section palmaris brevis muscle

Carpal tunnel release

- Hemostasis with bipolar coagulation
- Close skin with interrupted vertical mattress nylon sutures
- Apply protective bulky hand dressing
- Post-op instructions
  - Encourage finger movement
  - Restrict wrist movement x few days
  - Wrist is not immobilized with a splint



Endoscopic Carpal Tunnel Release

- Similar indications but more limited release
- NOT indicated in
  - rheumatoid arthritis
  - significant tenosynovitis
  - recurrent CTS
  - concurrent ulnar tunnel syndrome
  - space occupying lesion.

Complications

- Wound infection
- Nerve injury
  - median n. damage, ulnar n. damage due to retraction
  - neuroma of palmar cutaneous branch of median (palmar pain – cut and cauterize)
- Inadequate release of ligament → persistence of symptoms
- Post-op fibrosis & scarring → return of symptoms
- Tender or hypertrophic scars
- Section of recurrent motor branch of median nerve → complete denervation & atrophy of thenar muscles
- Reflex sympathetic dystrophy
- Bowstringing of flexor tendons

Outcome

Outcome of open release

- Overall:
  - Good to excellent relief of symptoms in ~80%
  - Partial relief in ~10%
  - No change ~9%
  - Exacerbation of condition in <1%
- Patients with muscle atrophy & weakness pre-op:
  - 50% of patients have recovered grip strength at 6 weeks
  - 80% of patients have full recovery at 6 months to 1 year
- Sensory symptoms:
  - 78% have reduction in paresthesias & numbness post-op
  - 59% recover sensory function
- Pain & mild sensory symptoms usually resolve
- More severe manifestations partially improve post-op
  - Severe degree of axonal loss & nerve damage
- Conduction velocities improve in parallel to clinical response, over 8 to 12 weeks

Endoscopic Carpal Tunnel Release

- Earlier return to work
- Pain seems to be less.
- Strength improves earlier but overall, no significant benefit over the open release.
- Possibly higher complications
  - Incomplete release is most common complication
  - Median nerve injuries, superficial vascular arch injuries, and tendon injuries.

Open versus endoscopic

Systematic review of randomized clinical trials of surgical treatment for carpal tunnel syndrome

A. A. M. Gerritsen, B. M. J. Uitdehaag*, D. van Geldere†, R. J. P. M. Scholten‡, H. C. W. de Vet and L. M. Bouter

Institute for Research in Extramural Medicine and *Department of Neurology, VU University Medical Centre, Amsterdam, †Department of Surgery, Amstelveen Hospital, Amstelveen and ‡Dutch Cochrane Centre, Department of Clinical Epidemiology and Biostatistics, Academic Medical Centre, University of Amsterdam, Amsterdam, The Netherlands

Correspondence to: Ms A. A. M. Gerritsen, Institute for Research in Extramural Medicine, VU University Medical Centre, Van der Boechorststraat 7, 1081 BT Amsterdam, The Netherlands (e-mail: aam.gerritsen.emgo@med.vu.nl)

Background: Carpal tunnel syndrome (CTS) is a common disorder for which several surgical treatment options are available. However, there is no consensus on the most effective method of treatment. The object of this systematic review is to compare the efficacy of the various surgical techniques in relieving the symptoms of CTS and promoting return to work and/or activities of daily living.

Methods: Computer-aided searches of Medline, EMBASE and the Cochrane Controlled Trials Register were conducted, together with reference checking. A rating system, based on the number of studies and their methodological quality and findings, was used to determine the strength of the available evidence for the efficacy of the treatment.

Results: Fourteen studies were included in the review. None of the alternatives to standard open carpal tunnel release (OCTR) seems to offer better relief of symptoms. There is conflicting evidence about whether endoscopic carpal tunnel release results in earlier return to work and/or activities of daily living.

Conclusion: Standard OCTR is still the preferred method of treatment for CTS. It is just as effective as the alternatives, but is technically less demanding, so incurs a lower risk of complications and of added costs.

Paper accepted 16 May 2001

British Journal of Surgery 2001, 88, 1285–1295

Severe CTS

- 1511 subjects (1985-91)
- 89 with severe CTS *(median CMAP <2mV)*
- 75% symptom relief in 78% of subjects *(ie. nocturnal)*
- studies did not return to normal

Finestone M&N 1996

Recurrent CTS

- Importance of pre-op studies
- Scenarios
  - NCS worse - suggest incomplete release
  - NCS no change
  - NCS improved but not normal
- Diagnosis
  - pronator syndrome
  - cervical radiculopathy
  - UMN disorder
  - generalized polyneuropathy