



# Wrist and Hand Anatomy/Biomechanics

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Orthopaedic Manual Physical Therapy Series  
Charlottesville 2017-2018



Orthopaedic Manual Physical Therapy Series 2017-2018

## Anatomy - Hand

- The wrist
- The metacarpals
- The Phalanges
  - Digit 1 - thumb
  - Digit 5 - digiti minimi

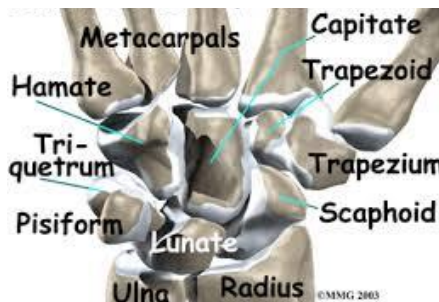


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# Osteology

- Proximal Row
  - Scaphoid
    - Tubercle – palpated on palmar surface
  - Lunate
  - Triquetrum (triangular bone)
  - \*Pisiform
- Distal Row
  - Trapezium – Articulates w/ 1<sup>st</sup> MC
  - Trapezoid – Articulates w/ 2<sup>nd</sup> MC
  - Capitate – Articulates w/ 3<sup>rd</sup> MC
  - Hamate – Articulates w/ 4<sup>th</sup> & 5<sup>th</sup> MC
    - \*Hook of Hamate



\*Space between hook of Hamate and Pisiform = Guyon's Canal

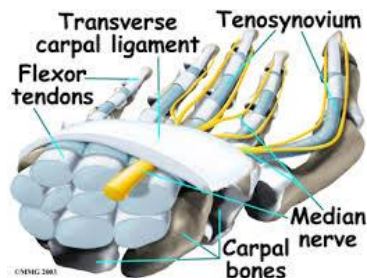


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# Carpal Arch

- The carpal bones form an arch, concave anteriorly
- The flexor retinaculum forms the roof of the carpal tunnel

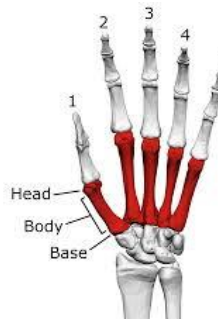


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## Metacarpals

- Base
  - Articulate with carpals
  - Bases of MC bones of digits articulate with one another
- Body
- Head
  - Articulate with the proximal phalanges of the digits
- MC 1 - Thumb
- MC 2-5 – Associated with digits 2-5



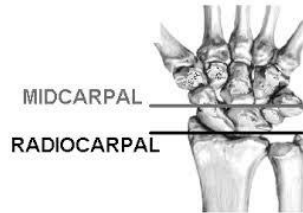
## Phalanges

- Each Phalange
  - Base
  - Body
  - Head
- Proximal
- Middle
  - Thumb lacks a middle phalange
- Distal



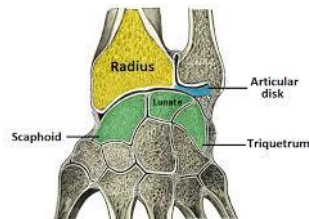
# Joints of Wrist

- Radio-carpal
  - Proximal: distal surface of radius, radioulnar disc
  - Distal: scaphoid, lunate, triquetrum
- Mid-carpal
  - Proximal: 1<sup>st</sup> row of carpals - scaphoid, lunate, triquetrum
  - Distal: 2<sup>nd</sup> row of carpals - trapezium, trapezoid, capitate, hamate
  - Pisiform does not participate
- Inter-carpal
  - The synovial joints between the carpals
- The movements at these joints contribute to hand position



# Radiocarpal Joint

- Classification
  - Synovial
  - Ellipsoidal/Modified Ovoid
    - Two degrees of movement
      - Flexion/Extension
      - Radial and ulnar deviation
  - Compound – more than one articular surface
  - Complex – due to presence of TFCC

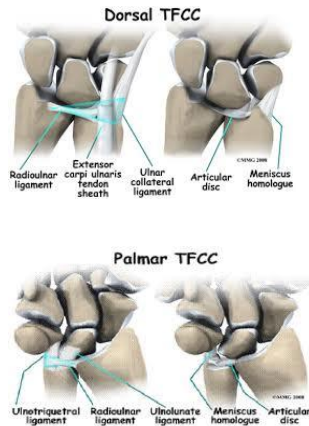


## TFCC

- Triangular Fibrocartilage Complex (TFCC)

- Radioulnar disc
- Connective Tissue Wedge
- Attachments

- Apex – On ulna, between styloid process and articular surface of the head
- Base – Fans out, on radius, between ulnar notch and articular surface of the carpal bones
- It expands the articular surface of the RC joint



## Midcarpal Joint

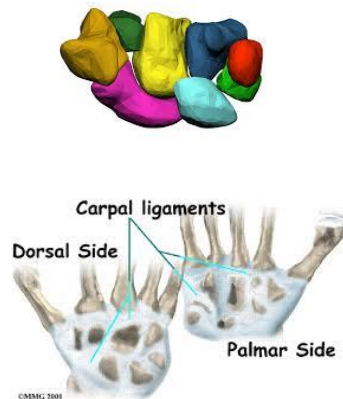
- Classification

- Synovial
- Modified ovoid – as a whole, convex on concave
- Compound



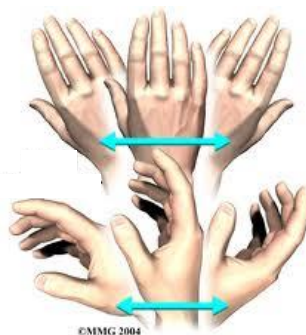
## Intercarpal Joints

- Classification
  - Synovial
  - Modified ovoid
  - Planar
  - A lot of ligamentous support – not much movement
  - Assess/treat in volar/dorsal glide



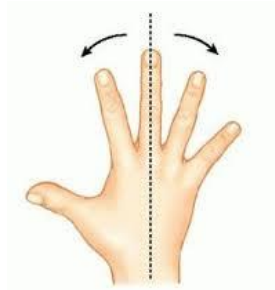
## Wrist Motions

- Frontal plane
  - Radial deviation/abduction
  - Ulnar deviation/adduction
- Sagittal plane
  - Flexion
  - Extension



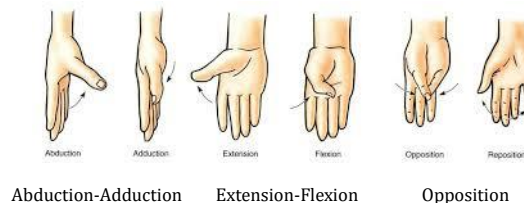
## Finger Abduction/adducton

- Abduction and Adduction are defined using the long axis of the middle finger as a reference
- The 3<sup>rd</sup> digit only abducts (radial or ulnar)



## Thumb Movements

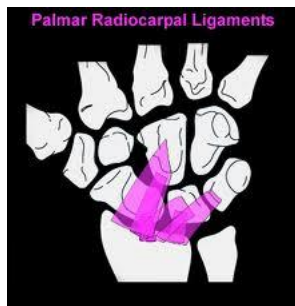
Movements of the thumb are at right angles to the movements of the other digits



## Wrist Ligaments

(highlights)

- Palmar radiocarpal ligaments
  - Resist extension/palmar glide of carpals
  - To scaphoid, capitate, triquetral, lunate

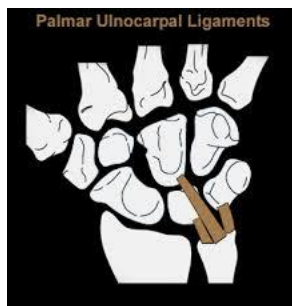


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## Wrist Ligaments

- Palmar Ulnocarpal ligaments
  - To lunate, triquetrum, and capitate



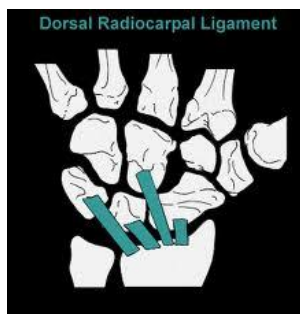
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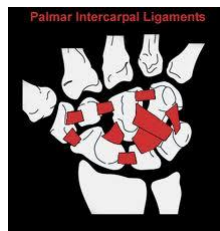
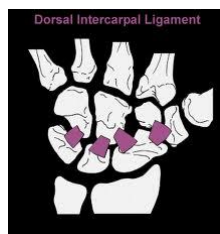
## Wrist Ligaments

- Dorsal radiocarpal ligament
- Resists flexion/dorsal glide of carpals on the radius



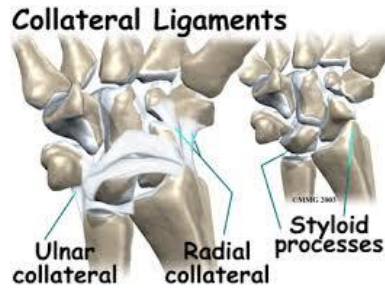
## Wrist Ligaments

- Dorsal Intercarpal ligaments
- Palmar Intercarpal Ligaments



## Wrist Ligaments

- Radial (lateral) collateral ligament
  - Resists varus stress to the wrist
- Ulnar (medial) collateral ligament
  - Resists valgus stress to the wrist



## Carpometacarpal Joints (CMC)

- 5 CMC joints between the base of each MC and the distal carpal bones
- 1<sup>st</sup> CMC – 1<sup>st</sup> MC/Trapezium
- 2<sup>nd</sup> CMC – 2<sup>nd</sup> MC/Trapezoid
- 3<sup>rd</sup> CMC – 3<sup>rd</sup> MC/Capitate
- 4<sup>th</sup> CMC – 4<sup>th</sup> MC/Hamate
- 5<sup>th</sup> CMC – 5<sup>th</sup> MC/Hamate



## 1<sup>st</sup> CMC Joint

- Unique
- Synovial
- Saddle shape
- Unmodified sellar joint – allows 2 degrees of freedom
  - Sagittal plane – Abd/add. Convex MC on concave trapezium
  - Coronal plane – Flexion/extension. Concave 1<sup>st</sup> MC on convex trapezium
  - Combined Motion – opposition (circumduction)



## 1<sup>st</sup> Metacarpophalangeal Joint

- Synovial
- Modified ovoid
- Condylloid
- Compound
- 1 degree of freedom
  - Frontal plane: Flexion/Extension



## 2<sup>nd</sup>-5<sup>th</sup> CMP Joints

- Synovial
- Ellipsoidal
- Modified ovoid
- Compound
- 2 Degrees of Freedom
  - Flexion/Ext
  - Abduction/Adduction



## MCP Joints

- Palmar Ligament
- Medial Collateral Ligament
  - Resists valgus stress
- Lateral Collateral ligament
  - Resists varus stress



## Interphalangeal (IP) Joints

- Synovial
- Modified ovoid
- Hinge joints
- 1 degree of freedom – Flex/ext
- 2<sup>nd</sup> degree – a little rotation in transverse plane in full fist



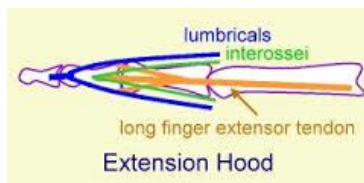
## Palmar Fascia

- Deep fascia that covers the palm. Anchored to skin distally
- Apex is continuous w/ Palmaris longus tendon/flexor retinaculum
- Distal fibers to base of each digit
- Function: Protection of vessels, nerves, and tendons of the palm

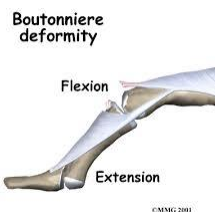
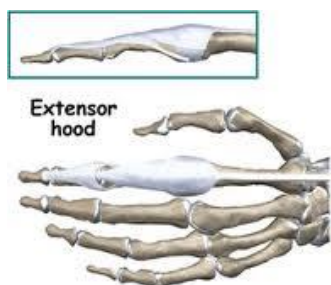


## Extensor Hood

- Extensor digitorum extends and attaches to middle phalanx of each digit 2-5 by central tendon slip. If ruptured, lack of extension of proximal IP joint
- Medial and lateral wing tendons from intrinsic (lumbricals, interossei) of the hand extend dorsally to terminal tendon at distal phalanx. Rupture causes lack of ability to extend the DIP

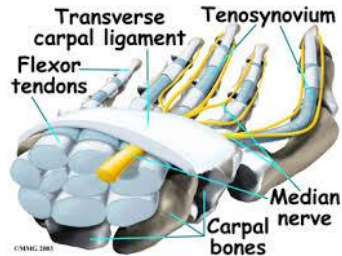


## Extensor Hood



## Carpal Tunnel

- Formed by the arch of the carpal bones and the flexor retinaculum (transverse carpal ligament)
- 4 tendons of the flexor digitorum profundus
- 4 tendons of the flexor digitorum superficialis
- Tendon of the flexor pollicis longus
- Median nerve



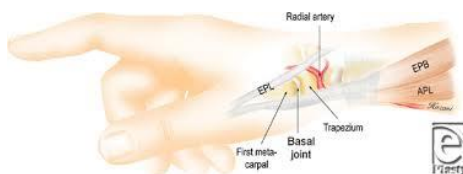
## Carpal Tunnel

- Over the top of the tunnel
  - Ulnar artery
  - Ulnar nerve
  - Palmaris Longus tendon
  - Palmar cutaneous branch of median nerve



## Anatomical Snuff Box

- Base of triangle at the wrist and the apex in the thumb
- Lateral border – tendons of the abductor Pollicis Longus and the Extensor Pollicis Brevis
- Medial Border – tendons of the Extensor Pollicis Longus
- Floor Scaphoid and Trapezium – A great place to palpate these



## Muscles of the Hand Thenar Muscles

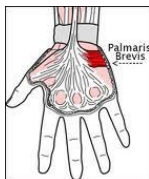
- Flexor pollicis brevis
- Abductor pollicis brevis
- Opponens pollicis
- Innervated by median n.
- Deep head of FPB also innervated by ulnar n.





## Hypothenar Muscles

- Palmaris brevis



- Flexor digiti minimi brevis
- Abductor digiti minimi
- Opponens digiti minimi
- Innervated by ulnar n.



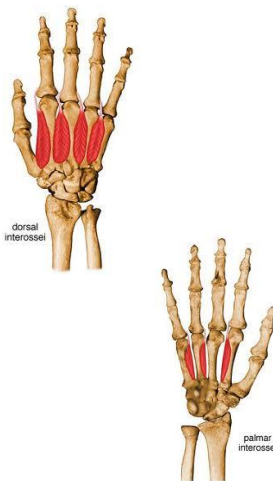
## Intermediate Muscles

- Lumbricals
  - Dual innervation
  - 1,2: median n
  - 3,4: ulnar n
- Adductor pollicis
  - Ulnar n.



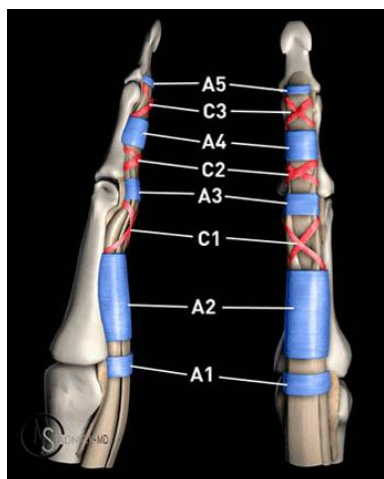
## Deep Muscles

- Dorsal Interossei
  - 4 total
  - 3<sup>rd</sup> digit abducts medially and laterally
  - Thumb and 5<sup>th</sup> finger have separate abductors
- Palmar Interossei
  - 3 total
  - 3<sup>rd</sup> digit doesn't adductor
  - Thumb has it's own adductor



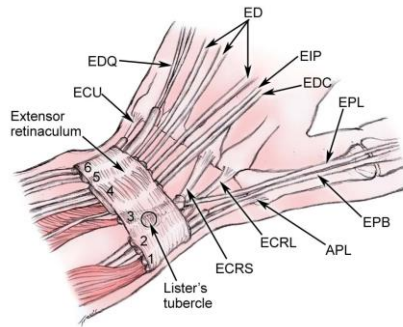
## Flexor Tendon Pulleys

- A2 and A4 most important for finger function and prevent bowstringing
- A1 – Trigger Finger
- 9cm of flexor tendon excursion for wrist/finger flexion
- 2.5cm required for full finger flexion



## Dorsal Compartments of Wrist/Hand

- I – APL/EPB
- II – ECRL/ECRB
- III – EPL
- IV – EI/EDC
- V – EDM
- VI – ECU



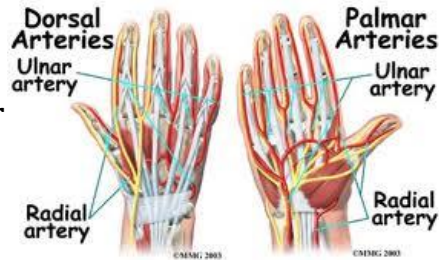
## Biomechanics/Kinematics

- Flexion – 60% midcarpal, 40% radiocarpal
- Extension – 66% radiocarpal, 33% midcarpal
- Radial Deviation – Scaphoid/Lunate Volar Flexion
- Ulnar Deviation – Scaphoid/Lunate Palmer Flexion
- Distal row moves first, Proximal row follows
- Flexion – Distal row flexes and UD
- Extension – Distal row extends and RD
- RD – Distal row RD and extends, Proximal row UD and flexes
- UD – Distal row UD and flexes, Proximal row RD and extends



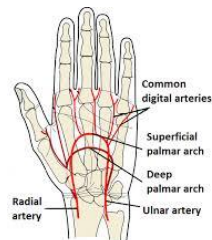
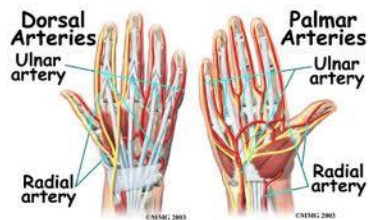
## Vasculature – Ulnar Artery

- Ulnar a/n enter the hand on the medial side of the wrist superficial to the flexor retinaculum
- Branches in the hand



## Radial Artery

- Curves around the lateral side of the wrist
- Over the floor of the anatomical snuff box
- Between 2 heads of the 1st dorsal interosseus
- Between the 2 heads of the adductor pollicis
- To the palm to form the deep palmar arch



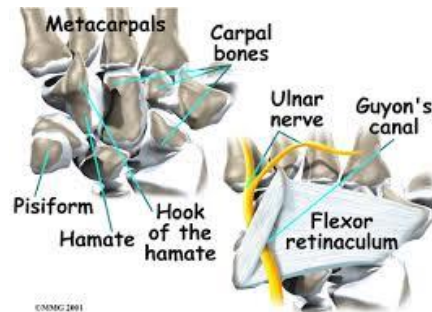
## Veins

- Dorsal venous network drains the back of the hand
- Cephalic Vein – Radial
- Basilic Vein – Medial side

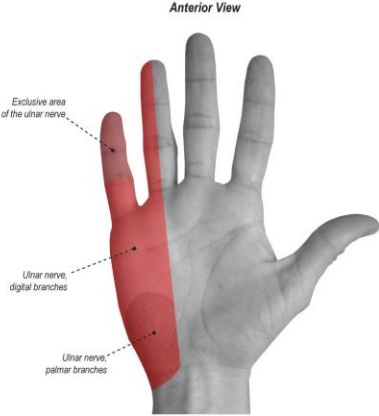


## Innervation of the Hand – Ulnar Nerve

- Enters hand lateral to the pisiform with the ulnar a. in the Guyon's canal
- 2 branches
  - Superficial branch
    - Palmaris brevis
    - Cutaneous to palmar surface of the medial 1 ½ digits
  - Deep branch
    - Hypothenar muscles
    - DL, PL, AP and medial 2 lumbricals
  - Articular branches to the wrist



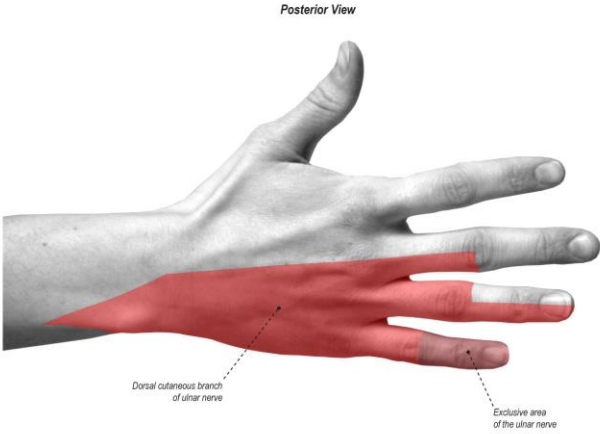
# Cutaneous Distribution of Ulnar Nerve



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# Cutaneous Distribution of Ulnar Nerve

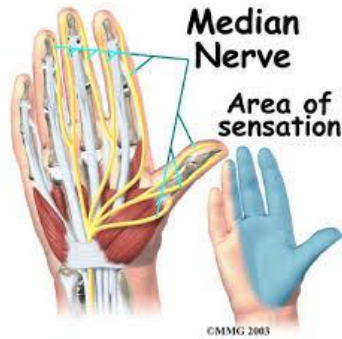


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# Median Nerve

- Enters hand through carpal tunnel
- 2 branches
  - Recurrent branch
    - Thenar muscles
  - Palmar digital branches
    - Skin on lateral 3 ½ digits on palmar surface and dorsal aspects of these digits distal to the DIP joints
- Innervates lateral 2 lumbricals



# Radial Nerve – Superficial Branch

- Through anatomical snuffbox
- Innervates skin dorsal lateral 3 ½ digits distal to the DIP jts.

