Anatomy of the Hand and Nomenclature

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- Bony skeleton
- Muscles and ligaments
- Nervous, arterial and venous system
Ossification of bones: carpus

- Most carpal bones are cartilagenous at birth.
- Each carpal bone ossifies from 1 centre.
- Capitate ossifies first and the pisiform last.
Ossification of bones: carpus

- Capitate: 2 months
- Hamate: 3 months
- Triquetral: 3 years
- Lunate: 4 years
- Scaphoid
- Trapezium: 4-5 years
- Trapezoid
Ossification of bones: metacarpus

- Primary and secondary centres
- Primary at 9 months and in order of 2nd to 5th metacarpal up to 2 years
- 1st metacarpal base at 2-3 years
Ossification of bones: metacarpus

- Thumb metacarpal ossifies like a phalanx
- Some believe that the thumb consists of 3 phalanges
- Broom (1930): distal phalanx represents fused middle + distal phalanges
Ossification of bones: phalanges

- Primary centre for shaft
- Proximal epiphyseal centre
- Shafts: distal 8 wks, proximal 10, middle 11
- Epiphyseal: proximal 1m, middle and distal 2m
CMC Joint of the Thumb

- Classical saddle joint
- Eaton and Littler (1973) felt that there were 2 apposing saddles
CMC Joint of the Thumb

1742: Weitbrecht gave an accurate description

Pieron in 1973:
Anterior Oblique (volar ligament of Kaplan)

Dorsoradial

Posterior Oblique

Intermetacarpal
2nd to 5th CMC Joints

- 2nd to 4th are planar gliding joints
- 5th is a saddle joint
- Flatt (1959): ‘stable central post of the hand’ for the joint between the capitate and the 3rd metacarpal
2nd to 5th CMC Joints

- Limited AP gliding movement in the 2nd and the 3rd cmc jt.
- Maximum movement between the 4th and the 5th metacarpal bases and the hamate.
- Average of 20-30 degrees.
- Gunther’s cadaveric study in 1984 showed 8 degrees in the 4th cmc jt. And 15 degrees in the 5th cmc joint.
2nd to 5th CMC Joints

- 2 important soft tissue relationships to the cmc joints.
- Motor branch of the ulnar nerve: 5th cmc joint.
- Deep palmar arterial arch : 3rd cmc joint.
Intermetacarpal Joints

- Dorsal ligament
- Palmar ligament
- Interrosseous ligament
MCP Joint of the Thumb

- Condyloid joint
- Very wide ROM: 5-115 degrees
- Palmer and Louis felt that the ROM depends on the shape of the head
- Harris: flat head associated with less movt. And more prone to injury
MCP Joint of the Thumb

- Static stabilisers: collateral ligaments, capsule, dorsal aponeurosis, volar plate

 Dynamic stabilisers:

 adductor aponeurosis
2nd to 5th MCP Joints

- Condyloid joint
- Globular head articulates with the reciprocal concave base of the proximal phalanx
Eaton (1971): Key to the stability is the snug like configuration of the 3 ligaments.

- Primary stabilisers
- Secondary stabilisers
2nd to 5 MCP Joints

Collateral lig.

Tendon sheath

Volar plate

Deep transverse metacarpal lig.
2nd to 5 MCP Joints

- Extension: collateral ligament is lax and the joint contact is minimum
- Maximum joint capacity: short of full extension
Interphalangeal Joint

- Uniaxial hinge joint
- Bicondylar tongue in groove appearance
- Kuczynski: sloppy hinge designed mainly for flexion and extension
- ROM: 0 to 105(120) degrees
- 7-10 degrees of lateral deviation
Interphalangeal Joint

- Same as the MCP joint
- Cord like collateral ligaments
- Volar plate
- Metacarpoplenoidal ligament
- Capsule and the long extensor tendon
Volar Plate

- Volar plate is less mobile in the PIP joint than in the MCP joint: Kuczynski
Interphalangeal joint: check rein ligaments

• ‘Swallowtail’ extensions of the volar plate which prevent hyperextension of the pip joint: Bowers
The CAM effect of the PIP joint is less significant than that of the MCP joint.
The tension in the collateral ligaments is the same in flexion and extension in the PIP joint.
Dorsal Plate of the PIP Joint

- P G Slattery: J of Hand Surg. 15 B, 1990
- Histologically similar to the fibrocartilage volar plate
- Constant structure in 70 cadaveric fingers
Dorsal Plate of the PIP Joint

- Morphologically similar to the patella
First described by Jacob and Testut in 1906 as 'fibrocartilagenous glenoidien'
Dorsal Plate of the PIP Joint: functions

- Stability of extensor tendon
- Adds to the stability of the PIP joint
- Increases the moment arm of the tendon
- Prevents attrition of the extensor tendon in extreme flexion
- Circulation of the synovial fluid
Palmar Aponeurosis

- 2 layers of deep fascia in the hand
- Deep: covers the interosseous muscles
- Superficial: palmar aponeurosis
Palmar Aponeurosis

- Originates from the palmaris longus muscle
- Function: improves grip strength and prevents the flexor tendons from bowstringing in the palm
Palmar Aponeurosis

- thins out laterally
- consists of longitudinal and transverse fibres
- continues with flexor tendon sheaths of the fingers
Palmar Aponeurosis
Midpalmar spaces of the hand

3 compartments in the palm:
thenar
hypothenar
intermediate
lateral    medial
Synovial sheaths of the palm

- Flexor tendons are surrounded by these sheaths
  - Visceral layer
  - Parietal layer

- Each finger sheath is a double walled hollow tube sealed at both ends
Flexor digital sheath
Synovial sheaths of the palm

- 3 sheaths
  - FPL
  - FCR
  - FDP + FDS (common flexor sheath)

- In 70% the sheath of the little finger is continuous with the common flexor sheath
In 50% there is a communication between the common flexor sheath and the sheath for the FPL at the wrist.
Long Flexor tendons: Nutrition

- Tendon nutrition
- Synovial fluid
- Vincular circulation

- Vinculum longus superficialis
- Vinculum longus profundus
- Vinculum breve superficialis
- Vinculum breve profundus

- Potenza (1963): diffusion is most important
- Manske: both are important
Long Flexor tendons: Nutrition

- Vincula are folds of periosteum carrying blood supply to the tendons
- They exit on the dorsum of the tendon and hence sutures on the volar aspect are advocated
Long Flexor tendons: nerve supply

- Mechanoreceptors and free nerve endings present in the flexor tendons: Zimny 1986
- Branch of the digital nerve, accompanying the digital artery present within the vinculum brevis
Zones of flexor tendons: Verdan’s Zone System
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Pulley system of the fingers

- 5 annular and 3 cruciate pulleys
- Annular: thicker and prevents tendon bowstringing during flexion
- Cruciate: thinner and allows the sheath to conform in flexion by approximating the annular pulleys.
Pulley system of the fingers
Pulley system of the fingers

- A2 and A4 are the most important for optimum tendon function
Significance of A1 pulley in RA

- Minimal bowstringing
- MCP volar subluxation with loss of terminal flexion (11 degrees)
Pulley system of the thumb

3 constant pulleys:

A1 pulley
Oblique pulley
A2 pulley
Thenar eminence

- Opponens pollicis
- Abductor pollicis brevis
- Flexor pollicis brevis
Hypothenar eminence

- Abductor digiti minimi
- Opponens digiti minimi
- Flexor digiti minimi
Intrinsic muscles

- Lumbricals: origin from FDP
  flexion at MCP joint
  part of extensor apparatus

- Interossei
  4 palmar (PAD)
  4 dorsal (DAB)
Extensor apparatus of the hand

2 separate and neurologically independent systems:

- radial nerve innervated extrinsic extensors
- ulnar and median nerve innervated intrinsic muscles.
Extensor apparatus of the hand

- Extrinsic extensors arise from multiple muscle bellies in the forearm
- Ext. digitorum
- Ext. pollicis longus
- Ext. pollicis brevis
- Ext. indicis
- Ext. digiti minimi
Extensor apparatus of the hand

- Kaplan: Ext. digitorum has 4 distinct tendons
- Doyle: Ext. digitorum to the little finger is present in less than 50% of fingers and when absent it is replaced by *juncturae tendinum* of ring finger
Extensor apparatus of the hand: wrist

- 6 extensor tunnels: 5 fibrosseous and 1 fibrous (5th)
- Extensor retinaculum is a wide fibrous band measuring 2.9-8.4 cm (avg. 4.9 cm)
**Extensor apparatus of the hand: wrist**

- EPB/APL
- ECRB/ECRL
- EPL
- ED/EI
- EDM (fibrous tunnel)
- ECU
Extensor apparatus of the hand: MCP joint

- Central extensor tendon
- Conjoined tendon of interossei and the lumbricals
- Transverse lamina (dorsal digital expansion)
- Sagittal band of the volar plate
Extensor apparatus of the hand: MCP joint
Extensor apparatus of the hand: MCP joint

- Conjoined tendon is volar to the axis of the MCP axis of rotation
- Interosseous: medial to central tendon
- Lumbricals: lateral
Extensor apparatus of the hand: MCP joint

Extensor hood is movable
The right hand.

The tendon of the first digit has been injected with a red-tinted solution. The tendons of the second, third, and fourth digits appear as at 13 and the tendon of the fifth digit is at 14. The proximal phalanx of the thumb has been removed to show the origin (6) of the anterior interosseous artery (4), which lies on the lateral side of the proximal phalanx. The profunda digitalis artery (7) passes through the transverse metacarpal ligament to join the proper plantar digital arteries (14).
Extensor apparatus of the hand: pip joint

- Trifurcation of the extensor tendon
- Central slip
- 2 lateral bands

- Lateral bands dorsal to axis of PIP joint
Extensor apparatus of the hand: pip joint
Extensor apparatus of the hand: pip joint

- transverse retinacular ligaments of Landsmeer (‘link ligaments, 1949)
Extensor apparatus of the hand: pip joint
Extensor apparatus of the hand: pip joint

- The fibres are differentially loaded
- In flexion, the central fibres are tense
- In extension, the lateral fibres are tense
Extensor apparatus of the hand: dip joint

- Lateral bands merge to form a conjoint tendon which inserts at the base of the distal phalanx
Extensor apparatus of the dip joint - vascular anatomy

- Warren et al, JBJS 1988
- Critical area of avascularity at the osseotendinous junction
Extensor tendon: zones of injury - Kleinert and Verdan

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<td>II</td>
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<td>Proximal phalanx</td>
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<td>III</td>
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<td>MP joint</td>
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<td>IV</td>
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<td>V</td>
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<td>CMC joint/radial styloid</td>
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<td>VI</td>
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