Quick Guide
- Carpal Instability
- Distal Radio-Ulnar Instability
- Keinbock Disease
- Fracture Scaphoid
- Rhizarthrosis
- Flexor Tendon Injuries
- Rheumatoid Hand
- DeQuervain’s Syndrome
- Ulnar Impaction Syndrome
- Dupuytren’s Contracture
Applied Anatomy

WRIST Consists of 3 Columns:

1. Central column (Flex-extr)  Distal row & lunate  Centre of rotation = capitate
2. Second mobile column  Scaphoid  Abduction – adduction & Axial loading
3. Rotation column  Triquetrum  Carpus rotates around triquetrum independent of FA rotation

2 Rows:
A. Proximal row:
   [1]. SCAPHOID (boat): articulates é distal radius and distally é trapezium and trapezoid.
   [2]. LUNATE (crescent): articulates with the LUNATE FOSSA of the distal radius & é capitate
   [4]. PISIFORM (pea-shaped): articulates é the palmar surface of triquetrum (FCU sesamoid)

B. Distal row:
   [5]. TRAPEZIUM (quadrangular): articulates é scaphoid, and distally with the base of MC1. Its palmar surface is grooved for FCU tendon é a crest lateral to the groove.
   [6]. TRAPEZOID (irregular): articulates é scaphoid, and distally with the base of MC2.
   [7]. CAPITATE (headed): articulates with the Scaphoid, lunate & MT3
   [8]. HAMATE (hooked): articulates é triquetrum, capitate and distally with the base of MC4,5.
       Hook of hamate # may encroach on Ulnar N medial To It
       Bipartite Hook = HAMULI PROPRIUM

Anatomy of carpal ligaments:
**Extensor Compartments**

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<th>TENDONS</th>
<th>NOTES</th>
<th>PATHOLOGY</th>
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<td>1</td>
<td>EPB, APL</td>
<td>Both in separate synovial sheaths</td>
<td>De Quervains</td>
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<tr>
<td>2</td>
<td>ECRL, ECRB</td>
<td>Radial to Lister’s tubercle</td>
<td>Carpal boss</td>
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<td>3</td>
<td>EPL</td>
<td>Ulnar to Lister’s tubercle</td>
<td>Rupture over Lister’s tubercle</td>
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<td>4</td>
<td>EDC, EIP</td>
<td>Common synovial sheath</td>
<td>Tenosynovitis &amp; ruptures</td>
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<td>5</td>
<td>EDM</td>
<td>Double tendon, over DRUJ</td>
<td>Tenosynovitis &amp; ruptures</td>
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<tr>
<td>6</td>
<td>ECU</td>
<td>Lies over distal ulna</td>
<td>Subluxating at ulnar styloid</td>
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</table>

**Flexor retinaculum** (Transverse Carpal Ligament)
- Radial attachment ................................... tubercle of scaphoid + ridge of trapezium
- Ulnar attachment ...................................... hook of hamate + pisiform

**Carpal Tunnel**
- Floor and walls = .................................... bony carpus
- Roof = ................................................... flexor retinaculum / **TRANSVERSE CARPAL LIGAMENT (TCL)**
- Contents:
  1. Median nerve ........................................ most superficial (just beneath the retinaculum)
  2. FPL / FCR (deep to FPL)
  3. FDS - middle & ring lie superficial
  4. FDP

**Guyon’s Canal**
- Roof = .............................................. volar carpal & pisohamate lig
- Floor = .............................................. TCL to pisiform
- Ulnar wall = ........................................ pisiform
- Radial wall = ....................................... hamate hook
- Contains .............................................. ulnar n & a
- Compression occurs by:
  1. Zone1 ............... Hamate hook # (trunk)
  2. Zone2 ............... ganglion cyst (deep br)
  3. Zone3 ............... ulnar a aneurysm (superficial br)

**Ossific Centres around the wrist:** C H T L STRAP
  1. Capitate ......................6m
  2. Hamate .......................1y
  3. Triquetrum ...................3y
  4. Lunate ........................4y
  5. Scaphoid ......................5y
  6. Trapezium .....................6y
  7. Trapezoid .....................7y
  8. Pisiform .....................12y

**Muscles**

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<tr>
<th>MUSCLE</th>
<th>ORIGIN</th>
<th>INSERTION</th>
<th>TRY &amp; 2RY Action</th>
<th>DESCRIPTION</th>
<th>INNERVATION</th>
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<tr>
<td>Brachial</td>
<td>Mid 1/3 Humerus</td>
<td>Ulna coronoid</td>
<td>Elbow: Flexion</td>
<td>The main flexor of FA</td>
<td>Musculocutaneous</td>
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<tr>
<td>Coraco-brachial</td>
<td>Coracoid Process</td>
<td>Middle 3rd of humerus</td>
<td>Elbow: Flexion</td>
<td>CORACOBRACHIALIS SYNDROME – has Musculocutaneous N.</td>
<td>Musculocutaneous N. (lateral cord)</td>
</tr>
<tr>
<td>Biceps</td>
<td>Short Head: Coracoid</td>
<td>Tuberosity of Radius</td>
<td>Elbow: Flexion supination</td>
<td>Head is the lateral border of rotator cuff</td>
<td>Musculocutaneous N. (lateral cord)</td>
</tr>
<tr>
<td></td>
<td>Long Head: Supraglenoid</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Triceps</td>
<td>Infraglen tubercle Above &amp; below spiral groove</td>
<td>Olecranon of Ulna</td>
<td>Elbow: Extension</td>
<td>Triangular Interval and Quadrangular Space are between the two heads of the Triceps</td>
<td>Radial N.</td>
</tr>
<tr>
<td>Muscle</td>
<td>Origin</td>
<td>Insertion</td>
<td>Try &amp; 2 Try Action</td>
<td>Description</td>
<td>Innervation</td>
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<td>---------------------------------------------</td>
<td>-----------------------------------------------</td>
<td>------------------------------------</td>
<td>----------------------------------------------------------------------------</td>
<td>------------------------</td>
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<tr>
<td>Palmaris Longus</td>
<td>Common Flexor Tendon</td>
<td>None</td>
<td>Wrist: Flexion</td>
<td>Does not pass via tunnel Used in transfers</td>
<td>Median N.</td>
</tr>
<tr>
<td>Sublimis</td>
<td>Common Flexor Tendon (CFT)</td>
<td>Middle phx of 2-5 digits.</td>
<td>Digits: Flexion of fingers</td>
<td>SPACE OF PARONA is directly deep to it.</td>
<td>Median N.</td>
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<tr>
<td>FCR</td>
<td>Base of index finger MC</td>
<td>Wrist: Flexion, Abduction</td>
<td>Median N.</td>
<td>Median N.</td>
<td>Radial A., Ulnar A.</td>
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<tr>
<td>FCU</td>
<td>CFT and proximal ulna</td>
<td>The Pisiform Bone</td>
<td>Wrist: Flexion and adduction</td>
<td>CUBITAL TUNNEL $; Ulnar N. Entrapment bet 2 heads;</td>
<td>Ulnar N.</td>
</tr>
<tr>
<td>FDP</td>
<td>CFT &amp; Radius</td>
<td>Distal phx of the 2-5 digits</td>
<td>Digits: Flexion of fingers</td>
<td>SPACE OF PARONA is directly superficial to it.</td>
<td>Lateral Half: Ant Interosseus N., Med Half: Ulnar N.</td>
</tr>
<tr>
<td>FPL</td>
<td>1st distal phx</td>
<td>Digits: thumb Flex</td>
<td>Ant Interosseus A.</td>
<td></td>
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<tr>
<td>Pronator Quad</td>
<td>The distal ulna</td>
<td>Forearm: Pronation + elbow ext</td>
<td>Forearm: Pronation + elbow ext</td>
<td>PRONATOR TERES SYNDROME – Median N. Entrapment between the two heads</td>
<td>Median N.</td>
</tr>
<tr>
<td>Pronator Teres</td>
<td>Humeral Head: Med Epicondyle; Ulnar Head; Proximal Ulna</td>
<td>Distal third of radius</td>
<td>Forearm: Pronation (Radius over Ulna)</td>
<td></td>
<td></td>
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<tr>
<td>APL</td>
<td>Radius, Ulna &amp; Interosseus Membrane</td>
<td>MC; base</td>
<td>Abduction of thumb</td>
<td>Radial N.: Deep Branch</td>
<td>Posterior Interosseus A.</td>
</tr>
<tr>
<td>EIP</td>
<td>Prox phx of the 2nd digit</td>
<td>Digits: Extension of index finger</td>
<td>Radial N.: Deep Branch</td>
<td>Posterior Interosseus A.</td>
<td></td>
</tr>
<tr>
<td>EPB</td>
<td>Prox phx of the 1st digit</td>
<td>Digits: Extension of thumb</td>
<td>DeQuervain’s Disease in Radial Bursa</td>
<td></td>
<td>Radial N.: Deep Branch</td>
</tr>
<tr>
<td>EPL</td>
<td>Distal phalanx of the 1st digit</td>
<td>Digits: Extension of thumb</td>
<td>DeQuervain’s Disease in Radial Bursa</td>
<td></td>
<td>Radial N.: Deep Branch</td>
</tr>
<tr>
<td>Supinator</td>
<td>Proximal ulna and lateral epicondyle of humerus</td>
<td>Proximal radius</td>
<td>Forearm: Supination</td>
<td>Deep br of Radial N. pierces the supinator to go to post forearm – SUPINATOR CHANNEL SYNDROME</td>
<td>Radial N.: Deep Branch</td>
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<tr>
<td>Anconeus</td>
<td>Common Extensor Tendon</td>
<td>Elbow: Ext</td>
<td>Abduction of ulna during pronation</td>
<td>It gets the ulna out of the way during pronation of the forearm</td>
<td>Radial N.: Deep Branch</td>
</tr>
<tr>
<td>Brachioradialis</td>
<td>Common Extensor Tendon</td>
<td>Styloid process of the radius</td>
<td>Elbow: Power flexion</td>
<td>MOBILE-WAD: part of lateral compartment. May become damaged with radial fractures near the wrist</td>
<td>Radial N.</td>
</tr>
<tr>
<td>ECRB</td>
<td>Common Extensor Tendon</td>
<td>Base of the metacarpal bones</td>
<td>Wrist: Extension and Radial deviation (abduction)</td>
<td>Radial N.: Deep Branch</td>
<td>Posterior Interosseus A.</td>
</tr>
<tr>
<td>ECRL</td>
<td>Common Ext Tendon</td>
<td>Base of MC bones</td>
<td>Wrist: Ext &amp; abd</td>
<td>MOBILE-WAD: Part of lateral compartment</td>
<td>Radial N.</td>
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<tr>
<td>ECU</td>
<td>Common Ext Tendon</td>
<td>The base of the MC bones</td>
<td>Wrist: Ext &amp; add</td>
<td>Radial N.: Deep Branch</td>
<td>Posterior Interosseus A.</td>
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<tr>
<td>EDM</td>
<td>Common Ext Tendon</td>
<td>The prox phx of the 5th digit</td>
<td>Digits: Ext of little finger</td>
<td>Radial N.: Deep Branch</td>
<td>Posterior Interosseus A.</td>
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<tr>
<td>ED</td>
<td>Common Ext Tendon</td>
<td>All med 3 phx</td>
<td>Digits: Extension of fingers</td>
<td>The tendons split &amp; reunite to insert on the distal 2 phx</td>
<td>Radial N.: Deep Branch</td>
</tr>
<tr>
<td>Abductor Digits Minimi</td>
<td>Digits: Abduction of Little Finger</td>
<td></td>
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<td>Ulnar N.</td>
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<tr>
<td>FD minimi</td>
<td>Digits: Flexion of the little finger</td>
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<td>Opponens Digits M</td>
<td>Digits: Opposition of little finger</td>
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<tr>
<td>Dorsal int</td>
<td>Abduction of Fingers</td>
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<tr>
<td>Palmar Int</td>
<td>Adduction of fingers</td>
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<tr>
<td>Lumbral</td>
<td>Tendons of the FDP</td>
<td>Post aspect of prox &amp; distal phx</td>
<td>Digits: Flexion of MCP joints; Ext of PIP &amp; DIP joints; proprioeception</td>
<td>Ant to MCP joints &amp; post to PIP and DIP joints; proprioeception</td>
<td>Ulnar N.</td>
</tr>
<tr>
<td>APB</td>
<td>Abduction of thumb</td>
<td></td>
<td>Median N.</td>
<td></td>
<td>Princeps Pollicis A. (from Radial A.)</td>
</tr>
<tr>
<td>Adductor Pollicis</td>
<td>Digits: Adduction of thumb</td>
<td></td>
<td>Ulnar N.</td>
<td></td>
<td>Princeps Pollicis A. (from Radial A.)</td>
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<td>FPB</td>
<td>Flexion of thumb</td>
<td></td>
<td>Median N.</td>
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<tr>
<td>Opponens Pollicis</td>
<td>Digits: Opposition of thumb</td>
<td></td>
<td>Median N.</td>
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EMBRYOLOGY of the Upper Limb at Weeks 4 to 6

- The critical APICAL ECTODERMAL RIDGE (翕) the limb mesenchyme for growth & development of the limbs. Factors play a vital role in this process.
- The upper extremity, with pronated forearms begins to rotate externally.
- Developmental disturbances during this period give rise to major congenital malformations. Early suppression of limb development causes AMELIA (complete absence of a limb); Late suppression causes MEROMELIA (partial absence).

Weeks 7 to Birth
- By wk 7 the ten finger rays appear & continue to differentiate till 12 wk when the hands appear.
- The fingers develop as a result of cell death in tissue bet.digits (failure of this causes syndactyly).

INTERNATIONAL CLASSIFICATION (FDD.OUC)

1. Failure of Formation
   - Transverse Arrest / Aplasia
   - Phacomelia: complete, proximal, distal
   - Radial deficiencies (radial club hand)
   - Central deficiencies (cleft hand)
   - Ulnar deficiencies (ulnar club hand)
   - Hypoplastic digits

2. Failure of Differentiation
   - A. Synostosis: elbow, forearm, wrist, metacarpals, phalanges
   - B. Radial head dislocation
   - C. Symphalangism
   - D. Syndactyly
     - Simple
     - Complex
     - Associated syndrome
   - E. Contracture
     - i. Soft tissue
       - Arthrogryposis
       - Trigger digit
       - Hypoplastic thumb
       - Camptodactyly
     - ii. Skeletal
       - Cleinodactyly
       - Kirner’s deformity
       - Delta bone

3. Duplication (polydactyly)
   - A. Thumb (preaxial) polydactyly
   - B. Triphalangism/hyperphalangism
   - C. Finger polydactyly
     - Central polydactyly (polysyndactyly)
     - Postaxial polydactyly

4. Overgrowth
   - Macroductyly

5. Undergrowth
   - Brachidactyly

6. Constriction bands
Arm

- These include extra bones, absent bones, hypoplastic bones and fusions.
- Failure of Differentiation
- Failure of Formation - transverse [Aplasia] or axial
- Most of the defects are non-genetic but some are AD

1. **Amelia**: complete absence of a limb
2. **Phocomelia**: almost complete absence (stub remaining)
3. **Ectromelia**: partial absence

4. **Congenital radio-ulnar synostosis**
   - Union of the forearm bones usually proximally placing the arm in a pronated position. Associated with DDH, CTEV, chromosomal abnormalities and foetal alcohol $ Two types
   1. Medullary canals are linked creating a large radius with anterior bowing
   2. Proximal radial dislocation with less extensive fusion (usually unilateral)
   - Both types are difficult to treat. Osteotomies for disabling pronation but if bilateral leave the dominant arm and osteotomize the other to 20-30° supination.

5. **Congenital dislocation of the radial head**
   - Abnormally formed radial head + bowed ulna.
   - *Capitellum shape abnormal* ≠ traumatic dislocation.
   - Radial head excision if pain develops otherwise leave alone.

6. **Congenital pseudoarthrosis of the forearm**
   - Rare disorder associated with **Neurofibromatosis**. Refractory to ttt but vascularized BG may be useful.

7. **Congenital webbing of the elbow (Pterygium cubitale)**
   - Broad skin web crossing the elbow causing a flexion deformity and a pronated forearm. Surgery is difficult because it sometimes requires vessel and nerve lengthening.

8. **Madelung’s Deformity**

**Definition:** it is a developmental disorder of premature fusion of ulnar half of distal radial physis

**Pathology**

1. Dorsal + lateral bowing + shortening of the distal radius
2. Dorsal DRUJ subluxation (ulna dorsal)
3. Wedged carpal bones
4. Atrophic radial head + Hypertrophic capitulum
5. Associated with: Dysplasias, Turner, Langer syndrome

**Dx**

- Adolescence; **median nerve irritation**; wrist pain.

**PXR:**

1. ↑ width between the distal radius and ulna.
2. Positive ulnar variance
3. Triangularization of the distal radial epiphysis.
4. Wedging of the carpus bet radius and ulna, with the lunate at the apex of the wedge.

**Treatment:**

1. Child ........................................Corrective osteotomy + Milch ulnar resection
2. Adult ........................................Corrective osteotomy + Darrach ulnar resection
9. **Radial Hemimelia / deficiency (Radial club hand)**
   - Absence or hypoplasia of pre-axial structures:
     a. radius
     b. radial carpus (scaphoid, trapezium, trapezoid)
     c. Thumb - may be floppy (Pouce Flottante) or absent
   - May occur in association with visceral anomalies (CVS/GI/GU), VATER or blood dyscrasias e.g. Fanconi’s syndrome.
   - Most common in the right hand
   - Bilateral in 50% of cases.
   - Classified I-IV based on how much radius is present

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<tr>
<th>Type</th>
<th>Features</th>
<th>Treatment</th>
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<tr>
<td>I</td>
<td>Short</td>
<td>address thumb</td>
</tr>
<tr>
<td>II</td>
<td>hypoplastic</td>
<td>individualized</td>
</tr>
<tr>
<td>III</td>
<td>partially absent</td>
<td>centralization</td>
</tr>
<tr>
<td>IV</td>
<td>totally absent</td>
<td>centralization</td>
</tr>
</tbody>
</table>

   - Treatment is difficult - mild cases - strapping & manipulation; severe cases - correction of wrist deformity (Centralization) by fusing ulna to carpus or circular frame & provision of a thumb (Pollicisation) using Buck-Gramko method (transfer, shortening & rotation of index finger).
   - Abnormal distribution of nerves & arteries must be appreciated prior to surgery.

10. **Ulnar Hemimelia / deficiency (post-axial)**
    - This is not associated with systemic disorders as is the radial club hand but can be associated with other musculoskeletal deformities, especially hand deformities.
    - Only if function is severely disturbed should wrist stabilization be performed.

11. **Reduplication of the ulna** (Mirror hand)
    - The radius and pre-axial
    - Ulna and carpus are reduplicated leaving 7/8 digits and no thumb. Treatment includes removing most abnormal digits and pollicization to create a 5-digit hand.

12. **Central Deficiency (cleft hand / lobster claw hand / ectrodactyly)**
    - Central absense of at least one digit
    - other digits may fuse (syndactyly)
    - Typical Deformity = AD; often bilateral; more common in boys & may involve the feet
    - Atypical Deformity = sporadic; associated with cardiac & GI/T abnormalities
Hand Deformities

- Goals of surgery are to preserve or improve hand function and appearance.
- Timing of surgery should be:
  - Immediate if limb/digit threatening e.g. constriction bands
  - Within the first year if disorder has a tethering growth effect e.g. club hand
  - Before 3 if development patterns are affected e.g. pollicisation
  - Delayed until past 4 years if co-operation is required e.g. tendon transfers.

Digits
1. **Syndactyly (joined phalanges)**
   - Can be Simple (skin only) or Complex (bone involvement).
   - may be Complete or Incomplete: [complete= entire length of digit is affected]
   - Incidence = 1:2000 births (commonest congenital abnormality of the hand)
   - Can be associated with many anomalies.
   - Apert Syndrome = acrocephalosyndactyly
   - Release performed 18 months-5 years.
   - PreOp Planning:
     - Individual Allen’s tests to each involved digit
     - Radiographs to rule out tethering of digits
     - One side of digit should be operated on at a time, in order to avoid vascular insufficiency
     - With multiple syndactyly attention is first directed to border digits
     - The usual strategy is to preserve as much regional skin as possible on the radial side of the involved digits (pinch sensation) and saving FTSG for ulnar side of the affected digit

2. **Polydactyly (duplicated digits)** Of three types
   - Extra soft tissue only
   - Bone, tendon and cartilage
   - Completely developed with its own metacarpal [rare]

3. **Thumb Duplication** (pre-axial polydactyly)
   - Incidence = 1:1000 births
   - Look for Cardiac anomalies & Fanconi anaemia.
   - **Wassel classification**: seven subgroups depending on level of bifurcation.
     1. Bifid distal phalanx
     2. Duplicated distal phalanx
     3. Bifid prox phalanx
     4. Duplicated prox phalanx
     5. Bifid metacarpal
     6. Duplicated metacarpal
     7. Triphalangism [single MC, duplicated PP & DP + additional phalanx at end of one]
4]. **Brachydactyly** (short digits) / undergrowth

5]. **Macrodactyly** / overgrowth
   - Enlargement of all structures, especially nerves of one or more digits. Can be associated with Neurofibromatosis.

6]. **Deviated digits**

Clindactyly
   - Skeletal abnormality causes deviation in the lateral plane. Usually involves the little finger and is caused by a **trapezoidal middle phalanx**. Surgical correction for cosmesis only.

Camptodactyly
   - Familial soft tissue abnormality with deviation in the sagittal plane. Commonly involves the little finger causing a flexion contracture at the PIPJ.
   - May be associated with Dupuytren’s, Marfan’s, arthrogryposis or other genetic syndromes.
   - Few good surgical procedures exist.
   - 2 stage correction (with ex-fix applied at the time of FDS – extensor transfer has good results.

Kirner’s Deformity
   - In-curling of little finger DIPJ in prepubertal girls. Usually requires no treatment

Sympalangism (Stiff PIPJ’s)
   - Secondary to congenital ankylosis of the joint. Associated with **Apert Syndrome**. Observe only.

Delta phalanx
   - Triangular phalanx and physis, usually of the thumb and little finger. A delta bone results in a sideways curve of the finger. Surgery only if significant deformity.

**Thumb anomalies (Hypoplastic thumb)**

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<th>Blauth Grade</th>
<th>Description</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Short thumb, hypoplastic thenar muscles</td>
<td>Augment intrinsics</td>
</tr>
<tr>
<td>II</td>
<td>Grade I + Adducted MPJ</td>
<td>Soft tissue Z-plasty</td>
</tr>
<tr>
<td>III</td>
<td>Deficient MC + Abducted thumb</td>
<td>Augment/ BG/pollicisation</td>
</tr>
<tr>
<td>IV</td>
<td>Floating thumb</td>
<td>Pollicisation</td>
</tr>
<tr>
<td>V</td>
<td>Absent thumb</td>
<td>Pollicisation</td>
</tr>
</tbody>
</table>

**Congenital trigger thumb**
   - Congenital stenosis at A1 pulley. Often bilateral. **30% may resolve spontaneously by 1 year.** Attempt splinting but aim to correct surgically by 3 years.

**Constriction band/ring (Streeter’s Dysplasia)**
   - Commonly involves digits or toes (especially centrally) but can occur more proximally
   - Associated with syndactyly, club feet and neurological abnormalities. Treatment is by **Z-plasty**.

**Congenital amputation**
   - Ø either constriction bands or failure of development, commonest short below elbow amputation.
Carpal Instability

**Definition:** is the state of loss of normal relationship of different parts of wrist joint through motion arc.

**Anatomy of carpal bones & ligaments:** see before

**Wrist kinematics**
- **LICHET** proposed the carpal ring analogy “The distal carpal row is moving as 1 unit & scapoid, lunate, triquetrum are moving as independent units.** WEBER later on proposed that the carpus is composed of 2 columns: the scaphoid, lunate, capitate, trapezoid are the column for load transfer; and the triquetrum & hamate are the column which control pronation supination moves.
- Wrist flexion → abduction + pronation
- Wrist extension → adduction + supination

**Pathomechanics of carpal instability**
- Normally forces affecting scaphoid push it into flexion, and those of triquetrum are extension forces, the lunate is connected to both and in a state of equilibrium between them that keeps it in neutral position.
- If the lunate is dissociated from any of the two bones; it will follow the other.
- If SL lig is disrupted scaphoid will flex, & lunate will extend → triquetrum → SL angle (DISI).
- In the same way, disruption of LT lig → VISI = flexed scaphoid & lunate + extended triquetrum.

**Classification:**

**I. According to Chronicity**
- A. Acute
- B. Sub-acute > 1w
- C. Chronic > 6w

**II. According to Pattern**
- I. Carpal instability dissociative (CID)
  - A. Dorsiflexion DISI
  - B. Palmar flexion VISI
- II. Carpal instability non-dissociative (CIND)
  - A. Radiocarpal
  - B. Midcarpal
  - C. Ulnar Translocation
- III. Carpal instability complex (CIC)
  - A. Perilunate Dislocation (Dorsal / volar)
  - B. Trans-scaphoid Perilunate
- IV. Carpal instability longitudinal [Axial]
  - A. Axial Ulnar: Capitate-Hamate diastasis
  - B. Axial Radial
  - C. Axial Ulnar-Radial – Combined

**III. According to Constancy**
- I. Dynamic instability [Normal PXR; +ve cinerdiographs]
- II. Static [fixed] Instability [seen on plain x-rays]
- III. Predynamic

**IV. According to Direction**
- I. DISI
- II. VISI
- III. Ulnar translocation
- IV. Radial translocation
- V. Volar translocation
- VI. Dorsal Translocation
Diagnosis:
Mechanism of injury:
1. Commonest FOOSH:
   A. Dorsiflexion + abduction → VISI, scaphoid #
   B. Dorsiflexion → capitale or lunate fracture
   C. Dorsiflexion + adduction → DISI, Perilunar dislocation
2. Fall on flexed wrist → dorsal lunate dislocation
3. Rarely a direct trauma may cause fracture hook of hamate
4. RA: cause radiocarpal disruption → ulnar translocation and radial tilt

Clinically
1. History of trauma even if very old
2. Pain, swelling and limitation of wrist motion are the main presentations.
3. Palpation of the specific carpal bones and ligaments
4. Point tenderness over the dorsal scapholunate and lunotriquetral spaces
5. Grip strength; grabbing examiner fingers, specific mech pressure gauge, sphignomanometer
6. WATSON'S SL INCOMPETENCE: press on the distal scaphoid tubercle volarly, then passive add & abd in this position → the proximal pole sublux dorsally (SL dissociation)
7. LUNO-TRIQUETRAL BALLOTMENT test: pinch the lunate between the thumb and index of one hand & the triquetrium in the other hand and try to shear them apart → pain
8. PIVOT SHIFT: the hand is grasped and apply axial compression + alternating adduction & abduction → Painful clunk = mid carpal instability (CIND)

PXR
A. The PA -palm down- or AP full supination views are examined for:
   - Disturbed GILULA'S LINES
   - Wide scapholunate distance (TERRY THOMAS SIGN)
   - Fracture scaphoid
   - Scaphoid ring sign (flexed attitude give the scaphoid the end on appearance)
B. The lateral view
   - Capito lunate angle ......(normally = 0°)
   - Scapholunate angle ......(normally = 60°)
   - Capito-lunate-radial alignment is disturbed: the capitate axis is dorsally displaced in DISI
   - Lunate attitude: flexed in VISI & extended in DISI
C. Oblique views
   - 20° pronation ......................back of triquetrium
   - 30° supination ....................luno-triquetrum space
   - Tunnel view ....................Hook of hamate
   - Scaphoid view ....................fracture scaphoid (wrist abduction)
D. AP clenched fist view: ..........view the SL dissociation better
E. Motion series: for dynamic instabilities

Measurements of carpal angles:
1. Capitatolunate angle: 0°-15° is normal
2. Scapholunate angle: Normally 30-60°; ↑ in DISI, and ↓ VISI
3. Carpal height Ratio: distance bet MC3base - distal radius / length of MC3 = 0.53 ± 0.03
4. The revised carpal height ratio = carpal height / capitale length.

Cineradiography: to delineate the dynamic carpal instability
CT scan: oriented along the scaphoid axis → collapse (humpback) & union in fusion
TC99: for occult fractures as scaphoid
MRI: best to assess soft tissue
Arthrography: has been replaced by MRI
Arthroscopy: visualize & treat some conditions
Carpal Instability Dissociative (CID)

I. Scapholunate dissociation:
- = (Dorsal Intercalated Segmental Instability) DISI
- **Mechanism** of injury: FOOSH in adduction
- **Pathology**: injury of RSL or inter SL ligaments.
- **O/E**
  1. Tenderness over SL joint & anatomical snuff box.
  2. **ROM by pain.**
  3. **WATSON TEST**: the examiner’s four fingers of the same hand as that to be examined are placed behind the radius, the thumb is volarly pushing on the distal pole. The other hand moves the hand from ulnar to radial deviation. In ulnar deviation the scaphoid is dorsiflexed, while in radial deviation the scaphoid become palmar flexed and assumes a position more perpendicular; pressure on the scaphoid will prevent it from palmar flexing and the proximal pole will displace dorsally out of its radial fossa if there is sufficient ligamentous laxity. Compare é opposite side
  4. **SCAPHOID LIFT** test: painful dorso-palmar translation of the scaphoid
  5. **SCAPHOID SHIFT** test: the same as Watson but in # scaphoid; the distal fragment subluxes on the proximal one

- **Radiographic diagnosis:**
  - **AP full supination view:**
    1. SL Gap, ≥ 3 mm → diagnostic = "TERRY THOMAS" sign, after the comedian diastema.
    2. Shortened scaphoid è Ring Pole sign = downward distance from the ring to the proximal pole ≈ 3mm
    3. TALEISNIK V" sign, in normal wrist the volar aspect of the radius and the scaphoid make a C-shape pattern, but when the scaphoid is rotated it changes into V-shaped.

Lateral View:
- 4. SL ang èDISI.
- **TREATMENT:**
  - **Acute:**
    1. Closed reduction, ORIF Wrist fracture fixation
    2. Closed reduction + K-wire in interosseus EPL bone
    3. ORIF AND REPAIR OR AUGMENTATION OF LIGAMENTS

  - **Subacute:**
    4. DORSAL TENDONUSING ECRB OR EDC
    5. BONE TENDON BONE ALLOGRAFT RECONSTRUCTION

  - **Irreducible:**
    6. SUBTILIS
    7. SL OR SCAPHALITATE ARTHRODESIS
    8. PROXIMAL ROW CARPECTOMY
    9. Lunate Arthrodesis
    10. FOUR CORNER FUSION (SLA operation): lunocapitate fusion
    11. **SCAPHALITATE NON-UNION**

- **SLA** advanced collapse

- **SLA** advanced collapse (SLA operation): lunocapitate fusion

- **SLA** advanced collapse (SLA operation): lunocapitate fusion
II. Lunato-Triquetral dissociation: Visci (Volar Intercalated Segmental Instability)

- **Mechanism of injury:**
  - FOOSH in abduction + pronation:
    - Stage I: partial or complete tear of the lunato-triquetral (LT) interosseous ligament
    - Stage II: complete disruption of the interosseous and volar LT ligaments
    - Stage III: as II + injury of the dorsal RC lig (either scaphoid or lunate portions)

- **Pathology:**
  - The underlying pathology is injury of the volar, dorsal, & Intercosseous LT ligaments

- **Physical examination:**
  - The most important is Point Tenderness directly over the LT joint
  - +ve Reagan Ballottement test: lunate is firmly stabilized é the thumb and index finger of one hand, while the triquetrum and pisiform are displaced dorsally and palmarly with the other hand → pain, crepitus, and excessive laxity
  - Modification is the "KLEINMAN SHEAR" test: with the patient's elbow resting on the table + palm down → examiner's contralateral thumb is placed over the dorsal aspect of the lunate (just beyond the medial edge of the distal radius); then, the examiner's other thumb directly loads the piso-triquetral joint in a dorso-volar direction (shear the LT joint) → pain

- **Radiographic diagnosis:**
  - ✤ LT Angle; normally (+14°) to (~16°)
  - ✤ SL angle; < 60°

---

**Carpal Instability Non-Dissociative (CIND)**

**Aetiology:**

1. Congenital:
   - Hyperlaxity
   - Marphan
   - Ehlar Danlos
2. Traumatic
3. Inflammatory:
   - Rheumatoid arthritis

**Pathology**

- The key feature:
  1. Absence of dissociation within the proximal carpal row
  2. **Destabilization** between either:
     - I. Distal & Prox rows (scaphotrapezial, capitolunate, & triquetrohamate)
     - II. Distal forearm & Proximal row
     - III. Carpus & Metacarpals
   - Locating the level of the instability is critical and often difficult.

**Clinically**

1. +ve Pivot Shift: the hand is grasped and apply axial compression + alternating adduction & abduction → Painful clunk

**PXR**

2. This shift is seen also on **Cineradiographs**
3. Absence of SL or LT dissociation on x-ray, or surgical exploration.

**Treatment**

- Since this entity has only recently been described, it is difficult to offer firm recommendation.
- Midcarpal (capitolunate and triquetrohamate) arthrodesis will obviously solve the problem, but that may be more than is needed.
- Soft tissue reconstruction is under trials
Carpal Instability Complex (CLIP Wrist)

Definition

It is a common carpal instability form in which the force propagate from radial side causing progressive disruption of carpal ligaments and/or bones around the lunate, with resultant dislocation of the distal row in a dorsal direction on the lunate.

Pathology

I. Lesser Arc: through the perilunar ligaments
II. Greater Arc: through carpal bones around (4stages)
   1. Trans-Scapho Perilunar Fr dislocation
   2. Luno-capitate dissociation
   3. Luno-triquetal dissociation
   4. Perilunate Dislocation
      • Tavernier's Reduction maneuver:
        1. 5-10 min of axial traction then in extension
        2. Lock the capitate into the lunate concavity by gradual palmar flexion è the lunate is fixed from the volar side
        3. Reduce the capito-lunate unit into the radius by extension, then check by PXR
        4. ± K wire fixation (SL & SC); remove at 8wk
        5. Scaphoid cast in 30° flexion 12wk
      • Open Reduction
        1. If closed reduction fail: Scaphoid # fixation è Herbert screw & supplemental K-wire
        2. If lost reduction after CRUGA with hump back scaphoid → ORIF + BG
           o As early as possible
           o Both dorsal & volar approaches

Carpal Instability Longitudinal (Axial)

Capitate–hamate dissociation and others

• Mechanism of injury: high-energy trauma (either a dorsopalmar crush or blast force).
• Pathology: Injury of the intrinsic ligaments
• Treatment:
  o The earlier the treatment the better
  o Debridement of damaged muscle, early skeletal stabilization
  o Address concomitant neuro-vascular or tendon injuries
  o Both dorsal approach to visualize the carpal disruption + extended palmar approach to assess the associated soft tissue damage are usually required.

Isolated Carpal Dislocations

• All are rare but the rarest is the capitate one case reported
  1. Scapho-trapezial dislocation
  2. Triquetro-hamate dissociation
  3. Volar/dorsal perilunate dislocation
    o Forced hyperflexion from a fall on the back of the hand.
    o Fall on the hyper-extended wrist with supination of the forearm
    o Easily made on the lateral view
    o “Crowded Carpal Sign” i.e., overlap of the proximal & distal rows on AP view

NB Gymnastic wrist = premature distal radial physeal closure + ulnar overgrowth → rest for 6mo
Distal Radio-Ulnar Instability

**Definition**
- Instability is the loss of the normal joint relationship throughout the whole arc of motion

**Anatomy**
- DRUJ is a pivot joint, in which the radius rotates around the ulna.
- Triangular fibro-cartilage complex (TFCC) = Ulno-carpal meniscal homologue is formed of:
  1). TFC
  2). Dorsal & volar radio-ulnar ligament
  3). MCL
  4). ECU sheath
  5). Some add UL, UC, UT ligaments
- All stabilizers insert into the ulnar styloid fovea. Isolated DRUJ dislocation # is rare
- Extensor retinacula does not insert into distal ulna → pisiform & triquetrum

**Etiology**
1). Acute instability:
   - Dorsal DRUJ dislocation ................. pronation inj → starts è dorsal capsule & volar RU lig inj
   - Volar DRUJ dislocation .................... supination inj → starts è volar cap & dorsal RU lig injury
2). Chronic instability:
   - Simple after residual acute
   - Complex after mal-united fracture BBFA
   - Resection arthroplasty

**Pathology:**
1). Rupture of the whole UCMH (TFCC)
2). Styloid ulna #
3). Fracture BB forearm.............................60%
4). Essex Lopresti injury .......................DRUJ + Interosseous membrane + radial head #
5). Galeazzi fracture dislocation ..............DRUJ + radial shaft # (fall on OSH + hyper pronation)
6). Coles’ fracture .................................with TFCC insertion avulsion or ulnar styloid avulsion

**Diagnosis:**

<table>
<thead>
<tr>
<th>Clinically</th>
<th>ACUTE</th>
<th>CHRONIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain</td>
<td>Acute pain ♦ by pressure and supination pronation</td>
<td>Chronic mild pain</td>
</tr>
<tr>
<td>Swelling</td>
<td>Severe</td>
<td>Mild</td>
</tr>
<tr>
<td>Deformity</td>
<td>- in dorsal DRUJ dorsal prominence (More common)</td>
<td>Same parameters</td>
</tr>
<tr>
<td></td>
<td>- in volar DRUJ wrist appears narrow ± sigmoid depression</td>
<td></td>
</tr>
<tr>
<td>Elbow</td>
<td>Normal motion</td>
<td></td>
</tr>
<tr>
<td>Piano &amp; Clunk</td>
<td>May be +ve</td>
<td>Usually +ve</td>
</tr>
<tr>
<td>PXR</td>
<td>1). Lat view shows subluxed or dislocated ulna</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2). AP in dorsal DRUJ ........... ♦ RU distance</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3). AP in volar DRUJ ............... RU overlap</td>
<td>Same</td>
</tr>
<tr>
<td>CT</td>
<td>Diagnostic</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ulna must fall within the confines of Mino’s lines</td>
<td>Same</td>
</tr>
</tbody>
</table>

**Treatment:**
1). Acute instability:
   a. Simple Dorsal ................................ reduction + supination cast
   b. Simple Volar ................................. reduction + pronation cast 6wk
   c. Complex = (unstable) .......................same but add wire fixation
2). Chronic:
   d. Simple subluxation ................. TFCC reattachment ± styloid ORIF
   e. Simple dislocation ...................... ECU sling operation
   f. Complex dislocation ..................... Corrective osteotomy + ECU sling
   g. After resection arthroplasty .............. ECU sling / Pronator Quad advancement / radius to ulna transposition (One bone forearm operation)
Keinbock Disease

**Definition**
- Collapse of the lunate due to vascular insufficiency & AVN

**Epidemiology**
- Male aged 20-40 y
- Dominant wrists
- 75% ulna minus
- Manual laborers & recreational activities

**Pathogenesis Theories:** (Uncertain aetiology)

**Intrinsic factors:**
1. **Pattern I** of the Lunate bl supply: .................. 30%
   - Single extraosseous vessels running in the dorsal and volar radiocarpal ligaments
   - Less intraosseous vessels → ↑ risk of losing vascular supply.

2. Lunate architecture: some authors found **Type I Lunate** is ulna minus has weaker architecture

3. **Radial Inclination**

**Extrinsic factors:**
4. Single forgotten Wrist Trauma
5. **Repetitive Microfractures** → vascular compromise → ↑ blood supply to lunate
6. Recurrent compression of lunate bet capitate & radius → disrupts the intraosseous structure. Associated is **Ulna Minus** (there is no report of Kienbock’s after Darrach’s)

**Diagnosis:**

**Clinically:**
- Symptoms:
  - Young adults
  - Wrist pain that radiates to forearm
  - Wrist stiffness
- Signs:
  - Tenderness over lunate dorsally
  - Weakness of grip

**PXR:**
- Ulnar variance is measured on PA views with wrist in neutral rotation

<table>
<thead>
<tr>
<th><strong>Lichtman Staging</strong></th>
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<tbody>
<tr>
<td><strong>Stage 1</strong></td>
</tr>
<tr>
<td><strong>Stage 2</strong></td>
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<td><strong>Stage 3</strong></td>
</tr>
<tr>
<td><strong>3A</strong></td>
</tr>
<tr>
<td><strong>3B</strong></td>
</tr>
<tr>
<td><strong>Stage 4</strong></td>
</tr>
</tbody>
</table>

**CT**
- Determining the true extent of disease.
- Demonstrate collapse more clearly
- Demonstrate coronal fractures that split the lunate into volar and dorsal halves

**TC**
- ↑ uptake (not specific, but exclude other causes of a hot lunate)

**MRI**
- MRI is most helpful in stage I → focal ↓ T1 + ↑ T2 = early involvement
- Other stages have both ↓ T1 and T2
- MRI is an extremely sensitive and specific to detect marrow changes in osteonecrosis.
- Demonstrate revascularization following operation
Treatment:
- Remember:
  1. Keinbock’s often causes little disability
  2. The radiological findings & symptoms do not correlate well.
  3. No surgical procedure has been conclusively shown to prevent progression.
  4. Excision of lunate alone → migration of other carpal bones → joint incongruity, limited wrist motion and grip strength, and OA
- Surgery:
  - **Stage 1 & 2:**
    - Indication: when pain & disability cannot be managed by splint, NSAIDs & reassurance
    - Aim: prevent lunate collapse
    - Results: 70% success rate in pain relief
    - Modalities:
      1. Joint Leveling:
        a. Radial shortening
        b. Ulnar lengthening - high non-union rate.
      2. Lunate Revascularization
        a. Vascularized Pedicle graft from distal radius + pronator quadratus
        b. Dorsal digital artery placed into drill hole on lunate
  - **Stage 3:**
    1. Limited carpal fusion ± lunate excision [STT or scapho-capitate]
    2. Four corner fusion: triquetro-luno-capito-hamate fusion
    3. Wrist denervation
    4. Proximal row carpectomy
    5. Total wrist arthrodesis - in heavy laborers + severe OA
    6. Titanium lunate implants ± limited fusion
  - **Stage 4:**
    1. Wrist denervation
    2. Total wrist fusion.

Blood Supply of the scaphoid:
- The bone is completely covered by cartilage except at two areas
  1. Volar insertion of the radio-scapho-capitate lig (Sling lig) that cross the waist of the scaphoid
  2. Dorsal spiral groove = waist of scaphoid through which blood supply to proximal 2/3 enters
- Radial artery gives:
  1. Dorsal branch .......... (~80% of supply via waist)
  2. Latero-volar branch .... (~20% via tuberosity)
  3. Distal branch ............ [variable presence]
- 65% ................................ have scattered arterial foramena
- 20%............................. foramena at waist only
- 15% .............................. foramena at distal 1/3 only
- This means that 35% of # scaphoids at proximal 2/3 would have inadequate blood supply.
Aetiology:
- FOOSH = fall on outstretched hand

Anatomy:
- Blood supply .................................................... See before

Pathology:
- 5 fracture configurations are defined ....... See picture

Classification (Herbert)
A. Stable acute
B. Unstable acute
C. Delayed union
D. Established non-union

Clinical

History
- Forcible dorsiflexion of the wrist
- Palmar flexion in 3% of cases

Examination
1. Fullness in the ASB = wrist effusion
2. Tenderness in the ASB and scaphoid tubercle
3. Pronation followed ulnar deviation will cause pain

Special tests
4. Scaphoid compression test – longitudinal force along the 1st metacarpal
5. Kirk-Watson’s test
6. Resisted pronation

X-ray
1. PA in ulnar deviation
2. Lateral with wrist in neutral
3. Scaphoid view 1: PA 45deg. pronation & ulnar deviation; + shows STT joint
4. Scaphoid view 2: AP with 30deg supination & ulnar deviation; + shows radioscaphoid joint
5. Others:
   - PA with wrist in slight extension (Ziter View)
   - AP with clenched fist to detect a ligamentous injury

Occult Fractures
Tc
- Sensitive but not very specific

CT
- Can still miss fractures

MRI
- Excellent sensitivity and specificity
- Fracture line will be visible on T2 (after 12 hours) as line of ↑ signal = BM oedema
TREATMENT

1. Stable non-displaced fractures
   - POP cast: Below elbow cast .................. 8wk (Moulded palm & neutral in AP)
   - No need to include thumb & excessive ulnar deviation \(\rightarrow\) distract the fracture
   - Re-examine + PXR \(\rightarrow\) If still ..................... 4 weeks cast more \(\rightarrow\) then remove what ever the result
   - Re-X-ray at 6 months

2. Operative treatment
   - Indications
     a. Trans-scaphoid perilunate dislocations
     b. Displacement of more than 1mm in any direction
   - Approach
     a. Volar through bed of FCR ............... Good for waist & distal # (Joe Dias)
     b. Dorsal bet EPL_{III} and EDC_{IV} ........... Good for proximal 1/3 fractures
   - Types of internal fixation
     a. Herbert screw
     b. Herbert-Whipple screw
     c. AO low profile compression screw
     d. Acutrack screw
     e. K-wires

SEQUELAE OF SCAPHOID FRACTURES

1. Delayed union .................................................. >4 months
2. Non-union .......................................................... 5-10%
3. Malunion .............................................................. "Hump Back" deformity
4. Avascular necrosis - See eHand Images
5. DISI
6. Scaphoid non-union advanced collapse (SNAC) = loss of carpal height. It takes 5-10 years to develop

<table>
<thead>
<tr>
<th>STAGE</th>
<th>PATHOLOGY</th>
<th>MANAGEMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>SNAC I</td>
<td>RS OA</td>
<td>• Radial styloidectomy &amp; preserve the radiocarpal ligaments</td>
</tr>
</tbody>
</table>
| SNAC II | SC + RS OA | • Partial scaphoid excision (distal pole)  
• Proximal row carpectomy  
• Prox pole excision or prosthesis are abandoned \(\rightarrow\) instability |
| SNAC III | LC + SC + RS OA | • Scaphoidectomy plus 4-corner fusion |

Luno-capitate (LC), scapho-capitate (SC), Radioscaphoid (RS).

What is the aim of treating non-union?
1. Correct carpal kinematics
2. To achieve union
3. Reduce pain
4. Increase function
5. \(\downarrow\) OA
Flexor Tendon Injuries Of The Hand

ACUTE FLEXOR TENDON REPAIR

Anatomy

- Annular & Cruciate pulleys prevent bow stringing of flexor tendons
- Thumb - Oblique pulley over proximal phalanx.

Tendon Nutrition
- The vinculae are remnants of mesotenon & provide the blood supply & nutrition to the flexor tendons.
- The vincular system is supplied by the transverse communicating branches of the common digital artery.
- Nutrition of the tendons is also derived from the synovial sheaths - thus early mobilisation post-op is important.

Types of Injury
- The position of hand at injury determines the tendon retraction:
  1- Flexed fingers - distal tendon retracts
  2- Extended fingers - proximal tendon retracts
Treatment

**Aim:**
1. Regain of normal anatomy
2. Provide functional results
3. Avoid complications

**Contraindications to Repair**
1. Wounds liable to infection
2. Inability of patient to cooperate with rehabilitation

- Failed primary repair is worse than no repair! If only one tendon is cut the functional result will be better than a poor repair.

---

**Zones**

<table>
<thead>
<tr>
<th>Zone</th>
<th>Tendon Suture Area</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone 1</td>
<td>FDS insertion to FDP insertion</td>
<td>The tight A4 pulley makes repair difficult. Aim to advance FDP stump to reattach to terminal phalanx.</td>
</tr>
<tr>
<td>Zone 2</td>
<td>Zone 1 to proximal part of A1 pulley</td>
<td>two slips of FDS; Vincula</td>
</tr>
<tr>
<td>Zone 3</td>
<td>Zone 2 to distal edge of flexor retinaculum</td>
<td>easily repaired with good results. Don't suture lumbrical muscle around tendon repair.</td>
</tr>
<tr>
<td>Zone 4</td>
<td>within carpal tunnel</td>
<td>Can use mattress sutures if many tendons need repair.</td>
</tr>
<tr>
<td>Zone 5</td>
<td>proximal to carpal tunnel</td>
<td></td>
</tr>
</tbody>
</table>

**Thumb T1**
FPL insertion to A2 pulley
FPL tendon lacerations often retract into the thenar area or wrist; unlike the fingers, the FPL often lacks a vinculum and does not have a lumbrical, and therefore the tendon is free to retract; Repair requires an incision prox. to carpal tunnel & 'pull-through'

**Thumb T2**
Zone 1 to distal part A1 pulley

**Thumb T3**
Zone 2 to carpal tunnel also damage thenar muscles & recc. br. median nerve.
**Incisions**

Safe Volar Hand Incisions

For retracted tendons:

- Try milk the tendon with the wrist flexed.
- Small incision a the distal palmar crease just proximal to A1 pulley. Pass a silastic cannula from the distal wound through the sheath to the proximal wound. Attach the proximal tendon to the cannula & pull through to distal wound.

**Technique**

Core Non-absorbable 4/0 suture - Modified Kessler technique. 6/0 monofilament running epitenon suture. Close sheath, if possible.

**Multiple Flexor Tendons at the Wrist (Zone 5)**

Order of Repair:
1. FPL
2. FDP tendons
3. FDS to middle & ring fingers
4. FDS to index & little fingers
5. Ulnar nerve
6. Ulnar artery
7. Median nerve
8. FCU
9. FCR

**Post-operative program**

**BELFAST REGIMEN:**

1. 48hrs post-op remove dressings & put splint
   - Thermoplastic splint: wrist 20°, MCP 70°, 2/3 up forearm, straps on palmar crease, wrist & forearm.

2. First 6 weeks:
   - Fingers: Every 2hrs:
     - Passive flex (2x/ individual finger)
     - Active extension (2x/ mass action)
     - Active flexion (2x/ mass).
   - Thumb: Every 3hrs.- as above.

3. After 6 weeks:
   - Remove splint & progress to active flexion of individual joints.

4. 6-8 weeks: use hand, no heavy lifting.

5. 8-10 weeks: slowly incr. activity, stretches into extension, fine work.

6. 10-12 weeks: Driving, heavier work.

7. >12 weeks: Full funtion (60% strength back at 16 weeks).

**Complications**

1. Rupture
2. Infection
3. Adhesions - prevented by early passive ROM
4. Joint contractures - too tight repair or from prolonged splintage
5. Bow stringing - from damaged pulleys
SECONDARY FLEXOR TENDON REPAIR & RECONSTRUCTION
Defined as delayed primary repair performed > 3wks after injury.
Contracture of the muscle-tendon unit has usually occurred & tendon graft often required.

Prerequisites for tendon reconstruction:
1. Adequate skin & soft tissue cover
2. Skeletal alignment
3. Good passive ROM of joints
4. Adequate sensation & circulation of finger

Methods:
1. Delayed direct repair
2. Single stage flexor tendon grafting
3. Two-stage grafting
4. Tenodesis or arthrodesis
5. Tendon transfer
6. Amputation

Two-stage Flexor Tendon Reconstruction

Contraindications:
1. Infection
2. Too much damage to support an implant or allow decent tendon gliding
3. Motivated patient
4. Experienced surgeon
5. Experienced Hand Therapist

First Stage:
Aims:
1. Joint contractures must be released
2. Tenolysis of scarred tendons
3. Finger must have free & full passive ROM
4. Digital nerve repair or grafting
5. Provide healthy skin (may require a flap)
6. Full flexion on traction of the silastic rod at the wrist
7. Preserve A1, A2 & A4 pulleys

Second Stage:
2 - 3 months after first stage.
Tendon Graft options:
1. Palmaris Longus
2. Plantaris - best for multiple tendon grafts
3. Long toe extensors - 2nd, 3rd or 4th toes
4. EIP
5. Fascia Lata

Jeanne’s sign identifies thumb metacarpophalangeal joint hyperextension of 10° to 15° with key pinch or gross grip.
Froment’s sign refers to the exaggeration of thumb interphalangeal joint flexion during key pinch by the flexor pollicis longus in ulnar nerve palsy.
Wartenberg’s sign is the inability to adduct the extended small finger due to an ulnar nerve palsy.
Duchenne’s sign refers to clawing of the ring and small fingers. Pollock’s sign is the inability to flex the distal interphalangeal joints of the ring and small fingers in high palsy
Trapezio-Metacarpal OA (Rhizarthrosis)

ANATOMY
- Key joint of the thumb
- Saddle-shaped joint: Biconcavo-convex shape
- Joint compression force = 12kg (120kg for strong grip)
- 3 Main ligamentous stabilisers:
  1. **Volar or Beak Ligament** (volar oblique lig., anterior oblique lig. [AOL], volar CMC lig., deep ulnar lig.)
     - Very strong - primary static stabiliser
     - Prevents dorsal translation of the MC in key pinch
     - Allows rotational motion
     - Important in bennett's fractures
  2. **Dorsal Ligament**
     - thin & reinforced by APL
  3. **Lateral Ligament**
     - broad band running from lateral surface of trapezium to 1st MC base

PATHOPHYSIOLOGY
- Described by Pelligrini (1991) as attritional changes in the beak lig. → destabilisation of the TMJ
- These changes initially occur in the palmar contact areas of the joint.

CLINICAL

History
1. Female: male .................................................. 10:1
2. Enquire about history of injury.
3. Pain ↑ by- forceful pinch grip such as turning door key, holding tea cup or sewing.

Signs
1. **Adduction-Flexion** deformity of the thumb reducing the thumb index web angle.
2. **Shoulder Sign** = radial prominence at base of thumb, from dorsal sublux. of MC on trapezium
3. **Crank Test** = axial loading + passive flexion & extension of 1st MC
4. **Grind Test** = axial loading + rotation of 1st MC on trapezium
5. **Torque Test** = Distract MC & rotate. - differentiates CMCJ OA from de Quervain’s disease.
6. Look for Trigger fingers & CTS ............. 45%

RADIOGRAPHS
- AP, oblique & lateral views are usually adequate.
- **Robert Pronated** view = fully pronate forearm & internally rotate shoulder.
- Dynamic stress views
  - Indicated where instability suspected & standard x-rays are –ve
  - = AP views of both 1st CMJ whilst pressing the radial aspects of thumb tips together.
**TREATMENT**

**Always non-operative initially**

- Splinting
- Strengthening thenar muscles
- Steroid injections

**Surgery.** When non-operative treatment fails.

1. Soft tissue reconstruction alone
   - for instability with no articular changes
   - FCR to reconstruct the beak lig.

2. Osteotomy
   - abduction-extension osteotomy to off-load the palmar surface of the joint.
   - For high demand young adults with early disease.

3. Arthrodesis
   - for young high demand patients
   - 20% failure rate

4. **Gervis Excision Arthroplasty** (Trapeziectomy) alone
   - Causes weakness, instability, prox. migration of MC

5. **Swanson Interpositional Arthroplasty** (silicone prosthesis)
   - Problems:
     1. implant subluxation & dislocation
     2. rapid wear
     3. silicone synovitis

6. Total joint arthroplasty
   - Constrained ball & socket design
   - Wear rates of 34% at 5yrs.
   - Less constrained designs in development.

7. Excision Arthroplasty & soft tissue reconstruction
   - **= Trapeziectomy & Ligament Reconstruction & Soft Tissue Interposition (LRSTI)**
   - Theoretically deals with articular degeneration + instability + length
   - Technique (Nottingham):
     - Incision: inverted 'Y', centred over bony prominent base of 1st MC. (over ASB)
     - Dissect down to joint avoiding radial artery (at proximal end of wound) & terminal branches of radial nerve (large)
     - Trapeziectomy: Divide Trapezium into halves or quarters w/ osteotome or saw, & remove it piecemeal. Avoid cutting FCR.
     - + LRSTI:
       [1]. Make hole in MC base ⊥ to plane of thumbnail, from radial cortex to base
       [2]. Harvest half of FCR tendon: thro a series of oblique incisions. (Split tendon longitudinally to insertion on MC). Detach a 10-12 cm strip.
       [3]. To suspend MC base: pass free end of FCR through hole in base of 1st MC & out radial hole. Suture it to the soft tissues on the MC & then to itself.
   - Close: Can put K-wire across trapezium fossa if not doing LRTI + volar slab, è thumb IPJ free.
   - Post-op: Mobilise at 3-6wks (Davis: remove k-wire at 3wks, mobilise at 6wks)
   - Complications: Damage to
     1. superficial branch of radial nerve
     2. Radial artery
     3. Palmar cutaneous branch of median nerve.
Rheumatoid Hand

Clinical Assessment
- Wrist radial shift
- MCP ulnar drift
- PIP swan & boutonniere’s & intrinsic +
- DIP mallet
- Rheumatoid Thumb
- Tenosynovitis

HISTORY:
1. Pain - due to synovitis or secondary OA
2. Loss of Function: Using toothbrush, hairbrush, knife, fork
3. Cosmesis - may be extremely imp to patient.

EXAMINATION: Quick elbow, shoulder & neck

Look (Most NB!):
1- Exensor surface
2- Flexor surface
   1- swelling
   2- Nodules
   3- wasting
   4- Deformity:
      • zig-zag - coronal / sagittal
      • MCPJs - dropped fingers, ulnar drift
      • finger deformities
   5- Piano sign of DRUJ when wrist supinated
   6- Features of SLE, Psoriasis, scleroderma (see below)

Feel:
1- Tender areas
2- Correctability of joints & MP flexion (tight lig) = soft tissue procedures indicated
3- Stability of the joints (e.g. MCL of thumb)
4- Sensibility

Move:
1- Actively Extend & Flex joints fully & Oppose thumb → ext lag or subluxation
2- Passive movement
3- Intrinsic Tightness:
   1- Bunnel Test: (DDx tight capsule)
      • Ask the pt to flex the PIPs & extended MPJ (taught intrinsics)
      • If it doesn’t flex .................... tight intrinsics or PIP capsule contracture.
      • Flex MP (relax intrinsics) ...... if it doesn’t flex = tight capsule.
   2- DDx Long flexor tightness
      • Ask the pt to flex the IPs if tight, Relax FDS & FDP (by wrist flexion)
      • If pt can flex the IPJs .............. intrinsic tightness
      • If can not ................................ Volkmann’s contracture.
   3- Bouvier’s Test [DDx PIPJ capsule & ext expansion tightness]
      • Block MPJ hyper-extension & ask the pt to extend IPJ:
      • If he can .............................. PIPJ capsule & ext. mech are normal
      • If he can not .......................... = abnormal (central slip adherent / volar sublux of lateral bands)
   4- DDx Lumbrical Plus
      • = MPJ flexion lead to IP extension; because FDP becomes an extensor of the PIP
      • Ask pt to flex fingers .............. PIP expansion
      • Relax FDP (wrist flexion) .... sublimis work without antagonism → PIP flex

General Medical Assessment:
1. cervical spine
2. TMJ
3. Pulmonary
4. General
Investigations:

1. Hb (anaemia of chronic disorders)
2. ESR
3. WBC (↓ in Felty's syndrome)
4. platelet count (↓ with NSAIDs)
5. Rh factor
6. Anti CCP
7. LFT (↑ è methotrexate)

Treatment

Aims of Treatment:
1. Pain relief
2. Improve function
3. Prevent further damage
4. Cosmesis

Principles:
- Operate on proximal joints then distal
- Tendons before joints
- Alternate fusions with motion-sparing procedures
- Staged procedures: according to Souter Staging

<table>
<thead>
<tr>
<th>Souter Stage</th>
<th>Clinical</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Acute synovitis</td>
<td>medical Mx &amp; splinting</td>
</tr>
<tr>
<td>2</td>
<td>Chronic synovitis</td>
<td>Synovectomy</td>
</tr>
<tr>
<td>3</td>
<td>Specific deformation</td>
<td>Reconstructive</td>
</tr>
<tr>
<td>4</td>
<td>Severe crippling</td>
<td>Salvage</td>
</tr>
</tbody>
</table>

Lumbrical plus: (lumbrical tighter than FDP)

**Causes:**
1. Fdp laceration or rupture distal to the lumbrical origin
2. Amputation of the distal phalanx (distal to central slip insertion)
3. Excessively long tendon graft.

**Treatment:** division of the lumbrical
**Metacarpophalangeal Joints**

**Ulnar Drift**

**Pathogenesis of the deformity:**

**Early**
1. Radial deviation of wrist
2. Synovitis push the extensor mechanism ulnar ward
3. Destabilization of volar plate, LCL, & A2 pulley → flexor tendon slips ulnar ward
4. Erosion of metacarpal heads.

**Late**
5. Contracture of MCL
6. Contracture of the interossei on ulnar side (At this stage passive correction is impossible)

**Clinical Investigations:**

- as before (look, feel,...)
- + main problem is **Inability To Hold Large Objects** (loss of MPJ ext)

**Treatment**

- as before (Principles, aim, staging)
- + **Reconstructive Procedures:**

1. **Soft Tissue Balancing:** Vital to ascertain which structures are tight
   1. **Flatt** radial ext mech reefing & double-breasting & LCL reconstruction
   2. Ulnar release; extensor mechanism, MCL ...
   3. Combined ulnar & radial procedures:
      1. Ulnar ext mech is passed via radial capsule to prox phx base
      2. Crossed intrinsic transfer - ulnar IOM transfer to the next radial finger (LCL)

2. **MP Arthroplasty:**
   1. Excision arthroplasty - causes unstable joint, shortening of ray
   2. Excision arthroplasty & soft tissue interposition - poor ROM

3. **MCPJ Replacement (Swanson's):**
   - Simply a spacer + some stabilising features → Good results
   - Complications:
     1. Silicone synovitis (very rare)
     2. Recurrent ulnar drift
     3. Implant failure
     4. Infection

---

**MP Joint - Lateral View**

- Extensor hood
- Sagittal band
- EDC tendon
- Metacarpal
- Proximal phalanx
- Lateral band
- Lumbrical tendon
- Interosseous tendon
- Transverse metacarpal ligament
Proximal Interphalangeal Joints

A. Swan-neck deformity:
- Causes:
  
  Failure of PIPJ stabilizers 2ry to:
  [1]. Generalized joint laxity
  [2]. Volar synovitis → FDS insufficiency (failed CHASMA OF CAMPER bet the 2 FDS slips)
  [3]. Volar plate insufficiency (2ry to synovitis)

  Intrinsic over activity 2ry to:
  [4]. intrinsic spasticity
  [5]. intrinsic tightness 2ry to MCPJ disease

  Long extensor over activity 2ry to:
  [6]. Extrinsic spasticity
  [7]. Tight posterior PIP capsule
  [8]. DIP mallet

<table>
<thead>
<tr>
<th>Nalebuff Swan Neck type</th>
<th>Pathology</th>
<th>Diagnosis</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>[1]. PIPJ flexible</td>
<td>- FDS insufficient</td>
<td>- Cannot</td>
<td>- FDS tenodesis (FDST)</td>
</tr>
<tr>
<td></td>
<td>- DIP mallet</td>
<td></td>
<td>- DIP Fusion</td>
</tr>
<tr>
<td>[2]. PIP flexion é ext MP = locked swan</td>
<td>- Tight Intrinsic</td>
<td>- Bunnell Test</td>
<td>- Intrinsic Release</td>
</tr>
<tr>
<td></td>
<td>- Weak volar plate</td>
<td></td>
<td>- Advance volar plate</td>
</tr>
<tr>
<td>[3]. PIP stiff even é flexed MP</td>
<td>- Tight post PIP cap</td>
<td>- Bunnell (PXN AD)</td>
<td>- MUA ± Dorsal release</td>
</tr>
<tr>
<td>[4]. PIP stiff + OA</td>
<td>- Sublux + OA</td>
<td>- PXR Articular/ bony changes</td>
<td>- Arthrodesis</td>
</tr>
</tbody>
</table>

B. Boutonniere deformity

- Causes:
  1. PIP Dorsal synovitis → tighten the extensor tendons
  2. Rupture of CENTRAL SLIP of extensor tendon 2ry to this synovitis
  3. Volar dislocation of LATERAL BANDS, being converted from extensors to flexors.
  4. HYPER EXTENSION OF DIP & MP occurs ð tightening of the extensor tendon

<table>
<thead>
<tr>
<th>Deformity</th>
<th>Clinically</th>
<th>PXR</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild (10-15º)</td>
<td>PIP is actively correctable</td>
<td>N</td>
<td>Reposition the lat bands+ synovectomy ± extensor tenotomy</td>
</tr>
<tr>
<td>Mod (30-40º)</td>
<td>PIP is passively correctable</td>
<td>N</td>
<td>Central band reconstruction ê the lateral band</td>
</tr>
<tr>
<td>Severe (fixed)</td>
<td>Stiff</td>
<td>OA</td>
<td>Arthrodesis - from 20º (index) – 45º (little finger)</td>
</tr>
</tbody>
</table>

C. Intrinsic Plus Deformity
- Due to intrinsic tightness. Pathology. CP as previous
- Treatment:
  1. Intrinsic release
  2. Synovectomy
  3. Total arthroplasty


### OTHER FORMS OF ARTHRITIS OF THE HAND

#### Systemic Lupus Erythematosus (SLE)
- Ligamentous laxity of the MCPJs
- Joint surfaces often unaffected

#### Psoriasis
- DIPJ involvement
- Gross joint changes
- No tendon involvement
- Nail changes

#### Scleroderma
- Calcinosis causing fingertip ulceration
- CREST syndrome - Calcinosis, Raynaud’s syndrome, Eosophageal strictures, Sclerodactyly, Telangectasia.
FLEXOR TENOSYNOVITIS

Pathogenesis:
- Tendons are affected by either the synovitis or attrition on a bony irregularity

[I]. Trigger fingers: synovium is thickened hypertrophied & has fibrinoid rice bodies
  1- Type I: .................Proximal to A1 pulley
  2- Type II: ..................Proximal to A1 pulley
  3- Type III: ..................A2 Pulley
  4- Type IV: ..................Generalized

[II]. Tendon Ruptures: The most commonly affected are:
  1- EPL on prominent LISTER tubercle
  2- EDC to ring and little Δ prominent ulna VAUGHN-JACKSON $
  3- FPL Δ attrition on spike from scaphoid = MANNERFELT $
  4- FDP to index finger

Clinical Investigations:
  1- As before (look, feel,...) +
  2- Trigger finger
  3- CTS, Cubital tunnel $, Posterior Interosseous $
  4- PUFFY thick feeling palm
  5- PINCH TEST – thickened tenosynovium can be 'pinched' thro defects in fibrous sheath
  6- Test function of FDP index & FPL by asking patient to pinch:
     o Normal = tip-to-tip
     o AbN = pulp-to-pulp (also occurs with AIN palsy) [also called PINCH TEST by some]

Management:

I. Acute synovitis = splinting & drugs (NSAIDs, steroids)

II. Chronic synovitis:
   - If conservative Rx has failed after 4 months should consider surgery.
   - Synovectomy at three sites:
     1. Carpal tunnel
     2. Palm at level of mouth of A1 pulley
     3. Just distal to A2 pulley

III. Tendon Rupture:
   - Same as secondary tendon reconstruction in flexor tendon injury; see before

Vaughn-Jackson Syndrome
- Rupture of EDC of ring & little fingers
- Δ prominent ulna (CAPUT ULNA) & DRUJ synovitis
- Clinically: TUCK SIGN = synovitis tucks under the skin with movement.
- DD= subluxation, PIN palsy, locked trigger finger
- Treatment:
  1- DARRACH for pre-rupture
  2- TENDON TRANSFER (EIP to EDM) for rupture.

Mannerfelt Syndrome
- FPL rupture due to Scaphoid spike or volar synovitis
- Treatment:
  1- IPJ arthrodesis

Zones of extensor tendons
De Quervain’s Syndrome

Definition
- It is an entrapment tendinitis of the 1st dorsal compartment tendons at the wrist, resulting in pain and thumb motion.

Anatomical Considerations:
- APL & EPB tendons pass through 1st dorsal compartment (DC₁), & anchored by ext retinaculum
- APL tendon usually is multistrand
- EPB tendon is single slim and β congenitally absent
- A septum separating DC₁ into 2 subcompartments often is noted at surgery → move the thumb; if a tendon glides with MCP

Aetiology:
1. Acute trauma + thickening of the tendon sheathes
2. Repetitive trauma
3. Efforts at thumb motion + radial or ulnar deviation of the wrist ⬇ inflammation

Epidemiology
- The most common entrapment tendinitis in the wrist
- Trigger digit is the most common in hand and wrist (20 times more common)
- Mothers of infants aged 6-12 mo; repetitive lifting of the baby

Diagnosis:
Clinically:
- Symptoms:
  - Usually bilateral
  - Pain with thumb and wrist motion
  - Thickening at the radial styloid.
  - Crepitation or actual triggering rarely is noted.
- Signs:
  - Fusiform thickened over DC₁
  - Tenderness
  - +VE Finkelstein Test: thumb flex across palm + ulnar deviation → sharp pain at DC₁
  - Tenderness is absent over the muscle bellies proximal to the first dorsal compartment.
  - Tenderness is absent on axial loading at CMCJ unless the patient has arthritis

PXR
- It is not done for routine diagnosis of DeQuervain
- It is used to exclude cases of rhizarthrosis

[Image of de Quervain's tenosynovitis]
**DD:**

1. **RHIZARTHROSIS** ........................................ PXR
2. **INTERSECTION SYNDROME** ...................................... Friction tenosynovitis of DC₂ tendons
   - Friction between ECRL, ECRB & APL, EPB (DC₂ & DC₁ Tendons)
   - It is more common than DeQuervain especially in athletes and heavy lifters
   - Clinically: .......................................................... more prox tenderness + **Wet Leather** crepitus
   - ttt: ............................................................ usually by activity modification
3. **WARTENBERG** syndrome: ........................................ radial sensory n irritation
   - As it winds out from deep fascia beneath brachio-radialis, to be superficial to ECRL
   - Both tendons may act as scissors entrapping the n
   - Pain & paraesthesia over the distribution of RSN; Δ with hyperpronation + Tinel’s sign
   - ttt: treated by surgical release

**Treatment:**

**Medical therapy:**

1. Splinting of the thumb
2. Steroid Injection .................................................. 50% permanently relieves symptoms

**Surgical therapy:** ................................................. If injection therapy fails
- Under local or regional anesthesia + tourniquet
- A 3-cm transverse incision is preferred ............ better appearance of the scar
- Longitudinal blunt dissection is used ............. until the first dorsal compartment is exposed.
- Care should be carried not to injure the superficial radial nerve
- DC₁ is sharply opened longitudinally............... for 2 cm to release APL & EPB.
- If a septum is found in DC₁ bet APL & EPB ...... release it
- Tendon sheath; could be excised, even partially for the thickened part, or step cut reconstruction may be done for loose roof reconstruction, to prevent subluxation

**COMPLICATIONS**

1. Superficial radial nerve injury is the most irksome complication.
2. Persistent entrapment ................................. if APL slip is mistaken for EPB Δ will remain entrapped.
3. Subluxation of released tendons is possible.
ULNAR IMPACTION SYNDROME

Anatomy: ulnar variance
- Normally distal surfaces of radius & ulna are leveled & share in lunate support = neutral variance
- 80% of loads transmitted through radius
- 20% of loads transmitted through TFCC to ulnar head
- Short ulna is called ulna minus & long ulna is called ulna plus
- Pronation and power grip the variance (2mm variance → 40% loads)

Etiology:
1. Congenital
   a. Ulna plus
   b. Madelung’s deformity
2. Traumatic:
   a. Ulnar styloid fractures
   b. Radial mal union: e.g. Galiazzi #
   c. Distal radial physeal arrest
   d. Longitudinal Radio-Ulnar Dissociation LRUD:
      i. Essex-Lopresti lesion
      ii. Radial head Fracture & excision
3. Wrist arthrodesis

Pathologic types
1. Ulnar impaction syndrome +ve variance
2. Ulnar impingement syndrome -ve variance
3. Impaction 2ry ulnar styloid process nonunion
4. Ulnar styloid impaction long ulnar styloid
5. Hamato-lunate impingement ........ Type II lunate é hamate articulation → hamate malacia

Stages:
1. Central TFCC wear
2. Ulno-lunate chondromalacia
3. Perforated TFCC
4. Perforated luno-triquetral lig
5. Ulno-carpal OA

Diagnosis:
Clinically:
- Symptoms: Ulnar sided pain é pronation & gripping
- Signs: Tenderness é ulnar deviation & pronation
PXR:
- Detect cause: ulnar variance, mal-union, ...
- Detect complication, e.g. OA

Treatment:
1. Conservative: activity modification, NSAIDs, spints
2. Surgical:
   a. Corrective osteotomies
   b. Ulnar shortening
   c. Arthroscopic Wafer: debride central TFCC perforation
   d. Excision arthroplasty for terminal stage 5

Chronic DRUJ disorders
1. DRUJ chronic instability
2. Ulnocarpal impingement
3. DRUJ arthritis
**De Quervain's Syndrome**

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- The most common entrapment tendinitis in the wrist.
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  - Tenderness is absent over the muscle bellies proximal to the first dorsal compartment.
  - Tenderness is absent on axial loading at CMCJ unless the patient has arthritis.

**PXR**
- It is not done for routine diagnosis of DeQuervain.
- It is used to exclude cases of rhizarthrosis.
**Clinical**

**HISTORY:**
1. Fingers get in the way with:
   - washing face
   - combing hair
   - putting hand in pocket
   - putting hand in glove
   - racquet sports & golf
2. Palmar **Thick Nodule** that progress to the little and ring fingers
3. **Progressive Deformity** & palmar puckering
4. Dominance, Family history, DM, IHD, COAD, Epilepsy, Alcohol, ...
5. Other involvement

**EXAMINATION: same +**
1. Sites of nodules & cords
2. Sensibility & RSD
3. **MP Angle** - measure
4. **PIP Angle** - measure
5. **Table Top Test of Hueston** - place the hand & fingers prone on a table. Positive = hand won’t go flat. If negative surgery is not indicated.
6. **Knuckle Pad (Garrod)** - well-circumscribed firm dermal papules, nodules, or plaques approximately 0.5 - 3.0 cm in size, located on the extensor aspect of the PIP or MCP joints
7. Other fibromatoses; Peyronie, andLedderhose

**STAGING - Woodruff**

<table>
<thead>
<tr>
<th>STAGE</th>
<th>DESCRIPTION</th>
<th>MANAGEMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No contracture</td>
<td>Leave alone</td>
</tr>
<tr>
<td>2</td>
<td>One finger MP contracture</td>
<td>Surgery</td>
</tr>
<tr>
<td>3</td>
<td>One finger MP + PIP contracture</td>
<td>Surgery not easy</td>
</tr>
<tr>
<td>4</td>
<td>&gt; one finger MP + PIP</td>
<td>Surgery prolonged &amp; only partly successful</td>
</tr>
<tr>
<td>5</td>
<td>Finger-in-palm deformity</td>
<td>consider amputation</td>
</tr>
</tbody>
</table>

**Surgery**

**INDICATIONS**
1. No absolute indications
2. Patient is incapacitated by the contracture.
3. Tabletop test of Hueston = Patient unable to place hand flat on table due to contractures.
4. Patient is understanding that it:
   - Recurs
   - Complications; CRPS, stiffness
   - May leave painful scar
   - <30° contractures needs no surgery
   - MP are better than PIP
   - Needs rehabilitation

**AIMS**
1. Excise the diseased fascia
2. Release digital contractures
3. Retain full flexion of the digits
4. Preserve neurovascular structures

**Dupuytren's Diathesis** = ↑ recurrence
1. young
2. male
3. family history
4. bilateral
5. fibromatosis elsewhere
Technique

<table>
<thead>
<tr>
<th>INCISION</th>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-Transverse midpalm</td>
<td>for pretendinous band</td>
<td>Requires frequent dressings &amp; cooperation post-op.</td>
</tr>
<tr>
<td></td>
<td>- Left open (McCASH technique)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Full thickness graft (HUESTON)</td>
<td></td>
</tr>
<tr>
<td>2-Bruner’s zig-zag</td>
<td>Good exposure</td>
<td>Difficult to raise flaps if thin skin</td>
</tr>
<tr>
<td></td>
<td></td>
<td>♦ NVB damage</td>
</tr>
<tr>
<td></td>
<td></td>
<td>♦ scarring at sides &amp; base</td>
</tr>
<tr>
<td>3-Longit., Z-plasties</td>
<td>Good exposure, ♦ damaging NVB</td>
<td>Difficult to match incision in 2 finger disease</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PROCEDURE</th>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-Fasciotomy</td>
<td>Elderly ≈ MCP contracture mainly</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Severe contracture ≈ bad skin</td>
<td></td>
</tr>
<tr>
<td>2-Partial Fasciectomy</td>
<td>Removes the nodules only</td>
<td>Impossible to remove all fascia,</td>
</tr>
<tr>
<td>(SKOOG)</td>
<td>Most commonly performed</td>
<td>Recurrence,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Swelling &amp; joint stiffness.</td>
</tr>
<tr>
<td>3-Total Fasciectomy</td>
<td>Removes most of the fascia</td>
<td></td>
</tr>
<tr>
<td>(MCNDOE)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4-Dermofasciectomy</td>
<td>For Dupuytren’s &amp; recurrence</td>
<td></td>
</tr>
<tr>
<td>(HUGSTON)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5-External Fixator</td>
<td>Gentle correction for 2wks. Then</td>
<td></td>
</tr>
<tr>
<td>(MESSINA)</td>
<td>surgical release; under distraction</td>
<td></td>
</tr>
<tr>
<td></td>
<td>the disease seems to regress!</td>
<td></td>
</tr>
<tr>
<td>6-Amputation</td>
<td>4 finger-in-palm ≈ macerated skin</td>
<td>neuromas, biomechanical</td>
</tr>
</tbody>
</table>

POST-OPERATIVE CARE

- Splint hand with comfortably extended wrist & fingers
- Check wounds at 48hrs. & apply Thermoplastic splint esp for McCash open palm.
- Hand therapy & scar care continue for 3 months
- Night splint for 6 months.

COMPLICATIONS

1. Digital nerve division
2. Ischaemic digit
3. Haematoma
4. Infection (early debridement)
5. Skin necrosis
6. Scar contracture
7. Joint stiffness
8. CRPS
9. Zry CTS & trigger finger
10. Recurrent disease

PIP Joint Release:

- Never perform volar plate capsulectomy, since it can cause stiffness
- Preferred method =
  1. Release Cleland’s ligaments
  2. Release the fibrous flexor sheath
  3. Release the check-rein ligaments of the volar plate
  4. Release the lateral bands of the extensor mechanism (so it shifts dorsally)
  5. Can use a percut. transarticular K-wire for 7-10days.
  6. For a severe flexion contracture consider arthrodesis with digital shortening.
Thoracic Outlet Syndrome

- It is a group of manifestation related to impingement of subclavian v, and lower trunk (C8/T1) of brachial plexus
- Boundaries: scalenus anterior and medius, and the 1st rib
- Age 18-40 (never before puberty rare after 50yr)

**Aetiology:**
1. Cervical rib ...................................... 10% will have TOS
2. Fibrous bands
3. Scaleneus anterior constriction
4. Clavicular fractures & AC dislocation grade 6
5. Pancoast tumour
6. In some cases, it is accentuated by recurrent anterior shoulder instability, µıs → Dead Arm $$

**Examination:**
1. Tenderness or mass in supra-clavicular fossa
2. Lower trunk C8/T1 manifestation:
   o Sensory changes in the ring and little finger
   o Intrinsic weakness
3. Vascular Examination
   o Radial pulse obliteration is not itself specific, but loss of pulse with reproduction of symptoms is a positive test

**Provocative Tests**

1. **Adson’s Test**
   - Arm of the affected side adducted with forearm supinated
   - Turn head toward the affected side
   - Extend neck and hold breath
   - Positive test is obliteration of the radial pulse

2. **Reverse Adson’s Test**
   - As above but head turned away from the affected side

3. **Wright’s Test (Hyperabduction stress test)**
   - Axillary vessels and plexus bent 90° at the junction of the glenoid and humeral head
   - Place extremity in full abduction, external rotation and reach back as far possible. Turn head away and check for decrease or loss of radial pulse
   - Creation of a bruit in the supraclavicular area is further evidence

4. **Roos**
   - Overhead exercise test
   - Above head repeated forearm exercise may reproduce symptoms

**Investigations:**

1. X-ray - Cervical ribs may be seen but more commonly the cause is a fibrous band which will not show up on X-rays
2. CXR to rule out pancoast tumour
3. MR scan to exclude cervical disc disease

**Treatment**

1. **Non-Operative** (for at least 4 months)
   - Postural re-education
   - Activity modification
   - Weight loss

2. **Operative** (rarely required)
   - Excision of first rib with fibrous band and anterior scalene muscle via supra-clavicular, subclavicular or axillary approach
CHRONIC WRIST PAIN

DIFFERENTIAL DIAGNOSIS:

<table>
<thead>
<tr>
<th>Location</th>
<th>Cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radial</td>
<td>1]. De Quervain's tenosynovitis</td>
</tr>
<tr>
<td></td>
<td>2]. Rhizarthrosis</td>
</tr>
<tr>
<td></td>
<td>3]. Intersection $</td>
</tr>
<tr>
<td></td>
<td>4]. Wartenberg $</td>
</tr>
<tr>
<td></td>
<td>5]. Scaphoid non-union</td>
</tr>
<tr>
<td></td>
<td>6]. ganglion</td>
</tr>
<tr>
<td>Dorsal/ Central</td>
<td>1]. SL dissociation</td>
</tr>
<tr>
<td></td>
<td>2]. SLAC</td>
</tr>
<tr>
<td></td>
<td>3]. SNAC</td>
</tr>
<tr>
<td></td>
<td>4]. Intra-osseous ganglion</td>
</tr>
<tr>
<td></td>
<td>5]. Ganglion</td>
</tr>
<tr>
<td></td>
<td>6]. Keinbock's disease</td>
</tr>
<tr>
<td>Ulnar</td>
<td>Dorsal Zone</td>
</tr>
<tr>
<td></td>
<td>1]. Traumatic:</td>
</tr>
<tr>
<td></td>
<td>a. Fractures: hook of hamate</td>
</tr>
<tr>
<td></td>
<td>b. Carpal instability: CID, CIA</td>
</tr>
<tr>
<td></td>
<td>c. DRUJ instability</td>
</tr>
<tr>
<td></td>
<td>d. TFCC tears</td>
</tr>
<tr>
<td></td>
<td>e. ECU subluxation</td>
</tr>
<tr>
<td></td>
<td>2]. Inflammatory:</td>
</tr>
<tr>
<td></td>
<td>a. DRUJ OA</td>
</tr>
<tr>
<td></td>
<td>b. Ulno-carpal OA</td>
</tr>
<tr>
<td></td>
<td>a. CMC OA</td>
</tr>
<tr>
<td></td>
<td>3]. Tumors:</td>
</tr>
<tr>
<td></td>
<td>b. Ganglion</td>
</tr>
<tr>
<td></td>
<td>c. Intraosseous ganglion</td>
</tr>
<tr>
<td></td>
<td>4]. Vascular:</td>
</tr>
<tr>
<td></td>
<td>f. Kienböck</td>
</tr>
<tr>
<td></td>
<td>g. AVN capitate</td>
</tr>
<tr>
<td></td>
<td>5]. Miscellaneous:</td>
</tr>
<tr>
<td></td>
<td>h. Ulnar abutment syndromes</td>
</tr>
<tr>
<td>Volar zone</td>
<td>1]. Traumatic:</td>
</tr>
<tr>
<td></td>
<td>a. Fractures: piso-triquetal</td>
</tr>
<tr>
<td></td>
<td>b. DRUJ volar dislocation</td>
</tr>
<tr>
<td></td>
<td>2]. Inflammatory:</td>
</tr>
<tr>
<td></td>
<td>c. Piso-triquetal OA</td>
</tr>
<tr>
<td></td>
<td>d. FCU tendinitis</td>
</tr>
<tr>
<td></td>
<td>3]. Tumors: Ganglion</td>
</tr>
<tr>
<td></td>
<td>4]. Miscellaneous:</td>
</tr>
<tr>
<td></td>
<td>e. Guyon's Canal $</td>
</tr>
</tbody>
</table>
Tourniquets

The use of a bloodless field is an integral part of much limb surgery, but may have become a ritual.

Application

- Application of a pneumatic tourniquet should be performed by experienced personnel who possess a good knowledge of its use and potential complications.
- Relative contraindications are sickle cell disease, peripheral vascular disease, prosthetic vascular graft or extensive soft tissue injury.
- The tourniquet should be tested by inflation, and then completely deflated, prior to limb application. To apply the tourniquet, the limb is exsanguinated, either by elevation for 3 to 5 minutes, or by applying a soft rubber compression bandage.
- The tourniquet should be padded with a soft dressing to prevent the wrinkles and blisters that may occur when the skin is pinched. It should be applied to the upper arm or thigh where there are adequate muscle envelopes to protect invested nerves from compression.
- Following tourniquet application, inflation should be rapid to prevent filling of the superficial veins before arterial occlusion.
- Deflation prior to wound closure allows identification and coagulation of major bleeding vessels.

Inflation pressure

- The ideal pressure to which the tourniquet should be inflated is unknown. It depends on the patient’s age, blood pressure and extremity size.
- On conical extremities, for example in very muscular or obese individuals, curved cuffs are ideal because they require significantly lower arterial occlusion pressures than straight (rectangular) cuffs.
- In addition, wider cuffs are more effective at lower inflation pressures than are narrower ones.
- Several methods are proposed for the determination of optimal inflation pressure for extremity surgery.

### Methods used in determining pneumatic tourniquet inflation pressure

1. Add 50-75 mm Hg above the systolic by Doppler stethoscope, to allow for collateral circulation
2. Add 90-100 mm Hg to the preoperative arm blood pressure for lower limb surgery
3. Add 50-75 mm Hg / 100-150 mm Hg above the systolic pressure for UL / LL surgery, respectively.

Post-tourniquet syndrome pathology

- Interruption of blood supply leads to tissue hypoxia, metabolic derangement and ultimately, cell death.
- Cellular hypoxia results in anaerobic metabolism and lactic acidosis.
- Depletion of high-energy phosphate occurs with subsequent loss of physiological ion gradients cross the cell membrane due to impaired sodium pump activity.
- Prolonged tissue ischaemia ultimately leads to cell necrosis.

### Pathophysiological consequences of tourniquet ischaemia

1. Tissue hypoxia & acidosis
2. Blood coagulation changes
3. Capillary permeability
4. Depletion of muscle ATP
5. Muscle necrosis

### Post-tourniquet syndrome picture:

#### Features of post-tourniquet syndrome

1. Edema
2. Stiffness
3. Pallor
4. Weakness without paralysis
5. Subjective numbness of extremity without anaesthesia

- The post-tourniquet $ is common but concealed with casts and splints
- Usually resolves within one week, though the recovery period may be prolonged.
**Tourniquet-application time**
- Two hours is considered safe for human upper limb surgery; otherwise sCPK ↑ and damage the ms
- Limiting tourniquet application to one and one-half hours avoids skeletal muscle ischaemic injury.
- Short periods of ischaemia followed by reperfusion (ischaemic preconditioning) renders cardiac muscle more resistant to a subsequent ischaemic episodes

**Complications**

<table>
<thead>
<tr>
<th>Complications of pneumatic tourniquets</th>
<th>Systemic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local</td>
<td>Systemic</td>
</tr>
<tr>
<td>1. Compression neuropraxia</td>
<td>1. Cardiorespiratory decompensation</td>
</tr>
<tr>
<td>2. Bone and soft-tissue necrosis</td>
<td>2. Increased CVP</td>
</tr>
<tr>
<td>3. Direct vascular injury</td>
<td>3. DVT</td>
</tr>
<tr>
<td>4. Postoperative swelling and stiffness</td>
<td>4. Cerebral infarction</td>
</tr>
<tr>
<td>5. Delay in recovery of muscle power</td>
<td>5. Alterations in acid-base balance</td>
</tr>
<tr>
<td>7. Wound infection</td>
<td></td>
</tr>
</tbody>
</table>

**Avoiding pneumatic tourniquet complications**

**Measures to avoid pneumatic tourniquet complications**

1. Use of a wide low-pressure tourniquet cuff
2. Anticoagulant prophylaxis
3. Juxtaposition of two tourniquets
4. Ensuring good padding beneath the tourniquet
5. Any solution applied to the skin must not be allowed to run beneath the tourniquet
6. Careful perioperative haemodynamic monitoring of patients with poor cardiopulmonary reserve
7. Regional hypothermia by cooling the extremity

**Portals:**

**Indications:**
1. Diagnostic for unexplained pain
2. TFCC tears
3. Chondral lesion debriddment
4. Arthroscopic assisted intra-articular #
5. Synovectomy
6. Loose body removal
**Wrist Arthroplasty**

**Rationale:**
1. Improve function till 50% of normal
2. Best for dominant side
3. Best for certain recreational jobs as musicians, surgeons, artists
4. Other laborer jobs are better treated with fusion
5. 15 y follow up has been reached

**Indications:**
1. Severe arthritis; OA, RA
2. Incapacitating pain

**Types:**
1. Capitate resurfacing after proximal row carpectomy OA
2. Silicon spacers severe reactive synovitis
3. Total wrist replacement

**Total wrist design**
1. Radial component
2. CMC component: either stemmed or fixed by screws
3. PE spacer between the two components: either fits on the distal or proximal component

**Operative details:**
- Dorsal wrist approach is used
- Transect the dorsal carpal lig from its ulnar side
- Proximal row carpectomy + total synovectomy + excision of all the pannus
- Radial cut is done + trim the end of the ulna to the same level
- Capitate cut is done; through reaming of MC3
- If tight ulnar side (radial deviation); release the FCU & ECU & ulnar capsule
- Insert cement by a syringe
- Insert the distal segment first then the proximal
- Reduce the prosthesis and hold it till the cement sets

**Complications:**
1. Loosening
2. Infection
3. Neuro-vascular injury