The anatomy, examination and management of injuries of the flexor tendons

Alan Cooney

Northern Deanery Registrar Teaching

Introduction

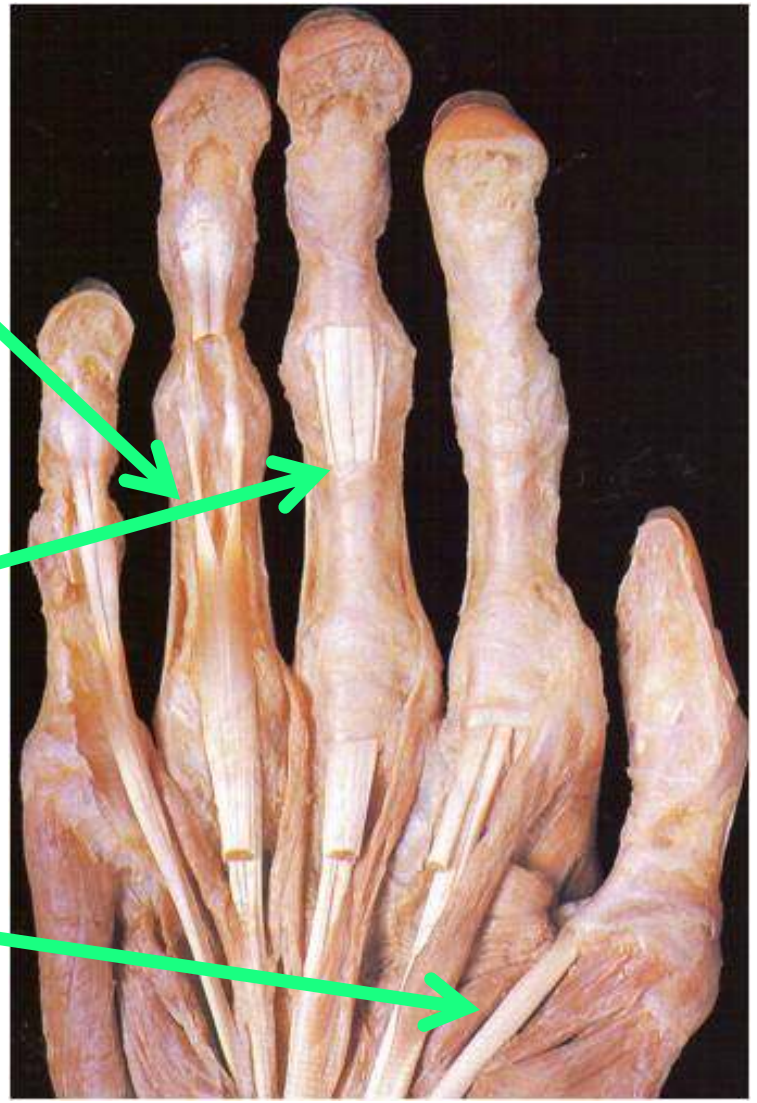
- Anatomy
- Examination
- Management
  - Basic principles
  - Partial lacerations
  - Primary repair
  - Thumb
  - Secondary repair/reconstruction

Tendon anatomy

- 9 long flexors
- Pass through carpal tunnel
- Flexor digitorum superficialis paired
  - Middle and ring volar
  - Index and little dorsal

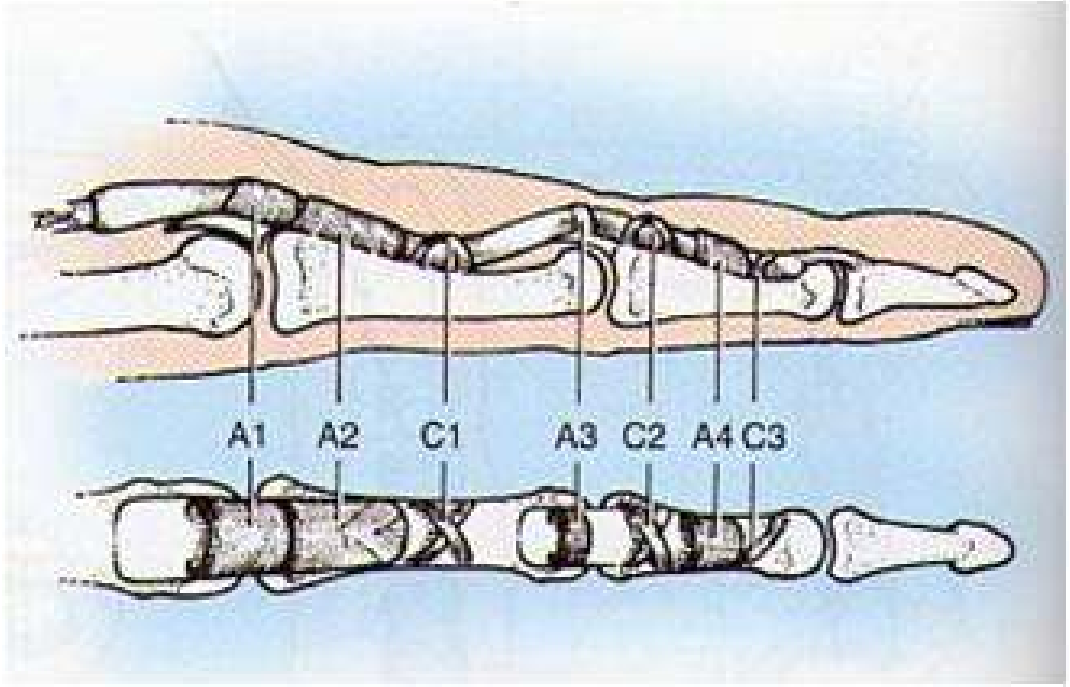
Anatomy

- Flexor digitorum superficialis (FDS)
  - Divides at base proximal phalynx
  - Inserts mid-portion middle phalynx
- Flexor digitorum profundus (FDP)
  - Pass through the division in FDS
  - Inserts into base terminal phalynx
- Flexor pollicis longus (FPL)
  - Also passes through carpal tunnel
  - Inserts base terminal phalynx



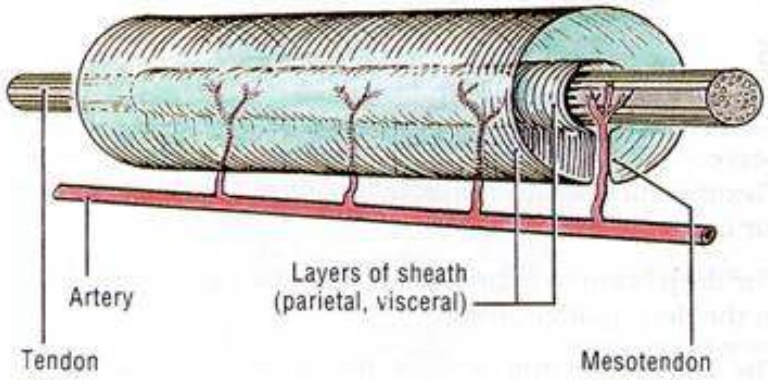
Anatomy

- Fibro-osseous canals
  - Pulleys
    - A1-5
    - C1-3

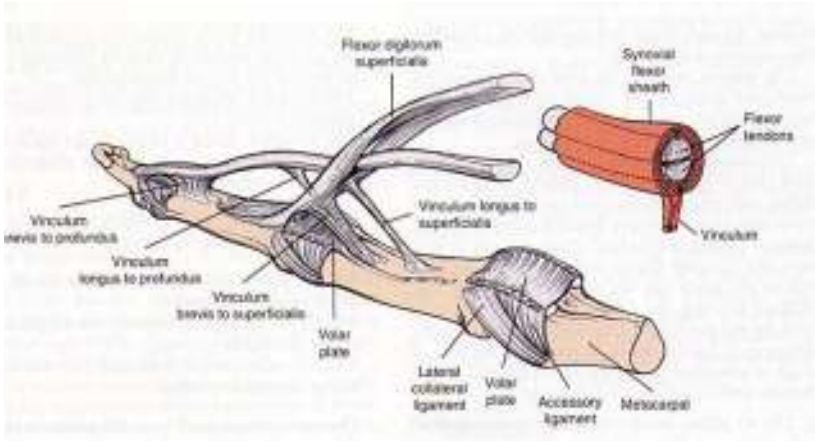


Anatomy

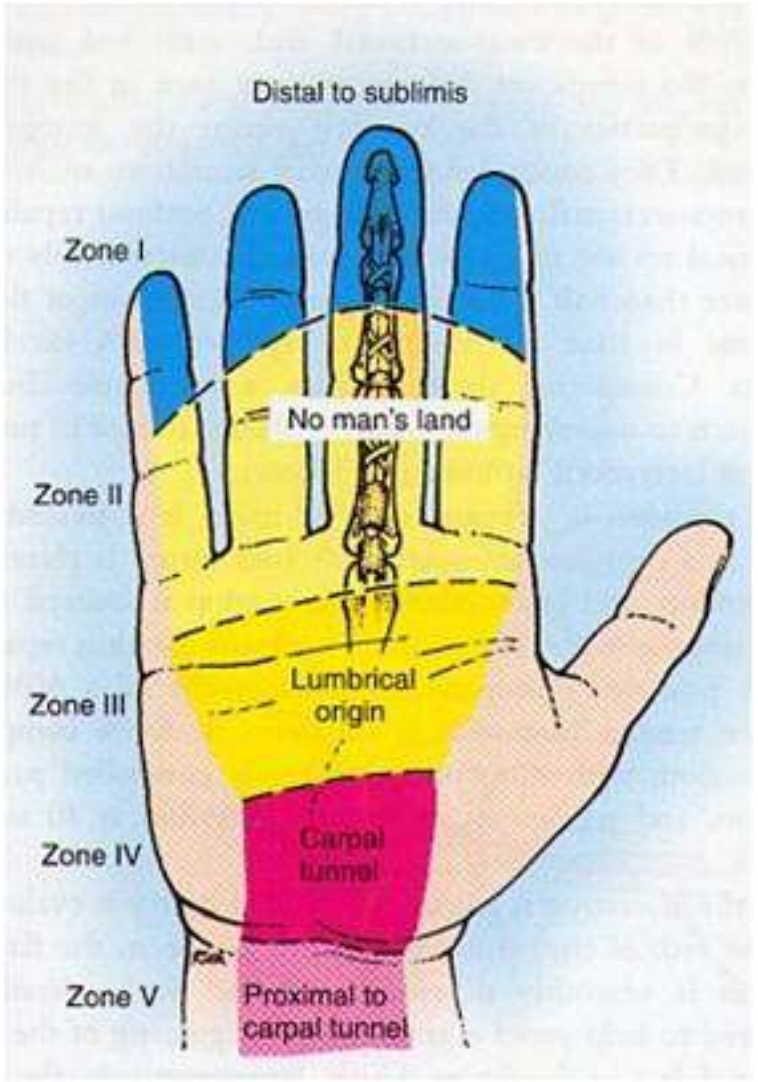
- Synovial sheath

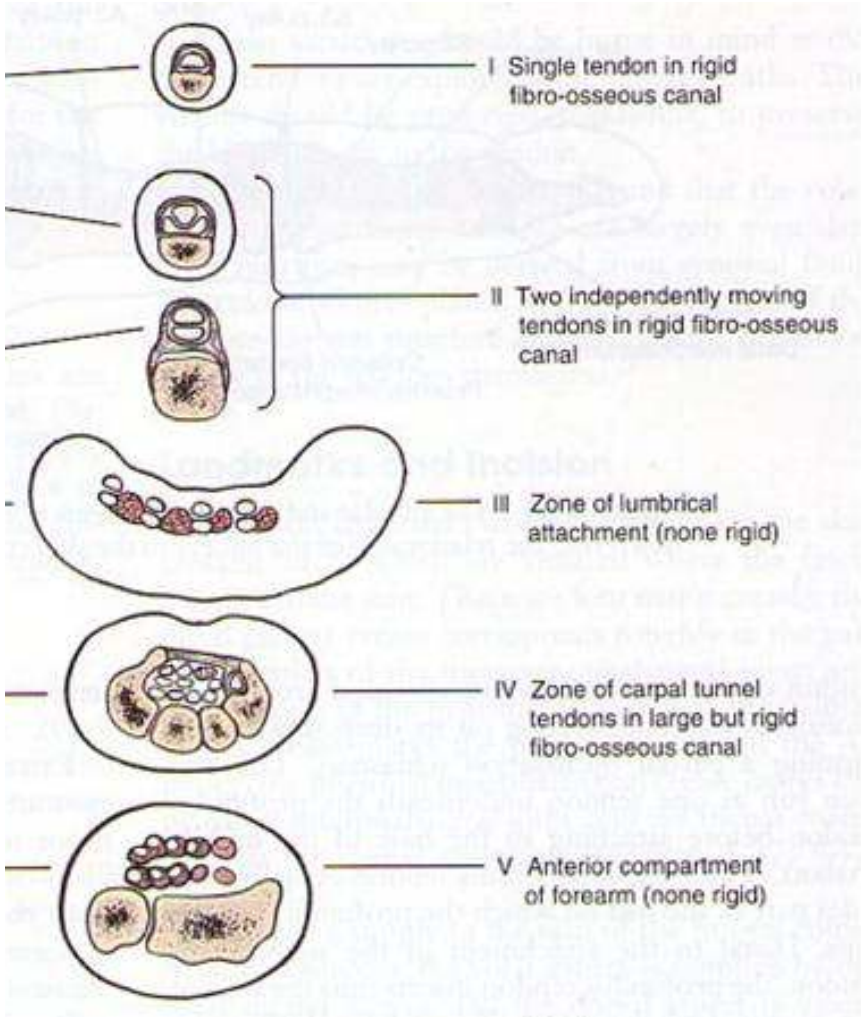


- Connected by *vincula*



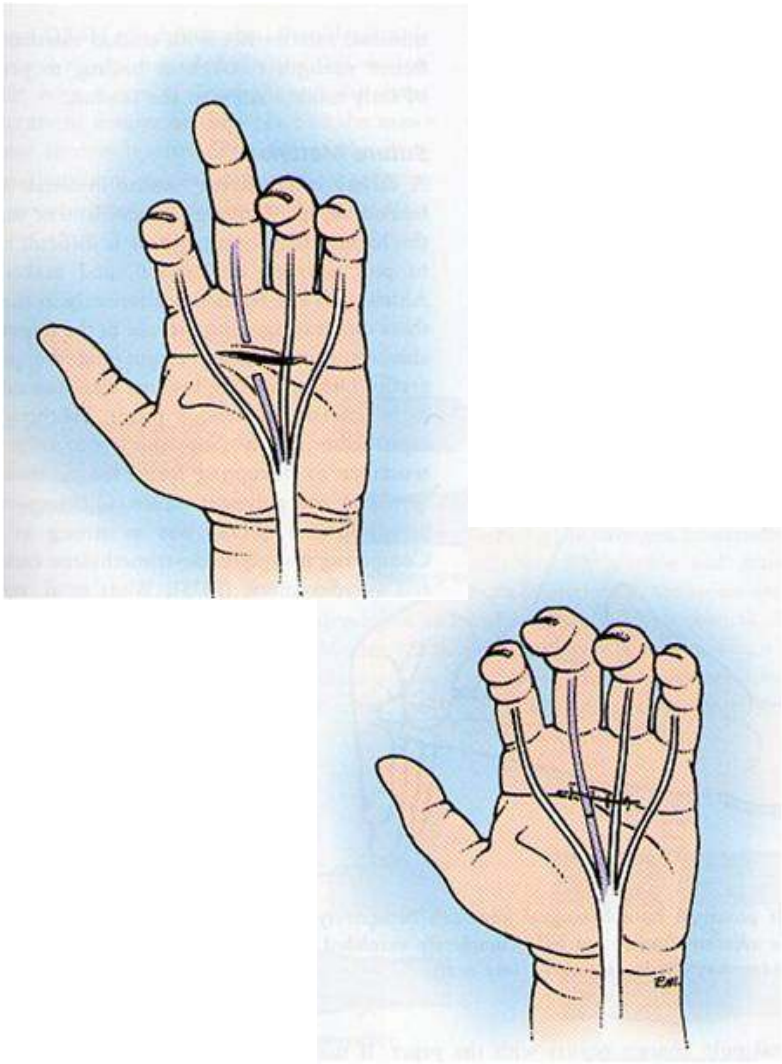
Anatomy – Zones (Verdan)[1]





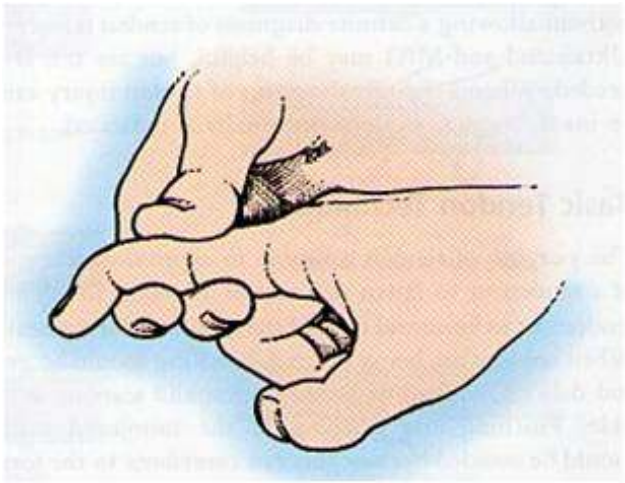
Examination

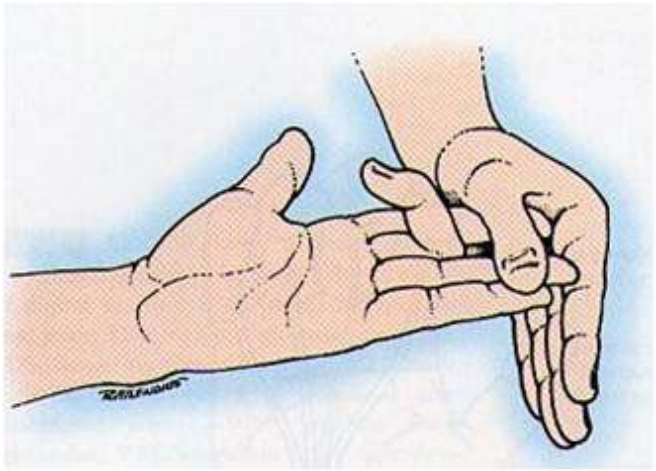
- Neurovascular status
- Posture of the hand
  - "the finger points the way"
- Passive extension of the wrist
- Compression forearm muscle mass



Examination

- Active
  - FDP
    - Stabilise PIPJ
  - FDS
    - Maintain adjacent fingers in extension
    - Exception can be index finger
    - Lister – pinch a piece of paper
  - FPL
    - Stabilise MCPJ





Examination pitfalls

- Unreliable uncooperative patients/children
- In wrist injuries, finger flexion may still be possible
- Partially divided tendons usually functional
- When definitive diagnosis cannot be made…

Surgical exploration

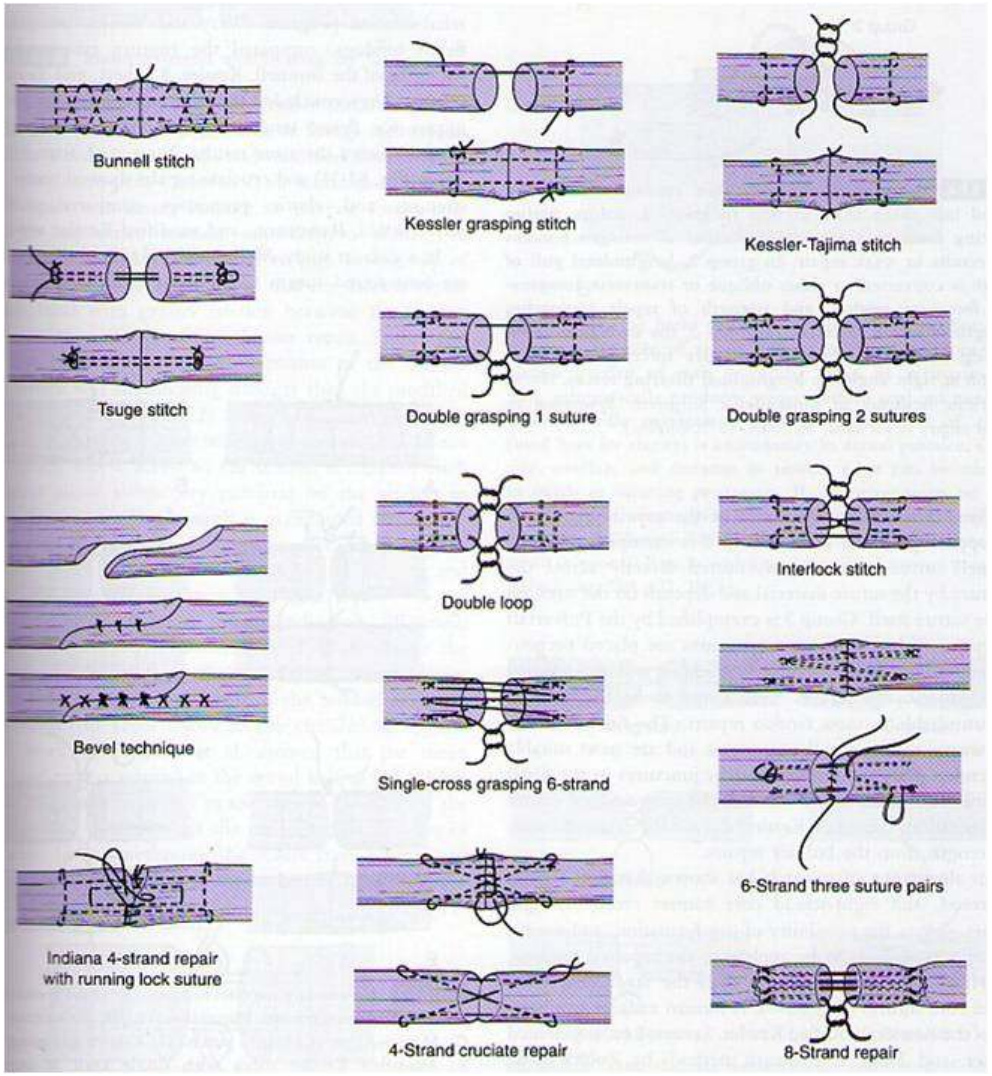
Basic principles

- Approximate ends and hold whilst healing takes place
- Gentle tissue handling
- Strickland
  1. Easy placement of sutures
  2. Secure knots
  3. Smooth juncture of ends
  4. Minimal gaping at repair
  5. Minimal interference with vascularity
  6. Sufficient strength to promote early motion

Suture configurations

- Lots!

- Core suture
- Circumferential suture



Suture material

- Non-absorbable suture
  - PDS, prolene, tycron
  - Not nylon as earlier gap formation[2]

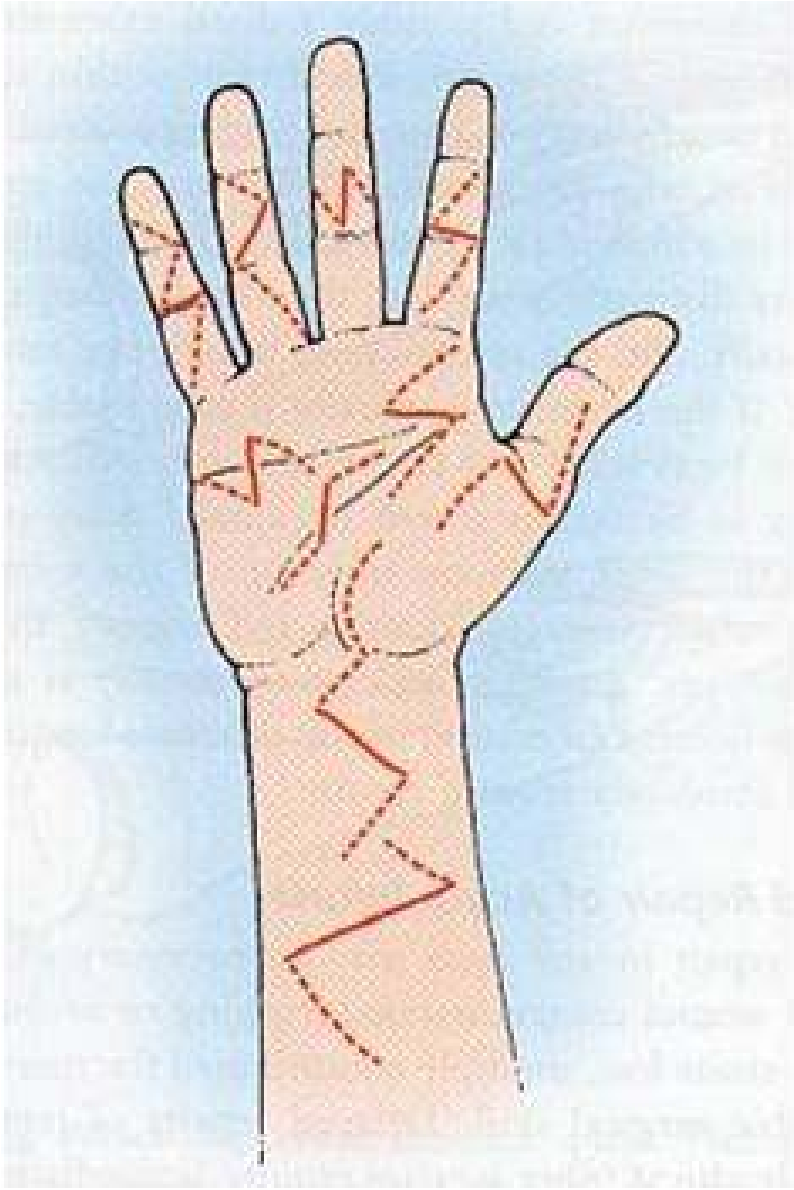
- Suture size
  - 3-0 forearm, palm, large digits
  - 4-0 smaller digits
  - 5-0/6-0 for circumferential suture

Timing of repair

- Primary
  - <12 hrs, can be extended to 24hrs
  - Clean wound, neurovascular injury repaired and # stabilised
- Delayed primary
  - Up to 10 days
- Secondary
  - >10-14 days
  - Crush injuries, bony comminution, severe neurovascular/joint injury, skin loss, reconstruction of pulleys

Exposure

- Extend/additional incisions
  - Avoid crossing flexor creases
  - Usually need more exposure proximally

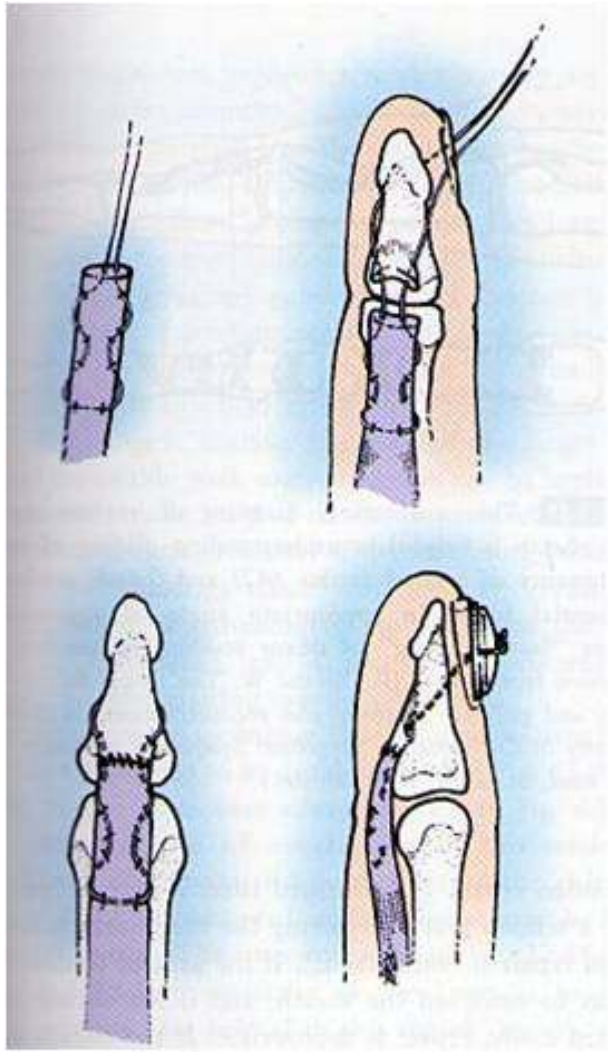


Partial lacerations

- >60% treat as complete transection
- <60%
  - Evaluate risk of triggering
    - Debride tendon
    - Repair flexor sheath

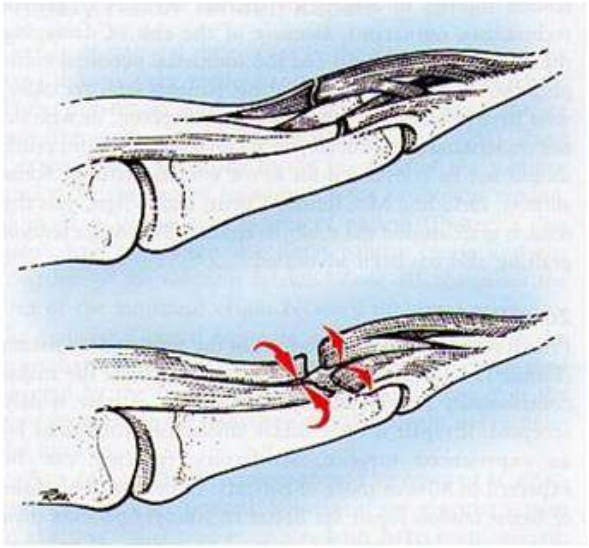
Primary repair – Zone I

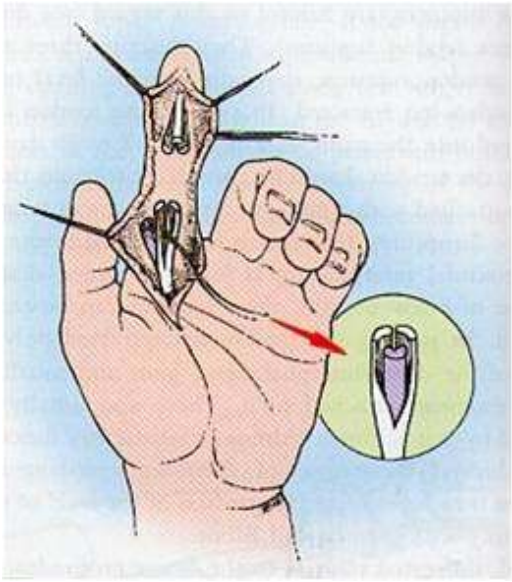
- Direct suture to distal stump
- Advancement and direct insertion to distal phalynx if less than 1cm
  - Care to avoid flexed posture
  - Can lengthen tendon at wrist or consider grafting
  - Pull out wire technique



Zone II – Bunnell's "No man's land"

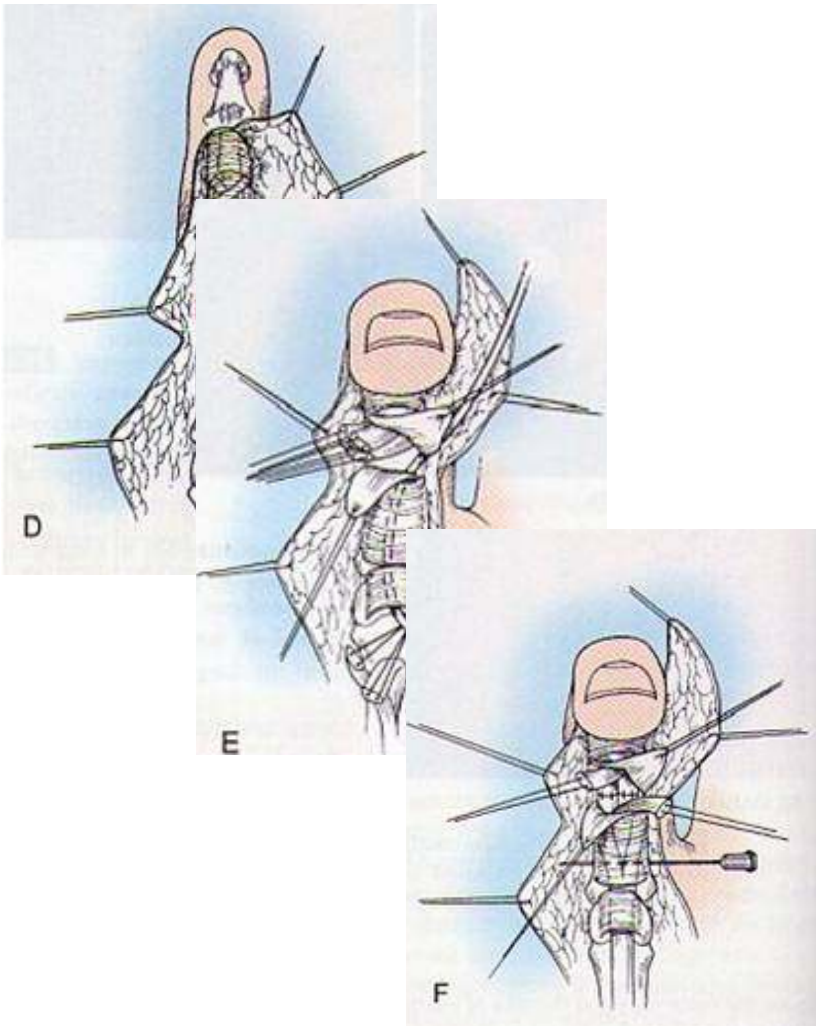
- Primary repair traditionally controversial
- Technically demanding
  - Orientation of FDP within FDS slips
  - Attachment of FDS slips in thin flat area
  - Flexor sheath, preserving A2 & A4 pulleys
  - If retracted, correctly position FDP before passing tendons distally
  - Timing of repair
- Better outcome in primary repair[3]





Zone II

- Identify tendon ends
- Open sheath at C pulleys
  - L-shaped opening allows closure
  - Z lengthening, particularly if delayed
- Deliver proximal tendon end
  - Transverse incision at distal palmer crease if in palm
  - If difficult, can use plastic tubing to lead the FDP
- Secure tendon in sheath with a needle



Zone II

- Core suture, 2 or more strands, buried knots
- Circumferential suture – smooth repair
- FDS before FDP
- Repair sheath with 5-0 or 6-0 non-absorbable suture

Zone III

- Usually primary repair
- If not possible, suture tendons to fascia to prevent retraction
- Do not repair lumbricals as can cause “lumbrical plus” finger

Zone IV

- Usually primary repair
- May need to release the transverse carpal ligament
  - Can be risk of bowstringing
    - Repair (Z-lengthening)
    - Avoid wrist flexion beyond neutral

Zone V

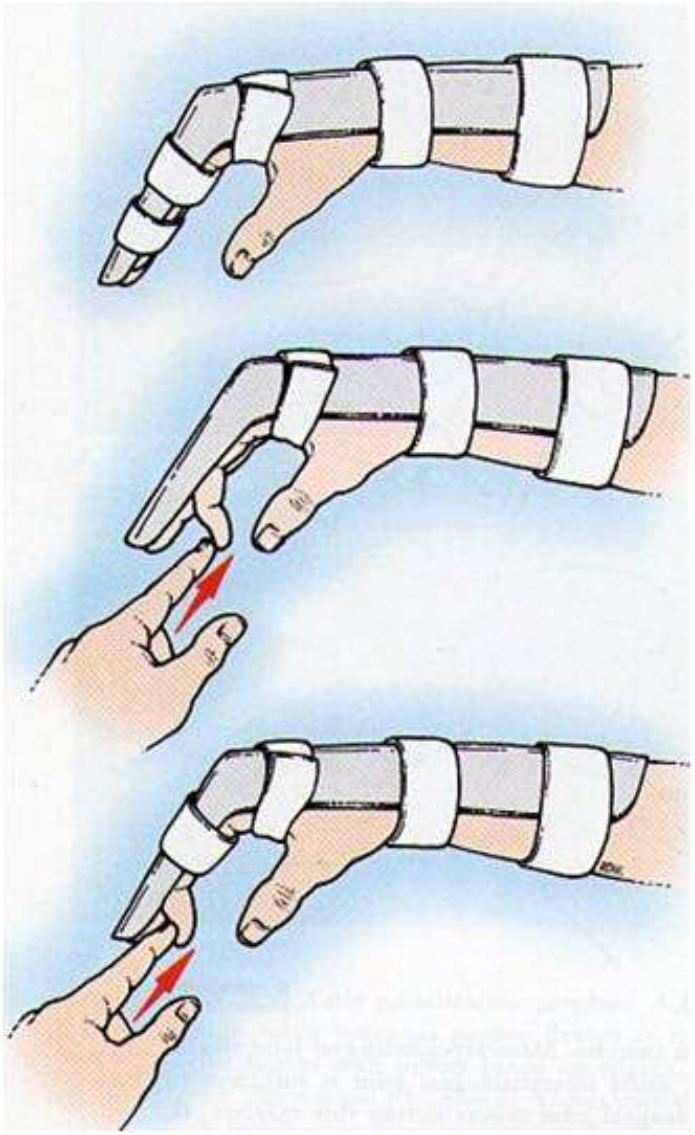
- Usually primary repair
- Tendon gliding not usually a problem
- Isolated palmaris longus injury does not usually require repair

Splintage

- Wrist 45-50º flexion
- MCPJ 50-60º flexion
- IPJs extended

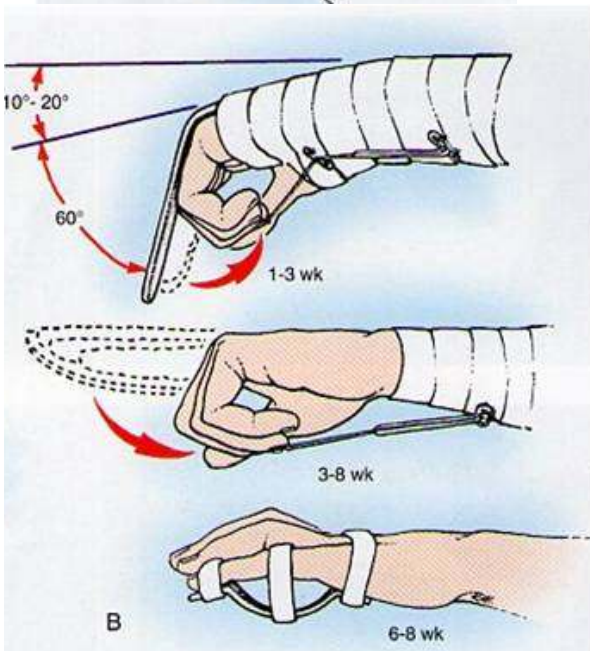
Aftercare

- Controlled passive motion with dorsal blocking
  - Dorsal splint 3-4 weeks
  - Movement of finger tip to create 3-5mm tendon excursion
  - Start day 1 post op
  - Repetitions of PIP and DIPJ flexion/extension



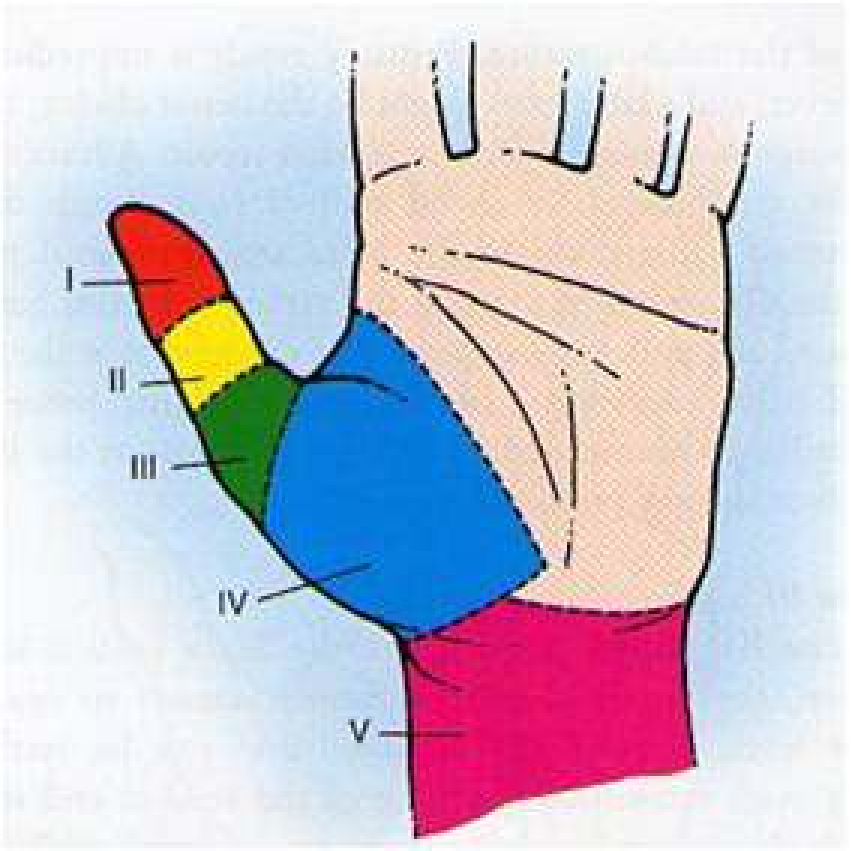
Aftercare

- Active finger extension and passive finger flexion
  - Suture/hook to finger nail with elastic band
  - Elastic band under a roller, secured at distal forearm
  - Can start 1st post op day
  - Splint removed after 3 weeks
  - Further 3 weeks with elastic band
  - Consider night splintage
  - Strengthening 8-12 weeks



The thumb

- Also divided into zones
- Repair as other tendons
- Zone II
  - Often better with delayed graft
- Zone III
  - Often retracted
  - Can make an incision at wrist



Secondary repair and reconstruction

- After 10-14 days
- Techniques
  - Direct suture
  - Tendon graft
    - 1 or 2 stage
  - Tendon transfer
- Requirements
  - Healthy wound
  - Adequate skin coverage
  - Tissues which tendon passes free of scar
  - Bony alignment
  - Joints good range passive movement
  - Undamaged or restored sensation

Secondary repair and reconstruction

- Zone I
  - Can advance if less than 1cm
  - Can be difficult/impossible to thread FDP through FDS – graft, but unpredictable
  - Take into account occupation/age/finger involved
- Zone II
  - FDS only, repair usually not necessary
  - FDP only, direct repair usually unsuccessful
    - Tenodesis or arthrodesis
  - Both tendons, single stage graft

Secondary repair and reconstruction

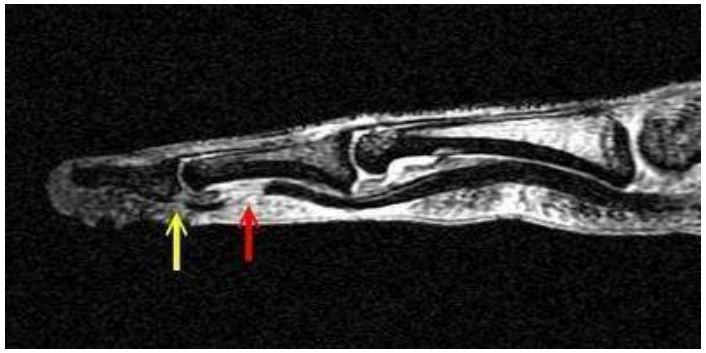
- Zone III, IV & V
  - Usually direct suture
    - Flexing wrist to overcome muscle retraction
  - If after 4-5 weeks, graft may be necessary
  - If tendons destroyed, FDP has priority

Tendon graft

- Palmaris longus
  - Tendon of choice
    - Similar length, diameter
    - Easily accessible
    - Absent ~ 15% of the population
- Plantaris
  - Twice as long but not as accessible
- Long extensors of toes

Complications

- Adhesions
  - Tenolysis 18-25%
    - When patient has reached a plateau
    - Wounds supple and flexible
    - Fractures healed
    - No joint contractures
  - Usually 5-6 months after repair
- Adherence to bone
  - Loss of active and passive movements
  - Can take down and insert silastic sheet
- Post repair rupture
  - Reasonable results with direct repair if diagnosed early[4]
  - MRI useful to differentiate from adhesions



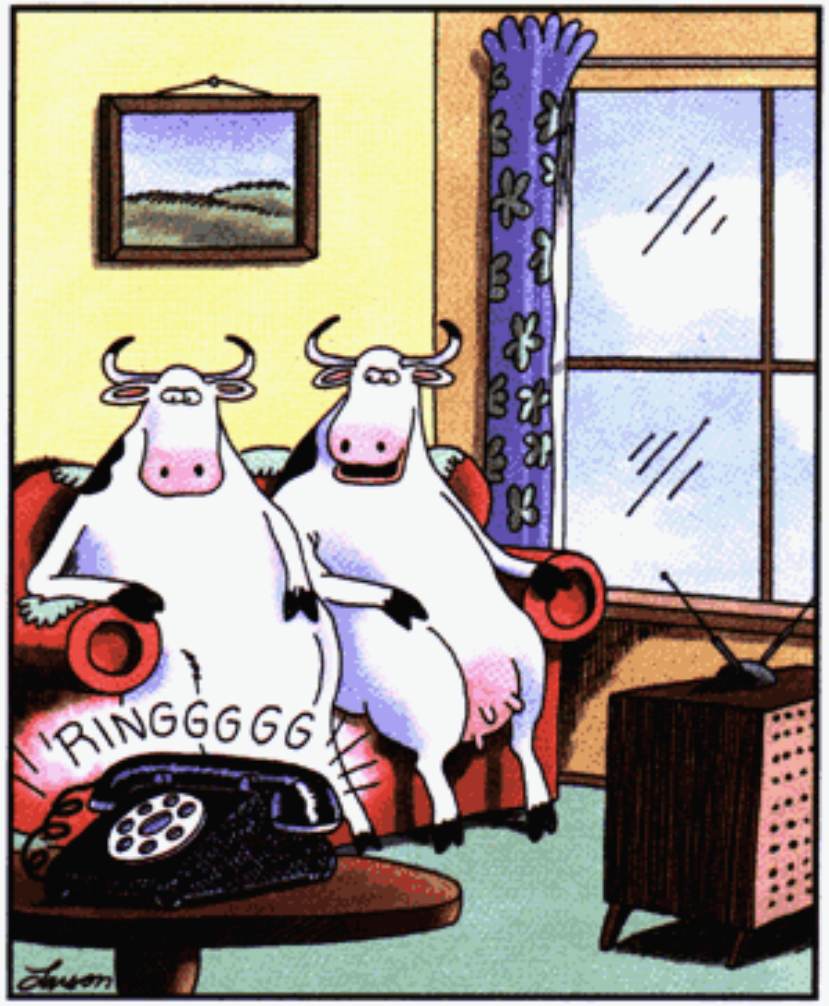
Complications

- "Lumbrical plus" finger
  - Tendon graft too long
  - Can transect involved lumbrical
- "Quadriga" effect
  - Graft tension too tight
  - Reaches palm before the other fingers

Conclusion

- Intricate relationship of FDS and FDP tendons
- If doubt with clinical examination – explore
- Treatment will depend on
  - Zone of injury,
  - Associated injuries to the surrounding area
  - Patient factors
- Technically challenging
- Experienced surgeon

Questions?



"Well, there it goes again. … And here we sit without opposable thumbs."

References

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