FLEXOR TENDON INJURIES
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“No Man’s Land”
Bunnell
Anatomy

• Early in the flexor sheath, the FDS divides and passes around the FDP tendon, the two portions of the FDS reunite at "Camper’s Chiasma"
Anatomy

- FDS tendons usually arise from single muscle bundles and act independently.
- There is often a common muscle origin for several FDP tendons with the result that there is simultaneous flexion of multiple digits.
Blood Supply

• From segmental branches of the paired digital arteries which enter the tendon through:
  – long and short vincula
  – at the osseous insertions

• Synovial fluid diffusion
Up to 9 cm of flexor tendon excursion may be required to produce composite wrist and digital flexion, while only 2.5 cm of excursion is required for full digital flexion with the wrist stabilized in neutral position.
Flexor tendon healing

• 2 forms:
  – **Intrinsic healing**: occurs without direct blood flow to the tendon
  – **Extrinsic healing**: occurs by proliferation of fibroblasts from the peripheral epitendon; adhesions occur because of extrinsic healing of the tendon and limit tendon gliding within fibrous synovial sheaths
Phases of Intrinsic healing

1. Inflammatory (0-5 days) : strength of the repair is reliant on the strength of the suture itself
2. Fibroblastic (5-28 days) : or so-called collagen-producing phase
3. Remodelling (>28 days)
Loss of strength after repair

Days

Bunnell

Kessler

Bunnell

Modified Kessler (2 sutures)
Adhesions formation

- Healing that is largely based on intrinsic cellular activity will result in fewer, less dense adhesions.
- Factors that influence the formation of adhesions:
  - Trauma to the tendon and its sheath from the initial injury and reparative surgery
  - Ischemia
  - Tendon immobilization
  - Gapping at the repair site
  - Sheath resection
Diagnosis

- Alteration in the normal resting posture of the fingers
- Functional tests of FDS and FDP
- Lacerations on the palmar aspect of the fingers almost always injure the FD before FDS
- A careful sensory evaluation is mandatory
Preoperative planning

- Severed flexor tendon ends will retract well away from the laceration site, esp. when the digit is in flexion at the time of injury
Flexor tendon repair
Contraindications of primary repair

- When there are severe multiple tissue injuries to the involved fingers or palm
- When the wounds are badly contaminated by potentially infecting materials
- When there has been significant skin loss over the flexor system
- Inability of patient to cooperate with rehabilitation
Cont’ Contraindications of primary repair

• Concomitant fractures or neurovascular injuries are NOT necessarily C/I to primary or delayed primary repair
Facts

- Flexor tendon repair is not a surgical emergency. It is proved that equal or better results can be achieved by delayed primary repair.
- Better to repair both FDP & FDS tendons rather than FDP alone.
Surgical Incisions

- Incisions should **not** compromise the viability of the skin flaps and when healed, will not create contractures or cosmetically unsightly scars
- Zigzag (Bruner) or midaxial incisions
Ideal repair

- Easy placement of the sutures in the tendon
- Secure suture knots
- Smooth juncture of tendon ends
- Minimal gapping at the repair site
- Minimal interference with the vascularity
- Strong enough to stand early motion stress
What *can* we provide?

- Minimal dissection and handling
- Tendon apposition without gapping
- Early protected mobilization
Core Suture Techniques

- Bunnell stitch
- Crisscross stitch
- Mason-Allen stitch
- Robertson and Al-Qattan Interlock stitch
Kessler stitch

Modified Kessler

Tajima modification
Of kessler stitch with
double loop at repair site
Sheath repair

• Conflicting lab and clinical studies

• Advantages:
  – barrier to the formation of extrinsic adhesions
  – quicker return of synovial nutrition
  – better tendon-sheath biomechanics
Sheath repair

• Disadvantages:
  – technically difficult
  – may narrow and restrict tendon gliding
Suture Materials

- Core Non-absorbable 4/0 suture
- Different configurations
- 6/0 monofilament running epitenon suture.
- As noted by Singer MD et al. 1998, 3-0 prolene or mersilene suture may be suture of choice
• The strength of the a tendon repair is proportional to the number of the suture strands that cross the repair site
• The number of the suture knots in the repair site should be minimized
• Repairs are stronger when the core sutures are placed dorsally
• **Direct repair**: if laceration is more than 1 cm from FDP insertion

• **Tendon advancement**: if the laceration is less than 1 cm from insertion. In this case, a pull thru technique is used.
Direct repair

- There is usually little difficulty in finding the proximal tendon end, which is retained in the finger by its vinculum and can usually be located in the proximal phalanx or at the level of the PIP.
- When exposing the distal stump, the entire A4 annular pulley should be preserved.
- The proximal tendon is retrieved and passed underneath A4 pulley.
Tendon advancement

• When the distal stump is insufficient to hold a suture, the proximal FDP stump may be reattached by first elevating an osteoperiosteal flap from the base of the distal phalanx and then drilling an oblique hole beneath the flap, directed so as to penetrate the dorsal cortex just beneath the proximal fingernail.
• A doublearmed (straight needles) 3-0 suture is placed in the proximal tendon stump and passed through the bone hole. Tie the suture over felt and a button.

• Another alternative is to use suture anchors (but they are weaker than the button as noticed by Silva et al 1998).

• When possible, the tendon attachment should be supplemented by sutures through the adjacent sheath or periosteum.
Zone II Injuries

No man’s land
• Dissection proceeds with identification and protection of the digital nerves and arteries
• It is necessary to open either the C1 (between A2 and A3) or C2 (between A3 and A4) cruciate-synovial sheath
• Always restore the normal relation between the two tendons
Proximal Tendon Retrieval

1. Try to milk the tendon with the wrist flexed

   
   single skin hook is carefully inserted into sheath, then the hook is then turned toward the tendons and when it is secured to the tendon, withdrawal of the hook should retrieve both tendons
Proximal Tendon Retrieval


a small catheter is passed into the sheath and is delivered proximally into a small wound in the palm, just proximal to the A1 pulley, the catheter is sutured to both tendons 2 cm proximal to A1 pulley, which is then pulled distally to deliver the tendons into the synovial window.
Partial laceration

- Partially severed tendon should not be repaired if at least 40% of the tendon remains intact

  - Over a 5-year-period, 15 patients with zone II partial flexor tendon lacerations that were larger than half the width of the tendon were treated conservatively without tendon suturing
  - If present, the cause of triggering was determined and eliminated by trimming any beveled tendon edge
  - Early protected mobilization was started the first day after injury using a dorsal splint
  - The results were excellent in 93% of cases and good in the remaining 7%
Postoperative Management
Different Methods

1. Active Extension-Rubber Band Flexion Method: e.g. Kleinert, and Brooke-Army
2. Controlled Passive Motion Methods: e.g. Duran’s protocol
3. Controlled Active Motion Methods
Kleinert Protocol

• Combines dorsal extension block with rubber-band traction proximal to wrist
• Originally, included a nylon loop placed thru the nail, and around the nail is placed a rubber band
• This passively flexes fingers, & the patient actively extends within the limits of the splint
Kleinert Protocol
Duran protocol

• At surgery, a dorsal extension-block splint is applied with the wrist at 20-30° of flexion, the MCP joints at 50-60° of flexion, and the IP joints straight
Duran protocol
Complications

- Joint contracture
- Adhesions
- Rupture
- Bowstringing
- Infection
Summary

• Meticulous technique
  – Minimal handling
  – Appropriate suture configuration
  – Minimal resection of tendon sheath
• Postoperative mobilization
• *Supervision!*
THANK YOU

Complications &
Late reconstruction of
Flexor tendon injury
Nov 3/04
FDP Avulsion/Rupture

• Results from forceful hyperextension of DIP joint w/ FDP in maximal contraction
• Known as rugger Jersey finger
• Tendon may rupture directly from its insertion into the bone, or it may avulse bone fragment from the base of distal phalanx
• **Ring finger** is most often involved (75%)
Classification

• **Type I** - retracts to the palm
• **Type II** - retracts to the PIP joint
• **Type III** - bony fragment distal to A4