

Tendon Repair

WHAT'S NEW IN HAND SURGERY?

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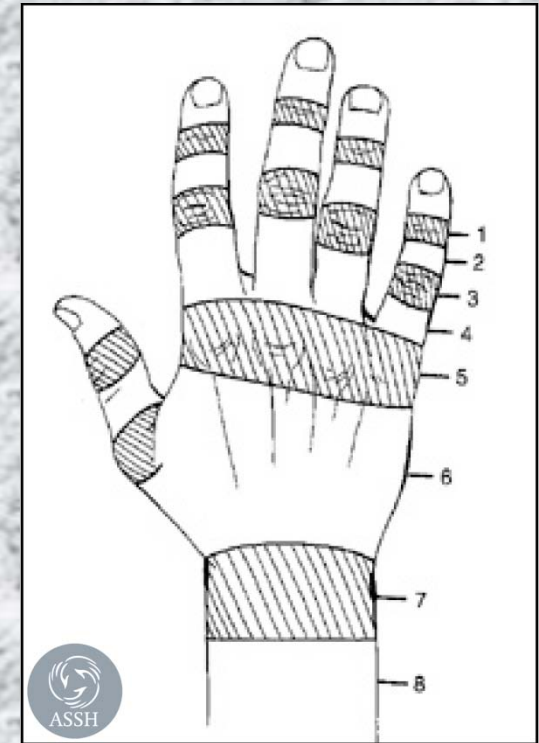
DISCLOSURES

- Consultant for Auxilium and Pfizer Pharmaceutical Companies



Zones of extensor tendon injury

- Zone 1: terminal tendon
- Zone 2: triangular ligament
- Zone 3: central slip
- Zone 4: over proximal phalanx
- Zone 5: over MCP joint
- Zone 6: over metacarpals
- Other (7, 8, 9): proximal



Essentials of Hand Surgery 2002

- Zone 1 Injury
 - Loss of active DIP extension
 - Mallet Finger Subtypes
 - Tendinous
 - Bony



Extensor tendon

- Closed Zone 1 - Tendinous Mallet Finger
 - Full time extension splinting for 6-8 weeks
 - PIP joint mobilization
 - Dorsal Splints
 - Better extension but more skin irritation
 - Volar splints
 - Less effective but fewer skin complications



- Results – Closed treatment
 - Crawford, *J Hand Surg* 1984
 - 62 patients
 - Excellent/good results
 - <10 deg. loss of extension in 79%
 - Fair and poor results in patients with delayed treatment or improper use of splint



- Complications – Closed treatment
 - Rate ~ 45%
 - Transient skin problems (maceration, ulceration, tape allergy) .
 - Many complications with dorsal aluminum splints.
 - Skin blanching at 50% of passive DIP hyperextension (avg 14°).

» Rayan et al, *J Hand Surg* 1987.

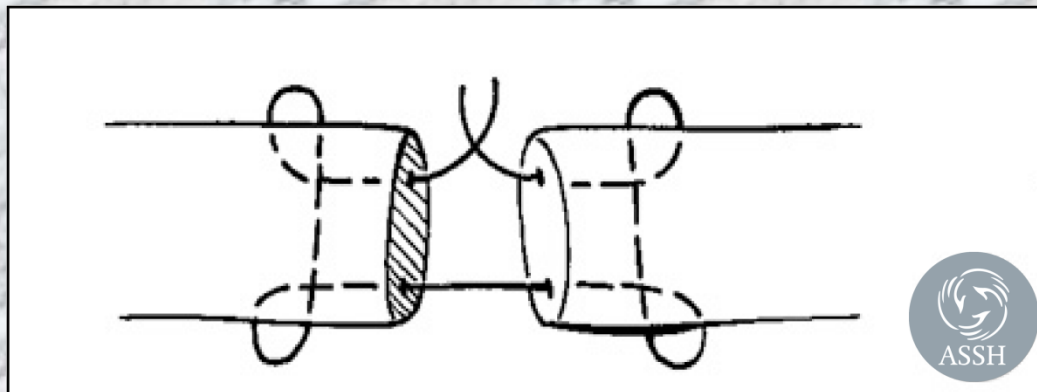


- Open Zone 1 Injuries
 - Operative treatment is recommended by most authors
 - +/- transarticular K-wire in full extension



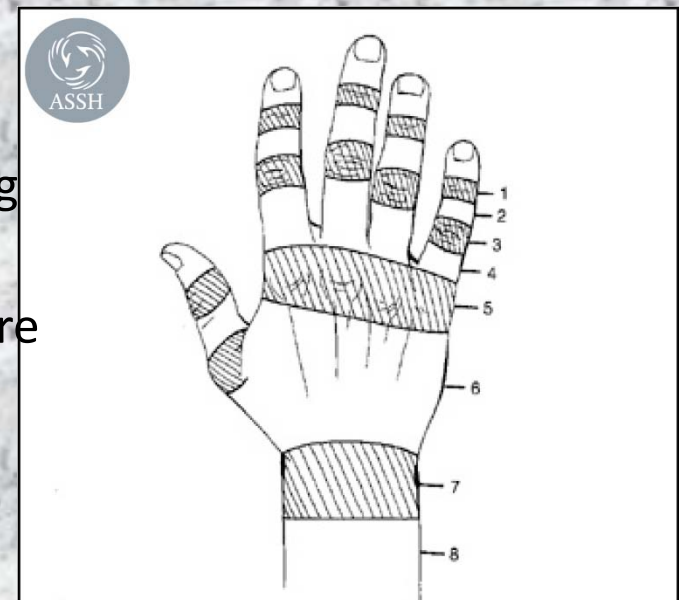
Extensor tendon

- Extensor Tendon Suture Methods
 - For more distal injuries (zones 1-4) the tendon is flat
 - Figure of 8 repair or mattress suture repair
 - As the caliber thickens (zones 5-8)
 - Core suture method



Courtesy of Martin I. Boyer, MD

- Zone 2,4 Injuries – most common due to laceration
 - Acute Zone 2,4,6
 - Lateral band, EDC laceration
 - Can excise one lateral band without losing extension
 - May repair with 4-0 non-absorbable suture
 - Aftercare is identical to mallet
 - Chronic Zone 2 with swan neck deformity
 - Spiral oblique retinacular ligament reconstruction



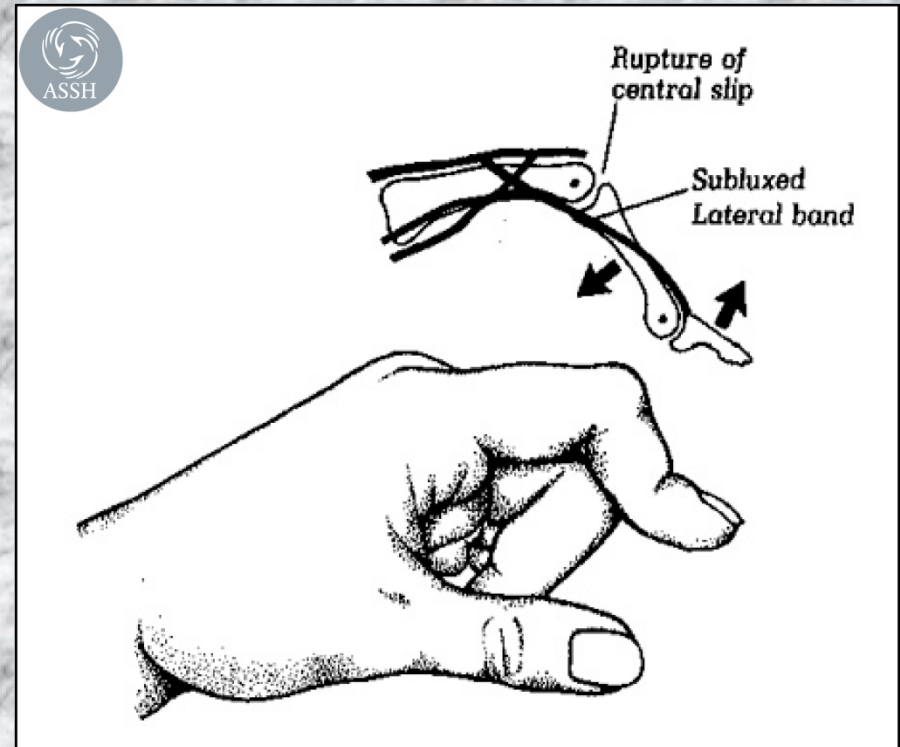
- Zone 3 Injuries

- Central slip injury

- Leads to loss of active PIP extension
 - If palmar subluxation of lateral bands Boutonnière deformity develops
 - Flexion of the PIP

- Hyperextension of the DIP

- Can occur within one week



- Zone 3 extensor injury -
Physical Examination
 - Patient p/w pain over the dorsal PIP, loss of 15-20° active PIP extension with wrist and MP joints flexed
 - Weak extension of the middle phalanx against resistance
 - + Elson test = central slip rupture
 - Loss of passive flexion of the DIPJ with the PIPJ extended



- Zone 3 extensor injury - Treatment
 - Splint PIP in neutral for 6-8 weeks
 - Allow DIP active flexion (helps approximate ruptured tendon ends)
 - Can use serial casts or K-wire fixation when needed



- Open Zone 3 Injuries
 - Patient who maintains active PIP extension against resistance
 - Active motion
 - Close follow up
 - Patient with active PIP extension, but weak against resistance
 - Extension splint 3-4 weeks
 - Close follow up
 - Patient with extensor lag
 - Open repair with 3-0 braided suture
 - May require microsuture anchor if injury at the central slip insertion

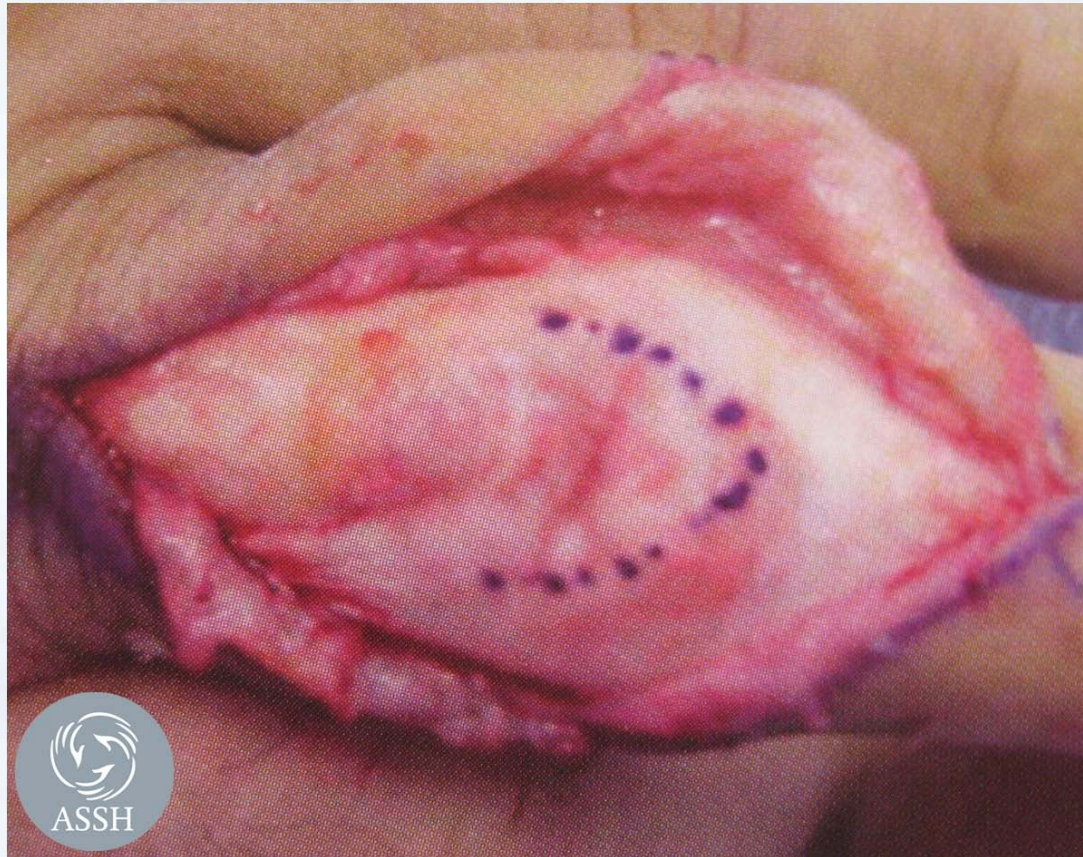
- Chronic Zone 3 Injuries
 - Stage I: Supple boutonnière deformity
 - Active extension therapy + extension splinting
 - Stage II: Fixed boutonnière deformity (Contracted lateral bands)
 - Trial of active extension therapy + extension splinting
 - Tenotomy: release the lateral bands distal to the central slip
 - Maintain the spiral oblique retinacular ligament
 - Allows central slip to relax, but maintains DIP extension
 - Stage III: Fixed boutonnière deformity – joint degeneration
 - May require arthroplasty or fusion

- Boutonnière Deformity - Repair





- Boutonnière Deformity - Repair



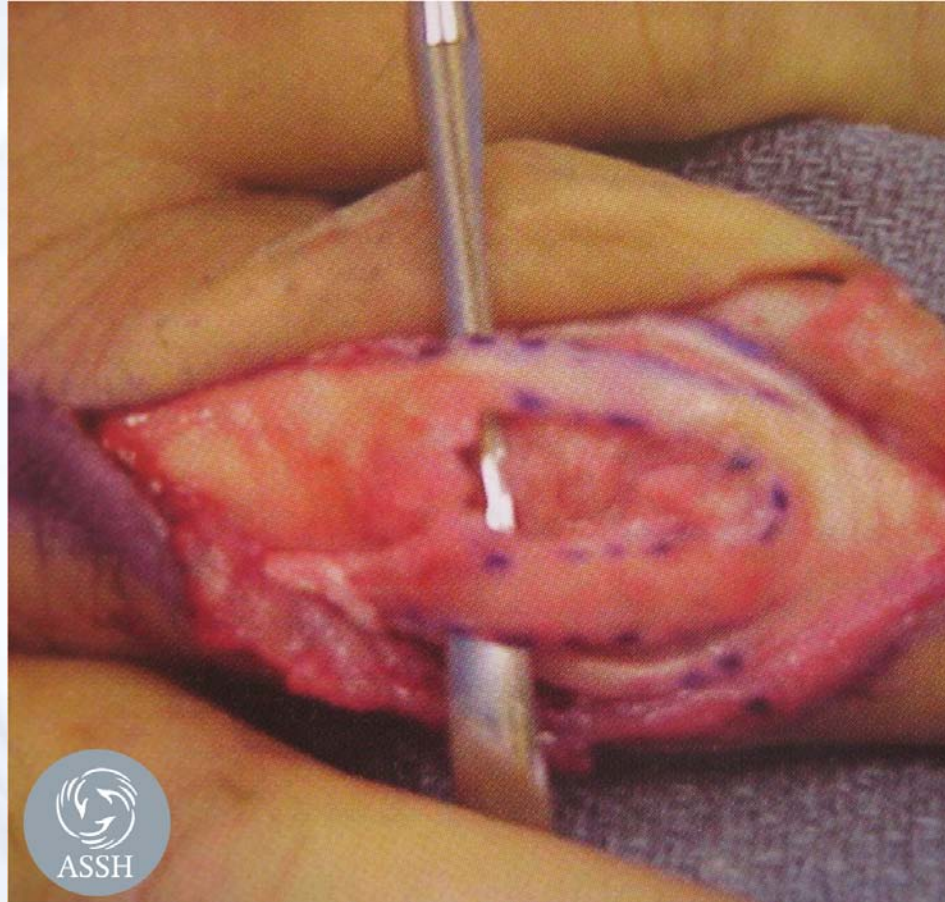
Hand Surgery Update IV, Fig 6, P 365

Attenuated tendon

Extensor tendon



- Boutonnière Deformity - Repair

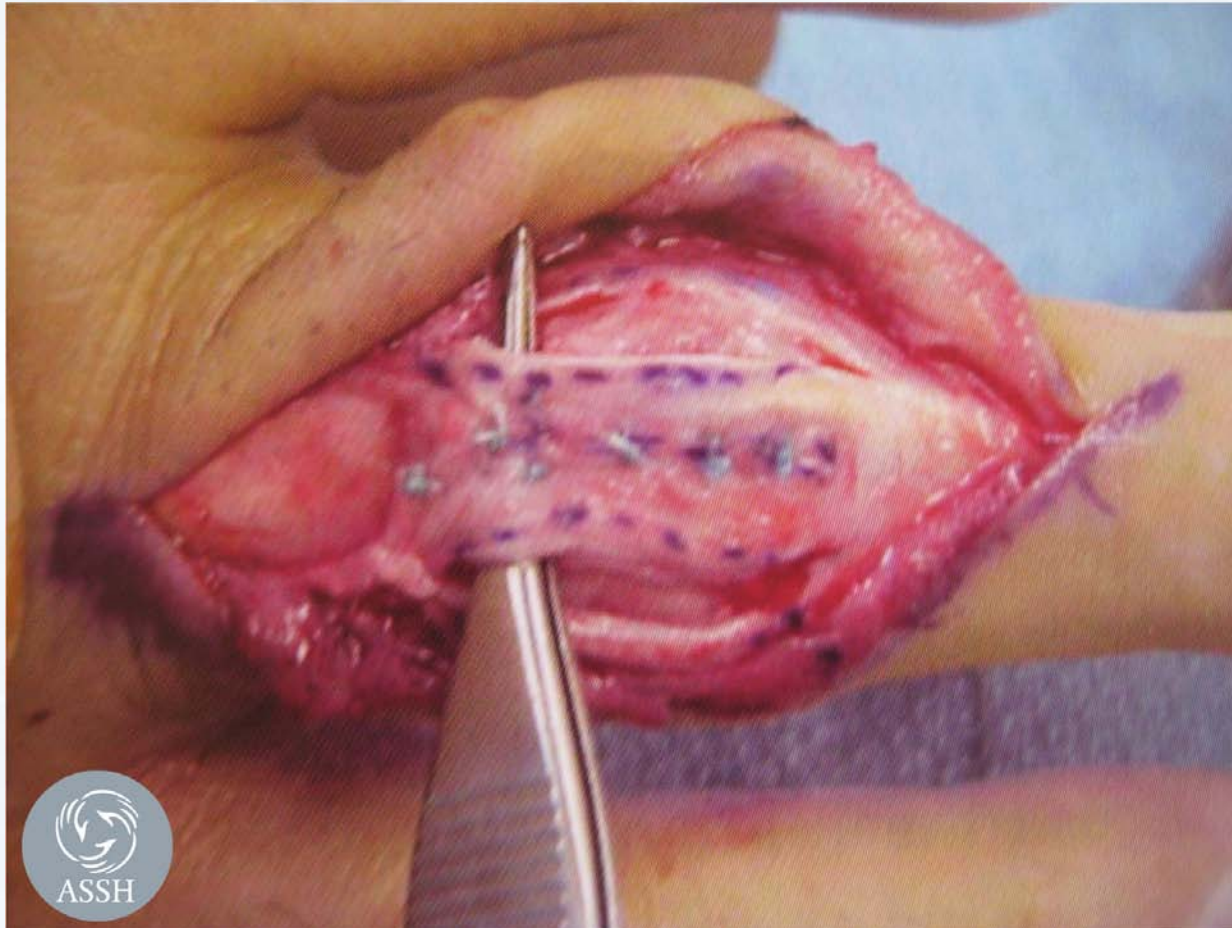


Hand Surgery Update IV, Fig 6, P 365

Removal of attenuated tendon

Extensor tendon

- Boutonnière Deformity - Repair

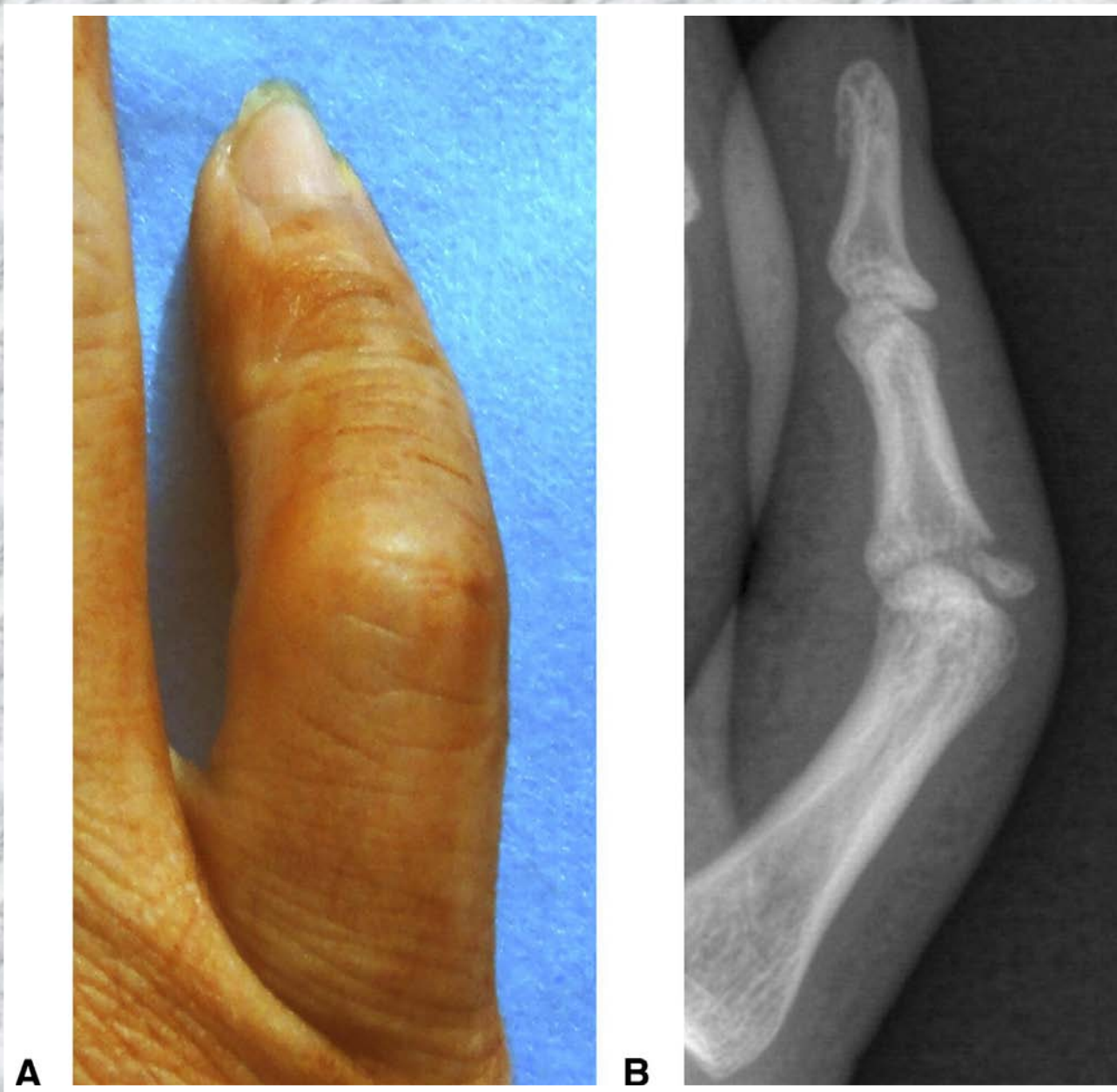


Hand Surgery Update IV, Fig 6, P 365

Repair of tendon, centralization of lateral bands

- Boutonnière Deformity – Treatment of Chronic injuries
 - Repair with repositioning of the lateral bands (+/- [staged] PIP contracture release)
 - Fowler's terminal tenotomy
 - PIPJ arthrodesis

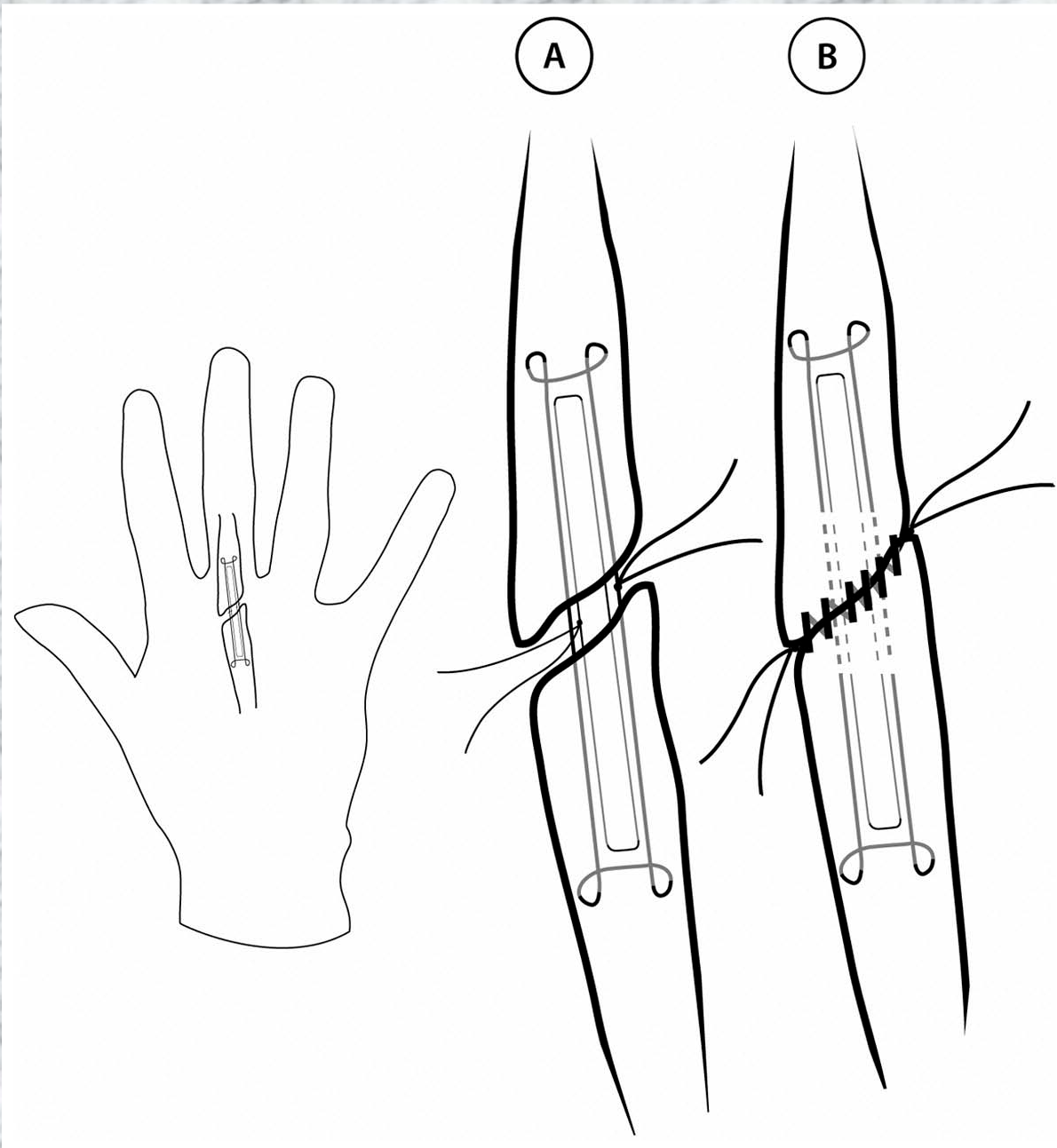
FIGURE 1



A

B

FIGURE 1



Rehabilitation

- Passive
- Early Active



FIGURE 2

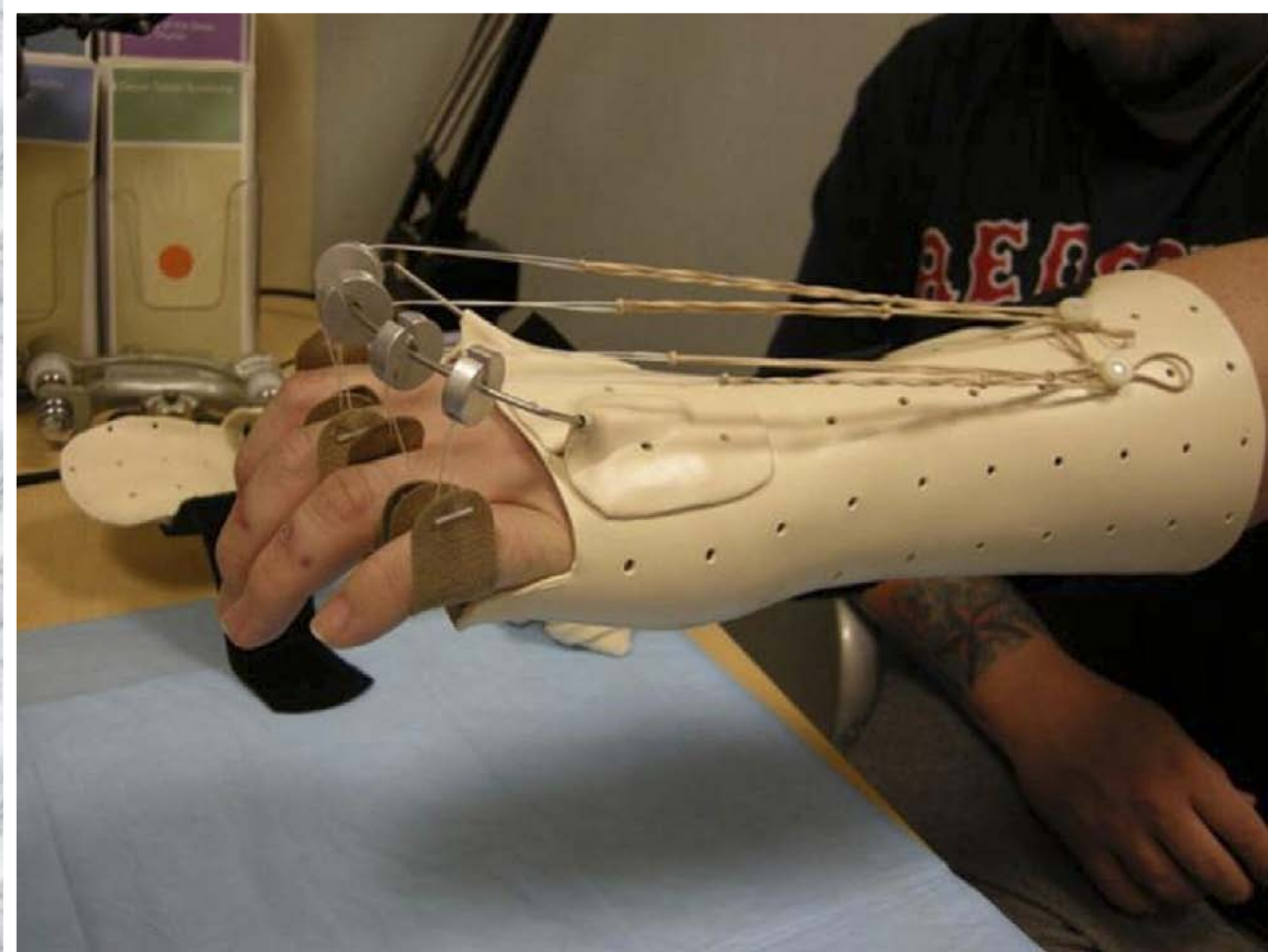


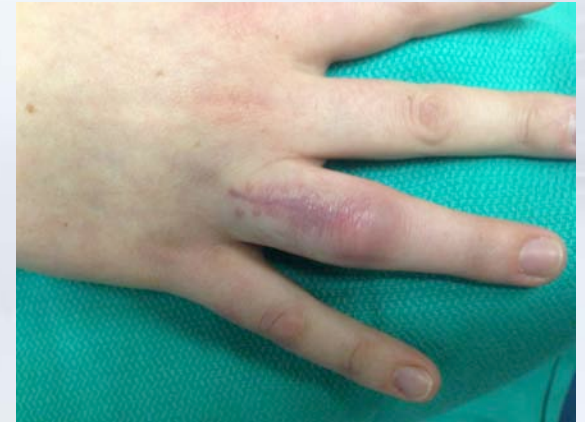
FIGURE 3



- Stiffness Following Extensor Tendon Repair

- Loss of MCP, PIP or DIP flexion can be due to:

- Loss of tendon excursion
 - Shortening
 - Adhesions
- Joint contracture



- Restoration of functional range of motion may require multiple procedures

Extensor Tendon Loss/Reconstruction

- Spiral Oblique Retinacular ligament
- Fowler Release
- Turnover Flap from Zone 4
- EIP

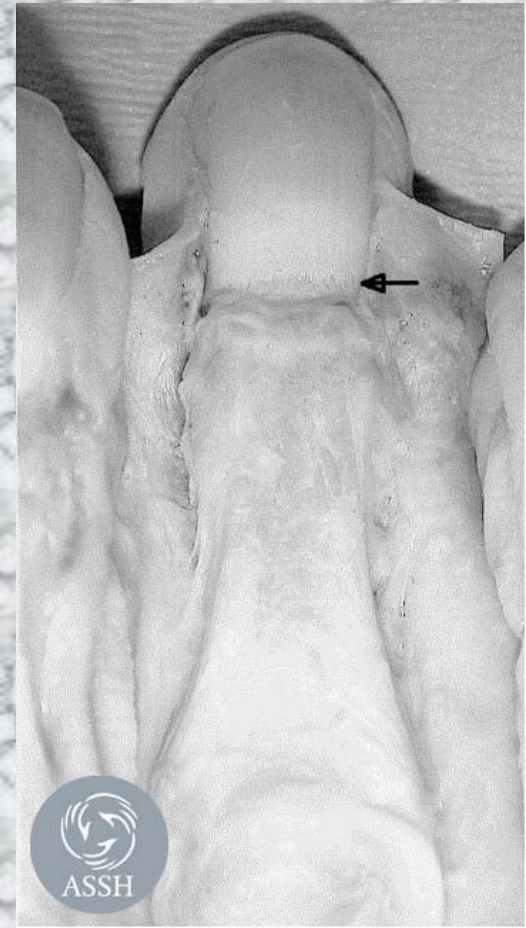


FIGURE 4

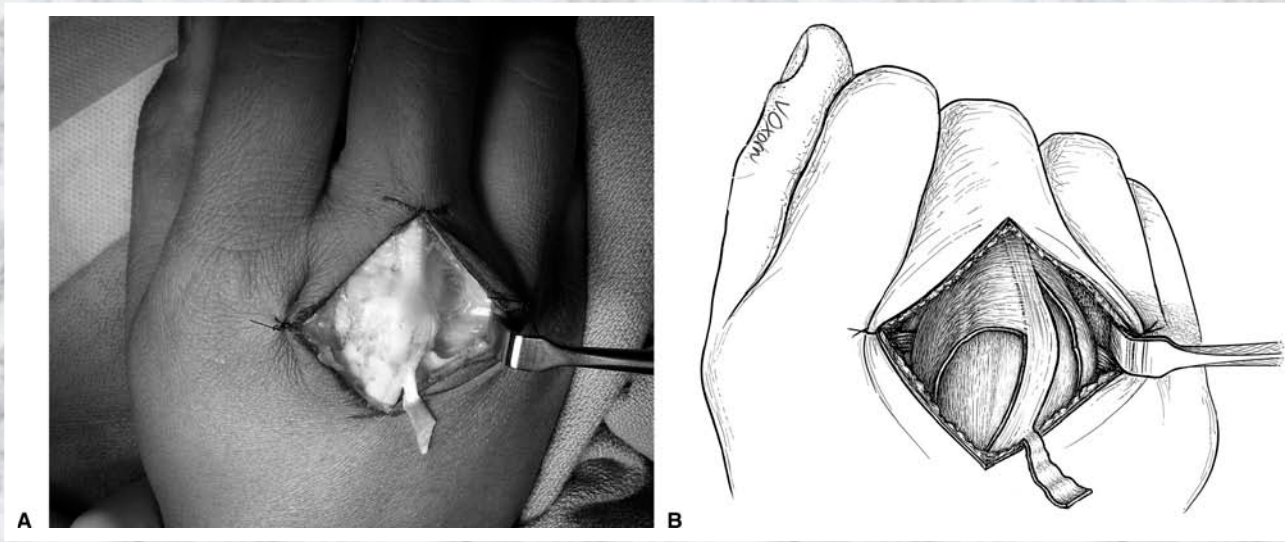


Extensor Subluxation

- Centralization
- Lumbrical
- Junctura
- EIP
- Sagital Band Repair



FIGURE 1



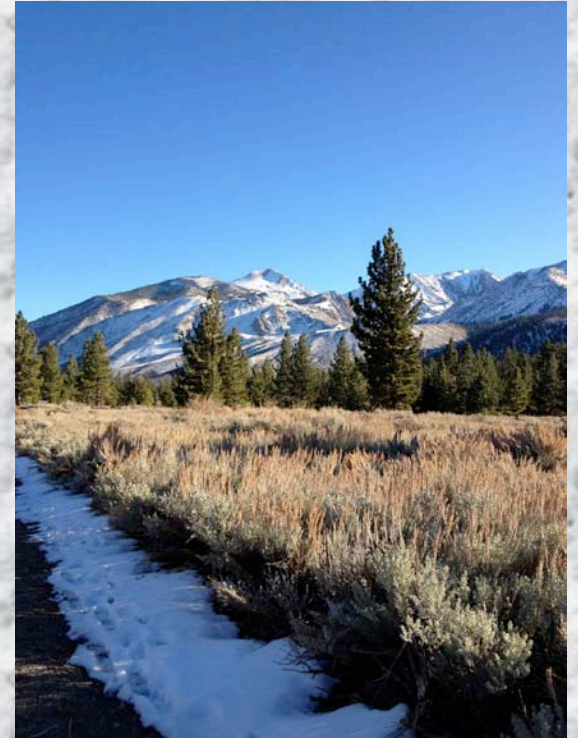
Flexor Tendon Repair

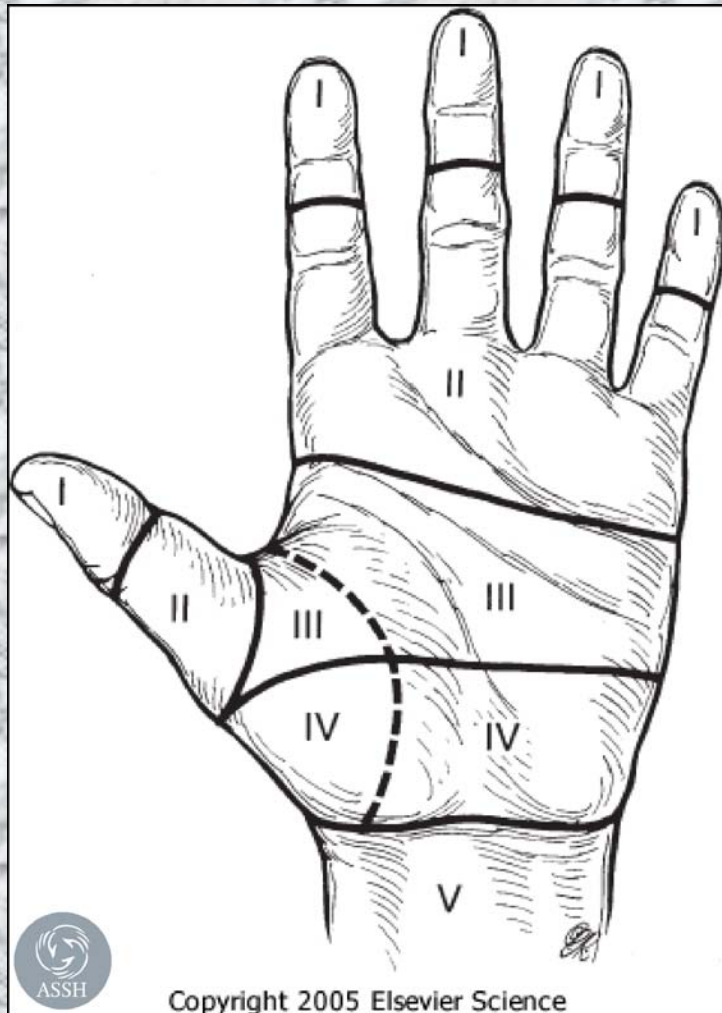


- Goals in Flexor Tendon Repair
 - Prevent gap formation
 - Prevent adhesions
 - Allow differential gliding between FDS and FDP tendons
 - Allow gliding under pulleys
 - Perform a repair of adequate strength to allow early rehabilitation
 - Allow for full functional recovery



- Strickland (JAAOS 1995)
 - Ideal repair
 - Sutures easily placed in tendon
 - Secure suture knots
 - Smooth juncture of tendon ends
 - Minimal gapping at the repair site
 - Minimal interference with tendon vascularity
 - Sufficient strength throughout healing





- Anatomy

- Zones on injury - FDP

- I Distal to FDS insertion

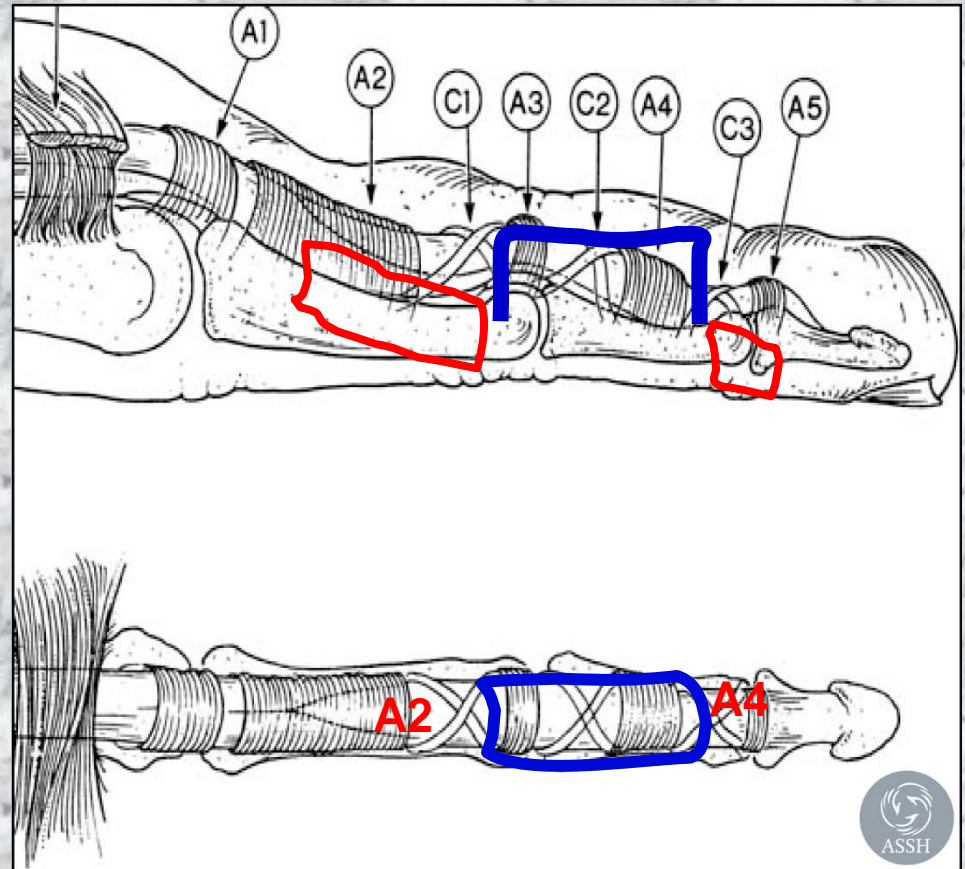
- II Proximal aspect of flexor sheath to FDS insertion

- III Lumbrical origin to proximal aspect of flexor sheath

- IV Carpal tunnel

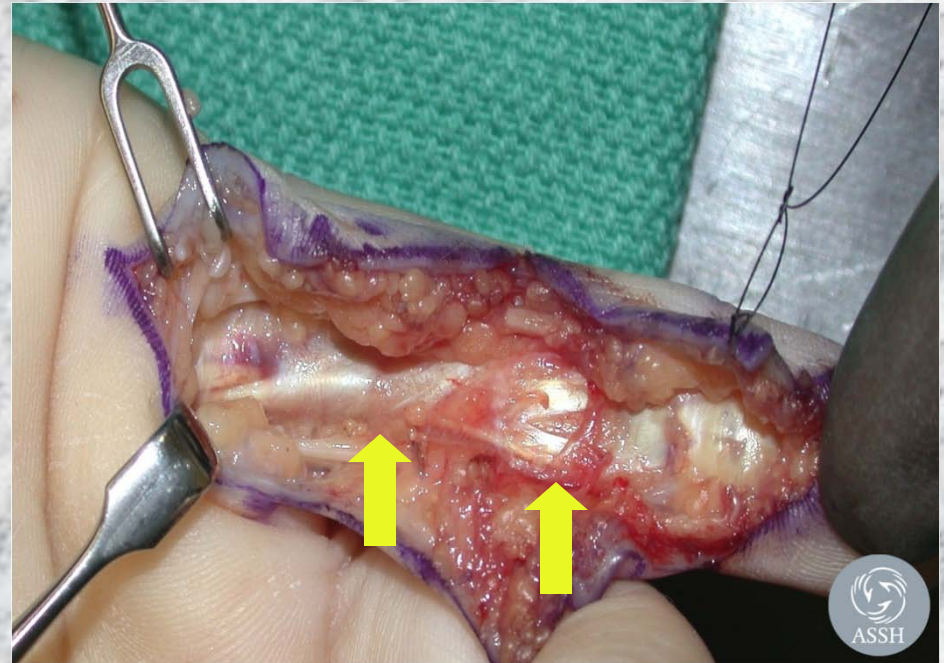
- V Proximal to carpal tunnel

- Approaches
 - Preserve **A-2** and **A-4** pulleys
 - Use cruciate pulley windows (**C1, A3, C2**)
 - Raise flap of **C1, A3** and **C2** for exposure
 - Repair between **A-2** and **A-4** pulleys



Courtesy of Martin I. Boyer, MD

- Approaches
 - Venting (partial release) of the A-2 and A-4 pulleys up to 50% can be used to facilitate exposure and allow tendon gliding following repair (Mitsionis et al, JHS 1998)



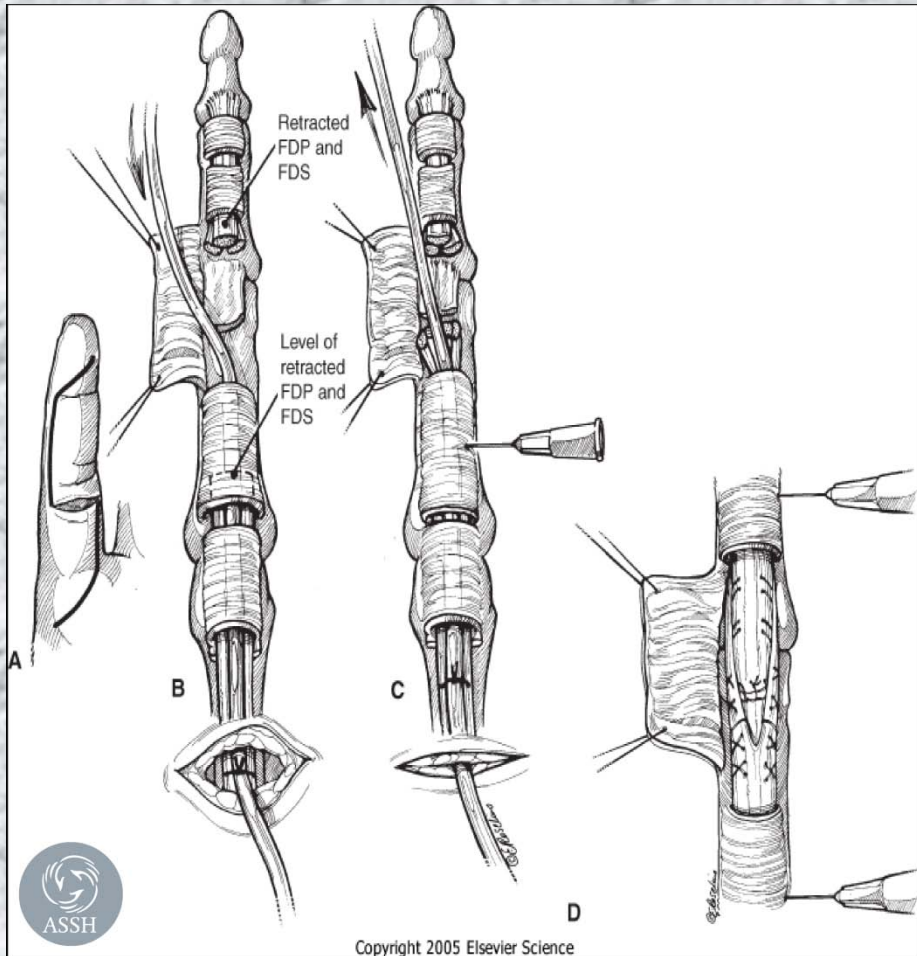


FIGURE 1

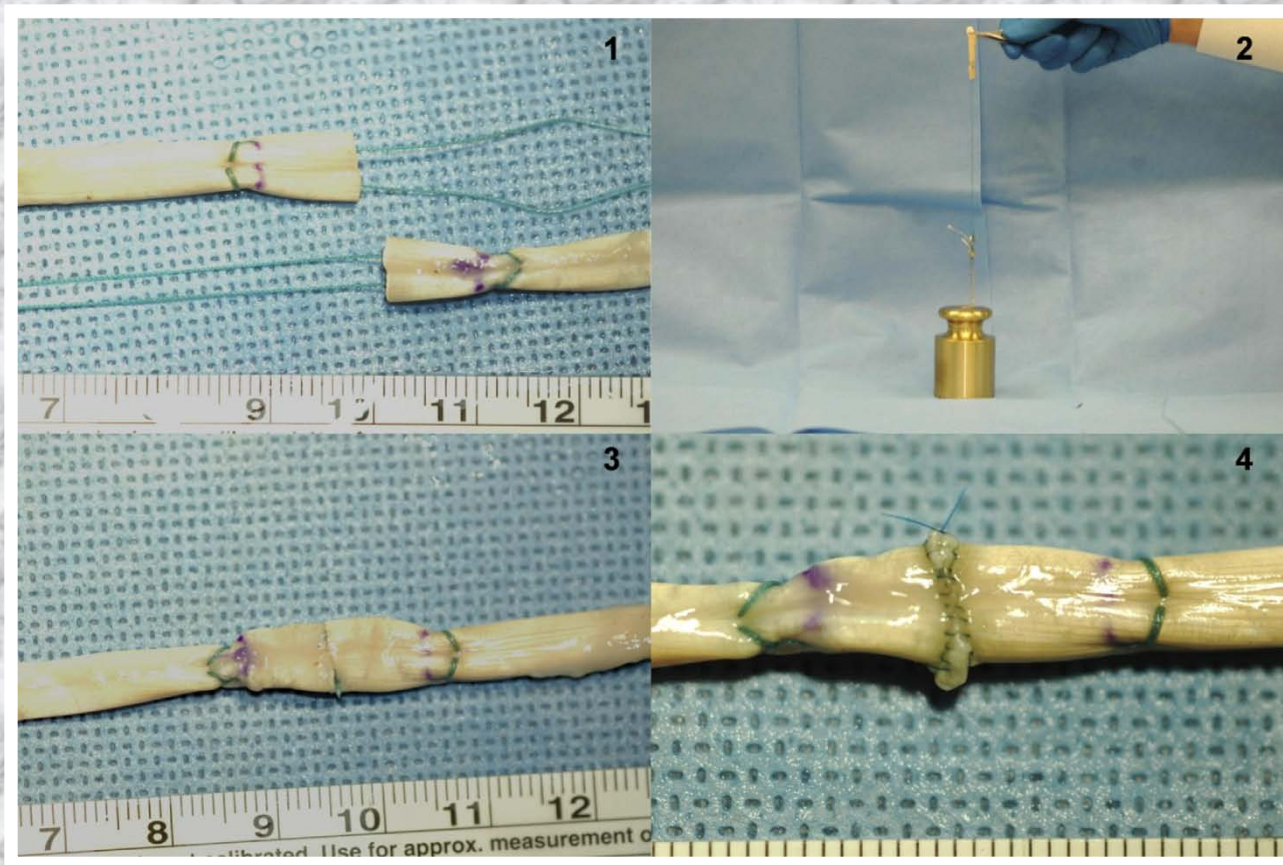
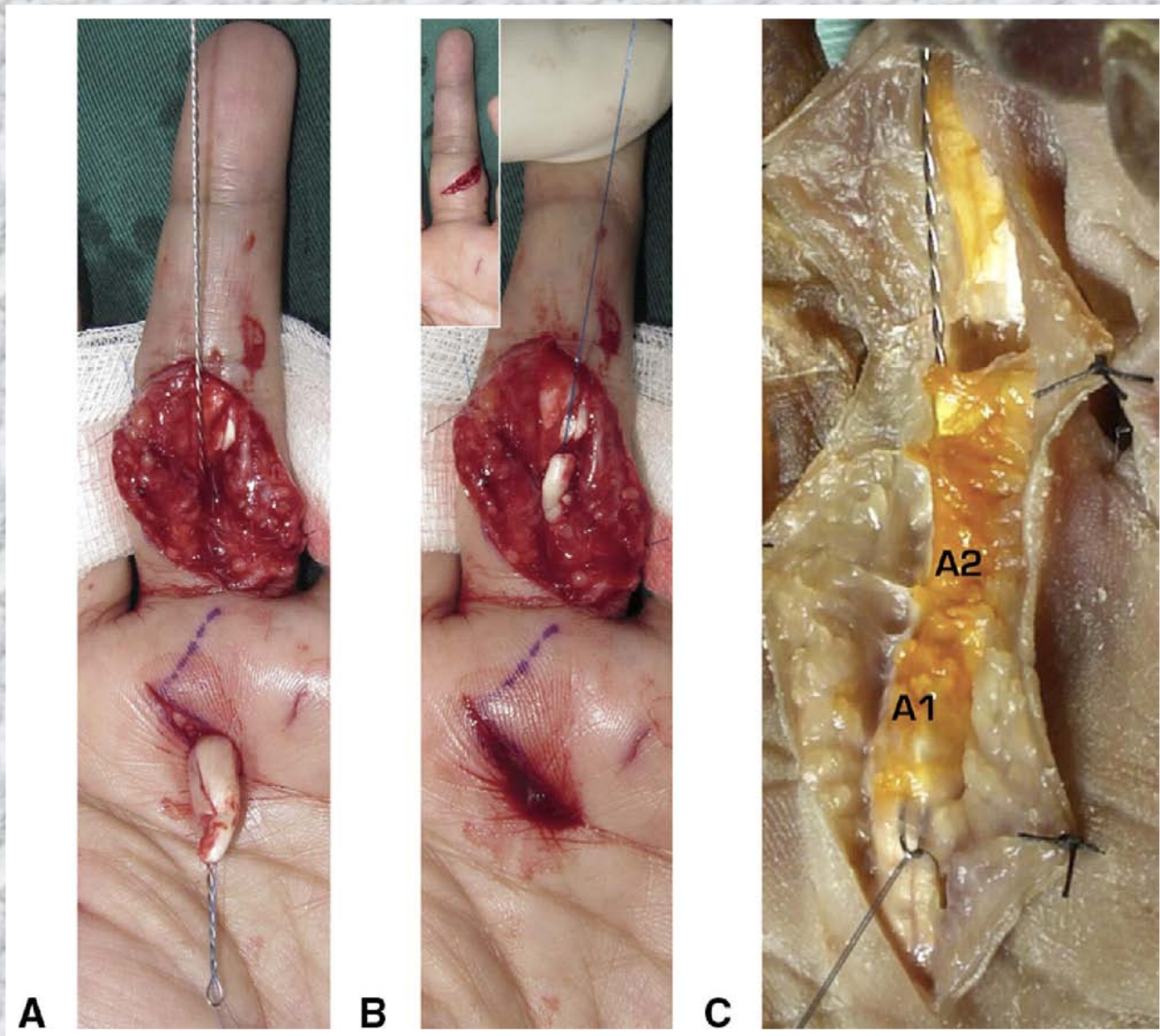


FIGURE 1



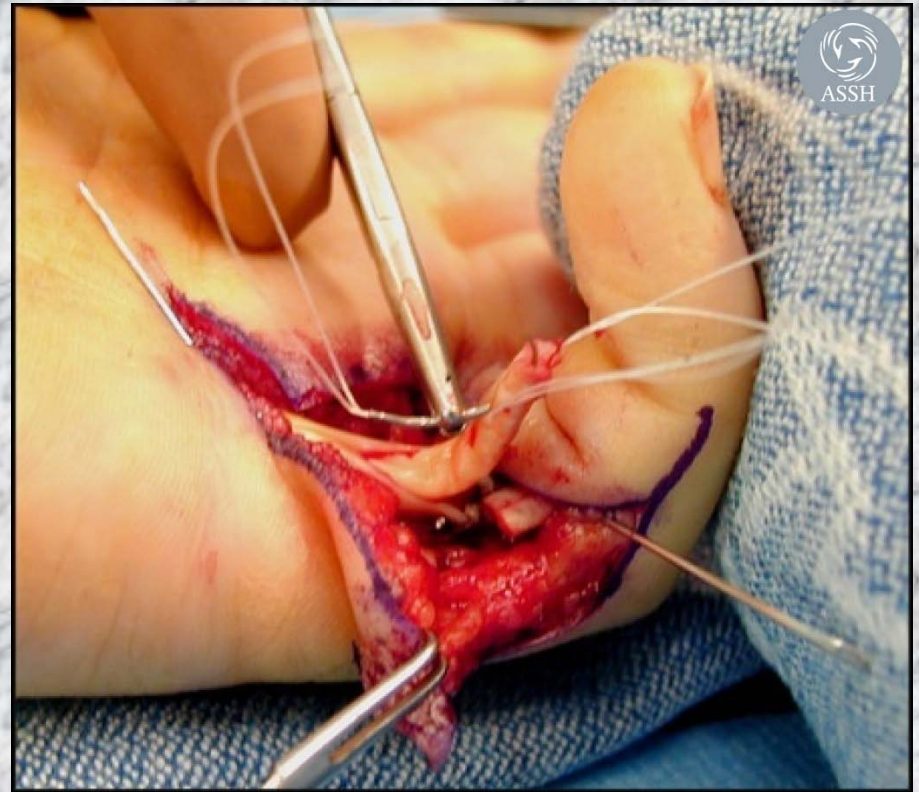
A

B

C



- Repair Technique
 - The finger will need to be flexed to allow delivery of the distal stump of the FDP into the wound
 - Core suture
 - Epitendinous suture



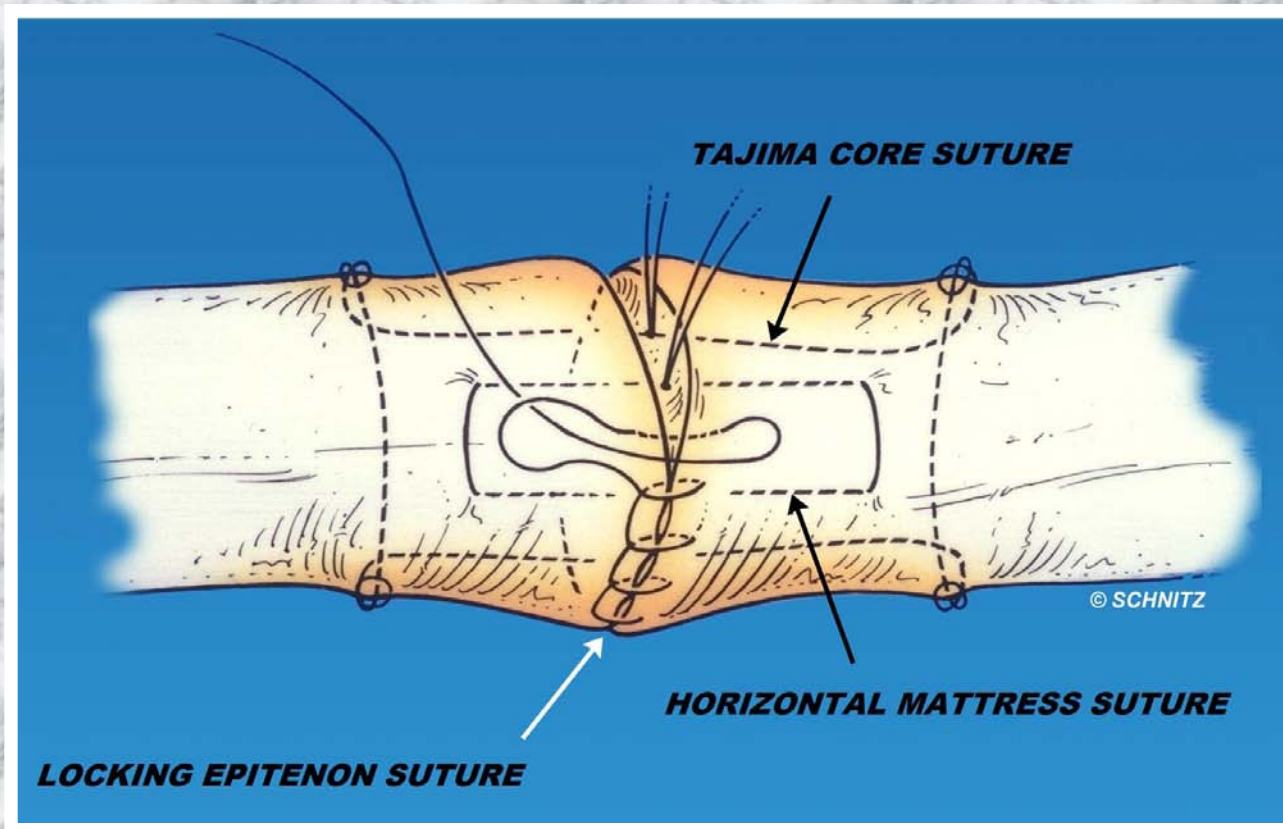
Courtesy of Martin I. Boyer, MD

OPTIMAL SUTURE TECHNIQUE

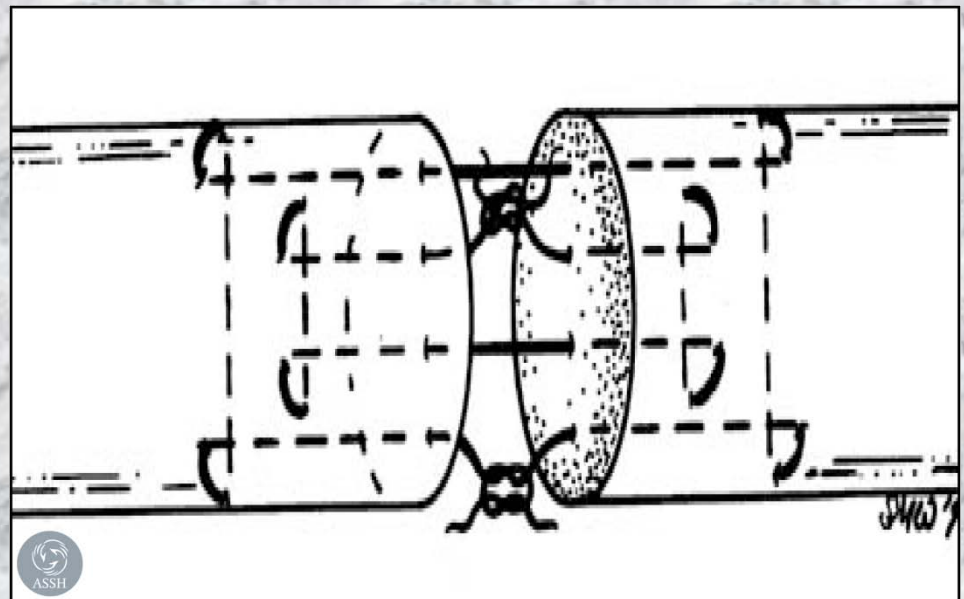
- Found in Dictionary between Dragon and Unicorn
- 4 to 6 Strand Core 7-10 mm Purchase
- Knots Outside Stronger
- Palmar Entry, Less Vascular
- 3-0 Braided Polyblend
- Fiberwire/Stainless Steel Stronger
- 6-0 Epitenon 2mm Purchase



FIGURE 1



- **Strickland Repair**
 - Four strand repair
 - Uses two sutures
 - Modified Kessler outer stitch
 - Horizontal Mattress or modified Kessler inner stitch

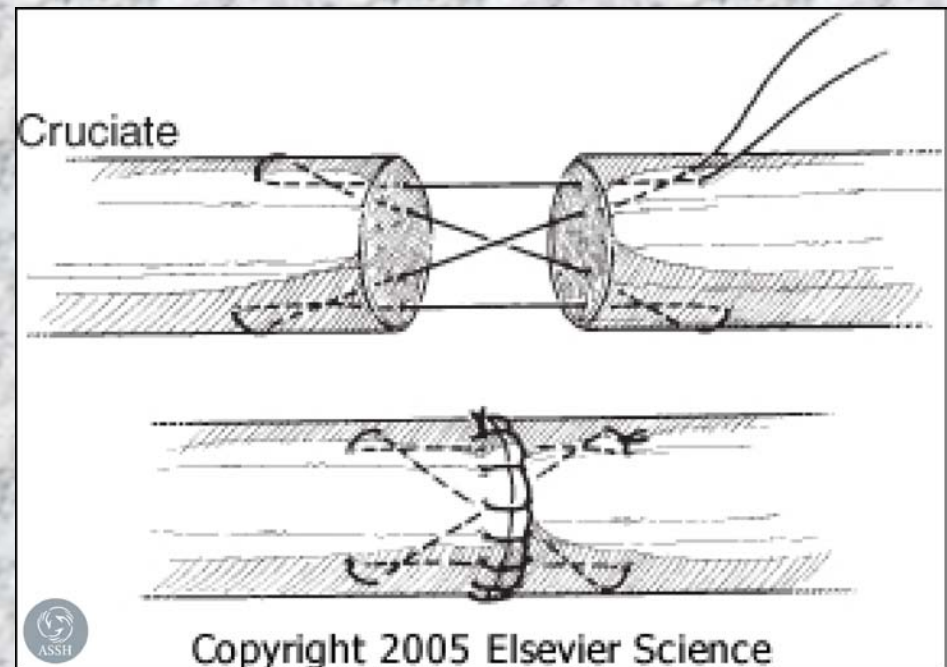


Courtesy of Martin I. Boyer, MD

- Cruciate Repair

- Four strand repair

- Single suture
 - Modified as locked suture if desired or with placement of knot inside repair



- Modified Becker/
MGH Repair
 - Four Strand Repair
 - Excellent for FDS
repair after
decusation (Miller,
JHS 2000) or distal
FDP repair
(Gelberman, *JOR*
2002)

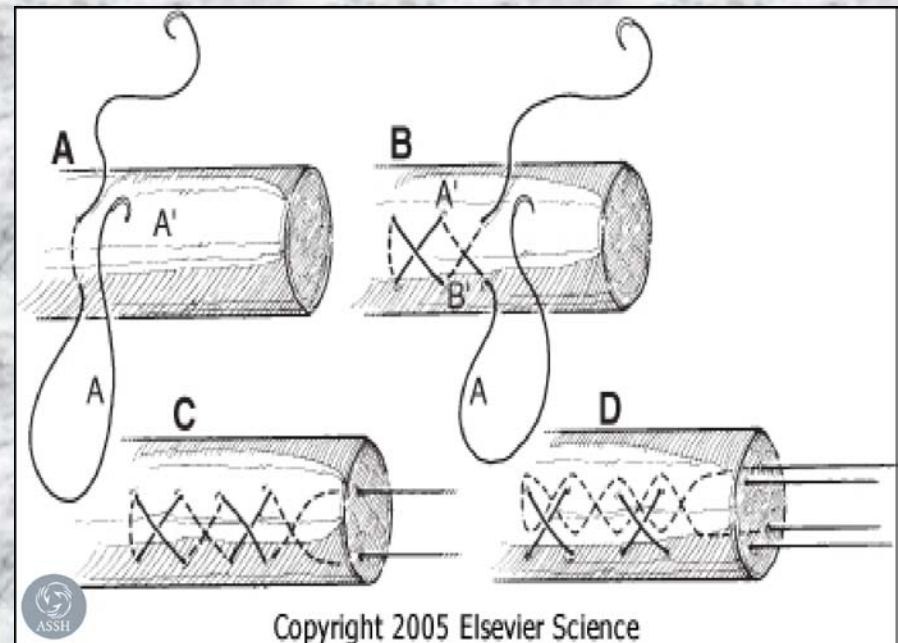


FIGURE 1



- Six Strand Repair

- Savage

- Tsai

- Tsuge

- These are technically difficult, but strong and can be used with early active motion protocols



FIGURE 1

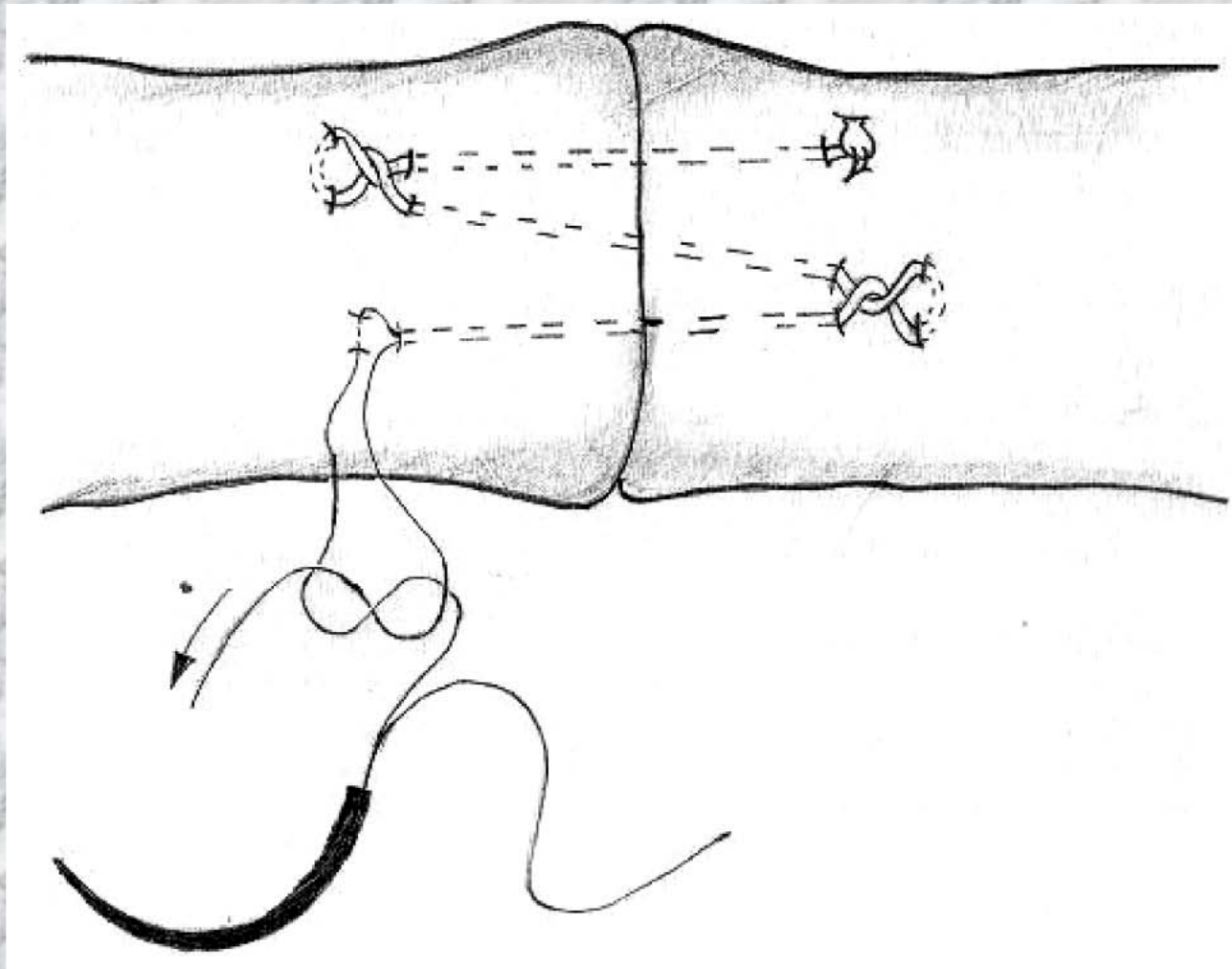
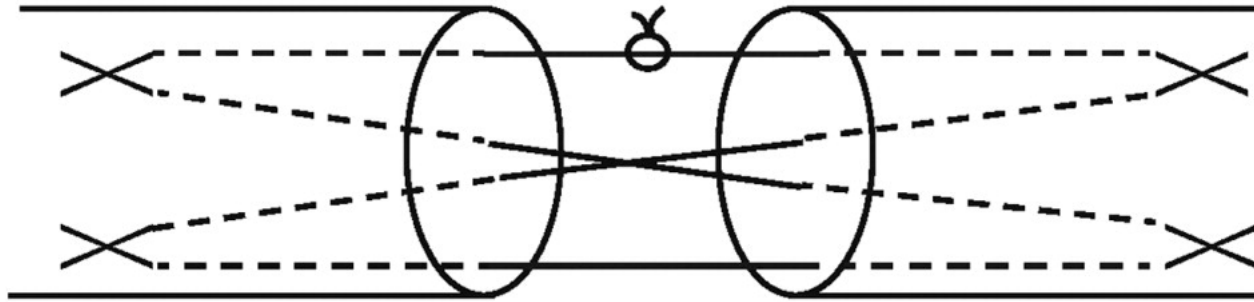


FIGURE 2

GROUP 1



GROUP 2

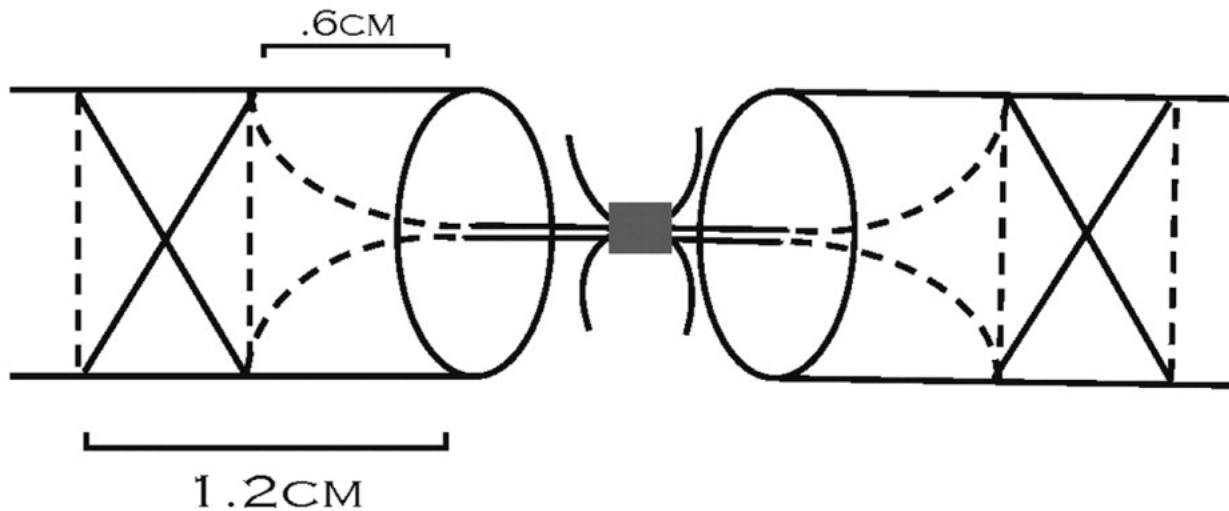


FIGURE 3

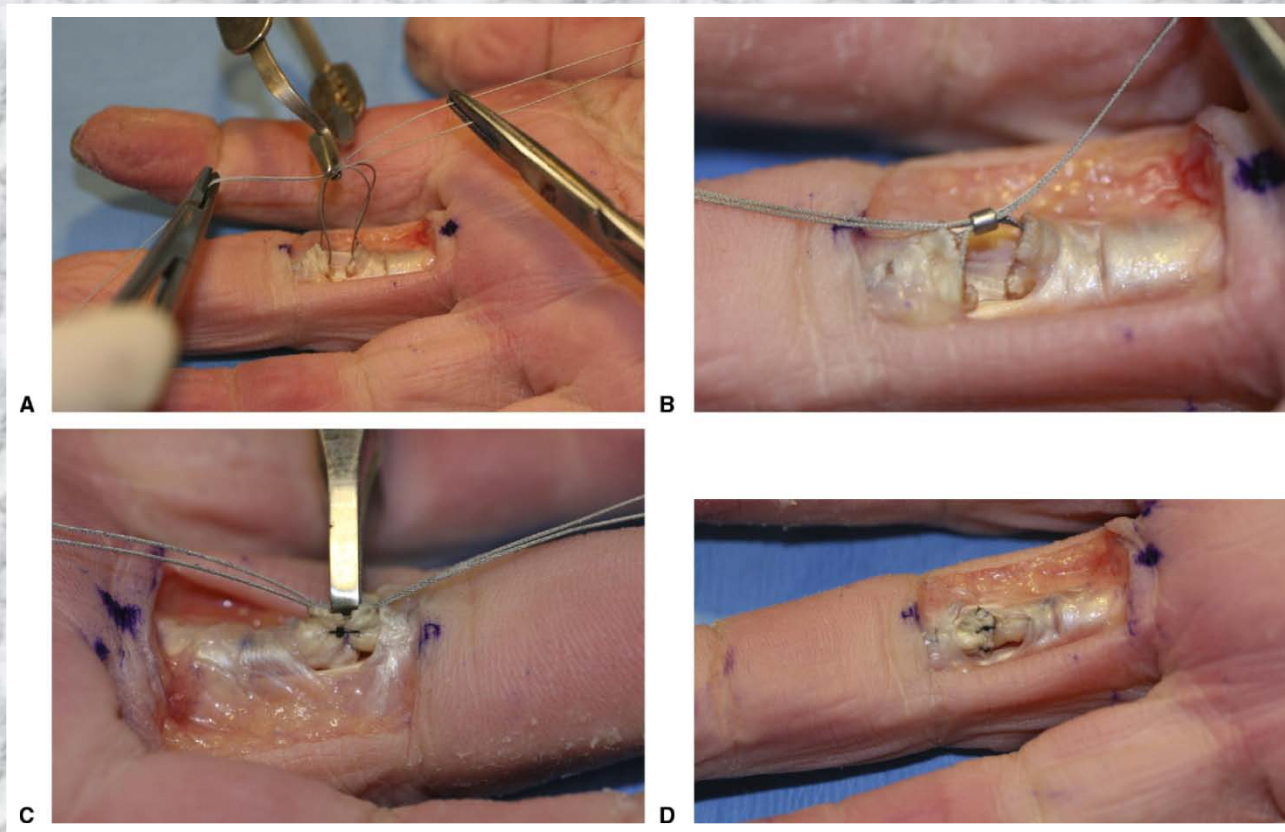
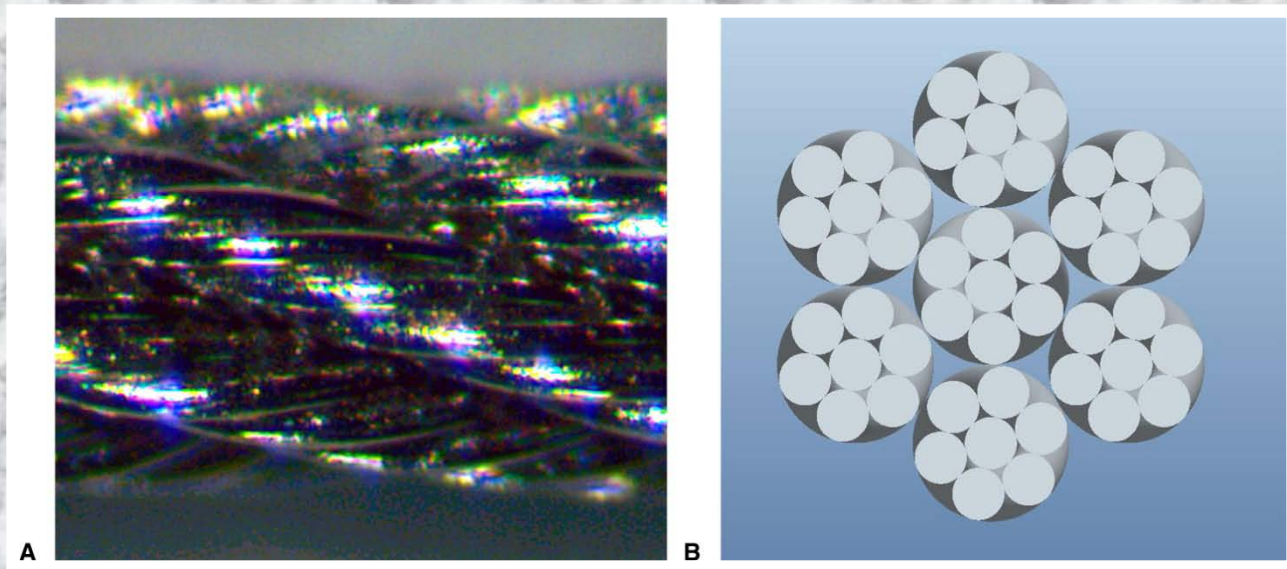


FIGURE 1



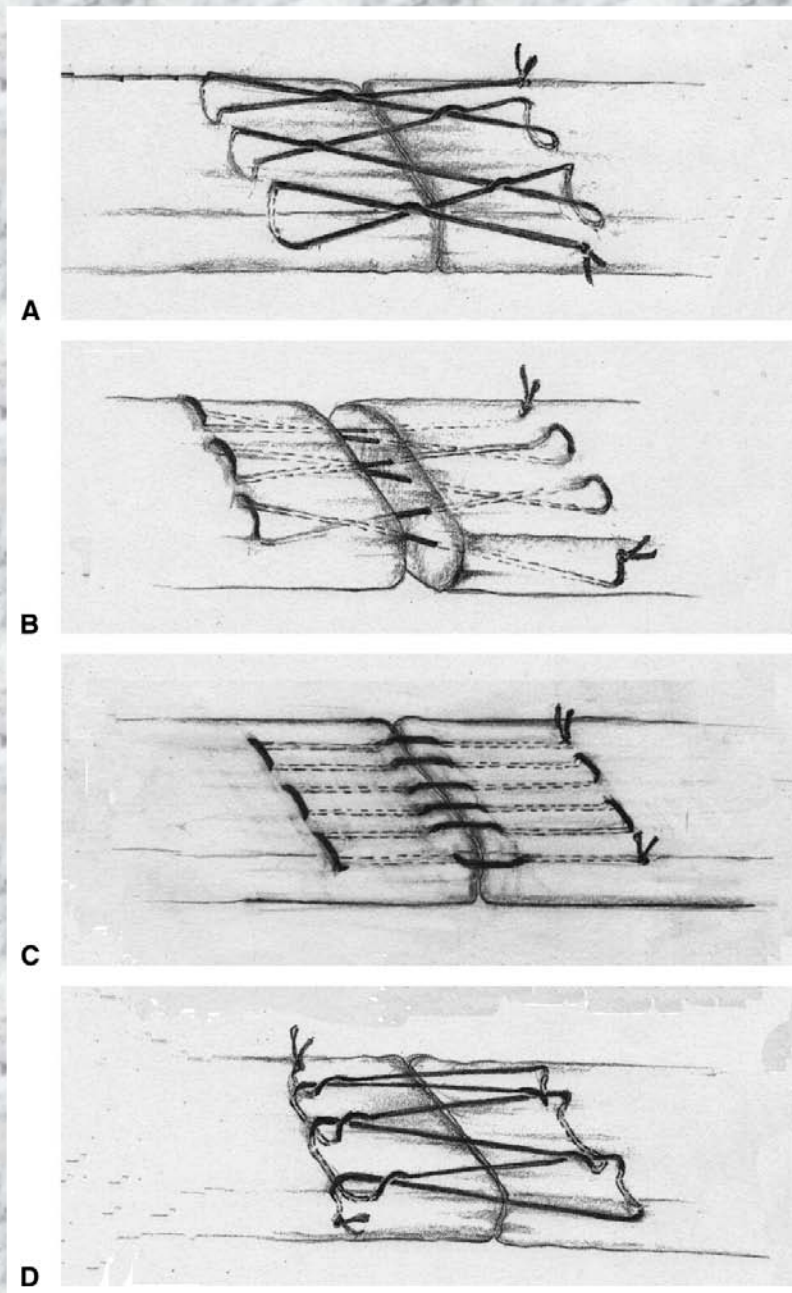
A

B

- Epitendinous Repair
 - Sutures placed in the periphery, circumferentially in a running fashion
 - Increases repair strength by 10-50%
 - Tidies repair site
 - Allows better gliding under pulleys
 - Prevents gapping



FIGURE 1



- **Distal FDP Repair**
 - If less than 1 cm of distal stump present, use a multi strand repair in the proximal tendon and advance it into bone, repair with button over the distal nail or bone anchors



- **Distal FDS Repair**
 - A modified Becker/ MGH type of repair works well (Miller and Mass, *JHS 2000*)
 - Excision of one slip of FDS to improve gliding reduce work of flexion
 - Vincula can provide up to 93% flexion of PIP joint (Stewart *JHS 2007*)

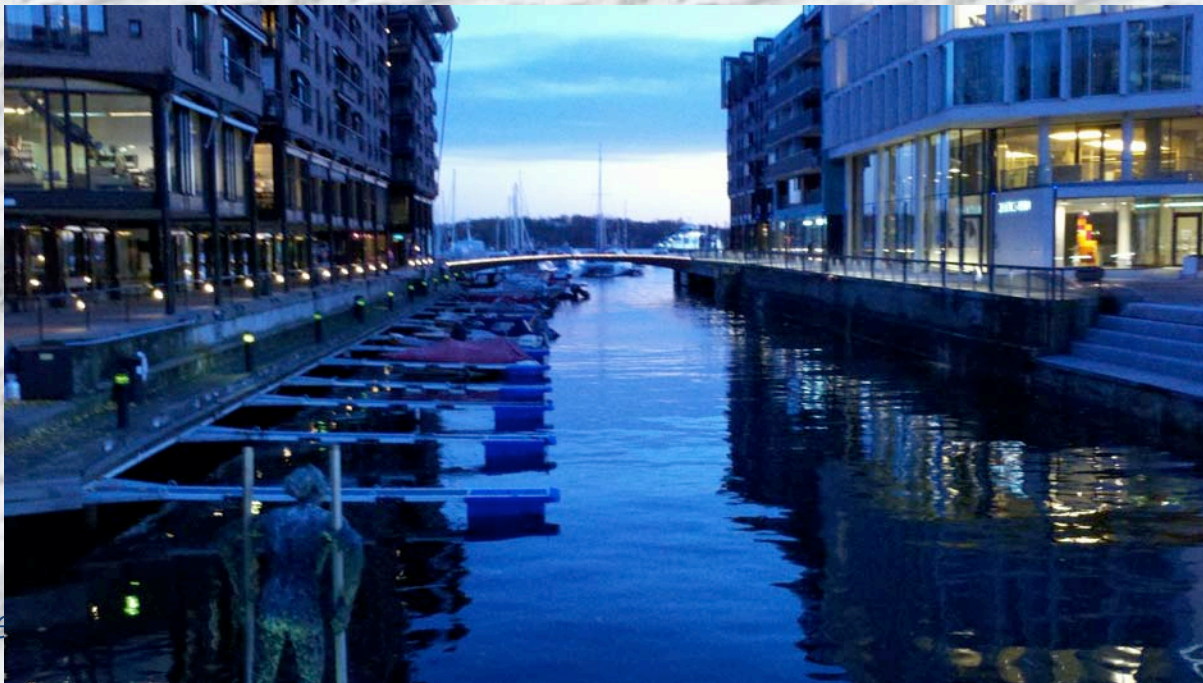


- Partial Tendon Lacerations

- Lacerations involving greater than 70% are repaired similar to complete lacerations
- Lacerations between 50 and 70% can be repaired with an epitendinous suture only
- Lacerations involving less than 50% should be debrided to smooth edges



- Flexor Sheath Repair?
 - There is no evidence that sheath repair improves outcomes, but this may be useful when it improves tendon gliding

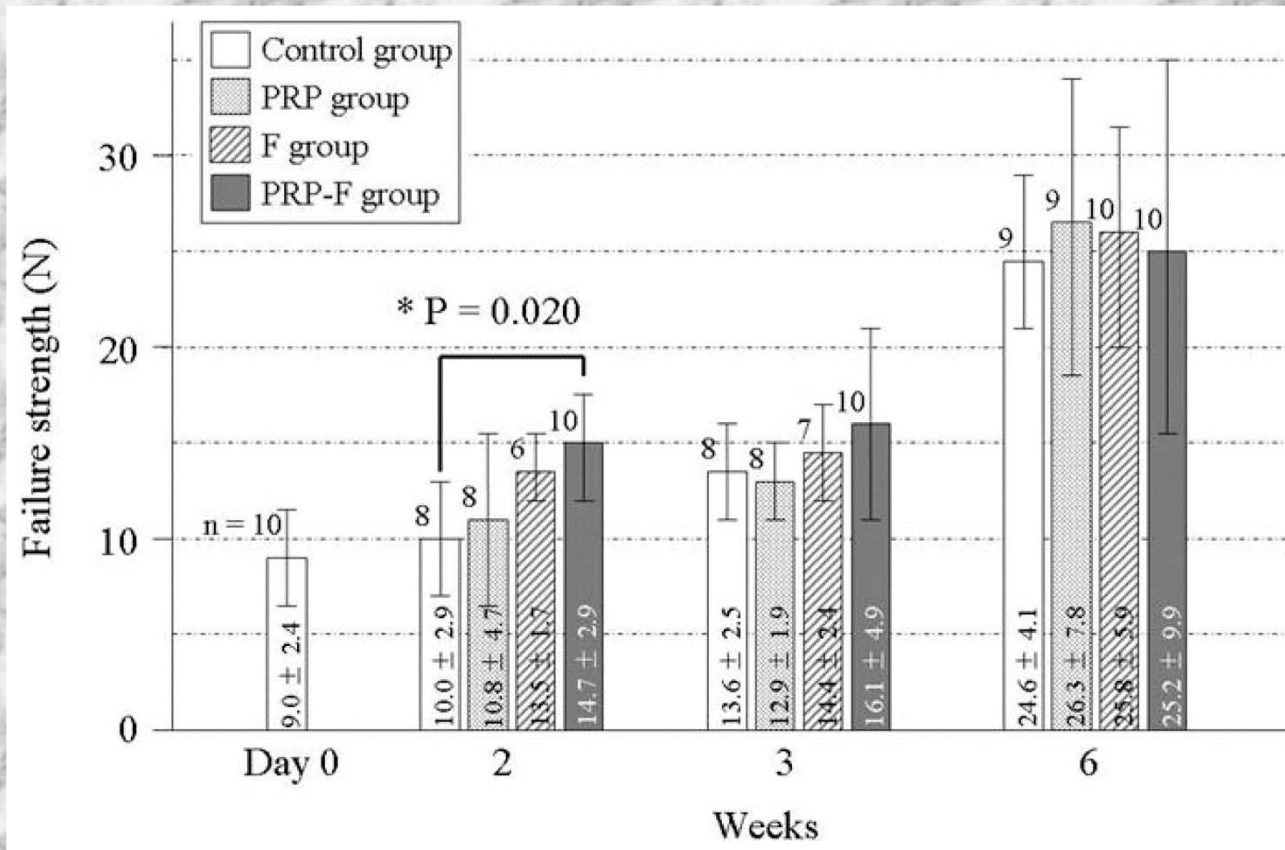


Platelet Rich Plasma

- Promote More Rapid Healing
- Up Regulate Transforming Growth Factor Beta
- Decrease Interleukin 1 Associated with Inflammation



FIGURE 1

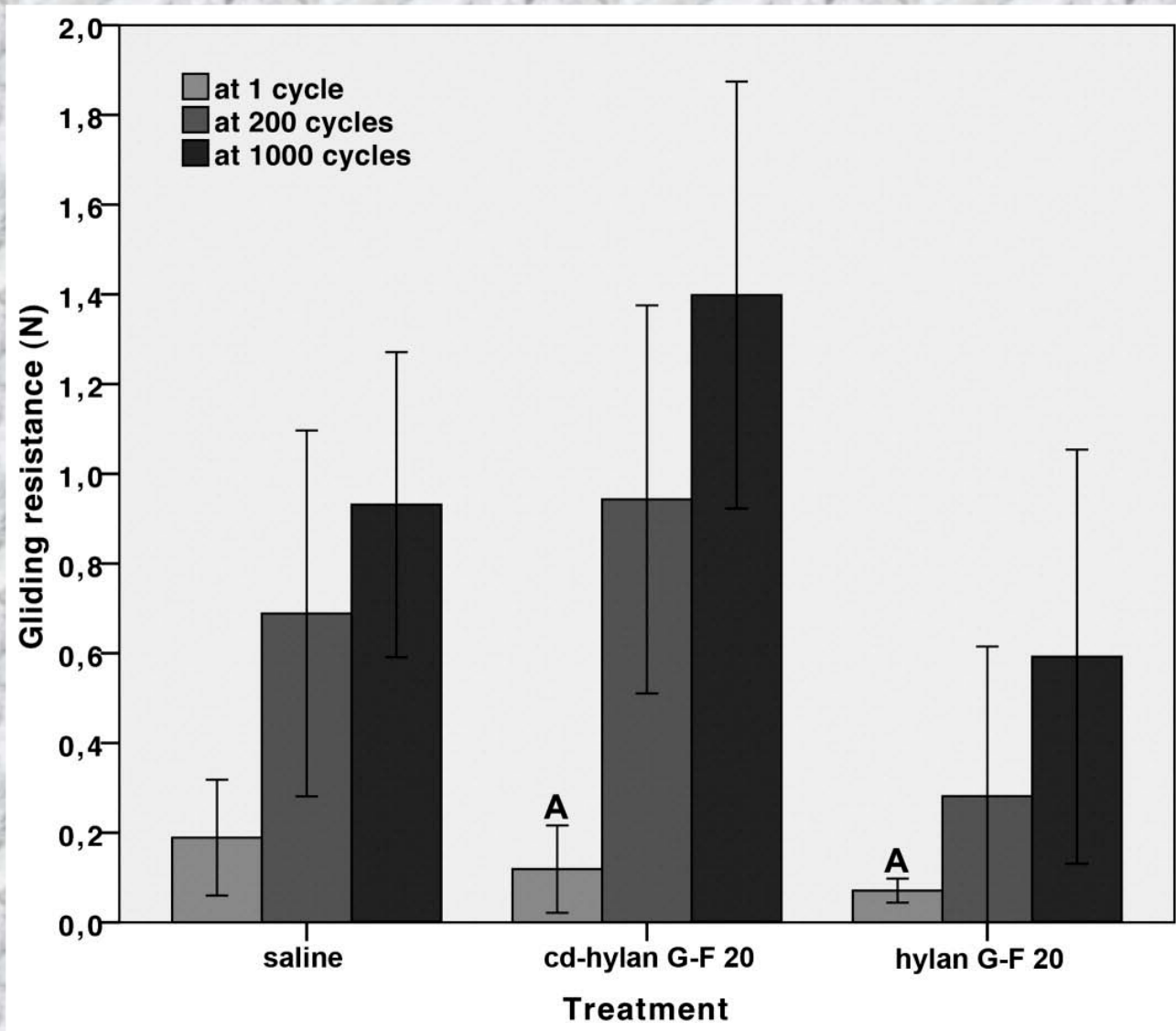


Tendon Gliding/Adhesions

- Hylan G-F 20
- PXL01

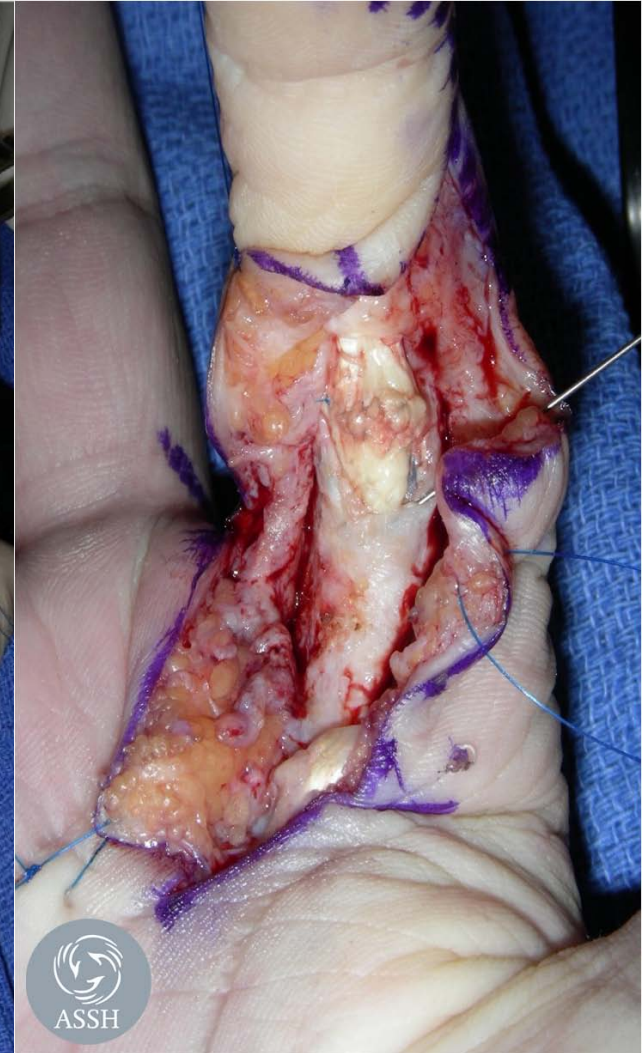
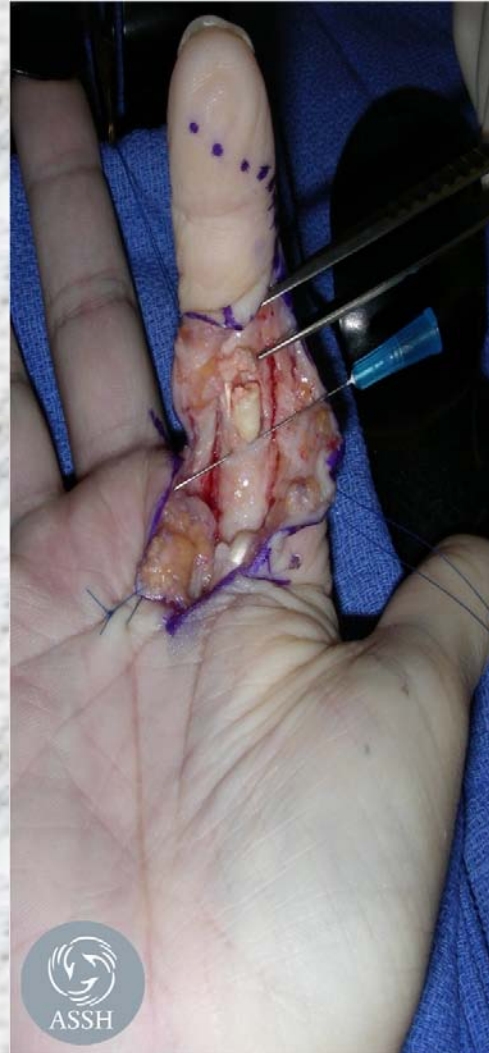


FIGURE 3



- Rupture

- Rupture in a compliant patient warrants exploration and re-repair
- In this situation, excision of the FDS may be indicated, depending on operative findings



- Flexor Tenolysis
 - Must have good passive motion of all affected joints
 - Therapy must have reached plateau (no further progress in with motivated, compliant patient)
 - Usually considered around 4-6 months



Flexor tendon repair

- Flexor Tenolysis

- Early rehabilitation, depending on operative findings, to minimize further adhesions
- This may involve full active motion or frayed tendon protocol with place and hold



Flexor tendon repair

Tendon Reconstruction

- Single Stage Intrasyovial vs Extrasynovial
- Two Stage Silicone Rod, Tendon



- One Stage Grafting and Pulley

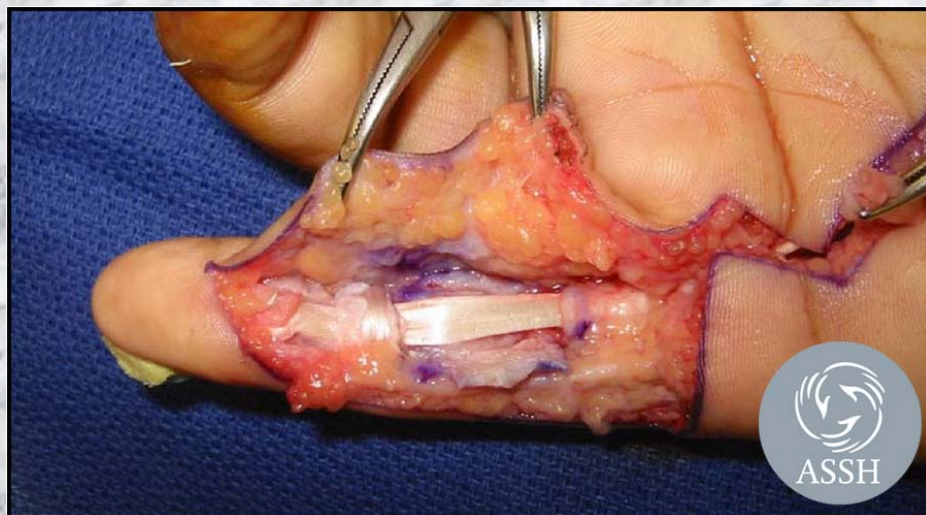
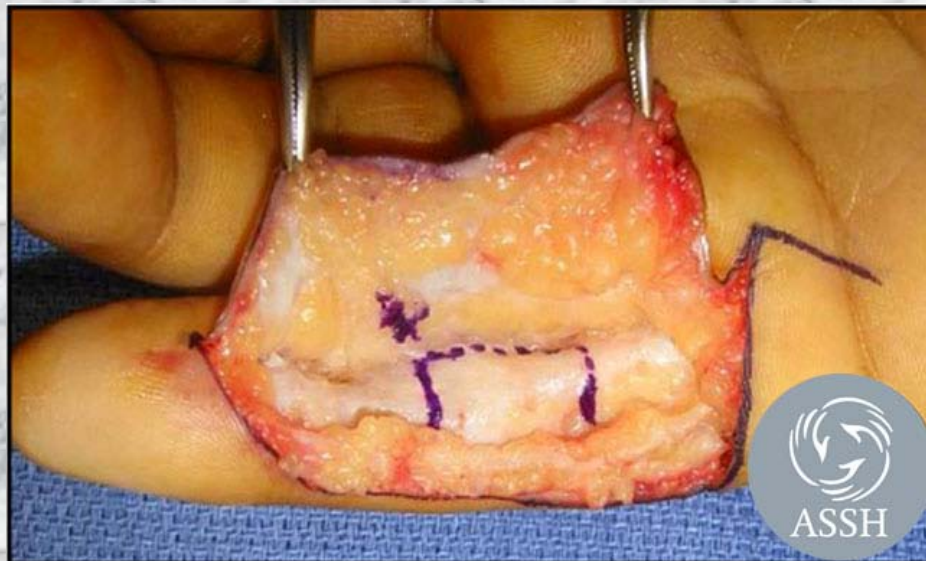
Reconstruction

- Donor tendon

- Intrasynovial
- Toe flexors

- Extrasynovial

- Palmaris
- Plantaris
- Toe extensors



Courtesy of Martin I. Boyer, MD

- Two Stage Grafting

- First stage involves silicone rod insertion and pulley reconstruction to create a new sheath
- Second stage involves placement of tendon graft into sheath created by silicone rod approximately four months later



Courtesy of Martin I. Boyer, MD

- Two Stage Grafting
 - Silicone rod is exposed distally, tendon graft is sutured to rod proximally and graft is pulled through newly formed sheath



Courtesy of Martin I. Boyer, MD

- Conclusions

- Repair both FDP and FDS tendons in zone II
- Consider excision of one slip of FDS to improve tendon gliding
- At least four strand repair with core and epitendinous sutures
- Early rehabilitation
- Early Active if Repair Strength Adequate



Questions

- Which of the following epitenon suture techniques has the lowest tensile strength?
- A. Interlocking Horizontal Mattress
- B. Cross-stitch
- C. Interlocking Cross stitch
- D. Silverskiold
- E. Simple Running
- (E)

Questions

- In a zone 2 FDS laceration the intact vincula tendinum can be responsible for proximal joint flexion of up to what percent of normal?
- A. 10%
- B. 33%
- C. 50%
- D. 74%
- E. 93%
- (E)

THANK YOU!

San Diego Museum of Man

INSTRUMENTS OF
TORTURE