Flexor Tendon Injuries

Mark E Puhaindran
Examination & Diagnosis

• Mechanism of injury and whether injury occurred in flexion or extension

• Examine before administration of anaesthesia/ sedation

• Examine integrity of volar and dorsal skin

• Look for deformity of the digit (angular/ rotational)
  – Fractures
  – Dislocations

• Alteration in resting posture
Examination & Diagnosis

• Examine for continuity of flexor tendons
  – FDS
    • Individual muscle bellies
    • Need to check each one separately
    • Need to isolate FDP action
  – FDP
    • Common muscle belly for MF/RF/LF
    • Need to check IF separately by O sign
      & absence of DIPJ flexion

Important:
• Absent/ common/ independent function of FDS LF
  (5%/ 27%/ 46%)
• Negative test does not rule out partial injury
• Active flexion against resistance to elicit pain in
  order to confirm partial injury is to be condemned
Examination & Diagnosis

• Examine digital neurovascular status
  – 2PD to assess radial and ulnar digital nerves
  – Pulp and nail bed capillary filling

• Structures to be assessed intra-op
  – Vincula
  – Parietal paratenon
  – Pulleys esp. A2 & A4
  – Volar plate
  – Extensor mechanism, esp. lateral bands

• Investigations
  – Plain radiographs (C-arm resolution inadequate for subtle bony injury & avulsion fractures)
  – Can consider USG/ MRI in cases of a rupture to localise proximal end
Examination & Diagnosis

• Difficult Situations

  – Children/ inebriated-non cooperative patients
    • Tenodesis effect on wrist flexion and extension
    • Compression of forearm flexor mass by examiner

  – Multiple level injuries
    • Proximally divided muscle belly
    • Proximal injury to nerve (check sensory component)

  – Watch out and plan for
    • Loss of pulleys
    • Distally based thin skin flaps over the digits and palm following a slicing/shaving injury
    • Crushing injury
    • Segmental loss of tendons
Zones of Flexor Tendon Injury

- Zone 1: FDP alone. Distal to insertion of FDS
- Zone 2: Beginning of flexor tendon sheath (distal palmar crease)
- Zone 3: Zone of lumbrical origin
- Zone 4: Carpal Tunnel
- Zone 5: Forearm
Zones of Flexor Tendon Injury

• Some Considerations

  – Blood supply poorer in Zones 1 & 2

  – Good blood supply in Zone 3, 4 & 5, but multiple structures

  – Zone classification does not depend on the skin wound, but upon where the cut tendon ends would lie, if the finger were extended
Surgical Considerations

• Timing of Repair
  – Primary tendon repair should be performed as early as possible
  – Delay of 24-72 hrs is not followed by poorer results
  – Flexor tendon surgery is not an emergency, unless complicated by vascular injury
  – Primary repair to be done only if infrastructure and trained surgeons are available. If not, refer to a better centre

  – How late can primary repair be done
    • Upper limit is three weeks before proximal myostatic contracture prevents bringing the divided ends together
Surgical Considerations

• Contraindications to Primary Repair

  – Combined injuries with substantial injury to two or more elements (skin/ bone/ nerve/ artery/ vein/ flexor/ extensor/ joint) with inability to repair traumatic tissues to allow post-operative mobilisation

  – Extensive contamination or deficiency of tissue

  – Purulent infection

  – Delayed presentation with unreliable history (prepare for tendon graft/ silicon rod insertion pre-op)
Surgical Considerations

• Incisions for Surgical Exposure
  – Type of incisions
    • Good exposure & Viability of skin flaps
    • Minimize scarring and contracture
    • Bruner vs. Mid lateral vs. Mid axial
Surgical Considerations

• Which side to extend first?
  – Flex the finger
    • If the distal end pops out easily, extend proximally (injury in extension)
    • If the distal end does not pop out, extend distally (injury in flexion)
Surgical Considerations

• Technique of tendon repair
  – No best suture material or suture technique (Elliot, JHSB, 2002)
  – Basic need is a Core suture and an epitendinous suture
  – What is proven – More tensile strength if
    • Multiple sites of tendon suture interaction
    • More number of suture strands crossing the repair
    • Dorsovolar location of the core suture
    • More cross-sectional area of tendon grasped or locked by the redirecting loop of suture
  – No effect of
    • Location of knot

• Commonest technique is the Tajima modification of a Kessler Core suture (3.0/4.0) with an epitendinous non locking continuous suture (5.0/6.0)
Surgical Considerations

• Technique of tendon repair
  – Difficult to translate biomechanical findings to help clarify clinical questions

  – Rupture rate of 5% and tenolysis rate of 5% for most series of primary zone 2 flexor tendon repairs regardless of method

  – Very little clinical work to justify laboratory work showing stronger multi-strand core sutures

  – The newer sutures are elaborate, difficult to insert neatly with precision the line diagrams suggest. Their use is complicated procedure even more so, especially since most primary tendon work is done by trainees worldwide (Elliot, JHSB, 2002)

  – Deformation/ bunching/ buckling and increased bulk are very likely. Friction tests should be considered compulsory for publication
Surgical Considerations

• Technique of tendon repair – Core Suture

- KESSLER GRASPING STITCH
- BUNNELL STITCH
- DOUBLE LOOP (Lee)
- DOUBLE GRASPING SINGLE SUTURE (Taras et al)
- TAJIMA STITCH
- TSUGE STITCH
- INTERLOCK STITCH (Robertson)
- DOUBLE GRASPING TWO SUTURES (Taras et al)
- KESSLER-TAJIMA STITCH
- BECKER (Bevel Technique)
- SINGLE-CROSS GRASP SIX-STRAND (Sadow)
- SIX-STRAND USING THREE SUTURE PAIRS (Lim and Tsai)

Figure 59-10. Commonly used techniques for end-to-end flexor tendon repair.
Surgical Considerations

• Technique of tendon repair – Epitendinous Suture

![Diagram of tendon repair techniques]

- Simple Running
- Running Lock Loop Suture (Lin)
- Cross-Stitch Epitendinous Repair Technique (Silfverskiold)
- Halsted Continuous Horizontal Mattress Suture (Wade)
- Horizontal Mattress Intrafiber Suture (Mashadi and Amis)
- Technique of tendon repair – Strength of Repair

Core Suture Only

<table>
<thead>
<tr>
<th>Technique</th>
<th>0 week</th>
<th>1 week (-50% )</th>
<th>3 week (-33%)</th>
<th>6 week (+20%)</th>
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<tr>
<td>Two strands</td>
<td>1800 g</td>
<td>900 g</td>
<td>1200 g</td>
<td>2200 g</td>
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<tr>
<td>Four strands</td>
<td>3600 g</td>
<td>1800 g</td>
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<td>4200 g</td>
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<td>Six strand</td>
<td>5400 g</td>
<td>2700 g</td>
<td>3600 g</td>
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• Technique of tendon repair – Strength of Repair
  Core + Epitendinous Suture

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<tr>
<td></td>
<td>2500 g (1800 g)</td>
<td>1200 g (900 g)</td>
<td>1700 g (1200 g)</td>
<td>2700 g (2200 g)</td>
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<tr>
<td>Four strands</td>
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<td></td>
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</tr>
<tr>
<td></td>
<td>4300 g (3600 g)</td>
<td>2150 g (1800 g)</td>
<td>2800 g (2400 g)</td>
<td>5200 g (4200 g)</td>
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<tr>
<td>Six strand</td>
<td></td>
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<tr>
<td></td>
<td>6000 g (5400 g)</td>
<td>3000 g (2700 g)</td>
<td>4000 g (3600 g)</td>
<td>7200 g (6500 g)</td>
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Surgical Considerations

• Technique of tendon repair
• How much strength is needed?

Tensile Stresses on Normal Flexor Tendons

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<tbody>
<tr>
<td>Passive motion</td>
<td>500 g</td>
</tr>
<tr>
<td>Light grip</td>
<td>1500 g</td>
</tr>
<tr>
<td>Strong grip</td>
<td>5000 g</td>
</tr>
<tr>
<td>Tip pinch- index FDP</td>
<td>9000 g</td>
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Special Situations

• Partial Tendon Lacerations

  – > 60% of cross sectional area
    • Standard repair technique

  – < 60% cross sectional area
    • No repair or debridement
    • Intervene only if there is evidence of triggering


  – 50% and 75% transverse volar laceration in AP diameter
  – 50% laceration able to withstand 117 N (in vivo force during active resisted flexion)
  – 75% laceration was able to withstand 34 N (in vivo unrestricted active finger movement)
Special Situations

• Flexor Tendon Rupture – Following H&L

– 77 yr old man with rupture of FDS & FDP of Lt middle finger 16 months after receiving two doses of H&L three
Special Situations

• Flexor Tendon Rupture – Following H&L

  – Intra sheath injection carries the risk of intra-tendinous injection

  – Intra-sheath injection has no benefit over extra sheath injection

  – Avoid intra-tendinous injection by passively/actively moving the finger after needle placement. This causes the needle to move slightly if the needle is in the tendon. It is then withdrawn gradually till the movement ceases.
Complications

• Rupture
  – Most dreaded complication
  
  – Digital extension at MP & IPJ combined with wrist extension maximises risk of gapping and rupture
  
  – Any motion of the wrist into extension beyond neutral is accompanied by passive placement of the digits into the flexed posture at the MCP, PIP, and DIP joints.
  
  – If rupture or substantial elongation occur up to 3 weeks postoperatively, or, in the case of zone I repairs if the dorsal button becomes loose, surgical exploration and re-repair is advocated.
  
  – If it occurs after 3 weeks postoperatively, the chances of a successful repair diminish. An attempt should be made, however, to explore the sheath and proceed with repair or reconstruction
Complications

• Adhesions

  – Tenolysis to be undertaken if

  • Serial joint measurements fail to demonstrate improved active digital motion despite continued therapy.

  • Full or nearly full passive digital flexion has been achieved

  • There is no dorsal impedance to passive and therefore active motion of the digit
Complications

• Joint Contractures
  – Usually follows rubber band mobilisation programmes
  – Gentle passive stretching exercises

• Quadrigia
  – Occurs when the shortened FDP of MF/RF/LF is advanced and sutured
  – Results in flexion contracture of the affected digit and weakness of distal flexion in the other digits
  – If the FPL or FDP of IF is sutured too tight, the other fingers are not affected and there will only be a flexion contracture of the affected digit