Hand Therapy Review Course
Curtis National Hand Center
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Extensor Tendon Rehabilitation
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Extrinsic Extensor Anatomy
- Central Slip
- Sagittal Bands
- Central Extensor (EDC + EIP/EDQ)

Intrinsic Extensor Anatomy
- Terminal Tendon
- Lateral Bands
- Lumbrical & Interossei

Juncturae Tendinum
- Broad intertendinous connections
- Connect RF to MF/SF
- Assist extension of adjacent digit by transferring forces during extension
- Laceration of an ET proximally to JT can mask the injury

Extensor Anatomy @ Hand
- EIP & EDC on ulnar side of EDC
- Juncturae tendinum
- EDC slips (variable)

Extensor Anatomy @ Wrist
- Need to consider gliding individual tendon in sheath and under retinaculum
Extensor Tendon Zones

- Zone I: DIP
- Zone II: Middle phalanx (P2)
- Zone III: PIP
- Zone IV: Proximal phalanx (P1)
- Zone V: MP
- Zone VI: Metacarpals
- Zone VII: Extensor retinaculum
- Zone VIII: Distal forearm
- Zone IX: Musculotendinous junction

It is much easier to prevent an extension lag than it is to fix one!

- The emphasis in therapy for all zones of injury is on maintaining extension while making gradual gains in flexion.

Work capacity

<table>
<thead>
<tr>
<th>Muscles and Sites</th>
<th>Max</th>
<th>Min</th>
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<tbody>
<tr>
<td>Flexor carpi radialis</td>
<td>0.8</td>
<td>0.2</td>
</tr>
<tr>
<td>Flexor carpi radialis longus</td>
<td>1.1</td>
<td>0.9</td>
</tr>
<tr>
<td>Flexor carpi ulnaris</td>
<td>1.1</td>
<td>0.1</td>
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<tr>
<td>Abductor pollicis longus</td>
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<td>0.1</td>
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<tr>
<td>Extensor pollicis longus</td>
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<tr>
<td>Extensor carpi ulnaris</td>
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<td>4.8</td>
</tr>
<tr>
<td>Extensor digitorum superficialis</td>
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<td>4.8</td>
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<tr>
<td>Extensor indicis proprius</td>
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<tr>
<td>Extensor pollicis brevis</td>
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<tr>
<td>Flexor digitorum communis</td>
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<td>0.8</td>
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- Flexors are 3-4 times stronger than the extensors
- Emphasize gradual gains in flexion while maintaining extension

Beware of the patient with that far away look in his eye

Therapy Management of Acute Extensor Ruptures

- Mallet Finger a.k.a. Baseball Finger
  - “Mallet” describes appearance of flexed DIP joint
  - Occurs from loss of extensor mechanism integrity at the base of the distal phalanx
Mallet Deformity with Swan Neck

- Watch for development of swan neck posture with hypermobile patients
- Splint PIP in 30-40 degrees of flexion, can be separate component
- Dorsal PIP splint makes performing PIP flexion ROM easier

Zone I and II

- skin maceration can be a problem
- pts. must be careful to avoid flexion during hand washing
- can line splints with moleskin to absorb perspiration
- can issue 2 splints- one for showering
- must adjust splint for edema, see patient more frequently during first week especially if it is a bony mallet
- Splint PIP in 30-40 flexion daytime if needed, and at night if patient is developing PIP hyperextension
Rehabilitation

- Gradual orthosis weaning
- 1st 2 weeks use PM and between exercises
- Gradually decrease wearing time
  - Morning, afternoon, evening.
  - Continue night splinting
- Composite flexion
  - Avoidance of isolated joint motion - 2 schools of thought here!
- Lateral tracing of digit to monitor lag

LAG

- Can be measured by:
  - goniometry
  - lateral tracings
- If lag increase by 5° or more, immobilize for 2 add’l weeks then restart protocol

Zone I and II

- Wk 7: 20-25° flexion
  - 10-20 reps hourly
- Wk 8: 35° flexion IF NO LAG!
  - use templates for the overly ambitious patient
  - resplint if lag develops
- Continue splint between exercise periods

Exercises:

- 7-8 weeks:
  - full fisting / hook fisting
  - blocking for DIP extension / flexion
- 10-12 weeks:
  - gentle passive DIP flexion (if no lag present)
- D/C day splinting at 8-10 weeks post injury
- Continue night splinting for add’l 4 wks. After day splint D/C’d

Gradually increase flexion

- Begin with rolling large cylinders
- Progress to rolling smaller cylinders
- Emphasis on maintaining extension
- Strengthen extensors prior to starting grip strengthening

Fig. 9. Application of the elastic tape to the Dorsum of the Fingers

Courtesy of Rebecca Neiduski
Boutonniere Deformity ("buttonhole")

- PIP flexion and DIP hyperextension
- Causes: central slip/triangular ligament rupture or PIP synovitis
- Lateral bands slide volar

Zone III/IV: Boutonniere Deformity

- Stage I
  - Dynamic boutonniere that is passively mobile
- Stage II
  - Established deformity that cannot be corrected passively
  - Immobilization of PIP in full extension for 6-8 weeks
  - Active flexion of DIP to maintain length of oblique retinacular ligament and facilitate gliding of lateral bands
  - Recommend reassessing the central slip function at 2-3 weeks and if the patient has active extension then start gradual remobilization using SAM or a relative motion MP flexion splint with continued use of PIP ext orthosis between exercises and PM

Zone III/IV: Boutonniere Deformity

- Stage III/IV
  - Established deformity with resultant structural changes of the PIP joint
  - Surgical release of PIP and correction of extensor mechanism as needed

Acute Extensor Ruptures

- Central slip injury with or without triangular ligament rupture
  - Elson's test can help determine if a boutonniere deformity is likely to occur if the PIP joint is not splinted/protected for a sufficient amount of time
  - When in doubt, assume worst injury until proven otherwise

Zone III/IV: Boutonniere Deformity

- Lateral bands transmit force towards PIP flexion and DIP hyperextension
- PIP flexion contracture
  - Pseudoboutonniere
    - DIP joint remains passively flexible
  - True boutonniere
    - The DIP joint cannot be passively flexed
Rehabilitation

• Achieve full passive PIP extension using dynamic, static progressive, serial static splints or casts
• Must be held in extension for 6 weeks prior to remobilization

Rehabilitation

• Aggressive DIP flexion with PIP supported in full extension during immobilization phase
• Begin Active PIP ext with just relaxing into flex and focus on active extension
• Orthotic use PM and when not performing exercises 4-5 times per day
  – Add passive PIP flexion
• Two weeks or more after splinting is discontinued
  • If flexion is not increasing (and extension remains good)
  • Monitor extension closely as activities in flexion progress

Relative motion splinting for boutonniere

For the passively supple boutonniere

• Splint MP of affected digit in 15-20° less MP extension and allow full excursion
• Splint PIP’s in extension at night for 10-12 weeks after initiating mobilization
• Splint PIP in ext intermittently daytime if there is a lag
• Chronic boutonnieres – require orthotic or casting to restore passive ext first, may require use of relative flexion splint for 3 months after initiating mobilization phase
• Merritt recommends accepting a 30° lag with chronic bouts who plateau during attempts at regaining full extension, then full time use of Relative Extension splint for 3 months

Name this deformity

Therapy Management of Acute Extensor Lacerations
Protocols = Guidelines

- Types of Protocols
  - Static immobilization
    - Used for young, cognitively impaired or uncooperative patients
  - Early Controlled Mobilization
    - Used for zones III-VIII
  - Early Active Mobilization
    - Used for zones III-VIII

Rehabilitation zones III, IV

- Immediate passive extension
  - Outrigger orthosis supporting the PIP at 0° with rubber band traction
  - 30 degrees of flexion or more allowed at PIP joint initially
    - JH 1994
    - Thomas, 1994
  - Gradually increase flexion excursion
  - Start AROM at 5 weeks per Thomas
  - Protective splinting 0°-3° at 6 weeks

- Relative Motion Flexion orthosis blocking MP in slight flexion to facilitate IP ext through Interossei and lumbrical (not the standard of care for acute repairs)
  - This orthosis can be used following D/C of the dynamic orthosis to help decrease extension lag if present.

Early Short Arc Motion of the Repaired Central Slip
Evans JHS 1994

<table>
<thead>
<tr>
<th>Results</th>
<th>Group</th>
<th>Immobilization</th>
<th>Group</th>
<th>SAM</th>
<th>Statistical Significance or Trend</th>
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<td>Mean day injury to D/C</td>
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<td>51.38</td>
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<td>PIP not lag 1st Motion day</td>
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<td>&lt;0.001</td>
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<tr>
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<td>13.1°</td>
<td>2.3°</td>
<td>&lt;0.01</td>
<td>$</td>
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<td>PIP motion at 6 wks</td>
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<td>$</td>
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<tr>
<td>PIP motion D/C</td>
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<td>88°</td>
<td>&lt;0.001</td>
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<tr>
<td>TAM at D/C</td>
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<td>155, 59</td>
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<tr>
<td>DIP motion D/C</td>
<td>37, 63</td>
<td>45</td>
<td>&lt;0.01</td>
<td>$</td>
<td></td>
</tr>
</tbody>
</table>

Rehabilitation zones III, IV

- Short arc motion (SAM)
  - Evans JHS 1994
  - McAuley JHS 2011
  - PIP and DIP (unstable) at 0° extension between exercises
    - Wrist positioned in 30 degrees flex, MP's neutral for exercises
      - Template with 30° PIP and 20° DIP flexion
      - Finger flexion to the template with active extension to 0°
      - 10-20 reps every 1-2 hours
      - Template progressed weekly
      - IF lateral bands were repaired DIP flex is limited to 30° with the PIP at neutral
• Brand noted that no other area in the human body has a ratio of tendon to bone as unfavorable as it is over the proximal phalanx
• Intimacy of periosteum and extensor mechanism as well as gliding requirements in this area make it prone to functional deficits due to adhesions.

Zone V-VII: Immediate Passive/Active Extension

- Dynamic extension splint
  - Volar block/stop allowing 30° MP flexion
  - Volar forearm based resting splint with MP's at neutral
- Evans & Thompson, 1993
  1. Passive wrist extension, MP's relax to 40°
  2. Wrist relaxes to
    - 0° to 20° flexion (Zones V-VI)
    - 10° extension (Zone VII)
    - 20° extension if wrist extensors are repaired

Rehabilitation

- Initiate AROM carefully at 3 weeks continuing splint use PM and after exercises 4-5 times per day
  - MP flexion with IPs extended
  - “Hook fist”: PIP/DIP flexion with MP extension
  - Progress to composite digital AROM after 4 weeks
  - Progress to composite wrist and digital flexion at 5 weeks
  - Monitor extensor lags closely
  - Timely initiation of scar management
  - D/C splint generally at 6 wks, wrist ext repairs require protection for 2 additional weeks due to the work demands on the wrist

Extensor Anatomy @Zones VI, VII

Need to consider individual gliding of tendons in the sheaths and under the retinaculum.
Immediate Controlled Active Motion (ICAM)

- Concept based on “relative motion” of the MP joint
- Wrist placed at 20-25° extension
- MPs in 15-20° more extension relative to other MP joints

ICAM Protocol

- Inclusion criteria
  - Injury to at least one but not all extensor tendon(s) in zone 4-7
  - 2 visits in first 10 days
  - 1 visit per week thereafter
- Phase 1
  - 0-21 days post repair
  - Edema and scar management
  - Both splint components worn continuously
  - Goal: Full active motion within limits of splint
- Phase 2
  - 22-35 days post repair
  - Yoke splint worn at all times
  - Wrist splint removed for active wrist motion
  - Goal: Composite wrist/digit flexion and extension without extensor lag
- Phase 3
  - 36-49 days post repair
  - Wrist splint discarded; yoke or buddy strap worn during activity
  - Yoke splint removed for active digital motion
ICAM Outcomes

- Robinson et al., 1986
  - ASHT Annual Meeting, New Orleans
  - 22 patients
  - "full ROM within 5 weeks of surgery, joint stiffness was nonexistent and no patient required a therapy program after removal of the splint"

- Howell et al., 2005
  - 140 patients
  - No extension lag: 114 patients
  - 5-10° lag: 21 patients
  - 11-44° lag: 5 patients
  - Average discharge 49 days
  - No complications or secondary surgeries

Thumb zones

- T1 – treat similar to mallet if closed, 6-8 wks continuous immobilization; if repaired 5-6 weeks of immobilization
- Always check the amount of IP ext present on the uninjured thumb
- Require 4 more weeks of orthotic use once mobilized
- Gradual increments of flex as long as extension is maintained
- Mild resistive pinch/grip between 6-8 weeks dependent on if a lag is present
- T2 – hand based splint MP/IP at neutral with radial extension
- Short Arc active motion 25-30° at 3 wks; continue orthotic use PM and post ex for 6 weeks

Thumb zones

- T3,4 – forearm based splint wrist 30 degrees, MP neutral and slight CMC abduction
- T5 early motion should be considered to prevent dense adhesions at the retinaculum
- Evans and Burkhalter found intraoperatively that with wrist neutral and MP neutral 60° IP flex created 3-5 mm glide at Lister’s tubercle
- Use dynamic ext orthosis
- Passive motion in therapy of 30°- MP flex with wrist/IP extended; wrist tenodesis with thumb in ext from full ext to 0°
Evaluating outcomes

<table>
<thead>
<tr>
<th>TABLE 20-1</th>
<th>Miller's Classification of Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Results</td>
<td>Total Extensor Lag (Degrees)</td>
</tr>
<tr>
<td>Excellent</td>
<td>0</td>
</tr>
<tr>
<td>Good</td>
<td>≤10</td>
</tr>
<tr>
<td>Fair</td>
<td>11-45</td>
</tr>
<tr>
<td>Poor</td>
<td>≥45</td>
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</table>

From Miller H: Surgery of the hand; 1942;75:693-698.

Extensor tendon management references:

Outcomes of Extensor Tendon repair
Newport, Blair et al JHS Nov 1990

- % of digits losing flexion
- > % losing extension
- More distal zones have significantly > number of poor results (I-V)
- Zone V: 83% Good – Excellent
  - When associated with a fracture results dropped to 50% (G-E)