MANAGEMENT OF EXTENSOR TENDON INJURY BY ZONES

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May 6, 2016

Extrinsic Extensor Anatomy

Central Slip
Sagittal Bands
Central Extensor (EDC + EIP/EDQ)

Intrinsic Extensor Anatomy

Terminal Tendon
Lumbral & Interossei

Extensor Anatomy @ Hand

1st: APL/EPB
2nd: ECRL/ECRB
3rd: EPL
4th: EIP/EDC
5th: EDQ aka EDM
6th: ECU

Need to consider gliding individual tendon in sheath and under retinaculum

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
Therapy Management of Acute Extensor Lacerations

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

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

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

- Flexors are 3-4 times stronger than the extensors
- Emphasize gradual gains in flexion while maintaining extension

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Work Capacity of Muscles</th>
<th>Mkg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexor carpi radialis</td>
<td>0.8</td>
<td></td>
</tr>
<tr>
<td>Extensor carpi radialis longus</td>
<td>1.3</td>
<td></td>
</tr>
<tr>
<td>Extensor carpi radialis brevis</td>
<td>0.9</td>
<td></td>
</tr>
<tr>
<td>Extensor carpi ulnaris</td>
<td>1.1</td>
<td></td>
</tr>
<tr>
<td>Flexor pollicis longus</td>
<td>0.1</td>
<td></td>
</tr>
<tr>
<td>Flexor digitorum profundus</td>
<td>1.2</td>
<td></td>
</tr>
<tr>
<td>Flexor digitorum superficialis</td>
<td>4.5</td>
<td></td>
</tr>
<tr>
<td>Brachioradialis</td>
<td>4.8</td>
<td></td>
</tr>
<tr>
<td>Flexor carpi ulnaris</td>
<td>1.9</td>
<td></td>
</tr>
<tr>
<td>Abductor pollicis brevis</td>
<td>2.0</td>
<td></td>
</tr>
<tr>
<td>Palmaris longus</td>
<td>1.2</td>
<td></td>
</tr>
<tr>
<td>Extensor pollicis longus</td>
<td>0.1</td>
<td></td>
</tr>
<tr>
<td>Extensor digitorum communis</td>
<td>1.7</td>
<td></td>
</tr>
</tbody>
</table>

Rehabilitation Zones III-IV

- Conservative management
  - PIP joint immobilization at 0° extension 6-8 weeks
  - Initiate AROM at 6-8 weeks
  - Orthosis use in between exercises and PM
  - Gradually increase flexion activities while monitoring extension lag
  - D/C of orthosis determined by AROM and response to exercise/functional use of hand

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
  - Heal et al., JAM 1994
  - Thomas, JAM 1994
- Gradually increase flexion excursion
- Start AROM at 5 weeks per Thomas
- Protective splinting O/C at 6 weeks

Relative Motion Flexion orthosis blocking MP in slight flexion to facilitate IP ext through interossei and lumbral.
This orthosis can be used following O/C of the dynamic orthosis to help decrease extension lag if present.

Early Active Short Arc Motion Following Central Slip Repair

John A. McAuliffe, MD  JHS  Jan 2011

### Rehabilitation zones III, IV

- Short arc motion (SAM)
  - Evans JHS Nov 1994
  - McAuliffe JHS Jan 2011

- PIP and DP immobilized at 0° extension between exercise
- 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 MP at neutral

<table>
<thead>
<tr>
<th>Results</th>
<th>Group I</th>
<th>Group II</th>
<th>Statistical Significance on T Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean-day</td>
<td>76.07</td>
<td>51.30</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>PIP at 1° Motion-day</td>
<td>27°</td>
<td>23°</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Tend ext at O/C</td>
<td>3.19°</td>
<td>2.96°</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>PIP motion at 30°</td>
<td>46°</td>
<td>53°</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>PIP motion at 5°</td>
<td>72°</td>
<td>88°</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>TMA at O/C</td>
<td>111.39°</td>
<td>122.13°</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>DR motion O/C</td>
<td>37.63°</td>
<td>25°</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>

Early Active Short Arc Motion Following Central Slip Repair  
John A. McAuliffe, MD  JHS  Jan 2011
Zone V: MP Joint

- 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

MPJ: IF/MF 30°, RF/SF 40° create 3-5 mm glide in ZONE V

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, MPs 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
- MPJs 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
ICAM Protocol

- **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

ICAM Outcomes

Original article

Early return to work and improved range of motion with modified relative motion splinting: a retrospective comparison with immobilization splinting for zones V and VI extensor tendon repairs

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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°;
Early active motion for EPL Zones T III-V

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>
</tr>
</tbody>
</table>


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-IV)
- Zone V: 83% Good – Excellent
  - When associated with a fracture results dropped to 50% (G-E)

Time to chill for a few minutes!