EXTENSOR TENDON INJURIES

6TH ANNUAL MEETING:
HAND THERAPY ASSOCIATION OF NORTHERN
CALIFORNIA

Andrew J. Watt MD
The Buncke Clinic
DISCLOSURES:

I have no personal or financial interest in the products contained within this presentation.

All identifiable photos utilized with permission.
GOALS & OBJECTIVES:

• To review the **Anatomy and Biomechanics** of the Extensor Mechanism

• To understand the Management of **Acute and Chronic** Deformities Resulting from Injuries to the Extensor Mechanism
  – Techniques
  – Indications
  – Contraindications
  – Optimizing Success
ANATOMY OF THE EXTENSOR MECHANISM:

- All Extensor Musculature Innervated By Branches of the Radial Nerve (C6-C8)

- 2 Dorsal Forearm Compartments
  - **Superficial:**
    - Origin From Lateral Humeral Epicondyle
    - ECRL, ECRB, ECU, EDC & EDM
  - **Deep:**
    - Origin from Radius, Ulna, IOM
    - APL, EPB, EPL, EIP
ANATOMY OF THE EXTENSOR MECHANISM:

- 2 Notable Anatomic Variations:

1. Accessory Extensor Carpi Radialis Intermedius (12%)

2. Extensor Medii Proprius (10%)
ANATOMY OF THE EXTENSOR MECHANISM:

- Extensor Retinaculum:
  - Radial Palmar Radius to Pisiform/Triquetrum

- Extensor Compartments: Fibro-osseous tunnels
  1. APL, EPB
  2. ECRL, ECRB
  3. EPL
  4. EDC, EIP
  5. EDM*
  6. ECU

* 5th compartment is unique as a fibrous tunnel without bony attachment
ANATOMY OF THE EXTENSOR MECHANISM:

- *Juncturae Tendinae (Connexus Intertendinei)*
  
  - Vary in thickness from filamentous band to tendinous band
  
  - A, B, C

- 3 Primary Biomechanical Functions
  1. Stabilization
  2. Force Distribution
  3. Coordination of Tendon Movements
ANATOMY OF THE EXTENSOR MECHANISM:
ANATOMY OF THE EXTENSOR MECHANISM:
ANATOMY OF THE EXTENSOR MECHANISM:
ANATOMY OF THE EXTENSOR MECHANISM: FUNCTIONAL SUMMARY

**Proximal Phalanx:** EDC tendon via the sagittal bands

**Middle Phalanx:** Central slip in conjunction with lateral bands

**Distal Phalanx:** Terminal extensor tendon
ANATOMY OF THE EXENSOR MECHANISM: TRANSVERSE RETINACULAR LIGAMENT
BIOMECHANICS OF THE EXTENSOR MECHANISM

- Tendon Length is Critical
  - Less Excursion compared with flexor tendons
    - Active 2-3cm
    - Combined 5cm
    - Primarily proximal to wrist
  - Heavily reliant on “Tenodesis” effect (position of wrist)
  - Intricate balance within the finger
    - Intrinsic
    - Extrinsic
EXTENSOR INJURIES:
EXTENSOR INJURIES:
EPIDEMIOLOGY

• Patillo & Rayan
  – 125 tendons

• Predominately Male: 83%

• Mean Age: 34.2

• Dominant Extremity: 60%

• Zone V laceration most common injury

• Distribution of Injury:
  – Thumb: 25.7%
  – Long Finger: 24.8%
  – Small Finger: 10.5%

• Complex injuries more common distal to the MCP

• Lacerations more common proximal to the MCP

EXTENSOR INJURIES: ZONES OF INJURY

1: Overlies DIPJ
2: Overlies Middle Phalanx
3: Overlies PIPJ
4: Overlies Proximal Phalanx
5: Overlies MCPJ
6: Overlies Metacarpal
7: Overlies Carpus, Underlies Extensor Retinaculum
8: Overlies Distal Forearm
EXTENSOR TENDON INJURIES: ZONE 1

• **Acute Injury: Mallet Finger**
  – *Injury to the terminal tendon*

• **Doyle Classification**
  – Type 1: Closed
  – Type 2: Open
  – Type 3: Open with loss of skin & tendon substance
  – Type 4: Mallet Fracture
EXTENSOR TENDON INJURIES: ZONE 1

- Management Considerations:
  - Nature of Injury
    - Open vs. Closed
    - Soft tissue Envelope
  - Reliability & Preference of Patient

- Closed Treatment:
  - 15° Hyperextension x 6 weeks (if bony), 8 weeks if soft tissue
  - Night splint x 6 weeks
EXTENSOR TENDON INJURIES: ZONE 1

- **Surgical Indications**
  - Open Injuries
  - Associated Soft Tissue Loss
  - Fracture Fragment >30-50%*
  - Subluxation of the distal interphalangeal joint.
  - Occupation requiring frequent use of hands or inability to tolerate (or comply) with a splinting
EXTENSOR TENDON INJURIES:
MALLET FRACTURE TECHNIQUE
EXTENSOR TENDON INJURIES: ZONE 2

- **Acute Injury:**
  - Laceration of the extensor tendon over the middle phalanx
  - Often associated with skin and skeletal injury

- **Management:**
  - Operative Repair
  - DIP joint immobilized with K-wire x 6 weeks
  - AROM, PROM at PIP and MCP allowed
  - Night extension splint x additional 6 weeks
EXTENSOR TENDON INJURIES: ZONE 3

• **Acute Injury:** Central Slip Disruption
  – Closed vs. Open
  – Volar PIP Joint Dislocations

• **Presentation:**
  – PIP swelling
  – Mild extensor lag with weak extension against resistance
  – + Elson Test

• **Management:**
EXTENSOR TENDON INJURIES: ZONE 3

• Management:
  
  – Closed:
    • *PIP extension splint* x 6 weeks
    • *Night splint* x 4-6 weeks
  
  – Open:
    • *Laceration*
    • *Avulsion +/- Fracture*
    • *Tendon Loss*
EXTENSOR TENDON INJURIES: ZONE 3

- **Management:**
  - Reconstruction with Tendon Loss
    - Palmaris Graft with suture anchor
    - Lateral Band Centralization
    - Central Slip Turndown (Snow Repair)
EXTENSOR TENDON INJURIES: ZONE 3

- Management:
  - Reconstruction with Tendon Loss
    - Palmaris Graft with suture anchor
    - Lateral Band Centralization
    - Central Slip Turndown (Snow Repair)
EXTENSOR TENDON INJURIES: ZONE 4

• **Acute Injury:**
  – Uniformly an open injury
  – Laceration of the extensor tendon over the proximal phalanx

• **Management:**
  – Tendon is broad and flat
    • Partial laceration
    • Stronger repair
    • Prone to Adhesions
  – Amenable to Early Mobilization so long as skeletal stability is present or achieved
EXTENSOR TENDON INJURIES: ZONE 5

• **Acute Injury:**
  
  *Most Common Level of Injury*
  
  – Laceration
  
  – Fight Bite
  
  – Sagittal Band Injury

• **Management:**
  
  – Laceration = Repair & Early Mobilization
  
  – Sagittal Band Injury
EXTENSOR TENDON INJURIES: ZONE 5

- **Sagittal Band Injury:**
  - **Mechanism:** Blunt trauma to the MCP joint
  - Almost exclusively the *radial* sagittal band
  - **Presentation:**
    - Extensor Lag
    - Tenderness over sagittal band
    - +/- Subluxation
    - “Snapping” associated with discomfort
EXTENSOR TENDON INJURIES: ZONE 5

- **Sagittal Band Injury:**
  - **Mechanism:** Blunt trauma to the MCP joint
  - Almost exclusively the radial sagittal band

- **Presentation:**
  - *Extensor Lag*
  - Tenderness over sagittal band
  - +/- Subluxation

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type I</td>
<td>Contusion without tear</td>
<td>RMES until nontender</td>
</tr>
<tr>
<td>Type II</td>
<td>Partial Subluxation</td>
<td>RMES x 6-8 weeks</td>
</tr>
<tr>
<td>Type III</td>
<td>Complete Subluxation</td>
<td>MCP Ext splint x 6 weeks</td>
</tr>
</tbody>
</table>

RMES = relative motion extension splint
EXTENSOR TENDON INJURIES: ZONE 5

• **Sagittal Band Injury:**
  – Surgical Indications & Management
    • Failure of nonoperative management
      – Type II & III injuries
    • Delayed presentation (>3-4 weeks post injury)
EXTENSOR TENDON INJURIES: ZONE 5

- *Sagittal Band Reconstruction:*

- *Multiple reconstructive options*

- *Kang & Carlson (2010)*
  - *Palmaris Longus Tendon Graft*
  - *1.6mm Bone Tunnel*
  - *Immobilize 1 week*
  - *RMES x 4-6 weeks*

Kang L, Carlson MG. Extensor Tendon Centralization at the Metacarpophalangeal Joint: Surgical Technique, JHS (35A), 1194-1197.
EXTENSOR TENDON INJURIES: ZONE 5

• Sagittal Band Reconstruction:

• Multiple reconstructive options

• Kang & Carlson (2010)
  – Palmaris Longus Tendon Graft
  – 1.6mm Bone Tunnel
  – Immobilize 1 week
  – RMES x 4-6 weeks

Kang L, Carlson MG. Extensor Tendon Centralization at the Metacarpophalangeal Joint: Surgical Technique, JHS (35A), 1194-1197.
EXTENSOR TENDON INJURIES: ZONE 5

- Sagittal Band Reconstruction:

- Multiple reconstructive options

- Kang & Carlson (2010)
  - Palmaris Longus Tendon Graft
  - 1.6mm Bone Tunnel
  - Immobilize 1 week
  - RMES x 4-6 weeks

Kang L, Carlson MG. Extensor Tendon Centralization at the Metacarpophalangeal Joint: Surgical Technique, JHS (35A), 1194-1197.
EXTENSOR TENDON INJURIES: ZONE 5

- **Sagittal Band Reconstruction:**
- **Multiple reconstructive options**
- **Kang & Carlson (2010)**
  - *Palmaris Longus Tendon Graft*
  - *1.6mm Bone Tunnel*
  - *Immobilize 1 week*
  - *RMES x 4-6 weeks*

Kang L, Carlson MG. Extensor Tendon Centralization at the Metacarpophalangeal Joint: Surgical Technique, JHS (35A), 1194-1197.
EXTENSOR TENDON INJURIES: ZONE 6-8

• **Acute Injury:**
  – Typically open, sharp lacerations
  – Tendon Loss in degloving injuries

• **Management:**
  – Primary Repair
  – Tendon Grafting
  – Tendon Transfers
CHRONIC EXTENSOR DEFORMITIES

- **Swan Neck Deformity**
  - Results from Chronic Disruption or Lengthening of the **Terminal Tendon**

- **Boutonniere Deformity**
  - Results from Chronic Disruption or Attenuation of **Central Slip**

- Both Represent Flexion Deformities with Subsequent Hyperextension (compensation)
SWAN NECK DEFORMITY

• **Inciting Causes:**

  – **Mallet Injury**

  – **PIP Laxity**
    • **Attenuation of Volar Plate**
    • **FDS rupture or loss**

  – **Intrinsic Tightness +/- MCP subluxation**
SWAN NECK DEFORMITY

• Characteristics:
  – Loss of DIP extension
  – Imbalance of Extension force at the PIP joint.
  – Hyperextension and diminished active and passive flexion at the PIP joint
SWAN NECK DEFORMITY

Disruption of Terminal Tendon
1. Closed Injury
2. Laceration
3. Infection
4. Inflammatory Arthritis

Lateral Bands Retract Proximally
* Exert at greater extension force on the PIP joint

Volar Plate Attenuation
Hyperextension of the PIP joint
SWAN NECK DEFORMITY

• Treatment Considerations:

  – Timing of Injury / Deformity
    • Acute (<2 weeks)
    • Subacute (2-8 weeks)
    • Chronic (>8 weeks)

  – Condition of Soft Tissues

  – PIP Joint
    • Supple or Fixed
    • Arthritis
SWAN NECK DEFORMITY

- **Acute Injury (<2 weeks)**

- **Critical Distinction**
  - **PIP in origin**
    - *Dorsal Blocking Splint x 4 weeks*
    - *Fixation of PIP fracture*
  - **DIP in origin**
    - *Closed: Mallet Tx*
    - *Open: Repair + Transarticular K-wire*
SWAN NECK DEFORMITY

- **Subacute Injury (2-8 weeks)**

- **Critical Distinction is whether or not the PIP joint is supple**
  - **Supple:** Tx like acute injury
  - **Stiff:** PIP Dorsal Block + DIP transarticular K-wire
**SWAN NECK DEFORMITY**

- *Chronic Injury (>8 weeks)*

- *Treatment is much more complex and results are much less predictable.*

- *Must address 3 critical components:*
  - DIP flexion
    - Tendon Repair
    - Arthrodesis
  - PIP joint Hyperextension
  - PIP joint (+/- arthrosis)
BOUTONNIERE DEFORMITY

- Mason 1930

- "It is the middle portion of the dorsal aponeurosis which ruptures, the two lateral slips now loosen from their attachment about the joint slip palmarward, and the joint comes to lie between them as in a "buttonhole."

BOUTONNIERE DEFORMITY

• Characteristics:
  – Weakness and loss of extension at PIP joint
  – Hyperextension and diminished active and passive flexion at the DIP joint
BOUTONNIERE DEFORMITY

Disruption of Central Slip
1. Closed Injury
2. Laceration
3. Infection
4. Inflammatory Arthritis

Disruption of Triangular Ligament
1. Injured with Central Slip
2. Attenuated

Volar Migration of Lateral Bands
* Move volar to the axis of rotation of the PIP joint.
Mechanically become a flexor of the PIP joint rather than an extensor

Contracture of ORL, CL & Volar Plate

Boutonniere Deformity

Tear in Central Slip

PIP Joint in Flexion

DIP in Hyperextension
BOUTONNIERE DEFORMITY

Boutonniere Deformity

Tear in Central Slip

PIP Joint in Flexion

DIP in Hyperextension
BOUTONNIERE DEFORMITY

- Treatment Considerations:
  - Timing of Injury / Deformity
    - Acute (<2 weeks)
    - Subacute (2-8 weeks)
    - Chronic (>8 weeks)
  - Condition of Soft Tissues
  - PIP Joint
    - Supple or Fixed
    - Arthritis
BOUTONNIERE DEFORMITY

• Acute Injury (<2 weeks)

• Closed
  – PIP extension splint with DIP free
  – 4 weeks

• Open Laceration (Zone 3)
  – Open Repair: Primary, Graft, Suture Anchor or Reconstruction

• Fracture
  – Open Repair
BOUTONNIERE DEFORMITY

- **Subacute Injury (2-8 weeks)**

- **Critical Distinction is whether or not the PIP joint is supple**
  - **Supple:** Tx like acute injury
  - **Stiff:** Static Progressive Extension splint or Serial Cast
BOUTONNIERE DEFORMITY

- Chronic Injury (>8 weeks)

- Treatment is much more complex and results are much less predictable.

- Must address 3 critical components:
  - Triangular ligament attenuation
  - Volar Migration of Lateral Bands
  - PIP joint (+/- arthrosis)
THANK YOU