### Red Flags for Potential Serious Conditions in Patients with Elbow, Wrist, or Hand Problems

<table>
<thead>
<tr>
<th>Condition</th>
<th>Data obtained during Interview/History</th>
<th>Data obtained during Physical Exam</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compartment Syndrome² ¹</td>
<td>History of trauma, surgery or extreme unaccustomed activity \ Persistent forearm pain and “tightness” \ Tingling, burning, or numbness</td>
<td>Palpable tenderness and tension of involved compartment \ Pain intensified with stretch to involved muscles \ Paresthesia, paresis, and sensory deficits \ Diminished pulse and prolonged capillary refill</td>
</tr>
<tr>
<td>Space Infection of the Hand³</td>
<td>Recent cut, scrap, or puncture wound, such as a human or animal bite \ Typical symptoms of infection and inflammation</td>
<td>Kanavel cardinal signs: 1) flexed posture of the digit, 2) uniform swelling of the digit, 3) tenderness over the length of the involved tendon sheath, and 4) severe pain on attempted hyperextension of the digit</td>
</tr>
<tr>
<td>Long Flexor Tendon Rupture⁴</td>
<td>Laceration in area of tendon \ Forceful flexor contraction</td>
<td>Loss of isolated DIP or PIP active flexion \ Possible palpable defect in involved muscle</td>
</tr>
<tr>
<td>Lunate Fracture or Dislocation⁴</td>
<td>History or fall on hand or strain \ Generalized wrist pain</td>
<td>Pain at end ranges of wrist extension \ Decreased grip strength/pain with grasping objects</td>
</tr>
<tr>
<td>Scaphoid Fracture⁵ ⁶</td>
<td>History of fall on outstretched hand \ Prevalent in males aged 15-30 and females with osteoporosis</td>
<td>Swelling, bruising around wrist \ Tenderness over anatomical snuff box/scaphoid tubercle \ Increased pain with gripping</td>
</tr>
<tr>
<td>Distal Radius (Colles’) Fracture</td>
<td>Fall onto outstretched arm with forceful wrist extension \ Young male or older female</td>
<td>Wrist swelling \ Wrist held in neutral resting position \ Movements into wrist extension are painful</td>
</tr>
<tr>
<td>Radial Head Fracture⁷</td>
<td>History of fall on outstretched hand</td>
<td>Elbow joint effusion - arm held in loose packed position \ Restricted/painful supination &amp; pronation AROM \ Tenderness over radial head</td>
</tr>
<tr>
<td>Raynaud’s Phenomenon⁸</td>
<td>Positive family history \ Women on estrogen therapy \ Cold exposure/frostbite injury \ Underlying collagen vascular disease</td>
<td>In pallor, cyanosis, and/or hyperemic erythema of the fingers \ Taking medication promoting vasoconstriction such as B-blockers, amphetamines, decongestants, and caffeine</td>
</tr>
<tr>
<td>Complex Regional Pain Syndrome (Reflex Sympathetic Dystrophy)⁹¹⁰</td>
<td>History of trauma or surgery \ Severe burning/boring/aching pain out of proportion to the inciting event \ Pain not responsive to typical analgesics \ Secondary hyperalgesia/hypersensitivity</td>
<td>Area swollen (pitting edema), warm, and erythematous \ Temperature difference between involved and uninvolved extremity, hot or cold</td>
</tr>
<tr>
<td>Melanoma¹¹</td>
<td>History of cancer \ Female &lt; 40 years of age \ Male &gt;40 years of age \ Fair skin, history of sunburns</td>
<td>Asymmetric or irregular shape lesion \ Borders are notched, scalloped or vaguely defined \ Color uneven distributed or defined \ Diameter &gt;6mm</td>
</tr>
</tbody>
</table>

### References:
**ELBOW, WRIST, HAND SCREENING QUESTIONNAIRE**

NAME: ________________________________       DATE: _____________

Medical Record #: ___________________________

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Have you recently had a trauma, such as a fall unto your hand?</td>
<td>☐</td>
</tr>
<tr>
<td>2.</td>
<td>Have you recently had a surgery for your neck, shoulder or arm?</td>
<td>☐</td>
</tr>
<tr>
<td>3.</td>
<td>Do you have numbness or tingling in your hands?</td>
<td>☐</td>
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<tr>
<td>4.</td>
<td>Has a doctor ever told you that you have osteoporosis (brittle bones)?</td>
<td>☐</td>
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<tr>
<td>5.</td>
<td>Have you recently had a sore, cut, scrape, or puncture wound, such as a human or animal bite?</td>
<td>☐</td>
</tr>
<tr>
<td>6.</td>
<td>Have you recently had an infection?</td>
<td>☐</td>
</tr>
<tr>
<td>7.</td>
<td>Have you recently or do you now have a fever?</td>
<td>☐</td>
</tr>
<tr>
<td>8.</td>
<td>Have you noticed an inability to move your wrist or elbow normally?</td>
<td>☐</td>
</tr>
<tr>
<td>9.</td>
<td>Do your easily hands or feet turn white or become painful when cold?</td>
<td>☐</td>
</tr>
<tr>
<td>10.</td>
<td>Have you noticed any newly formed or irregular moles on your body?</td>
<td>☐</td>
</tr>
<tr>
<td>11.</td>
<td>When you have pain, does it respond to pain medication?</td>
<td>☐</td>
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</table>
Elbow Mobility Deficits

ICD-9-CM code: 812.40 Ulnohumeral Capsulitis

ICF codes: Activities and Participation codes: d4300 Lifting, d4452 Reaching
Body Structure code: s73001 Elbow joint
Body Functions code: b7101 Mobility of a several joints

Common Historical Findings:
- Trauma (e.g., fracture)
- Stiffness following immobilization and healing
- Pain at end ranges of flexion and/or extension

Common Impairment Findings - Related to the Reported Activity Limitation or Participation Restriction:
- Limited elbow flexion and/or extension ROM (usually more limited in flexion)
- Pain at end ranges
- Limited ulnohumeral accessory motions

Physical Examination Procedures:

Elbow Accessory Movement Test
Ulnar Distraction

Performance Cues:
- Stabilize humerus at humeral shaft; or at lateral epicondyle
- Distract ulna from humerus using finger pads; or use hypothenar and thenar eminence with a flexed wrist
Elbow Mobility Deficits: Description, Etiology, Stages, and Intervention Strategies

The below description is consistent with descriptions of clinical patterns associated with the vernacular term “Ulnohumeral Capsulitis”

Description: Pain and stiffness in the elbow. The pain is most noticeable at the end ranges of flexion or extension movements, such as carrying a heavy object with the arm hanging or while attempting to dress, groom, or eat.

Etiology: Inflammation of the ulnohumeral capsule leads to increased fibrinogenesis of the collagen tissue that forms the capsule – eventually leading to capsular adhesions if the capsule is immobilized, such as following a trauma (e.g., fracture) and subsequent casting and/or splinting.

**Acute Stage / Severe Condition:** Physical Examination Findings (Key Impairments)

*ICF Body Functions code: b7101.3 SEVERE impairment of mobility of several joints*

- Limited elbow flexion and extension ROM – usually flexion limitation of motion is greater than the extension motion limitation
- Pain at end ranges of active and passive movements
- Limited ulnohumeral accessory motions
- Restricted myofascia – especially the one-joint elbow flexors and extensors (brachialis and short head of the triceps)
- Pain with palpation of the ulnohumeral joint

**Sub Acute Stage / Moderate Condition:** Physical Examinations Findings (Key Impairments)

*ICF Body Functions code: b7101.2 MODERATE impairment of mobility of several joints*

As above, except:

- Resisted tests reveal strength deficits – especially if the elbow has been immobilized for an extended period of time

**Settled Stage / Mild Condition** Physical Examinations Findings (Key Impairments)

*ICF Body Functions code: b7101.1 MILD impairment of mobility of several joints*

As above, except:

- Mild pain at end ranges of flexion and/or extension
Intervention Approaches / Strategies

Acute Stage / Severe Condition

Goals: Reduce pain with elbow flexion and extension
Increase elbow range of motion
Increase elbow function

- Physical Agents
  - Ice packs
  - Ultrasound

- Therapeutic Exercises
  - Gentle passive range of motion stretching

- Re-injury Prevention Instruction
  - Rest/relaxation to reduce pain

Sub Acute Stage / Moderate Condition

Goals: Improve flexibility of the involved extremity
Improve strength of the involved extremity

- Approaches / Strategies listed above

- Manual Therapy
  - Soft tissue mobilization to the restricted myofascia – (e.g., the brachialis myofascia)
  - Joint mobilization to the restricted ulnohumeral accessory movements – including mobilization with movement

- Therapeutic Exercises
  - Gentle, prolonged PROM and AROM stretching
  - Initiate strengthening program to the tolerance of the patient

- External Devices (Taping/Splinting/Orthotics)
  - Apply preventive brace in elbow if reinjury a potential fear.

Settled Stage / Mild Condition

Goals: Restore normal flexibility of the involved extremity
Restore normal strength of the involved extremity
Improve tolerance with participating in function activities of involved extremity
• Approaches / Strategies listed above

Intervention for High Performance / High Demand Functioning in Workers or Athletes

Goal: As above
Return to optimum level of patient function

• Approaches / Strategies listed above

Selected References


Nielsen KK, Olsen BS. No stabilizing effect of the elbow joint capsule; *Acta Orthop Scand* 1999; 70 (1):6-8

Impairment: Limited and Painful Elbow Flexion

Cues: Position patient sitting on the edge of a raised treatment table  
Stabilize the lateral side of the distal humerus with one hand  
Laterally glide the ulna (and radius) using the thenar eminence or 2nd metacarpal head of the other hand  
Use a pad to limit ulnar nerve discomfort  
Sustain the lateral glide as the patient actively flexes his/her elbow  
Alter the amplitude and direction of the lateral glide to achieve painfree active flexion  
If indicated, the patient can use his/her uninvolved hand to apply passive overpressure at the end range of available active flexion

The following reference provides additional information regarding this procedure:  
Impairment: Limited Elbow Extension or Flexion
Limited Ulnar Distraction (at the humeroulnar joint)

Cues: Stabilize the humerus via thenar eminence pressure on the lateral epicondyle – use distal thigh to help stabilize the forearm
Contact the ulna with the volar surface of a flexed wrist and provide the ulnar distraction
Counter the distraction with equal and opposite pressure on the lateral epicondyle
To improve extension - apply the distraction near the end of available extension ROM
To improve flexion - apply the distraction near the end of available flexion ROM
Generate the stabilizing and mobilizing forces using trunk rotation
Impairment: Limited and Painful Elbow Extension

Cues: Position patient lying supine
      Stabilize the humerus
      Laterally glide the ulna using a belt
      Sustain the lateral glide while the patient actively extends his/her elbow
      Make sure that the belt is long enough to allow for the therapist’s forearms to provide a stabilization/lateral glide force at nearly perpendicular to the humerus and ulna
      Due to the elbow’s “carrying angle”, the direction of lateral glide will likely need to be altered as the elbow extends
      Provide passive overpressure, if indicated, at the end of available active extension

The following reference provides additional information regarding this procedure:
**ICD-9-CM code:** 813.00  Proximal Radioulnar Capsulitis

**ICF codes:**

- Activities and Participation codes:  **d4453** Turning or twisting the hands or arms
- Body Structure code:  **s73001** Elbow joint
- Body Functions code:  **b7101** Mobility of a several joints

**Common Historical Findings:**
- Trauma (e.g., contusion, dislocation)
- Stiffness following immobilization, and healing
- Pain at end range of supination and/or pronation

**Common Impairment Findings** - Related to the Reported Activity Limitation or Participation Restrictions:
- Limited forearm supination and/or pronation
- Pain at end range(s) of limited motion(s)
- Limited radioulnar accessory movements

**Physical Examination Procedures:**

- **Radioulnar Accessory Movement Test**
  - Radial Posterior Glide
- **Radioulnar Accessory Movement Test**
  - Radial Anterior Glide

**Performance Cues:**
- Stabilize ulna, mobilize radius
- Modify the procedures to adapt to the patient who has co-occurring elbow extension ROM deficits
- Determine amount of accessory motion and symptom response - compare with uninvolved side

- **Radioulnar Accessory Movement Test**
  - Radial Distraction

**Performance Cues:**
- Stabilize humerus - which stabilizes ulna via the olecranon fossa - pull radius, in line with the shaft of the radius - away from the humerus
Use a “golfers” grip on the radius
This procedure also assesses accessory movement at the radiohumeral joint
Determine availability of motion and symptom response - compare with uninvolved side
Elbow Mobility Deficits: Description, Etiology, Stages, and Intervention Strategies
The below description is consistent with descriptions of clinical patterns associated with the vernacular term “Radiohumeral Capsulitis”

Description: Pain at end range of forearm supination and/or pronation that limits function.

Etiology: Trauma (e.g., contusion, dislocation) and the resultant inflammation, immobilization, and tissue healing commonly lead to elbow and forearm stiffness

Acute Stage / Severe Condition: Physical Examinations Findings (Key Impairments)

*ICF Body Functions code: b7101.3 SEVERE impairment of mobility of several joints*

- Swelling around the proximal radioulnar joint may be present
- Limited forearm supination and/or pronation active and passive mobility
- Pain at end range of limited motion
- Limited radioulnar accessory movements
- Tenderness to palpation of the proximal radioulnar joint

Sub Acute Stage / Moderate Condition: Physical Examinations Findings (Key Impairments)

*ICF Body Functions code: b7101.2 MODERATE impairment of mobility of several joints*

As above, except:

- Resisted testing reveals weakness of the forearm supinators and pronators

Settled Stage / Mild Condition Physical Examinations Findings (Key Impairments)

*ICF Body Functions code: b7101.1 MILD impairment of mobility of several joints*

As above, except:

- Mild pain at end range of with overpressure of supination and/or pronation motions
Intervention Approaches / Strategies

**Acute Stage / Severe Condition**

Goals: Alleviate pain in forearm supination and pronation  
Decreased swelling  
Increased range of motion and functional ability

- Physical Agents  
  - Cool packs  
  - Iontophoresis  
  - Ultrasound

- Manual Therapy  
  - Joint mobilization of the proximal radioulnar joint (radial posterior and anterior glides)

- Therapeutic Exercises  
  - Gentle (painfree) supination and pronation mobility/stretching exercises

**Sub Acute Stage / Moderate Condition**

Goals: Achieve normal range of motion  
Restore normal strength and extensibility of involved extremity

- Manual Therapy  
  - Progress intensity of the joint mobilization procedures – including mobilizations with movements  
  - Soft tissue mobilization to myofascial restrictions of the elbow and forearm region

- Therapeutic Exercises  
  - Progress intensity of stretching procedures  
  - Provide strengthening exercises for weak elbow and forearm muscles

**Settled Stage / Mild Condition**

Goal: Return to unlimited performance of functional activities of involved extremity

- Approaches / Strategies listed above

- Therapeutic Exercises  
  - Progress stretching and strengthening exercises
Intervention for High Performance /High Demand Functioning in Workers or Athletes

Goals: Return to optimal performance of desired activities

- Approaches / Strategies listed above
- Therapeutic Exercises
  Progress stretching and strengthening exercises – including exercises/activities that challenge the patient with work related or sport specific demands regarding strength, flexibility, and endurance.

Selected References


Impairment: Limited and/or Painful Forearm Pronation

Forearm Pronation MWM

Cues: Stabilize the distal radius
Anteriorly or posteriorly glide the distal ulna (which ever is painless)
Sustain the glide while the patient actively pronates his/her wrist
Alter the amplitude and direction of the glide to achieve painfree active pronation
Apply overpressure, if indicated, at the end of active pronation

The following reference provides additional information regarding this procedure:
Brian Mulligan MNZSP, DipMT: Manual Therapy, p. 84-84, 1995
Impairment: Limited Forearm Pronation
Limited Radial Posterior Glide (at the superior radioulnar joint)

Radial Posterior Glide

Cues: With the patient supine, stabilize (and pad) the ulna against the table
     Glide the radius posteriorly
     Use folded towels as a bolster at the wrist if the patient also has limited elbow extension

The following reference provides additional information regarding this procedure:
Impairment: Limited Forearm Supination  
Limited Radial Anterior Glide (at the superior radioulnar joint)

Cues: Position the patient prone with the involved forearm just off the edge of the table  
Stabilize (and pad) the humerus and ulna against the edge of the table  
Glide the proximal radius anteriorly - using a dummy thumb over the region of the radial head and under a thenar eminence
Elbow Muscle Power Deficits

ICD-9-CM code: 726.32 Lateral epicondylitis

ICF codes:
- Activities and Participation code: d4300 Lifting, d4452 Reaching, d4401 Grasping
- Body Structure code: s73012 Muscles of forearm
- Body Functions code: b7300 Power of isolated muscles and muscle groups

Common Historical Findings:
- Unaccustomed repetitive occupational or recreational activity involving gripping objects (e.g., tennis)
- Lateral elbow and forearm pain with resumption of activity

Common Impairment Findings - Related to the Reported Activity Limitation or Participation Restrictions:
- Extensor carpi radialis brevis (ECRB) or extensor carpi radialis longus (ECRL): weak and painful
- Tenderness and reproduction of symptoms with palpation/provocation of ECRB or ECRL (slightly superior to lateral epicondyle)

Physical Examination Procedures:

Manual Resistive Test
Extensor Carpi Radialis Brevis

Manual Resistive Test
Extensor Carpi Radialis Longus

Performance Cues:
- ECRB inserts into third metacarpal, ECRL inserts onto 2nd metacarpal
- Isolate ECRB by 1) full flexion of elbow (make ECRL insufficient), 2) ulnarly deviate wrist, and 3) resist 3rd metacarpal

Palpation/Provocation of Extensor Tendons
Performance Cues:  
1 = Lateral epicondyle 
2 = ECRB 
3 = ECRL 

Elbow Muscle Power Deficits: Description, Etiology, Stages, and Intervention Strategies
The below description is consistent with descriptions of clinical patterns associated with the vernacular term “Tennis Elbow”

Description: Inflammation of the tendon attaching the common wrist extensors to the lateral epicondyle of the humerus. The pathology most commonly occurs in the extensor carpi radialis brevis musculo-tendinous junction.

Etiology: More prevalent in men than women between the age of 40-50 years old. Repetitive wrist and finger extension during occupational and recreational activities constantly stretches the extensor tendon, causing microscopic tears. Thus, the physiological healing process is triggered. Normally, with adequate rest, the initial inflammatory stage subsides rather quickly and tissue repair follows. However, when the normal healing process is repeatedly interrupted by overloading the tissue too early, the tendon remains chronically inflamed and unrepaired. Consequently, the tendon is weakened and becomes vulnerable to more severe tears. Eventually the tendon becomes fibrotic and ruptures due to the lack of extensibility to the tensile force.

Acute Stage / Severe Condition: Physical Examinations Findings (Key Impairments)
ICF Body Functions codes: b7300.3  SEVERE impairments of muscle power

- Swelling in the lateral epicondyle region
- Increased temperature in the lateral epicondyle region
- Active wrist extension limited by pain
- Pain with passive wrist flexion, finger flexion, forearm pronation and elbow extension
- Pain and weakness with resisted wrist extension and 3rd MCP joint extension
- Tender (symptoms reproduced) with provocative palpation of the superior-lateral portion of the lateral epicondyle

Settled Stage/ Mild Condition: Physical Examinations Findings (Key Impairments)
ICF Body Functions codes: b7300.1  MILD impairments of muscle power

- Mild to no pain with palpation of the lateral epicondyle
- Full and pain free active wrist extension although mild discomfort may occur at end range
- Painfree or mild discomfort with full passive wrist flexion, forearm pronation, and finger flexion
- Mild pain with resisted wrist extension combined with ulna deviation and forearm supination – strength is near normal
Intervention Approaches / Strategies

Acute Stage / Severe Condition

Goals: Decrease pain
Decrease swelling
Restore normal elbow, wrist, and forearm active range of motion

- Physical Agents
  Ice packs or ice massage

- Manual Therapy
  Soft tissue and joint mobilization to co-existing impairments contributing to the symptoms, such as radial nerve entrapments near the elbow, superior radioulnar joint dysfunction, or C5-C6 segmental motion restrictions
  Friction massage to soft tissue restrictions in the lateral epicondyle area

- Therapeutic Exercise
  Passive and active movements of the the elbow, forearm, wrist and fingers into alternating flexion, extension, supination, pronation, ulnar and radial deviation to gradually regain normal muscle length without triggering overstretch to healing tissues

- External Devices (Taping/Splinting/Orthotics)
  Consider using a joint counterforce brace to remove the tensile force from the healing tissue and prevent premature overstretch

- Re-injury Prevention Instruction
  Educate patient to avoid activities that aggravates the elbow pain

Sub Acute / Moderate Condition

Goals: Restore normal muscle flexibility in the involved extremity
Restore normal strength in the involved extremity
Regain prior level of function with minimal discomfort

- Approaches / Strategies listed above

- Manual Therapy
  Friction massage to soft tissue restrictions in the lateral epicondyle area
  Soft tissue mobilization and manual stretching to shortened forearm myofascia

- Therapeutic Exercise
  Passive and active movements of the the elbow, forearm, wrist and fingers into alternating flexion, extension, supination, pronation, ulnar and radial deviation to
gradually regain normal muscle length without triggering overstress to healing tissues
Gradual progression of resistive exercises for weak forearm and wrist myofascia – Modify exercise difficulty according to patient’s tolerance – using pain as a guide to gage resistance progression.

• Re-injury Prevention Instruction
  Avoid long duration of aggressive activities to prevent re-injury.
  Incorporate regular stretching and rest periods during the day’s activity
  Apply ice if the pain returns with activity

Settled Stage / Mild Condition

• Approaches / Strategies listed above

Intervention for Higher Performance / High Demand Function in Workers or Athletes

Goals: Return patient to optimal level of occupational and recreational performance
  Avoid re-injury

• Therapeutic Exercise
  Simulate the similar movement patterns required by the patient’s job or sports with appropriate number of repetition and resistance to help patient become independent in recognizing the appropriate activity dose for preventing future injuries
  Emphasize on eccentric and plyometrics exercises, commonly involved in daily activities, to return muscles to its optimal level of performance

• Ergonomic Instruction
  Assess patient’s work environment to decrease risks of re-injury
Selected References


Elbow Movement Coordination Deficits

ICD-9-CM code: 841.1 Ulnar collateral ligament sprain

ICF codes: Activities and Participation code: d4401 Grasping, d4451 Pushing, d4452 Reaching, d4454 Throwing
Body Structure code: s73013 Ligaments and fasciae of forearm
Body Functions code: b7601 Control of complex voluntary movements

Common Historical Findings:
Medial elbow pain
Blunt trauma or strain to the medial elbow

Common Impairment Findings - Related to the Reported Activity Limitation or Participation Restrictions:
Symptoms reproduced with:
1. Valgus stress test
2. Ulna collateral ligament palpation

Physical Examination Procedures:

Performance Cues:
Fully supinate forearm
Firmly stabilize humerus into internal rotation
Determine symptom response and mobility - compare with uninvolved elbow
Elbow Movement Coordination Deficits: Description, Etiology, Stages, and Intervention Strategies

The below description is consistent with descriptions of clinical patterns associated with the vernacular term “Pitcher’s Elbow”

Description: Progressive medial elbow pain, edema, and lost of functional activities.

Etiology: The ulnar collateral ligament (UCL) is the major stabilizing factor against valgus stress, especially in 90° of elbow flexion. This structure is vital in helping generate enough varus torque to resist excessive medial elbow tension, lateral joint compression, and posteromedial impingement. With the exception of trauma, UCL injuries are usually associated with the throwing athlete as a consequence of repetitive valgus overload on the elbow joint. Avulsion fracture of the sublime tubercle of the ulna is a potential cause of chronic medial elbow pain in the throwing athlete. Diagnosis of UCL injury has been based on clinical findings of medial joint pain and valgus instability. Pain is localized to the medial side of the elbow, especially during the late cocking or acceleration phases of the throwing motion. The history typically is further characterized by one of three scenarios: (1) an acute “pop” or sharp pain on the medial aspect of the elbow with the inability to continue to throw; (2) the gradual onset of medial elbow pain over time with throwing; or (3) pain following an episode of throwing with the inability on successive attempts to throw above 50 to 75 percent of full function.

Physical Examination Findings (Key Impairments)

Acute Stage / Severe Condition: Physical Examination Findings (Key Impairments)

ICF Body Functions code: b7601.3 SEVERE impairment of motor control/coordination of complex voluntary movements

- Complaints of medial elbow pain during throwing can be reproduced by palpation over the anterior band of UCL
- Complaints of medial elbow pain during throwing can also be reproduced by a valgus stress to elbow with the elbow in 30° of flexion
- General weakness of the muscles about the elbow secondary to pain – this includes the muscles attaching to the medial epicondyle of the elbow – the wrist flexor group
- Patient are unable to throw in this stage
- Inflammation involving the UCL can secondarily affect the ulnar nerve as it crosses the elbow. Ulnar nerve compression can result from entrapment by thickened or inflamed tissue in the cubital tunnel and by hypertrophied musculature in the brachium and forearm. Symptoms of ulnar nerve irritation are present in over 40 percent of patients with UCL insufficiency

Sub Acute Stage / Moderate Condition: Physical Examinations Findings (Key Impairments)

ICF Body Functions code: b7601.2 MODERATE impairment of motor control/coordination of complex voluntary movements

As above, except:
• Resisted wrist and elbow motions are less painful
• Possible pain at the lateral elbow due to the compensation of lateral ligament secondary to the UCL laxity
• The patient may report associated recurrent pain or paresthesia radiating into the ulnar aspect of the forearm, the hand, and the forth and fifth fingers, especially with throwing
• At this state patients are unable to throw over 50% capacity because of the pain

Settled Stage / Mild Condition: Physical Examinations Finding (Key Impairments)

ICF Body Functions code: **b7601.1** MILD impairment of motor control/coordination of complex voluntary movements

As above, except:

• Pain with resisted motions are minimal
• Excessive valgus stress can also lead to posteromedial olecranon impingement on the olecranon fossa producing pain, osteophyte and loose body formation. Patients may have symptoms of ulnar never irritation, medial epicondylitis, or symptoms of loose bodies
• At this state patients are unable to throw over 75% capacity because of the pain
Intervention Approaches / Strategies

**Acute Stage / Severe Condition**

Goals: Reduce inflammation and pain
Promote tissue healing

- **Physical Agents**
  - Ice packs or ice massage
  - Ultrasound
  - Phonophoresis (with an anti-inflammatory drug such as dexamethasone)
  - Iontophoresis (with an anti-inflammatory drug such as dexamethasone)

- **Therapeutic Exercises**
  - Painfree active mobility exercises for wrist and elbow extension and flexion; forearm supination and pronation. Motions that do not create a valgus force at the elbow, such as midrange upper body ergometry, may be indicated if they can be performed without pain

- **Re-injury Prevention Instruction:**
  - Rest the joint with avoiding painful movements (e.g., gripping)

**Sub Acute Stage / Moderate Condition**

Goals: Improve flexibility
Increase muscular strength and endurance
Increase tolerance to perform functional activities

- **Approaches / Strategies listed above**

- **Therapeutic Exercises**
  - Stretching exercises for muscles with flexibility deficits
  - Strengthening exercises for muscles with strength deficits – include wrist, elbow, and shoulder exercise (where deficiencies are noted)

- **Re-injury Prevention Instruction:**
  - Initiate gradual return to stressful activities
  - Gradually reintroduce previously painful movements
Settled Stage / Mild Condition

Goals: Improve muscular strength and endurance
Maintain and enhance flexibility
Gradually return patient to sport or high-level activities

- Approaches / Strategies listed above
- Therapeutic Exercises
  Progress strengthening exercises (emphasize eccentric and concentric exercises)
- Re-injury Prevention Instruction:
  Initiate gradual return to sport activity
  Recommend equipment modifications (e.g., grip size, string tension, playing surface)
  Emphasize maintenance program
  Modification of work activities

Intervention for High Performance / High Demand Functioning in Workers or Athletes

Goal: Return to optimum level of patient function with occupation or sport

- Approaches / Strategies listed above
- External Devices (Taping/Splinting/Orthotics)
  Taping procedures may be used to reduce stress on the UCL during strenuous activities (or to remind the patient to avoid end range stresses)
- Re-injury Prevention Instruction:
  Slowly return to 75-100% capacity with sport or occupational activities
  Modification of work and sport activities as needed
Selected References


Freddie H. FU; Marc R. Safran: The Orthopedic Clinics of North America: Elbow problems in the athlete. Sport Medicine (26)3 1995

Elbow and Forearm Radiating Pain

ICD-9-CM code: 354.1 Other lesion of median nerve  
354.3 Lesion of radial nerve  
354.2 Lesion of ulnar nerve  

ICF codes:  
Activities and Participation Domain code: d4301 Carrying in the hands, d4400 Picking up, d4401 Grasping, d4402 Manipulating  
Body Structure codes: s73018 Neural structures of forearm  
Body Functions code: b2804 Radiating pain in a segment or region  

Common Historical Findings:  
Medial elbow and forearm pain:  
Medial elbow pain  
Forearm and hand paresthesias  
Unaccustomed repetitive occupational or recreational activity involving flexion and pronation(e.g., golfing)  

Lateral elbow and forearm pain:  
Lateral elbow and forearm pain  
Paresthesias in forearm and hand  
Unaccustomed repetitive activity involving gripping or manipulating objects  

Medial elbow pain:  
Medial elbow pain  
Paresthesias in ulnar distribution of forearm and hand  

Common Impairment Findings - Related to the Reported Activity Limitation or Participation Restrictions:  
Medial elbow and forearm pain:  
Symptoms reproduced with:  
1. Median nerve stretch test  
2. Palpation/provocation of median nerve entrapment in pronator teres  
3. Repeated pronator teres resisted movement tests  

Lateral elbow and forearm pain:  
Symptoms reproduced with:  
1. Radial nerve stretch test  
2. Palpation/provocation of posterior interosseous branch of radial nerve in supinator muscle  
3. Repeated supinator resisted movement tests  

Medial elbow pain:  
Symptoms reproduced with:  
1. Ulnar nerve stretch test  
2. Palpation/provocation of ulnar nerve in cubital tunnel area including the arcade of Struthers which is proximal to the elbow
Elbow and Forearm Radiating Pain
Description, Etiology, Stages, and Intervention Strategies

The below description is consistent with descriptions of clinical patterns associated with the vernacular term “Pronator Teres Syndrome”

Description: Vague, aching pain in the volar aspect of the elbow and forearm with accompanying paresthesias and decreased sensation in the thumb, index finger and middle finger, and may exhibit weakness of grip and palpable tenderness of the pronator teres muscle. These symptoms are exacerbated with repetitive use of the elbow flexors and wrist pronators. Such motions are typified by weight lifting, writing, doing needlepoint, gripping and swinging a golf club, tennis racket, or hammer – or repetitive use of a tool, such as turning a screwdriver.

Etiology: Unaccustomed repetitive occupational or recreational activity involving flexion and pronation may create an overuse type of tendonitis for the insertion of the pronator teres muscle. Compression or entrapment of the median nerve can occur at the supracondylar process and ligament of Struthers, the aponeurosis of the biceps brachii muscle (lacertus fibrosus), the pronator teres muscle or the flexor digitorum superficialis muscle. Typically the median nerve or its anterior interosseous branch becomes compressed within the cubital fossa or between the superficial and deep heads of the pronator teres muscle.

Acute Stage / Severe Condition: Physical Examinations Findings (Key Impairments)

ICF Body Functions codes: b2804.3 SEVERE radiating pain in a segment or region

- A dull aching forearm pain that is provoked with gripping, lifting, and repeated wrist and forearm movements
- Median nerve stretch test bias of the upper limb tension test reproduces the reported symptoms
- Passive stretch into wrist and finger extension with the combination, and elbow extension aggravates the patient’s symptoms
- Symptoms are provoked with repeated pronator teres resisted movement tests. Exacerbation of pain with resisted forearm pronation followed by elbow extension indicates entrapment at the pronator teres muscle, the most common site of compression
- Reproduction of pain with resistance to forearm supination with elbow flexed beyond 120 degrees implicates entrapment at the bicipital aponeurosis
- Pain with resisted middle-finger flexion localizes entrapment to the flexor digitorum superficialis muscle
- Decreased static two-point and vibratory discrimination in the involved hand, compared with the contralateral hand especially over the thenar eminence
- Positive Tinel’s sign may be present at the antecubital fossa.
Sub Acute Stage / Moderate Condition: Physical Examinations Findings (Key Impairments)

ICF Body Functions codes: b2804.2 MODERATE radiating pain in a segment or region

As above, except symptoms are less – for example, the patient experiences less aching and requires less time for symptom resolution. Symptom reproduction requires a stronger palpatory provocation or more repetitions with repeated resisted tests.

Settled Stage / Mild Condition: Physical Examinations Findings (Key Impairments)

ICF Body Functions codes: b2804.1 MILD radiating pain in a segment or region

As above, except symptoms are only noted following extensive repetitive activities that use pronator teres contractions or increase compression of the median nerve.

Intervention Approaches / Strategies

Acute Stage / Severe Condition

Goal: Restore normal, pain-free use of the involved extremity for non-strenuous activities

- Immobilization
  The elbow may be immobilized in 90 degrees of flexion, the forearm in neutral to slight pronation, and the wrist in neutral to slight volar flexion.

- Physical Agents
  Ice
  Electric stimulation

- Manual Therapy
  Soft tissue mobilization/stretching to the myofascial restrictions in the pronator teres near the entrapment site of the median nerve

- Therapeutic Exercises
  Median nerve mobility exercises in pain-free ranges

- Re-injury Prevention Instruction / Patient Education
  Modification of daily activities to reduce compression

NSAIDS may be prescribed for symptomatic relief but have not been shown to alter the course of the impairment. Injection of corticosteroids into the area of the median nerve may be considered as a last non-operative resort with extreme caution to avoid intraneural injection. Pain and weakness that are refractory to two to three months of non-operative therapy should be referred to a hand or orthopedic surgeon for further evaluation, in which case surgery to decompress the median nerve may be required.
**Sub Acute Stage / Moderate Condition**

Goal: To restore normal strength and extensibility of the pronator teres

- Approaches / Strategies listed above

- Therapeutic Exercises
  - Stretching exercises for tight muscles in the elbow, forearm and wrist
  - Strengthening exercises for weak muscles in the elbow, forearm and wrist (e.g., progressive resistive exercises for the wrist extensors and pronators, grip strengthening exercises)

- Ergonomic Instruction
  - Provide instruction in optimal shoulder and cervical positioning for household and work activities as well as pacing and sufficient breaks in activity where possible.

**Settled Stage / Mild Condition**

Goal: Ability to use arm without symptoms

- Approaches / Strategies listed above

- Therapeutic Exercises
  - Progress stretching and strengthening exercises for the elbow, forearm and wrist

**Intervention for High Performance /High Demand Functioning in Workers or Athletes**

Goal: Return to desired occupational or recreational activities

- Approaches / Strategies listed above

- Therapeutic Exercises
  - Progress stretching and strengthening exercises for the elbow, forearm and wrist to include sport/job specific training

- Re-injury Prevention Instruction
  - Adjust the grip size of sport equipment or hand tools
  - Keep wrist at neutral
Selected References


Elbow and Forearm Radiating Pain
Description, Etiology, Stages, and Intervention Strategies

The below description is consistent with descriptions of clinical patterns associated with the vernacular term “Supinator Syndrome”

Description: Lateral elbow and forearm pain with accompanying forearm and hand paresthesias. There may or may not be accompanying wrist extensor or supinator weakness. These symptoms are exacerbated with repetitive use of the wrist extensors and wrist supinators, such as with gripping objects or swinging a tennis racket – or repetitive use of a tool, such turning a screwdriver.

Etiology: Unaccustomed repetitive occupational or recreational activity involving gripping or manipulating objects may create an overuse type tendinitis for the insertion of the supinator muscle or the development of trigger points in the supinator muscle. Also, perhaps more common, is that repeated contraction of the supinator produces an irritation of the posterior interosseous branch of the radial nerve as it courses through the supinator. There is also evidence that a prolonged or heavily loaded pronated posture can increase the amount of pressure being placed upon the radial nerve as it travels through the supinator.

**Acute Stage / Severe Condition:** Physical Examinations Findings (Key Impairments)

*ICF Body Functions codes: b2804.3 SEVERE radiating pain in a segment or region*

- Symptom reproduction with radial nerve upper limb tension test
- Symptom reproduction with palpation of radial tunnel
- Limited forearm pronation
- Limited elbow extension
- End range pain with pronation with elbow extension
- Symptoms reproduced with repeated resisted supination
- Limited radial head posterior glide at the superior radioulnar joint

**Sub Acute Stage / Moderate Condition:** Physical Examinations Findings (Key Impairments)

*ICF Body Functions codes: b2804.2 MODERATE radiating pain in a segment or region*

As above, except:

- Symptoms more difficult to reproduce reproduced with radial nerve upper limb tension tests and repeated supinator resisted movement tests (i.e., require further end range stresses or more repetitions with resisted movements)

**Settled Stage / Mild Condition:** Physical Examinations Findings (Key Impairments)

*ICF Body Functions codes: b2804.1 MILD radiating pain in a segment or region*
As above, except:

- Only mild lateral elbow and forearm pain with repeated supinator resisted movements tests

Intervention Approaches / Strategies

Acute Stage / Severe Condition

Goals: Alleviate pain with active forearm movement
Improve strength of supinators

- Physical Agents
  Iontophoresis with corticosteroid
  Ultrasound: 0.5 w/cm² at 3 MHz pulsed at 5:1x 5-7 min
  TENS for pain control

- Manual Therapy
  Soft tissue mobilization to restricted supinator and extensor carpi radialis brevis myofascia, predominantly the myofascia near the radial head and posterior interosseous nerve

- Therapeutic Exercises
  Pain free nerve mobility exercises for the radial and posterior interossei nerve

- Re-injury Prevention Instruction
  Rest/relaxation to reduce pain
  Avoid aggravating postures and activities

Sub Acute Stage / Moderate Condition

Goals: Prevent re-injury of supinators
Improve strength of supinators

- Approaches / Strategies listed above

- Manual Therapy
  Joint mobilization to restore radial anterior glide at the proximal radioulnar joint

- Therapeutic Exercises
  Pain free nerve mobility exercises for the radial and posterior interossei nerve
  Slowly begin progressive resistive exercises for arm and forearm muscles
Settled Stage / Mild Condition

Goal: Maintain or return to optimum level of patient function

- Approaches / Strategies listed above
- Re-injury Prevention Instruction
  Modification of work activities

Intervention for High Performance / High Demand Functioning in Workers or Athletes

Goal: Return to optimum level of patient function

- Approaches / Strategies listed above

Selected References


Cervical Spine and Related Upper Extremity Radiating Pain
Description, Etiology, Stages, and Intervention Strategies

The below description is consistent with descriptions of clinical patterns associated with the vernacular term “Cubital Tunnel Syndrome”

Description: A peripheral compression neuropathy at the cubital tunnel (the posterior medial aspect of the elbow). This syndrome is related to repetitive activities of the elbow. Common symptoms are medial elbow or proximal forearm pain, numbness or tingling in the ring and little finger, loss of dexterity, fatigue, and possible loss of strength.

Etiology: Symptoms may arise without any obvious compression areas. Cubital tunnel syndrome may occur due to nerve enlargement or the narrowing of the space that the nerve runs through. Certain occupations that require repetitive elbow flexion and extension, prolonged elbow flexion, or direct compression of the ulnar nerve while leaning on the medial elbow against a hard surface may be at higher risk for the condition. The ulnar nerve may be compressed by muscle hypertrophy, compression by the aponeurosis of flexor carpi ulnaris, adhesions in the cubital tunnel or trauma to the elbow.

**Acute Stage / Severe Condition:** Physical Examinations Findings (Key Impairments)

*ICF Body Functions codes: b2804.3 SEVERE radiating pain in a segment or region*

- Impaired function of the ulnar nerve – as evidence by one or more of the following findings:
  - Muscle atrophy in hypothenar region
  - Clawing of the ring and little fingers
  - Weak ulnar intrinsic muscles (e.g., 1st dorsal interossei, positive Froment’s sign)
  - Weak flexor carpi ulnaris and ulnar portion of flexor digitorum profundus muscles
  - Decreased pinch and grip strength
  - Impaired sensation of dorsoulnar portion of the hand
- Pain primarily in region of elbow that may radiate proximally or distally with active movements
- Ulnar bias upper limb nerve tension test reproduce the patient’s symptoms
- Positive Tinel’s sign
- Anterior subluxation of the ulnar nerve at the elbow with elbow flexion
- Symptom reproduction with palpatory provocation of the cubital tunnel or the arcade of Struthers entrapment site

**Sub Acute Stage / Moderate Condition:** Physical Examinations Findings (Key Impairments)

*ICF Body Functions codes: b2804.2 MODERATE radiating pain in a segment or region*

As above – the severity of the ulnar nerve entrapment signs may resolve as the inflammation around the cubital tunnel diminishes

**Settled Stage / Mild Condition:** Physical Examinations Findings (Key Impairments)
ICF Body Functions codes: b2804.1 MILD radiating pain in a segment or region

As above – except less severe symptoms are exhibited

Intervention Approaches / Strategies

Acute Stage / Severe Condition:

Goals: Alleviate pain in medial elbow and forearm
Reduce ulnar nerve symptomology

- Re-injury Prevention Instruction
  Avoid any aggravating activities or postures, such as repetitive elbow flexion activities and prolonged elbow flexion postures

- Therapeutic Exercises
  Nerve mobility exercises for the ulnar nerve at the elbow in the painfree/symptom free ranges.
  Strengthening exercises for the ulnar nerve muscles found to be weak

  Note: Caution not to strain or irritate the ulnar nerve during performance of the mobility or strengthening exercises

- External Devices (Taping/Splinting/Orthotics)
  A splint to limit elbow flexion and/or wrist extension can be considered if symptoms are severe
  Elbow pad worn over the posterior medial elbow may be useful in some patients

Sub Acute Stage / Moderate Condition

Goal: Restore normal strength and extensibility of involved extremity

- Approaches / Strategies listed above

- Manual Therapy
  Soft tissue mobilization to the myofascial and fascial tissues that may be contributing to the nerve entrapment

- Therapeutic Exercises
  Stretching exercises that increase flexibility of forearm muscles, wrist and finger flexors are introduced slowly as tolerated. These exercises can be used as needed as long as symptoms are not increased. Gradually increase the performance of functional activities as tolerated
• **External Devices (Taping/Splinting/Orthotics)**
  
  As symptoms subside, splints can be worn only at night. Soft elbow pads can be worn during the day to protect the ulnar nerve from direct pressure or trauma and remind patient to maintain an extended elbow and to keep from putting pressure on elbow.

• **Ergonomic Instruction**
  
  Modify relevant work activity (e.g., keyboard operators should type with elbows relatively extended and arms adducted to avoid increased pressure on ulnar nerve.)

  Modify jobs that require forceful extension (e.g., hammering, modify activity by starting action from more extended position, decrease number of repetitions, more frequent rest periods, etc.)

**Settled Stage / Mild Condition**

Goal: Restore normal, painfree movements of the involved upper extremity

• Approaches / Strategies listed above

• Therapeutic Exercises
  
  Instruct in exercises to address the patient’s specific muscle strength deficits

**Intervention for High Performance / High Demand Functioning in Workers or Athletes**

Goal: To return to desired occupation or leisure time activities

• Approaches / Strategies listed above

• Therapeutic Exercises
  
  Encourage participation in regular activities with emphasis on modification of work areas, use of splint and elbow pad as needed to provide relief and protection of ulnar nerve.
Selected References


### SUMMARY OF ELBOW DIAGNOSTIC CRITERIA AND PT MANAGEMENT STRATEGIES

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Lateral Epicondylitis
Surgical Treatment and Rehabilitation

Surgical Indications and Considerations

Anatomical Considerations: Lateral epicondylitis primarily involves the origin of the extensor carpi radialis brevis, occasionally, the anterior edges of the extensor communis and the underside of the extensor carpi radialis longus and, rarely, the origin of the extensor carpi ulnaris. The extensor carpi radialis brevis muscle lies deep to the longus muscle and superficial to the joint capsule. The annular and collateral ligaments are located beneath and just distal to the origin of the ECRB muscle.

Pathogenesis: Lateral epicondylitis, also known as tennis elbow, represents a pathologic condition of the common extensor muscles at their origin on the lateral humeral epicondyle and is characterized by pain in this area. Lateral epicondylitis is directly related to activities that increase the tension and stress of the wrist extensor and supinator group. Repetitive eccentric muscle overload is thought to be a large contributing factor to the development of this condition. It is theorized that repetitive micro trauma leads to a micro tear which repairs itself, through this process also produces fibrosis and granulation tissue. With repetitive micro trauma, the tendon experiences mucoid degeneration and leads to a failure of the tendon over time.

The wrist extensor group falls in to the category of tendons that are vulnerable to injury. The tendons have poor vascular supply, wrap around a convex surface, cross more than one joint and are subjected to repetitive stress. In tendons, collagen fibers and primary tendon bundles run parallel courses. In normal tendons, nerves and blood vessels extend through the major connective tissue septa but do not invade the fascicles. On gross examination, the tendon appears firm, taut and tan or beige. In tendonitis, the abnormal tissue can be easily identified from the normal tissue. Examination usually reveals grey, shiny and edematous immature-appearing tissue. This tissue closely resembles scar tissue. Microscopically, the normal tendon fibers are disrupted by fibroblasts and vascular granulation like tissue. This appearance has been described as an angiofibroblastic hyperplasia. Upon surgical or microscopic examination there is usually no evidence of inflammation associated with tennis elbow. The term tendonitis is rapidly changing to tendinosis, to denote the difference between acute inflammatory changes verse a degenerating pathologic process.

Epidemiology: Tendonitis of the elbow is the most prevalent elbow injury, with an incidence of 1-3% in the general population and between 30% and 50% in tennis players. The characteristic age of onset is between 35 and 50 years, with a median of 41 years. Lateral epicondylitis is most common in participants of racket sports or in the industrial worker with jobs, which require repetitive and forceful use of the wrists and elbow. It is more common in white males and usually on their dominant side.
Diagnosis:

- Pain at the lateral elbow
- Point tenderness in the area of the ECRB tendon, slightly distal to the lateral elbow
- Pain with forceful gripping
- Pain with resisted wrist extension with elbow extended
- Pain with passive wrist flexion, pronation and ulnar deviation with the elbow extended
- X-Ray: to rule out radiocapitellar arthritis
- MRI: MR images correlate well with surgical and histological findings of neovascularization and mucoid degeneration

Differential Diagnosis:

- **Neuropathic**
  - Radial tunnel syndrome
  - Entrapment of posterior interosseous nerve
  - Entrapment of musculocutaneous nerve
  - Entrapment of median nerve
  - Ulnar entrapment syndrome
- **Inflammatory**
  - Radiocapitellar arthritis
  - Synovitis
  - Gouty arthritis
  - Infection
- **Trauma**
  - Radial neck fracture
  - Distal humerus fracture
- **Referred pain**
  - Cervical radiculopathy
  - Shoulder arthritis
  - Carpal tunnel syndrome
- **Other**
  - Medial Epicondylitis
  - Tumor
  - Bone cyst

Nonoperative Verse Operative Management: Surgical intervention is usually indicated for patients who have undergone conservative care but still have pain 6 months to a year after initial symptoms. Conservative care consists of activity modification, NSAIDs, counterforce bracing, physical therapy or cortisone injections. Surgery is usually considered for patients who have had 3 or more cortisone injections with minimal success or for patients who present with pain that alters routine daily function. Nonoperative treatment is successful in between 75 to 90% of cases.
According to the Cochrane Review, presently, there are no published controlled trials of surgery for lateral elbow pain. Without a control group, it is not possible to draw conclusions about the value of this modality of treatment.

**Surgical Procedure:** There are several surgical procedures for the treatment of lateral epicondylitis; including the open procedure, arthroscopic, and percutaneous release. This guideline will focus on the open procedure described by Nirschl and Pettrone, as this is still considered the gold standard procedure.

An oblique incision is made just proximal to the lateral epicondyle distally toward the radial head. The extensor aponeurosis is identified and a longitudinal incision is made to visualize the extensor group. The extensor carpi radialis longus is then retracted back to visualize the brevis tendon. The pathologic tissue usually includes the origin of the extensor carpi radialis brevis and less frequently the anterior extensor aponeurosis or extensor longus. The pathologic tissue is then excised. Often osteotome decortication of the exposed lateral epicondyle is performed to enhance blood flow and postoperative healing but recent evidence suggests no benefit to this aspect of the procedure.

**Preoperative Rehabilitation:**

- Patients are instructed to stay in their immobilizer for the majority of the time for 48 hours after surgery
- Supine sleeping is encouraged, with pillows to support the elbow
- Shoulder motions 3-5 times per day
- On day one, gently finger and wrist motions are allowed for 2-3 minutes 3 times per day

**POSTOPERATIVE REHABILITATION**

Note: The following guideline is a summary of the guidelines provided by Nirschl, Baker, and Galloway.

**Phase I:** Days 1-7

- Movement of the wrist and fingers for 2 minutes, 3-5x/day
- Ice and NSAIDs are utilized for pain control
- The patient is also educated on the signs of wound infection; including excessive swelling, redness, excessive heat, oozing from the incision, a dramatic increase in pain or a fever greater than 100° for more than one day
- Day 3: Showering is allowed, with bandages off, and gentle pain-free elbow, wrist and shoulder ROM is started. At this point the immobilizer is optional.
**Phase I: Days 7-17**

- More aggressive ROM is encouraged in and out of the shower
- Goals for day 17 are 80% of normal elbow ROM
- The arm can be used for light activity only
- Ultrasound
- High Volt Galvanic Stimulation

**Phase I: Days 18-21**

- Sub maximal Isometrics are started
- The patient begins antigravity wrist flexion, extension, supination and pronation without pain
- If painful the patient is instructed to utilize a counterforce brace during exercising
- Once the patient can perform 30 repetitions, without pain, they can progress to a 1-pound weight or light resistance band. All exercises are performed with the elbow bent to 90° and resting on a table or the lower extremity

**Phase II: Weeks 3 – 6**

Goals: Pain level less than pre-surgery level
- Full ROM.

- Therapeutic exercises:
  - Rotator cuff, elbow and scapular stabilization training with light resistance
  - Aerobic conditioning on a stationary bike or treadmill
  - Light stretching is encouraged at this stage with emphasis on end range and passive overpressure
  - Progressive resistive exercises – strengthening wrist flexion, extension, supination/pronation, ulnar and radial deviation. Progress the patient from a flexed and elbow supported elbow to a fully extended and unsupported elbow
  - Pain free grip strengthening with putty or ball
  - Utilize counterforce brace during exercise if pain continues
- Gentle soft tissue mobilization/massage along and against fiber orientation
- Consider use of ice after exercise.
**Phase III:** Weeks 8 – 12

- Begin task specific functional activities
- Return to sport activities
- Continue counterforce bracing if needed
- Continue wrist, elbow, shoulder and scapular strengthening
- Patient is allowed to return to athletics once their grip strength is normal.

Selected References:


Biceps Brachii Tendon Distal Rupture

Surgical Indications and Considerations

Anatomical Considerations: The two heads of the biceps merge to form the biceps tendon, which rotates through an arc of approximately 90 degrees to insert on the tuberosity of the radius. Contraction of the biceps brachii muscle produces both flexion and supination of the radius.

Pathogenesis: Possible predisposing mechanical, degenerative and vascular factors for distal rupture of the biceps tendon exist. The space available for the biceps tendon between the radial tuberosity and the ulna is significantly decreased in pronation and may squeeze and injure the tendon with forearm rotation. There is a possibility for degeneration in the form of hypertrophic lipping of the radial tuberosity that can be a possible mechanism for shearing of the tendon at its insertion site, which may also predispose it to rupture. There has been identified an area of hypovascularity near the insertion site of the biceps tendon which may limit the natural tendon repair mechanisms. Aside from all of the predisposing factors for biceps tendon repair, the usual cause is as a result of a sudden acute episode.

Epidemiology: Complete rupture of the tendon origin of the long head of the biceps is seen much more frequently than distal rupture (96% versus 3%). Rupture is felt to occur as a result of high-energy rapid eccentric overload. Distal biceps tendon rupture is typically seen in males between the age of 40 and 60 years old who are participating in manual labor, athletic endeavors or weight lifting, with the dominant arm being more commonly affected. This age group is susceptible to tendon ruptures because age is correlated with tendon rupture in that tensile properties of connective tissue decrease as age increases. It has been reported that between 30% and 70% of distal biceps tendon ruptures occur in patients during work related accidents and a vast majority of the ruptures are as a result of an extended arm being overstretched by and outside force such as eccentric tension.

Diagnosis:

- There is generally a report of a sudden and unexpected forceful extension against a flexed elbow, or a pop is felt during heavy lifting
- Flexion and supination of the elbow are reported to be painful and strength is noticed to be decreased in the affected extremity
- Flexion may be decreased mildly when compared to the unaffected side; however supination power is usually markedly decreased
- Magnetic resonance imaging (MRI) is not necessary for a complete tendon rupture, but may be a helpful diagnostic tool for the diagnosis of a partial tendon rupture
**Partial Tendon Ruptures:** Partial ruptures are not commonly diagnosed clinically and therefore, are rarely treated surgically. Incomplete ruptures or sprains to the biceps tendon that are clinically diagnosed are typically treated with three weeks of immobilization, three weeks of flexion, assisted brace, and activity modification for an additional three weeks. If nonoperative treatment fails, anatomic reattachment to the radial tuberosity through surgery is necessary to regain function.

**Nonoperative management:** Nonoperative management of the distal tendon has been shown to result in approximately a 50% decrease in supination endurance and strength and a 20% to 30% loss in flexion strength. Conservative treatment of distal biceps tendon ruptures results in decreased functional recovery.

**Surgical Procedure:** If surgical intervention is indicated for a patient with a distal biceps tendon rupture, surgical reattachment is most easily performed within the first 2 weeks after injury. Beyond two weeks, scarring and retraction of the biceps tendon may make the procedure much more difficult. The surgical repair involves direct reattachment of the tendon to the radial tuberosity, which is the anatomic insertion point for the biceps tendon. Reattachment of the tendon may be accomplished through a single anterior incision or by a two-incision method with tendon retrieval by way of the anterior incision and reattachment through the posterior incision. Overall the two-incision method is the most widely used for surgical exposure of the radial tuberosity; however the single incision approach is being seen more frequently. Suture anchors are becoming the popular method for attachment of the tendon to the cortical bone of the radial tuberosity.

**Postoperative Rehabilitation:** A near normal return of supination and flexion power and endurance has been noted in patients who have undergone tendon repair using a two-incision technique. Postoperative activities are dictated by the strength of the initial repair and tendon to bone healing. Results post-surgery are typically excellent, with near full recovery of both strength and function to the patient.

**POSTOPERATIVE REHABILITATION**

**Phase I:** Weeks 1-3

**Goals:** Protect the surgical reattachment
Control pain

**Intervention:**

- After surgery, the arm is generally placed in an adjustable hinged brace that is immobilized at 90 degrees of elbow flexion with the forearm in neutral pronation-supination for 2-3 weeks.
- Two to three weeks after surgery passive range of motion is started over a full arc of flexion to 90 degrees and is advanced by 10-15 degrees a week. At this point in time, active elbow extension is begun with the elbow being returned to flexion passively by the patient or therapist.
- Passive pronation and supination range of motion are begun at 3 weeks as well and is advanced by 5-10 degrees per week.
**Phase II: Weeks 4-6**

Goals: Maintain protection of the reattachment  
Gradually restore passive range of motion of the affected joints  
Maintain range of motion in the joints above and below the affected elbow  
Limit scar tissue adhesions

Intervention:

- At 4 weeks passive wrist and shoulder exercises are begun taking caution not to place stress across the repaired tissue  
- Light scar tissue mobilization taking care not to disrupt the surgical repair

**Phase III: Weeks 6-8**

Goals: Increase active range of motion in the affected elbow  
Increase strength  
Maintain optimal scar and tissue mobility

Intervention:

- Active flexion and supination are avoided until a point 6 weeks after the reattachment, at which point the patient is progressed to sub maximal isotonic exercised for elbow flexion and extension as well as pronation and supination.  
- From 8 weeks following surgery onward, the patient is allowed to progress strengthening exercises as tolerated  
- Scar and soft tissue mobilization to maintain proper mobility in tissues surrounding the surgical site

**Phase IV: 3-6 Months**

Goals: Return to presurgical level of strength and range of motion  
Begin sport or activity specific training

Intervention:

- Aggressive strengthening and high level plyometrics are advised to be avoided until 3-6 months after surgery  
- Return to jogging for cardiovascular exercise is allowed at 3 to 4 months with return to contact sports or other unrestricted upper extremity activities being limited to 6 months or longer
Selected References:


Elbow – Ulnohumeral Dislocation and Rehabilitation

Surgical Indications and Considerations

Anatomical Considerations: Elbow dislocations uncommon. Posterior dislocations are the most common; they comprise over 90% of all elbow dislocations. Anterior, divergent, and radial head subluxations in children comprise the other 10%.

Pathogenesis: Posterior dislocations are by far the most common and occur from a fall on an outstretched hand (FOOSH). This type of elbow dislocation occurs from hyperextension in which the trochlea is levered over the coronoid process. Anterior dislocations occur as a direct blow to a flexed elbow. This usually results in an olecranon fracture thus dislocating the ulna. Less rare is a divergent dislocation which is usually associated with a high-energy force in which the ulna and radius dislocate in opposite directions. Radial head subluxations occur in young children when they are being picked up by their arms.

Epidemiology: Elbow dislocations are more common in males than females. About 90% of elbow dislocations are posterior from FOOSH. Anterior dislocations occur from a direct blow on the flexed elbow usually fracturing the olecranon. Radial head subluxations occur when the arm is pulled. (The arm is usually pronated, flexed, and abducted against the body.)

Diagnosis

- Swelling and obvious deformity
- Obvious mechanism of injury
- Severe pain and guarding
- Limited ROM
- Posterior dislocations often have a prominent olecranon
- Radiographs confirm the diagnosis

Nonoperative Versus Operative Management: Surgical reduction is typically recommended for patients that have this condition. It consists of reduction of the ulna back into its anatomical position. This has to occur paying special attention to the ulnar nerve and median nerves. Motor function of the ulnar and median nerves is assessed by testing the opposibility of the thumb (median), and abduction/adduction strength of the digits (ulnar). Sensation of the median nerve is evaluated by testing the distal palmar aspect of the first through fifth digits. Sensation of the ulnar nerve is evaluated by testing ½ of the fourth and the fifth digits. It is also important to assess vascular responses because the brachial artery may be compromised.

Surgical Procedure: There have been several methods for reducing a posterior dislocation. Adequate analgesia and sedation is necessary for patient comfort. If the patient has a posterior dislocation, the patient is put in a prone position having their elbow flexed at 90 degrees. Downward traction is applied to the forearm while pressure is applied to the olecranon in a downward direction to facilitate reduction. The second method has the patient laying supine.
with the arm in flexion. Traction is applied to the humerus and another individual applies traction to the forearm, which is slightly supinated. Anterior dislocations are reduced by holding the humerus with two hands to apply counter traction. An assistant needs to apply traction to the forearm. Radial head subluxations in children are reduced by placing pressure to the radial head. Supination, flexion, and traction need to occur to reduce the dysfunction. There is little evidence that the surgical repair of ligaments is advantageous to the patient.

Preoperative Rehabilitation: There is no preoperative rehabilitation. The elbow needs to be reduced. Pre-hospital care should include splinting the limb in the position found. Secondary to neurovascular injury, reduction in the field is not recommended.

POSTOPERATIVE REHABILITATION

Note: There is currently no rehabilitation program developed specifically for elbow dislocations. The following rehabilitation protocol was developed from numerous sources of literature. Individual cases will vary dependent upon age, pain tolerance, and complications with the reductions. In most articles prognosis is excellent if the patient has full ROM within 3 weeks.

**Phase I:** Weeks 1-4

Goals: Control edema and pain
- Early full ROM
- Protect injured tissues
- Minimize deconditioning

Intervention:
- Continue to assess for neurovascular compromise
- Elevation and ice
- Gentle PROM - working to get full extension
- Splinting as needed
- General cardiovascular and muscular conditioning program
- Strengthen through ROM
- Soft tissue mobilization if indicated – especially assess the brachialis myofascia

**Phase II:** Weeks 5-8

Goals: Control any residual symptoms of edema and pain
- Full ROM
- Minimize deconditioning
Intervention:

- Active range of motion (AROM) exercises, isometric exercises, progressing to resisted exercises using tubing or manual resistance or weights
- Incorporate sport specific exercises if indicated
- Joint mobilization, soft tissue mobilization, or passive stretching if indicated
- Continue to assess for neurovascular compromise
- Nerve mobility exercises if indicated
- Modify/progress cardiovascular and muscular conditioning program

**Phase III:** Weeks 9-16

Goals: Full range of motion and normal strength
Return to preinjury functional activities

Intervention:

- Interventions as above
- Modify/progress cardiovascular and muscular conditioning
- Progress sport specific or job specific training

Selected References:


Halstead M. Elbow Dislocation. *emedicine.* 2001 July 26 1-11


Radial Head Fracture Repair and Rehabilitation

Surgical Indications and Considerations

Anatomical Considerations: The elbow is a complex joint due to its intricate functional anatomy. The ulna, radius and humerus articulate in such a way as to form four distinctive joints. Surrounding the osseous structures are the ulnar collateral ligament complex, the lateral collateral ligament complex and the joint capsule. Four main muscle groups provide movement: the elbow flexors, the elbow extensors, the flexor-pronator group, and the extensor-supinator groups. Different types of radial head fractures can occur each of which has separate surgical indications and considerations. Fractures of the proximal one-third of the radius normally occur in the head region in adults and in neck region in children.

The most recognized and used standard for assessing radial head fractures is the 4-part Mason classification system. It is used for both treatment and prognosis.

Classification:

Type I fracture
A fissure or marginal fracture without displacement.

Type II fracture
Marginal fractures with displacement involving greater than 2 mm displacement.

Type III fracture
Comminuted fractures of the whole radial head.

Type IV fracture (variation)
A comminuted fracture, with an associated dislocation, ligament injury, coronoid fracture, or Monteggia lesion.

Pathogenesis: Severe comminuted fractures or fracture dislocations of the head of the radius often occur as the result of a fall on an outstretched arm with the distal forearm angled laterally, or a valgus stress on the elbow. Fractures can also occur from a direct blow or force to the elbow (e.g. MVA). Chronic synovitis and mild deterioration of the articular surfaces associated with arthritis (e.g. rheumatoid arthritis, osteoarthritis) of the humeroradial and proximal radioulnar joints resulting in bone deterioration may cause fractures as well.

Epidemiology:
Radial head fractures are relatively uncommon. These fractures occur in all ages.
**Diagnosis**

- Reported fall on outstretched arm
- Guarding with elbow flexed
- Pain on the lateral side of the elbow
- Swelling/effusion at lateral elbow
- Difficulty with flexion or extension of the elbow, decreased ROM
- Difficulty with pronation and supination of the forearm, decreased ROM
- Tenderness with palpation near the radial head
- Fat pad sign with radiograph examination, CT scan also used

**Non-operative treatment:**
Conservative treatment usually coincides with Type I radial head fractures. An undisplaced fracture does not need manipulation. Fractures in adults with slight displacement < 2 mm, an attempt is always made to reduce the fracture with manipulation. In children closed reduction alone is often successful. After reduction, sling immobilization with active motion is a well-documented treatment of choice. The addition of a posterior splint for a few days may add comfort for the patient. Initial pain control includes cryotherapy, NSAIDS, and pain medication. Protection of the radial head from accidental bumping can be accomplished by elastic wrapping or loosely taping molded thermoplast over the lateral elbow.

**Operative treatment:**
This type of treatment is indicated for radial head fractures Type II-IV. This type of treatment is an option when closed manipulation has failed. There are two types of operative treatment: radial head resection and open reduction internal fixation. Open reduction internal fixation has shown to have better results. With an ORIF the fractures are internally fixed with the use of low-profile mini-plates and or Herbert screws. The radial head facture is accessed through a similar approach as in resection, which is a lateral or posterolateral approach. The fracture is reduced by small forceps, tenacular clamps, or fixed with 1.0-mm Kirschner wires. Ligaments are sutured back into place using number-1 nonabsorbable braided sutures. The elbow is then fitted with a long arm cylinder cast and the elbow at 90 degrees of flexion. The cast is to be worn for 2 weeks after which it is changed to a hinged brace to allow elbow movement in the following 4 weeks.

**NONOPERATIVE AND POSTOPERATIVE REHABILITATION**

Note: The following rehabilitation progression is a summary of the guidelines provided by Kisner and Colby, Gutierrez, and Teperman. Refer to their publication to obtain further information regarding criteria to progress from one phase to the next, anticipated impairments and functional limitations, interventions, goals, and rationales.
REHABILITATION FOR NON-OPERATIVE RADIAL HEAD FRACTURES

**Early Passive Motion:** (2-7 days post fracture)

Goals: Control pain and edema  
Protect fracture site  
Minimize deconditioning  
Maintain range in joints around the effected region (shoulder, wrist, fingers)  
Prevent contractures

Intervention:

- Modalities, such as TENS and ice, for pain control  
- Splint/Sling as direct by MD  
- Monitor use and weight bearing instructions per MD  
- Cardiovascular conditioning  
- Gentle range of motion exercises of the shoulder, wrist, and fingers  
- Passive flexion/extension of the elbow  
- Passive pronation/supination of the elbow

**Phase I maximum protection phase:** (3-6 weeks post fracture)

Goals: Continue to control pain and edema as needed  
Minimize deconditioning  
Regain range of motion within pain limits  
Prevent muscle atrophy

Intervention:

- Active assistive flexion/extension of the elbow  
- Active assistive pronation/supination of the elbow  
- Isometrics: flexion, extension, and pronation, supination  
- Active assistive hyper extension of elbow (at 6 weeks)  
- Gripping exercises

**Phase II moderate protection phase:** (6-8 weeks post fracture)

Goals: Regain full range of motion  
Actively work within newly gained range of motion  
Increase strength
Intervention:

- Active flexion/extension of the elbow
- Active pronation/supination of the elbow
- Active flexion/extension in standing with wand
- Pulleys with eccentric control of the elbow with flexion/extension

**Phase III minimum protection phase:** (8 weeks post fracture)

Goals: Educate patient on proper joint protection and therapeutic exercises
- Gain adequate strength in the forearm flexors and extensors to increase stability at the elbow
- Strengthen the elbow flexors and extensors to gain full range of motion

Intervention:

- Resistive exercises: standing with weights, theraband resisted (flexion, extension, pronation, supination) exercises
- Self-stretching: flexion/extension, pronation/supination, shoulder flexion/extension, and wrist flexion/extension, ulnar deviation/ radial deviation
- Advance elbow extension with radial deviation and elbow flexion with ulnar deviation

REHABILITATION FOR OPERATIVE RADIAL HEAD FRACTURES

Preoperative Rehabilitation
- Injury is protected with immobilization through casting, splinting and/or placed in a sling
- Patient is instructed of post-operative rehabilitation goals and plan

**Immobilization:** (3-5 days post op)

Goals: Control pain and edema
- Protect fracture site with posterior splint or compression bandage
- Minimize cardiovascular deconditioning
- Maintain range in joints around the effected region (shoulder, wrist, and fingers)
- Prevent contractures
- Patient can don/doff sling independently with elbow at 90 degrees flexion with forearm in neutral
Intervention:

- Modalities, such as TENS and ice, for pain control
- Splint/Sling as direct by MD
- Monitor use and weight bearing instructions per MD
- Cardiovascular conditioning
- Gentle range of motion exercises of the shoulder, wrist, and fingers
- Passive flexion/extension of the elbow
- Passive pronation/supination of the elbow

**Phase I maximum protection phase:** (7 days - 3 weeks post op)

Goals: Continue to control pain and edema as needed
  - Minimize deconditioning
  - Regain range of motion within pain limits
  - Prevent muscle atrophy

Intervention:

- Active assistive flexion/extension with stick or pulleys
- Active assistive pronation/supination with stick or pulleys
- Cardiovascular conditioning
- Increase mobility to tolerance, prevent stiffness
- CPM

**Phase II moderate protection phase:** (4-6 weeks post op)

Goals: Regain full range of motion
  - Actively work within newly gained range of motion
  - Increase strength

Intervention:

- Active flexion/extension of the elbow
- Active pronation/supination of the elbow
- Active: flexion, extension, pronation, supination with a wand or pulleys
- Pulleys with eccentric control during flexion/extension
- Isometrics: flexion, extension, pronation, supination
- Gentle stretching using inhibition/elongation techniques or joint mobilization to increase range of motion
**Phase III** minimum protection phase: (12 weeks post op)

Goals: Increase strength (especially at end ranges)
  - Educate patient on proper joint protection and therapeutic exercises
  - Gain adequate strength in the forearm flexors and extensors to increase stability at the elbow
  - Strengthen the elbow flexors and extensors to gain full range of motion
  - Increase speed and control of limb movement

Intervention:

- Resistive exercises: standing with weights, theraband resisted (flexion, extension, pronation, supination) exercises
- Self-stretching: flexion/extension, pronation/supination, shoulder flexion/extension, and wrist flexion/extension, ulnar deviation / radial deviation
- Advance elbow extension with radial deviation and elbow flexion with ulnar deviation
- Higher speed and high intensity isotonic flexion/extension, pronation/supination while standing or performing ADLs
- Incorporate open and closed-chain exercises

Selected References:


Elbow – Open Reduction Internal Fixation

Surgical Indications and Considerations

Anatomical Considerations: The elbow is composed of 3 articulations; humeroulnar, humeroradial, and the proximal radioulnar joint. The distal radioulnar joint is thought to be a part of the elbow complex due to the fact that its function is directly related to the proximal radio ulnar joint. The two major collateral ligaments and the joint capsule along with the surrounding muscles provide the strength and support to the joint. The radial head is more susceptible to fractures because of the 15° angle between the neck and the shaft of the radius.

Pathogenesis: Elbow fractures are classified as distal humeral fractures, proximal radial fractures, and proximal ulnar fractures. Most elbow fractures are a result of direct trauma or a fall onto an outstretched hand. (FOOSH) With the forearm in pronation and the elbow extended, the valgus (lateral) stress causes the elbow joint to be a vulnerable position. Approximately 60% of the body weight is forced onto the elbow joint during a fall, and especially to the radial head. Other medical factors such as arthritis, puts the patient at a higher risk to fracture the elbow joint.

The Mason classification system is most commonly used to classify and to treat the fractures.

Class I – Non-displaced
~ generally small, hairline fractures (easily missed)
~ may not be visible on X-rays (visible if X-ray is taken 3 weeks post injury)
~ can displace if too much movement occurs.

Class II – Marginal head fracture
~ splinting for 1 – 2 weeks
~ slightly displaced and involves a larger portion of the bone
~ may need surgical removal of small fragments
~ if fragments are larger, surgical procedures with pins and screws.
~ for geriatric patients, the surgeon generally removes the broken piece or entire even the entire radial head.

Class III - Comminuted
~ more than 3 fragments of bone
~ significant damage to joint and ligaments
~ surgery is required to remove fragments and repair soft-tissue damage
~ prosthesis can be used to prevent deformity

Class IV – With elbow dislocation
~ the dislocations are treated first, then the fracture
~ usually other complications involved such as ligament tear or other elbow fractures.
**Epidemiology:** Elbow fractures are not as common as other fractures of the body, accounting for 7% of all elbow trauma. The most common fractures of the elbow vary with the mechanism of injury and patient's age. Supracondylar fractures are more common in children and radial head fractures are most common in adults, occurring more frequently in women then men.

**Diagnosis**

~ Patient will report of a fall on outstretched arm (FOOSH) or a direct trauma to the elbow
~ Joint effusion and ecchymosis near the elbow may be present
~ Point tenderness at the radial head
~ Pain with ROM, especially with pronation and supination of the forearm

**Non-operative Versus Operative Management:**

Class I and some Class II fractures (non-displaced and non-comminuted fractures) are typically treated conservatively with immobilization. Open reduction and internal fixation is indicated for displaced fractures like Class II(displaced), Class III, and Class IV fractures. Ring et al. suggest that fractures involving the whole radial head should be treated with radial head arthroplasty rather than open reduction internal fixation. Open reduction and internal fixation is best reserved for minimally comminuted fractures with three or less articular fragments (Mason Type II fractures).

**Surgical Procedures:**

The surgical approach depends on the structures that are involved. If the ulna or medial side of the elbow needs to be accessed, a posterior approach is used for the incision. If the radial head alone needs to be accessed, a lateral incision is made. Exposure of the radial head varies according to the approaches used, however will involve the anconeus, extensor carpi ulnaris, and the supinator muscles. Miniature screws of different depths, a Herbert screw (headless screw), small Kirschner wires, and/or bioabsorbable pins may be used if the fracture does not involve the radial neck. However if the radial neck is involved, then a small plate is indicated. An autogenous bone graft is applied taken either from the lateral epicondyle or the olecranon if necessary. When applying the screws, the angle of placement is taken into consideration not to obstruct the radioulnar articulation for movement of pronation and supination. Any other damage (i.e. ligament tear) is then surgically repaired and the incision is sutured.

**Preoperative Rehabilitation**

~ Further injury protection using a splint or cast
~ Go over post-operative rehabilitation plan with the patient
POSTOPERATIVE REHABILITATION

**Protection:** Day 1-7
Immobilized in a splint* (90° flexion, neutral rotation) - about 3 days
*(Splint is removed for exercise but put back on after exercise and worn at night for several weeks)
Elevation – prevent or minimize edema

**Phase I:** Weeks 1 - 4

Goals: Pain and edema control
- Protect surgical repair site
- PROM progress to AROM
- Independent home exercise program

Intervention:
- Modalities for pain control
- Gentle active and active-assisted range-of-motion exercises
- Teach patient self ROM exercises and HEP

**Phase II:** Weeks 5 – 8

Goals: Increase upper extremity strength
- Increase/progress range of motion
- Implement function

Intervention:
- Modalities for pain control
- Gentle – mod stretching
- Active: Flexion, Extension, Pronation, Supination exercises
- Mobilization to increase range of motion (Grades I – II)
**Phase III:** Weeks 9 – 12

Goals: Normal functional use for ADL’s  
  Limit scar tissue adhesions  
  Full ROM  
  Improve strength of elbow muscles  
  Improve cardiovascular and muscular endurance

Intervention:  
  Progressive resistance exercises – to all weak elbow musculature  
  Soft tissue mobilization to hypomobile tissue near surgery site  
  Joint mobilization (Grades III – IV)  
  Functional use for light ADL’s

References:


Heterotopic Ossification About The Elbow: Repair And Rehabilitation

Surgical Indications and Considerations

Anatomical Considerations: The complex anatomy of the elbow joint and its relation to the hand, forearm, and shoulder underlie the functional deficits associated with heterotopic ossificans (HO). Despite much study and newly gained insights into its development, treatment of HO of the elbow remains largely based upon the more widely studied HO of the hip joint. The elbow differs from the hip in a number of different ways, one of which being that the cross-sectional area of the elbow in comparison with the upper limb is relatively much larger than that of the hip in relation to the lower limb; thus, involvement of neighboring nerves and vasculature by HO is much more likely at the elbow.

Pathogenesis: Acquired HO is a recognized complication of various traumatic etiologies such as spinal cord injury, traumatic brain injury, burns, surgical resection and joint arthroplasty. However, while many theories have been put forth to explain HO of the elbow, the true mechanism of how ectopic bone forms around a joint, possibly causing severe functional limitations, and even total joint ankylosis, remains uncertain. The transformation of primitive mesenchymal cells in connective tissue into osteoblastic tissue and osteoid involve diverse and poorly understood biological triggers, ranging from bone morphogenic proteins, human skeletal growth factors, to genetic, neurological and traumatic factors. The presence of limb spasticity, fracture, infection, and pressure sores are generally believed to increase the likelihood of HO development.

Epidemiology: The incidence of clinically significant HO in the common settings of elbow injury (trauma, brain injury, spinal cord injury) has been reported to be as high as 10% to 20%. In addition, the elbow is the most frequent site of HO in burn patients, of whom 1% to 3% may be affected, although estimates as high as 35% have been given in the literature. Other risk factors include the following: male gender, trauma, full-thickness burns, spinal cord injury, deep local infection, overzealous joint manipulation, microtrauma to the musculotendinous apparatus with resultant hemorrhage, circulatory stasis, postoperative immobilization with limitation of joint movement, bone demineralization from prolonged bedrest or assisted ventilation.

Diagnosis: HO characteristically begins approximately two weeks after injury, however, diagnosis is often delayed. Common signs and symptoms include decreased range of motion, pain, swelling, and erythema. These non-specific clinical signs may not appear until eight to ten weeks after the initial injury. Positive radiological findings may not appear for four weeks. An acute rise in serum alkaline phosphatase and a transient depression in serum calcium may occur within the first two weeks. However, these are non-specific laboratory findings and may not be helpful in early diagnosis. The determining characteristics of HO include a radiologically verification of a periarticular location, an intact cortex, a lucent zone between cortex and ossification (“string sign”), peripheral density of calcification, and contraction of the ossification zone with maturity. Finally, while plain films are used for delineating the precise extent of HO at the elbow, bone scans remain the gold standard for diagnosis.
Nonoperative Versus Operative Management: Surgery plays a prominent role in many treatment plans, particularly when orthopedic trauma is the initiating injury and if certain prerequisites are met. As a rule, if the elbow is able to span an arc of 30° to 110° (range of motion as described here assumes that complete extension represents an arc of 145° measured at the elbow joint), the elbow is not considered functionally impaired. In addition, there should be no evidence of acute inflammation in the periarticular tissues. The skin overlying the proposed surgical site should be completely healed. It must not, however, be assumed that surgery is always required for the treatment of HO of the elbow. One recent report of established HO noted decreased pain and improved range of motion after radiation therapy to the elbow joint, even without excision of the heterotopic bone. Similarly, neuropathic pain may respond better to anticonvulsants (e.g., gabapentin) or tricyclics (e.g., amitriptyline) than to operative intervention. One surgeon even observed that range of motion is maximized when gradual physical therapy, rather than surgical excision, is used to release muscle contractures. The fundamental prerequisite for surgical intervention then, is not the mere presence of HO, but peripheral nerve compromise, pain, or an impaired range of motion affecting daily activities that would not be manageable by more conservative medical or physical therapy intervention.

Surgical Procedure: Surgery is usually performed once the lesion has stabilized radiographically. And in the case of brain-injured patients, the key principle is that surgery should follow, not precede, neurological recovery (persistent loss of neurological function is the setting in which HO gains a foothold, and if excised, tends to recur). Surgical approach depends on the location of the heterotopic bone and its relation to normal structures.

A posterior approach is recommended to avoid traumatizing previously damaged skin. Access to the anterior capsule can be accomplished by removing the radial head. Once the capsule has been entered, the ulnar nerve should be transposed so heterotopic bone and ossified periarticular ligaments in surrounding soft tissue can be removed. The entire bridge of bone and its bony attachments must be removed.

A posterolateral approach is recommended when the elbow ankylosis in extreme flexion. In this setting, heterotopic impingement on the olecranon may be present. Here, the olecranon should be excised and the fibrofatty tissue within the fossa left in, because adipose tissue tends to prevent recurrence of heterotopic bone that has already formed. An incision is then made proximal to the mass on the posterolateral arm across the olecranon. The triceps aponeurosis is exposed, incised, and retracted medially to expose the subperiosteal heterotopic bone joining the lateral condyle of the humerus to the posterolateral olecranon. If the proximal forearm is involved, with compromise of supination and pronation, the incision is extended distally. An osteotome is used to remove the heterotopic bone, whereas the fat pad in the fossa is left in place. The elbow is passively flexed to facilitate removal of the bone from its attachments to the olecranon and humerus.

A medial approach is used if the posteriorly situated heterotopic bone extends medially, if its presence near the ulnar collateral ligament compromises range of motion, or if the ulnar nerve is to be transposed anteriorly. If bone encircles the ulnar nerve, it must be removed so that the ulnar nerve can be released before complete resection proceeds. If heterotopic bone follows the brachialis muscle in the direction of the coronoid process or follows the path of the biceps
tendon, anterior synostosis of the forearm may occur. In this setting, an anterolateral approach allows the brachialis and brachioradialis muscles to be identified and retracted from the radioulnar joint. The radial nerve is retracted laterally with the brachioradialis muscle. Heterotopic bone is then dissected subperiosteally, and the central bridge of bone is resected, with anterior capsule left intact. Postoperative hematomas are common in this setting.

Preoperative Rehabilitation

- Activity as tolerated (continue to assess function/lack of function)
- Infection control/integument healing
- In brain injury patients, continue with neurological recovery
- Pain management
- Instructions/review post-operative rehabilitation plan

POSTOPERATIVE REHABILITATION

Note: The following rehabilitation progression is a summary of the guidelines provided by Calandruccio, Akin, Griffith, Andrews, Hurd, and Wilk. Refer to their publication to obtain further information regarding criteria to progress from one phase to the next, anticipated impairments and functional limitations, interventions, goals, and rationales.

Phase I for Early Motion and Rehabilitation: Week 1

Goals: Prevent infection
- Decrease stress on surgical site
- Decrease pain
- Control and decrease edema
- Protect surgical site
- Elbow PROM to within 80% available limits structurally
- Maintain ROM of joints proximal and distal to surgical site

Intervention:

- Monitoring of surgical site
- Instruction of patient in activity modification
- Continuous passive motion (some MDs place CPM immediately post-op on the patient)
- AROM: exercises for hand, shoulder, elbow (within patient’s tolerance)
**Phase II for Early Motion and Rehabilitation:** Weeks 2-8

Goals: Reduce pain  
Manage edema  
Encourage limited activity of daily living performances  
Promote scar mobility and proper remodeling  
Promote full elbow PROM  
Encourage quality muscle contraction

Intervention:

- Continuation of edema and pain management techniques as in Phase 1  
- Soft tissue mobilization myofascial restrictions are present  
- Retrograde or lymphatic massage if tissue edema is present  
- Scar desensitization/mobilization after sutures are removed and incision is closed  
- AROM: Elbow flexion/extension/pronation/supination  
- PROM: Elbow flexion/extension/pronation/supination  
- Isometrics: wrist and shoulder, sub-maximal

**Phase III for Early Motion and Rehabilitation:** Weeks 9-24

Goals: Self-manage pain  
Prevent flare-up with progression of functional activities  
Improve strength:  
  - Grip strength to 75% of uninvolved side  
  - Wrist strength to within 80%  
Improve ROM if it still limited  
Return to previous activity level

Intervention:

- Continue pain and edema management as indicated  
- Patient education regarding activity modification and performance of activities with good mechanics  
- Progressive resistance exercises for shoulder, elbow, and wrist  
- Putty exercises-finger pinch and grip  
- Work simulator (at 16-20 weeks)
Selected References:


Median Nerve Compression at Pronator Teres

Surgical Indications and Considerations

Anatomical Considerations: The median nerve and brachial artery travel together down the arm. Therefore, one must be very careful not to interfere with either the median nerve or the brachial artery, especially when conducting surgical procedures. In the area of the pronator teres, there are many tendons as well. It is important to identify, as much as possible, the correct site of compression.

Pathogenesis: The median nerve can get entrapped or compressed by several structures in the arm. The pronator teres muscle is the most common. Others entrapment sites include the flexor digitorum superficialis arch, the lacertus fibrosis (bicipital aponeurosis), and ligament of Struthers (frequency occurs in that order). For compression of the median nerve at the pronator teres and flexor digitorum superficialis, the cause is almost always due to hypertrophy of the respected muscle. This hypertrophy is from quick, forceful and repeated movements to the involved muscle. Examples include a carpenter or a baseball batter. As the muscle hypertrophies, the signal from the median nerve is diminished resulting in paresthesias in the median nerve distribution (lateral arm and hand) distal to the site of compression. Pain in the volar part of the forearm, often aggravated by repetitive supination and pronation, is a common symptom of pronator involvement. Another indicator is forearm pain with the compression of muscle such as pain in the volar part of the forearm implicating pronator teres. Onset is typically insidious and diagnosis is usually delayed 9 months to 2 years.

Epidemiology: Pronator teres syndrome is the second most common cause of median nerve compression behind carpal tunnel syndrome. It tends to occur in athletics (especially those with rapid, exertional supination and pronation) and in occupations where the forearm may be hypertrophied. In addition, anomalies involving the ligament of Struthers and the course of the median nerve may contribute to median nerve entrapment.

Diagnosis

- Aching discomfort and easy fatigability of the muscle of the forearm
- Numbness and paresthesia in median nerve distribution and palmer cutaneous branch in hand
- Absence of nocturnal symptoms
- Direct compression of the pronator teres muscle resulting in symptom reproduction
- Electromyographic studies of muscles innervated by the median nerve are considered mildly reliable (confirms diagnosis of AIN syndrome in 80-90% of cases)
- Can occur with a sudden increase in use of pronation or supination muscles.

Nonoperative Versus Operative Management: Conservative management is almost always attempted prior to surgery and can often result in positive results. With conservative treatment, 50% of patients report recovery within 4 months. Other reports say improvement can be seen.
from 18 months to 2.5 years after conservative treatment. Conservative treatment involves rest and casting early, modalities and nerve gliding next, followed by return to modified duties and full work/recreation. Cortisone injections could be attempted after conservative treatment is deemed not successful. Surgery is the next option when both of the previous attempts were not able to improve the patient’s symptoms. Some literature says the decision to have surgery may be determined as early as 8 weeks or as long as 6 months after initiating conservative treatment. In general, median nerve decompression has an 85 to 90% good to excellent outcome.

**Surgical Procedure:** Decompression is performed with an anterior approach and uses a longitudinal incision along the arm. If it is determined the patient has a supracondylar process (ligament of Struthers) and requires decompression, the incision will start several centimeters above this site. Otherwise, the incision is made just above or at the elbow crease. It is then carried to the midforearm. Due to difficulty in differentiation, the surgery involves decompressing all possible sites along the course of the nerve. This can include several sites that may not be entrapping the nerve and may result in longer recovery and rehabilitation due to several sites of injury. In instances such as high-level athletes, careful identification of the site of entrapment is performed and only that site is decompressed. As stated earlier, median nerve decompression has an 85 to 90% good to excellent outcome.

**Conservative Rehabilitation (Preoperative Rehabilitation):**

**Phase I:** Weeks 1-2

Goals: Control edema  
Pain reduction

Intervention:

- Protect elbow from further entrapments with use of splinting the elbow at 90 degrees flexion and neutral supination/pronation  
- Gentle passive range of motion activities  
- Elevation, ice and compression  
- Modalities and medications for inflammation, pain, and swelling  
- Gentle median nerve gliding  
- Soft tissue mobilization and massage  
- Maintain physical fitness and conditioning

**Phase II:** Weeks 3-4

Goals: Improve Flexibility  
Strengthening  
(Caution is exhibited in this phase to prevent recurrence of overuse syndrome)
Intervention:

- Modalities may be used to help reduce inflammatory and pain
- Wrist flexion and extension exercises are initiated.
- Once this is tolerated well, the patient may begin with elbow flexion and extension exercises and gentle supination and pronation.
- Soft tissue mobilization/massage to forearm may be used to areas when entrapment is suspected
- Begin to address work or sport related activities
- Progress with physical fitness and conditioning
- Provide nerve mobility “gliding” exercises to address nerve mobility impairments and prevent recurrence

**Phase III:** Weeks 5-8

Goals: Progress to independent home program
- Return to occupational, recreational, or sport activities
- Prevent recurrence of injury
- For non-dominant arm, progress patient to 90% strength of opposite arm. For dominant arm, progress patient to 100% strength

Intervention:

- Education to patient regarding prevention and management
- Nerve gliding to prevent recurrence
- Strengthening and flexibility is large component for the athlete to return to sports
- Focus on tasks the simulate the patient’s sport or work or both

**POSTOPERATIVE REHABILITATION**

**Phase I:** Days 1-21

Goals: Control edema and pain
- Prevent infection of wound site
- Maintain AROM of surrounding joints
- Decrease sensitivity at incision site and increase scar mobility

Intervention:

- Instruct on surgical site protection and monitor drainage
- Rest, ice, and elevate arm
- Elbow splinted for 7 to 10 days in slight flexion
- Active finger, wrist, and shoulder movement – later in Phase I include elbow and forearm
motions
- Painfree, gentle nerve mobility exercises
- Iontophoresis and modalities as needed to reduce inflammation and control pain
- Gentle soft tissue mobilization and massage to decrease swelling and maintain tissue mobility

**Phase II:** Weeks 4-6

Goals: Grip and elbow strength 30-50% of uninvolved hand
- Increase forearm and elbow AROM to greater than 50% of normal.
- Continue to prevent scar adhesions and sensitivity
- Independence with activities of daily living
- Assess ergonomics at work or sport activity

Intervention:

- Passive stretches to elbow, forearm, wrist and shoulder
- Patient education regarding prevention of recurrence
- Isotonic exercises for elbow, wrist, forearm, and shoulder
- Begin work and sport simulated exercises

**Phase III:** Weeks 6-12

Goals: Adequate strength to return to full work duties or sport activities
- Self-management of symptoms

Intervention:

- Work or sport simulated activities
- Progress upper extremity exercises emphasizing endurance for return to work or sport
- Continue exercises and stretches from Phase I and II as indicated
Selected References:


Radial/Posterior Interosseous Nerve Decompression

Surgical Indications and Considerations

Anatomical Considerations: The close proximity of the radial/posterior interosseous nerve to bony, muscular, tendinous, and arterial structures puts it at risk for entrapment. There are several regions where compression of the radial/posterior interosseous nerve occurs – in the axillary/proximal region, at the elbow, and very rarely at the wrist.

Pathogenesis: Nerve compression of the radial/posterior interosseous nerve is caused by both intrinsic and extrinsic factors. In addition to the factors listed below, compression can be caused from tumors, septic arthritis in the elbow, synovitis secondary to rheumatoid arthritis, lipomas, hemangiomas, ganglion cysts, and other masses. Also, a tardy palsy may occur secondary to compression by a callus in a healing fracture at any of the locations.

High radial nerve (upper arm to elbow) compression sites and syndromes:
- Close proximity of the radial nerve to the radial groove of the humerus puts the nerve at risk for compression against the bone, being severed secondary to a fracture, or compressed by either orthopedic plates to repair a fracture or by a callus during bone healing
- Close proximity of the radial nerve to the medial and lateral head of the triceps, or a fibrous origin of the lateral head of the triceps leading to injury during strenuous activity
- Compression secondary to axillary crutches
- Secondary to “windmill” pitching in competitive softball
- “Saturday Night Palsy” – arm draped over a chair or hard surface as patient is asleep or intoxicated, “Honeymooners Palsy” – caused by one honeymooner resting on the other’s arm
- External compression and trauma most common cause of problems in this region

At the elbow
- Entrapment by fibrous bands around the anterior margin of the radial head
- Entrapment by the “Leash of Henry” - vessels from the radial recurrent artery
- Entrapment by the tendinous edge of Extensor Carpi Radialis Brevis
- Entrapment at the Arcade of Frohse (proximal entrance of the posterior interosseous nerve into the supinator muscle) - this structure is soft in childhood and can become fibrous in adulthood with fibrous occurrence ranging from 30-50% in cadaver studies but present in 80% of patients who undergo radial nerve decompression at the elbow
- Entrapment at the distal entrance of the posterior interosseous nerve from the supinator muscle
- Compression secondary to elbow synovitis in patients with rheumatoid arthritis
- Compression secondary to Monteggia fracture (fracture of proximal ulna in combination with posterior dislocation of the radial head)
- Frisbee flinging
Lipoma, elbow ganglion (tumor should be considered when there is dense paralysis)

At the wrist
  
  4th extensor compartment

**Epidemiology:** The radial nerve is involved less frequently than the ulnar or median nerve in entrapment syndromes, however the radial nerve is the most frequently traumatically injured nerve in the arm, usually secondary to fractures. The dominant arm is involved twice as much as the nondominant arm, and men are affected twice as often as women. Injuries involving the elbow are thought to be related to activities that involve repeated supination and pronation such as tennis, racquetball sports, swimming, violin playing, orchestra conducting, and manual labor. Radial nerve compression often coexists with compression syndromes of other nerves or with other conditions such as lateral epicondylitis.

**Diagnosis:** Radial nerve compression is difficult to diagnose due to its wide spectrum of presentation, which often coexist or are confused with nonneurologic syndromes. EMG studies generally not reliable for diagnosis, but can be used to rule out radiculopathies from C7. If compression is suspected to be secondary to fracture or due to pressure from a mass, the use of radiographs, MRI, CT scan, and sonography can be useful in diagnosis. More evidence for the use of sonography in diagnosing radial compression is becoming apparent.

High Radial Nerve

Proximal to the radial groove
- Involves weakness in elbow extension, wrist, thumb and finger extension
- Sensory loss over the posterior arm and forearm and of the posterior lateral hand and thumb
- Rule out C7 radiculopathy
- History of use of crutches with compression in the axillary region
- Mechanisms of injury consistent with “Saturday Night Palsy” or “Honeymooner’s Palsy”

At the radial groove
- Involves weakness in wrist extension, thumb and finger extension
- Possible sensory loss over posterior lateral hand and thumb with sensation of posterior arm and forearm intact

At the elbow

Radial tunnel (distal to the lateral intermuscular septum and proximal to the supinator muscle) **Note there is a discrepancy in the literature of what the radial tunnel refers to with several authors including the supinator muscle in the tunnel with the tunnel ending distal to the supinator.
- Weak thumb and finger extensors, varying degrees of wrist extension weakness (may or may not be present), may affect grip strength
- Possible sensory loss over posterior lateral hand and thumb with sensation of posterior arm and forearm intact
- Controversy over using a lidocaine injection to diagnose this syndrome
Aching in lateral humerus, lateral elbow, and extensor mass (most common point of pain is at radial neck where as for lateral epicondylitis it is most common at the radial head or on the lateral epicondyle)

Night pain common according to some literature
Elbow “popping” with passive pronation (may occur in some)
Resisted supination with elbow in extension reproducing pain a common test used for diagnosis (however also positive with lateral epicondylitis)
Middle finger test with resistance to elevation of middle finger with wrist in neutral and elbow extended reproducing pain is a test used for diagnosis but many authors have the opinion that it provides no diagnostic reliability
Rule out lateral epicondylitis (many times occurs along with radial nerve compression with decompression sometimes reliving symptoms of both and other times not)
Possible history of strenuous use of forearm

Posterior Interosseous Nerve
Weakness in wrist extension with ulnar deviation, thumb and finger extension (metacarpophalangeal joints), may cause grip weakness, may have thumb abduction weakness
Normal sensation
May be a history of strenuous or repetitive effort involving supination and pronation
Rule out tendon rupture (tenodesis is present with posterior interosseous nerve syndrome, not present in tendon rupture)
Pain in deep proximal forearm or elbow which may precede weakness
According to one recent study most consistent symptoms were deep aching pain in the forearm, pain radiation to the neck and shoulder, and a “heavy” sensation of the affected arm. The most common physical findings were tenderness over the radial nerve at the supinator muscle level, pain on resisted supination, and the presence of Tinel sign over the radial forearm.

Terminal Branch of Posterior Interosseous Nerve involvement
Dorsal wrist pain (may be following a resection of a dorsal wrist ganglion) described as a deep dull ache
Pain provoked by wrist flexion, extension, and pressure on the 4th compartment with wrist flexed
Pain relieved by a local anesthetic block
**Nonoperative Versus Operative Management:** High radial nerve injuries are generally neuropraxic in origin and resolve spontaneously. Treatment is conservative and guided by EMG, which should show evidence of recovery within 4 months, with surgical exploration recommended if no recovery by this time. When conservative measures for radial tunnel and posterior interosseous nerve syndrome fail to relieve symptoms within three months, surgical intervention is pursued. The same time frame is used for involvement with the terminal branch of the posterior interosseous nerve at the wrist. Favorable responses to nonoperative management have been reported to be infrequent, probably less than 10%. According to several authors it is not clear what candidates will have a successful decompression surgery and several complications are common such as keloid scar formation, recurrence of symptoms, and hematomas. Surgical outcome for radial tunnel syndrome is variable with success rates varying from 39% excellent or good outcome to 95%. Surgeries for posterior interosseous nerve syndrome have been reported to have a positive outcome with one study reporting a 97% good to excellent outcome and another reporting increase in strength, with most patients in the 4-5/5 range. The involvement of a patient in a worker’s compensation suit as a determining factor in outcome, is controversial. The definition of excellent results does not seem to correlate well with subjective patient report or return to work rates. Therefore, the best method for evaluating patients, initially and on follow-up, the most appropriate surgical techniques or alternative therapies for treatment is open to debate, despite detailed anatomical studies. A call for randomized controlled studies has been made, but as of yet has not been conducted.

**Surgical Procedure:** General surgical approaches include the anterior, posterior, transmuscular brachioradialis-splitting, and brachioradialis-extensor carpi radialis longus interval approach. For more details on the approaches see Hornbach and Culp. Most approaches involve proximal to distal dissection as this allows for less likelihood of injury to the radial nerve and it branches. Rinker et al. describe a different approach involving the use of intravenous corticosteroids before decompression with the idea that it reduces swelling and inflammation postoperatively. They also use a distal to proximal approach and a unique approach to bandaging, with no post-surgical immobilization cast or splint. A recent report of the use of arthroscopy to relieve radial tunnel syndrome by cyst decompression has also been reported. Intraoperative recordings of nerve action potentials were used in one study to make a decision for or against resection of the nerve.

**Preoperative Rehabilitation**

General preoperative care includes rest, non-steroidal anti-inflammatory medications, oral corticosteroids (in one study), refraining from repetitive supination/pronation activities (for compression or involvement at the elbow), various types of splinting with the use of buddy taping at times (taping a weaker finger to a stronger finger), and physical therapy using heat, ultrasound and massage. Steroid injections are controversial. Various time frames for conservative treatment are given from 1 month to 6 months unless there is motor weakness, clear trauma, or a suspected mass.

- Extensor tenodesis splint has been recommended for posterior interosseous nerve syndrome (Eaton)
- In radial tunnel syndrome, wrist extension splints are recommended with the elbow flexed and supinated to provide maximum relief (Levine)

General Conservative treatment according to Alba
**Acute Phase** *(Continues until patient reports decreased pain level at rest and during activities)*

Goal: Reduce patient’s pain and inflammation

Interventions:
- Rest via splinting
- Avoidance of exacerbating postures
- Pain and edema control through non-steroidal anti-inflammatories and modalities (ultrasound, phonophoresis, electrical stimulation, and cryotherapy)
- Range of motion exercises—Active, active-assistive and gentle passive range of motion
- Modify ADL’s

**Rehabilitation Phase** *(May last in addition to acute phase for a total of 3-6 months)*

Goal: Reintroduce dynamic forces across the forearm in a gentle, controlled manner to build endurance, strength, and postural awareness

Interventions:
- Progressive strengthening
- Modified work-simulated tasks
- Continued modalities

**POSTOPERATIVE REHABILITATION**

Note: Protocols vary and in many cases are not detailed in the literature with no research found on efficacy.

**General Protocols:**

Postoperatively active, but not strenuous motion is encouraged (Eaton)

Patient should be immobilized in a long arm posterior splint for 7-10 days with range of motion at the hand and shoulder encouraged immediately postoperatively. Gentle range of motion of the elbow is started when the dressings are removed at 7-10 days. (Levine, Spinner)

Following surgery for posterior interosseous nerve syndrome, patients should receive physical therapy that includes range of motion exercises. Many also benefited from a dynamic extension splint with outrigger, rubber bands and finger pads to maintain flexibility and mobility of all finger and thumb joints. (Cravens, Spinner)

Postsurgical protocol according to Rinker et al:

**Phase I** – Day 1 to 10
- Simple soft dressing is applied, without elbow immobilization
- Rest for 24 hours and maintain strict, continuous elevation of the limb for 48 hours
- Finger, thumb and shoulder exercises begun on day 2
**Phase II** – Day 10-12 to 2 months
Sutures removed post-op days 10-12 and scar taped longitudinally with 1-inch paper tape for a minimum of 2 months

General postoperative rehabilitation according to Alba

**Phase I**-Day 1 to 7
Goal: Rest
Treatment:
- No formal therapy until after 1st week
- Immobilization in a splint
- Postsurgical dressings usually removed by end of this 1st week

**Phase II**-Day 8-21
- Range of motion exercises
- Wrist extension splint may be worn to promote healing and patient comfort
- Modalities for pain and edema management (TENS, cryotherapy, pulsed ultrasound, high frequency electrical stimulation)
- Scar management, including desensitization as tolerated, once wound completely closes
- Radial nerve glides (only to point just before feeling of tension)

**Phase III**-5 to 6 weeks post-op to end of rehab.
- Resistance exercises begun at 5-6 weeks post-op (begin with concentric and isometric, progress to eccentric as tolerated)
- Work simulated tasks integrated as above progresses

Selected References:


Ulnar Nerve Transposition

Surgical Indications and Considerations

Anatomical Considerations: The ulnar nerve runs just posterior to the medial epicondyle in the cubital tunnel (ulnar groove). This key depression helps protect the ulnar nerve and is the most frequent site for ulnar nerve injury. Posner defined 5 areas of potential compression around the elbow as follows:

- **Under the heading intermuscular septum.** Posner lists the arcade of Struthers (a musculofascial band about 8 cm proximal to the medial epicondyle), the medial intermuscular septum (which the nerve pierces to reach the olecranon groove), and the medial head of the triceps muscle (which can be hypertrophied or can chronically snap over the medial epicondyle, causing a neuritis).

- **The area of the medial epicondyle is a valgus deformity caused by malunion of a condylar fracture, nonunion of a condylar fracture, or an epiphyseal injury to the lateral side of the elbow. These may cause tardy ulnar palsy secondary to chronic stretching of the ulnar nerve.**

- **The olecranon or epicondylar groove is a fibroosseous tunnel holding the ulnar nerve and its vascular accompaniment. A congenitally shallow groove or a torn fibrous roof can allow the nerve to chronically sublux or dislocate, causing neuritis and palsy.**

- **The cubital tunnel is the passage between the 2 heads of the flexor carpi ulnaris, which are connected by a continuation of the fibroaponeurotic covering of the epicondylar groove (Osborne ligament). During elbow flexion, the tunnel flattens as the ligament stretches, causing pressure on the ulnar nerve.**

- **Flexor-pronator aponeurosis is the fifth area. As the nerve exits the flexor carpi ulnaris, it perforates a fascial layer between the flexor digitorum superficialis and the flexor digitorum profundus. Entrapment can occur here also.**

Pathogenesis: With the anatomic positioning of the ulnar nerve, it is subject to entrapment and injury by a wide variety of causes. The most common sites of entrapment around the elbow are the olecranon groove and the cubital tunnel. With its superficial position at the elbow, it is often injured by excessive pressure in this area (leaning on the elbow during work, while driving a car, using elbows to lift the body from bed, and resting elbows on car windows while driving, epicondylar fracture). Fracture fragments and arthritic spurs in or around the groove impinging on the nerve can also cause entrapment and subsequent neuritis. Traumatic hemorrhage, soft tissue tumors, ganglia, infections, osteochondromas, and synovitis secondary to rheumatoid diseases may also cause entrapment and nerve dysfunction.

Epidemiology: Ulnar nerve entrapment is the second most frequent entrapment neuropathy in the upper extremity (the first being the median nerve and its branches). Because of the anatomic arrangement of structures, the area around the elbow is the most common area for entrapment. The ulnar nerve can also be compressed at Guyon’s canal.
Diagnosis: Presenting symptoms can vary from mild transient parasthesias in the ring and small fingers to clawing of these digits and severe intrinsic muscle atrophy. The patient may report severe pain at the elbow or wrist with radiation into the hand or up into the shoulder and neck. Patients may report difficulty in opening jars or turning doorknobs. Early fatigue or weakness may be noticed if work requires repetitive hand motions. If the patient rests on the elbows at work, increasing numbness and paraesthesias may be noticed throughout the day. Tenderness to palpation along the course of the nerve is probable. Flexor carpi ulnaris and flexor digitorum profundus strength may be weak. Weakness of thumb pinch may be elicited by the Froment sign. Numbness usually precedes motor loss. Muscle wasting and clawing of the ring and small digits are indicative of a chronic compressive syndrome.

Ulnar nerve compression will either occur at the cubital tunnel or Guyon’s canal. The dorsal cutaneous branch of the ulnar nerve comes off proximal to Guyon canal. Therefore, dorsal sensory involvement of the 4th and 5th digits would indicate a problem proximal to the wrist. Thus by assessing whether the numbness involves both volar and dorsal or just dorsal aspects of digits you can diagnosis compression site.

Radiographs of the elbow reveal abnormal anatomy, such as a valgus deformity, bone spurs or bone fragments, a shallow olecranon groove, osteochondromas, and destructive lesions (e.g., tumors, infections, abnormal calcifications). Electromyography tests and nerve conduction studies are indicated to confirm the area of entrapment, document the extent of the pathology, and detect or rule out the possibility of double crush syndrome.

Nonoperative versus Operative Management: Conservative treatment of ulnar nerve compression is most successful when parasthesias are transient and caused by malposition of the elbow or blunt trauma. Patient education and insight are important. Resting on elbows at work, using elbows to lift the body from bed, and resting elbows on car windows while driving all are causes of paraesthesia that can be corrected without surgical treatment. Patient education, anterior elbow extension splinting (if necessary), nerve mobilization techniques, soft tissue mobilization, ultrasound, strengthening exercises, stretching and correction of ergonomics at work should correct these transient palsies.

Nonsteroidal anti-inflammatory medications also are useful adjuncts to relieve nerve irritation. Oral vitamin B-6 supplements may be helpful for mild symptoms. This treatment should be carried out for 6-12 weeks, depending on patient response. Indications for surgery are the following: 1) no improvement in presenting symptoms after 6-12 weeks of conservative treatment, 2) progressive palsy or paralysis, 3) clinical evidence of a long-standing lesion (e.g., muscle wasting, clawing of the fourth and fifth digits.) Dellon’s investigation noted that ulnar nerve transposition was associated with an 88% rate of good to excellent results. Fitzgerald noted that the average duration of limited work capacity (full military active duty work status) was 4.8 months (range 3-7 months).
Surgical Procedure: Decompression with anterior transposition usually is the operation of choice for ulnar nerve compression at the elbow because it removes the nerve from its compressive bed and puts it in one that is more suitable. By transferring the nerve anteriorly, it effectively lengthens the nerve, decreasing tension on it in flexion. It is the most commonly used method of transposition because it is easy to perform and results are good. An incision begins 8 cm above the medial epicondyle and continues downward to a point midway between the medial epicondyle and the olecranon groove. It then continues for about 6 cm distally over the flexor carpi ulnaris. Once the nerve has been visualized the distal portion of the medial intermuscular septum, the fibroaponeurotic roof of the epicondylar groove, the Osborne ligament, and the fascia of flexor carpi ulnaris are incised, freeing the ulnar nerve. The nerve is positioned beneath the subcutaneous tissue and held to the muscle fascia with a few sutures through the epineurium. Postoperatively, the elbow is immobilized in a cast or splint at 45 degrees of flexion for 2 weeks.

Preoperative Rehabilitation

- Further injury protection using a splint – with the elbow in about 90 degrees of flexion for 2 weeks
- Instructions/review post-operative rehabilitation plan

POSTOPERATIVE REHABILITATION

Note: The following rehabilitation progression is a summary of the guidelines provided by Andrews, Hurd and Wilk. Refer to their publication to obtain further information regarding criteria to progress from one phase to the next, anticipated impairments and functional limitations, interventions, goals, and rationales.

Phase I for Immobilization and Rehabilitation: Weeks 1-3

Goals: Control edema and pain
- Protect surgical site
- Minimize deconditioning of upper extremity
- Manage edema
- Increase elbow ROM

Intervention:

- Posterior splint with elbow at 90 degrees of flexion
- At 2 weeks, place elbow in hinged elbow brace set a -30° extension and 100° flexion
- At 3 weeks progress brace ROM to -15° extension and 110° flexion
- Cryotherapy
- Submaximal isometrics for shoulder and wrist
- Active wrist flexion and extension
**Phase II for Immobilization and Rehabilitation:** Weeks 4-8

Goals: Elbow active range of motion 0-145°
- Continue to protect repair and from unprotected valgus force
- Increase upper quarter strength
- Improve tolerance to active range of motion

Intervention:
- Brace set at -10° extension and 120° flexion. May increase 5° extension and 10° flexion per week
- Isotonic exercise (1-2 lbs) – Wrist flexion/extension, forearm pronation/supination, elbow flexion/extension, and rotator cuff exercises avoiding internal rotation
- After 6 weeks, brace set at 0°-130°, add shoulder internal rotation exercises and progress all exercises as indicated

**Phase III for Rehabilitation:** Weeks 9-13

Goals: Increase strength of upper extremity
- Increase muscular control of upper extremity
- Full range of motion (ROM)
- Allow patient to become pain free or self-manage with gradual return to activities
- Strengthen upper extremity with sport-specific activities

Intervention:
- Progress with plyometric exercises
- Isotonic exercises – Progress wrist, elbow and shoulder
- Initiate eccentric elbow flexion and extension exercises
- Proprioceptive neuromuscular facilitation (PNF) patterns
- Light sporting activities such as golf or swimming

**Phase IV for Rehabilitation:** Weeks 14-26

Goals: Symmetric upper extremity strength
- Gradual return to unrestricted sport activity

Intervention:
- Continue intervention strategies listed in Phase III as indicated by remaining impairments
- Return to competitive sports between 22 and 28 weeks
Selected References:


Ulnar Collateral Ligament Reconstruction

Surgical Indications and Considerations

Anatomical Considerations: The ulnar collateral ligament complex consists of three ligaments including the anterior oblique, posterior oblique, and transverse ligament. The anterior oblique originates at the medial epicondyle and inserts into the medial coronoid process. The anterior oblique ligament is considered the primary stabilizer of the elbow to valgus stress during the throwing motion and is the most commonly injured portion.

Pathogenesis: The anterior bundle of the ulnar collateral ligament is the primary restraint to valgus force stress during the late cocking and acceleration phases of throwing. During these phases the tensile force placed on the anterior bundle exceeds its restraining capabilities. Repeated valgus stress results in a degenerative process of the ulnar collateral ligament with eventual increased laxity and medial instability. In this sense, overuse is the primary cause of ulnar collateral ligament injury. Often a single episode during the throwing motion will cause the final insult or tear. However, an underlying degenerative process is the primary pathology. Laxity of the ulnar collateral ligament results in overuse injuries of the dynamic stabilizers of the elbow secondary to compensatory mechanisms. These injuries include pronator and flexor mass tendinopathy. The instability of the ulnar collateral ligament will cause abnormal force and subsequent symptoms to other elbow structures including the radiocapitellar compartment, posteriomedial olecranon, medial epicondyle, and ulnar nerve.

Epidemiology: Ulnar collateral ligament injuries occur primarily in overhead athletes such as baseball players, javelin throwers, quarterbacks, tennis players, and water polo players. These athletes are subjected to valgus force at the medial elbow during the throwing motion, which is the primary cause of ulnar collateral ligament injuries. Other athletes subjected to medial valgus stress include wrestlers, gymnasts, and hockey players.

Diagnosis

- Differential diagnosis is usually difficult due to the fact that ulnar collateral ligament injuries have an underlying degenerative process that predispose the patient to concomitant symptoms of flexor and pronator mass tendinopathy, ulnar neuritis, and symptoms consistent with loose bodies in the elbow
- Most pain is felt during the acceleration phase of throwing and at the point of ball release
- Some patients will describe a “giving way” feeling after a throwing motion and will be unable to continue throwing thereafter (considered the final insult to a degenerative process)
- Point tenderness two centimeters distal to the medial epicondyle
- Pain and instability with a valgus stress test (humerus stabilized with elbow at thirty degrees flexion). This test may also produce numbness and tingling in the ulnar nerve distribution because the excess medial gapping at the elbow will stretch the ulnar nerve
Several types of valgus stress tests are described in the current literature with different positions of the humerus. Note that compensatory humeral torsion deformities are believed to occur with throwing athletes which may alter the examiners view of relative glenohumeral range of motion.

Imaging studies and arthroscopy have proven helpful with diagnosis of ulnar collateral ligament injuries. However, due to variability of ulnar collateral ligament laxity associated with symptomatic versus asymptomatic elbow pain, physical examination and patient history remain as the primary means of diagnosis.

Nonoperative Versus Operative Management: Nonoperative management has yielded acceptable results in the non-throwing athletic population. Nonoperative rehabilitation starts with a period of active rest, which consists of cessation of throwing while focusing on strengthening of the rotator cuff and shoulder girdle. Once elbow pain resolves, a strengthening program of the pronator and flexor musculature is initiated. If elbow pain remains controlled and shoulder mechanics are satisfactory, an interval-throwing program is employed. Surgical reconstruction versus repair is recommended for any patient wishing to return to throwing activities. Both non-surgical rehabilitation and postoperative repairs have shown a high incidence of valgus laxity in follow-up studies when compared to reconstruction procedures. Ulnar collateral reconstruction has proven effective in several patient populations including high level throwing athletes.

Surgical Procedure: The most current and accepted procedure is a modification of the original technique described by Jobe et al. This current method elevates the flexor-pronator muscle mass from the elbow without detachment and utilizes subcutaneous rather than sub muscular ulnar nerve transposition. Several types of tendon grafts have been used to reconstruct the ulnar collateral ligament including the gracilis, plantaris, and toe extensor tendons. Currently the palmaris longus is the graft of choice and the most commonly used tendon for reconstruction. The graft is woven in a figure eight fashion through bone tunnels at the medial ulna and humerus. The elbow is then placed in ninety degrees of flexion and splinted for one week after surgery for soft tissue healing.

Preoperative Rehabilitation
- Cessation of throwing program
- Focus towards controlling symptoms at the elbow
- Initiate a shoulder girdle strength and stabilization program including rotator cuff strengthening
- Flexor and pronator mass strengthening initiated if elbow pain is controlled
- Educate and familiarize patient to post-operative rehabilitation
POSTOPERATIVE REHABILITATION

Note: The following rehabilitation progression is a summary of the guidelines provided by Andrews, Hurd, and Wilk. Refer to their publication to obtain further information regarding criteria to progress from one phase to the next, anticipated impairments and functional limitations, interventions, goals, and rationales.

Phase I for Immobilization and Rehabilitation: Weeks 1-3

Goals: Protect surgical site
   - Improve tolerance to elbow range of motion
   - Control pain and edema
   - Improve upper extremity strength and muscle contraction
   - Improve active wrist range of motion

Intervention:

- Posterior splint with 90 degrees elbow flexion for 1-2 weeks replaced by hinged brace at 30 to 100 degrees
- At 3 weeks progress brace to 15 to 115 degrees
- Rest, ice, compression, and elevation
- Submaximal shoulder isometrics
- At 2 weeks begin wrist flexion and extension

Phase II for Mobilization and Rehabilitation: Weeks 4-8

Goals: Elbow active range of motion 0-145 degrees
   - Protect elbow from valgus force
   - Increase functional strength of upper extremity
   - Improve tolerance to active range of motion

Intervention:

- Elbow brace set at 10-120 degrees and increased by 5 degrees extension and 10 degrees flexion per week
- Isotonic exercise (1-2 pounds) for wrist flexion/extension, forearm pronation/supination, elbow flexion/extension, and rotator cuff exercises except internal rotation
- At 6 weeks: brace set at 0-130 degrees and add shoulder internal rotation exercises
**Phase III** for Mobilization and Rehabilitation:  Weeks 9-13

Goals: Increase muscular control of upper extremity
Prepare for return to previous activities
Allow patient to self manage symptoms and gradually return to activities
Sport specific training

Intervention:

- Continue exercises in phase I and phase II
- Begin plyometric exercises in throwing position
- Initiate eccentric elbow flexion/extension exercises
- Proprioceptive neuromuscular facilitation patterns
- Light sporting activities (golf and swimming)
- Rotator cuff, shoulder girdle stabilization, and shoulder active range of motion isotonics
- Elbow flexion/extension exercises
- Forearm pronation/supination exercises
- Wrist flexion/extension exercises

**Phase IV** for Mobilization and Rehabilitation:  Weeks 14-26

Goals: Symmetric upper extremity strength
Gradual return to unrestricted sport and throwing

Intervention:

- Interval warm up throwing program at 60 to180 feet with two sessions of 25 throws at each distance with a 10-minute rest between each session
- Fastball only throwing program starting at 15 throws off a mound at 50% and increasing the number of throws by 15 until reaching 60 throws
- Fastball only throwing program with the above progression at 75%
- Fastball progression as above with initiation of breaking pitches at 50%
- Work up to simulated game progression and limit breaking pitches to 25% of total throws
- Return to competitive level at 22 to 28 weeks
Selected References:


Total Elbow Arthroplasty and Rehabilitation

Surgical Indications and Considerations

Anatomical Considerations: There are three bones and four joint articulations that have a high degree of congruence in the elbow. Also, the ulnar nerve runs directly through the ulnar groove of the humerus and travels down the medial forearm. With joint replacement, careful consideration must be taken to limit ulnar nerve entrapment. The ulnar nerve is subject to transient (10%) or, occasionally, partial dysfunction. Routine anterior translocation has been beneficial, but there is considerable variation in technique in this regard. Triceps insufficiency can be virtually eliminated with the Kocher lateral-to-medial or the Bryan lateral-to-medial triceps-sparing approach.

Pathogenesis: In elbow arthritis the joint surface is destroyed by wear and tear, inflammation, injury, or previous surgery. This joint destruction makes the elbow stiff, painful, and unable to carry out its normal functions. Rheumatoid arthritis (RA) usually affects the elbow in the first five years of onset. Individuals with RA of the elbow usually notice pain, stiffness, and loss of the ability to use the elbow for their usual activities. Commonly, they have difficulty sleeping on the affected arm and notice a limited range of motion in the elbow. Some people with arthritis notice a grinding feeling when the elbow is moved. Rheumatoid arthritis of the elbow usually gets worse over time, but the rate of this progression varies widely. Distal humerus fractures typically occur during high energy situations (such as motor vehicle accidents) or during low energy situations (such as a fall).

Epidemiology: Total elbow arthroplasties are most commonly performed on elbows with severe rheumatoid arthritis and elbows with distal humerus fractures. Elbow fractures comprise approximately 4.3% of all fractures. These fractures typically occur in young boys ages 5-10. In contrast, total elbow arthroplasty is also considered to be a viable treatment for women over the age of 65 with distal humerus fractures.

Diagnosis
- Intractable pain
- Joint Instability
- Failed synovectomy
- Decreased elbow ROM
- Severe RA
- Ulnohumeral ankylosis

Non-operative Vs Operative Management: Non surgical interventions such as casting can be recommended for distal humerus fractures. Although, surgical intervention can become necessary for distal humerus fractures when fracture type, soft tissue involvement, joint stability and bone integrity are assessed. Surgical intervention is normally recommended for elbow joints with severe rheumatoid arthritis. The goal of elbow replacement arthroplasty is to restore functional mechanics to the joint by removing scar tissue, balancing muscles, and inserting a joint replacement in the place of the destroyed elbow.


Post Surgical Considerations

- Risk of infection
- Joint dislocation
- Prosthetic loosening

Surgical Procedure: There are many different surgical approaches and implants for total elbow arthroplasties. The Coonrad-Morrey implant has been found to prevent dislocation without increasing the risk of loosening (Little, 2005). This implant is semiconstrained (unlinked prosthesis) which requires the preservation of bone stock and the ability to achieve stability of the collateral ligaments. Elbow joint replacement surgery is a highly technical procedure; each step plays a critical role in the outcome.

The Bryan-Morrey approach is often used for this procedure. A straight 15cm incision centered lateral to the medial epicondyle and medial to the tip of the olecranon. The ulnar nerve is located and translocated to protect it from damage.

After the anesthetic has been administered and the elbow has been prepared, an incision is made along the medial aspect of the proximal ulna, from three inches above the elbow to three inches below it. This incision allows access to the joint without damaging the important muscles that are responsible for the elbow's motion. The medial aspect of the triceps along with the anconeus is reflected laterally. The radial and ulnar collateral ligaments are also released from the anconeus. This is done to avoid fracturing the medial column by the ligament when the forearm is manipulated. The ulnar nerve is also isolated to protect it during the procedure; as a result, the little finger is sometimes numb for a period of time after this surgery.

The muscles and other tissues near the elbow are mobilized by removing any scar tissue that may restrict their motion. The capsule is released in front of and behind the elbow joint. The distal end of the humerus and the proximal of the ulna are fit to receive their respective implants. The components are stabilized by cementing their stems inside the bones using polymethylmethacrylate (bone cement). Once the implants are securely fixed, they are linked together using a hinge pin. At the conclusion of the procedure, the deep tissues and skin are closed and a protective dressing is applied.

PREOPERATIVE & POST OPERATIVE REHABILITATION

Note: The following rehabilitation protocol is taken from Protocol for Rehabilitation from Seacoast Orthopedics and Sports Medicine (sosmed.org). Refer to the previously noted website for further information regarding this progression.

General Rehabilitation Guidelines
Program for Total Elbow Arthroplasty

Rehabilitation Considerations: Hematoma formation follow elbow arthroplasty can lead to pain and loss of motion in the early phases after surgery. Attempts to reduce and mobilize edema are critical in the early phases. Hematoma also increases the risk of infection which occurs in 2-3 percent of elective cases and up to 7% of cases performed for trauma.
Full flexion and extension can usually be obtained on the table but stiffness may ensue rapidly. Continuous passive motion is almost always employed when possible but patients must be encouraged to perform daily stretching exercises to preserve motion.

Because the extensor mechanism must heal back to the ulna, active elbow extension, such as using the arm to assist in rising from a chair, is not permitted for 8 weeks.

Adjacent joint therapy may be particularly important for patients with rheumatoid arthritis who may have concomitant disease of the shoulder and wrist.

**Pre-rehabilitation:**
- Instruct in application of ice and encourage use as much as tolerated within a 24 hour period for first week. If using ice packs, encourage to ice 20-30 minutes every 3-4 hours while awake.
- Instruct in home program of elbow flexion, extension, pronation and supination.
- Instruct in basic progression of rehabilitation program and expectations for time course to recovery
- Arrange follow-up physical therapy appointment on 7th-10th day post-op to correspond with physician’s post-operative evaluation

**Inpatient: (0-4 days)**
- Arm is generally splinted in extension with hemo-vac drain in place for 1st 36 hours to prevent swelling and reduce chance of a hematoma. Arm is generally elevated in a sling on a pole.
- Evening of the first postoperative day, the splint is removed and patients are started on CPM set to provide full flexion and extension.
- Arm should be removed every 1-2 hours to prevent compressive neuropathy
- Cryotherapy in between sessions

**ROM**
- Instruct in home program, and begin, active assisted elbow and wrist flexion, extension, pronation and supination
- Instruct in home program, and begin, self-assisted forward elevation and external rotation of the shoulder to prevent adjacent joint stiffness
- Finger ROM but no aggressive grip strengthening so that muscular attachments heal

**Other**
- Instruct to don and doff sling
- Methods of edema control
- Instruct in precautions of no active elbow extension and avoid direct pressure on posterior aspect of elbow
- Instruct on proper use of ice or cryocuff 20-30 minutes at a time, several times per day, especially after exercises
- Arrange for outpatient physical therapy follow-up to begin on day of office follow-up
Wound Instructions
- Dry gauze to wound q day until dressing totally dry, then cover prn
- May shower at 7 days but no bath or hot tub for 3 weeks

**Outpatient Phase 1: (Hospital Discharge to Week 4)**

**ROM**
- Continue program active elbow and wrist flexion, pronation and supination and active assisted elbow flexion.
- Continue shoulder flexibility exercises

**Strength**
- Can start gentle grip strengthening but no active elbow or wrist strengthening exercises until Phase II

**Sling**
- Sling should only be used when patients are out in busy or crowded locations but not around the house and not to bed

**Other**
- Incision mobilization and desensitization
- Modalities for pain, inflammation and edema control (no e-stim)
- Cryotherapy as needed
- Ulnar nerve desensitization

**Outpatient Phase 2: (Weeks 5-8)**

**ROM**
- Continue shoulder elbow and wrist ROM
- At 6 weeks can add active extension (anti-gravity only but no resistance)
- Night time extension splinting if flexion contracture developing

**Strength**
- May begin gentle isometric and isotonic wrist flexion/extension and elbow flexion strengthening
- Biceps strengthening should be done with elbow supported
- No elbow extension strengthening

**Sling**
- Sling should be fully discontinued at this point

**Other**
- Continue scar massage

**Outpatient Phase 3: (Weeks 9 -12)**

**ROM**
- Active range of motion in all planes
• Continue night time extension splinting if necessary
• Dynasplint if flexion contracture >30°

**Strength**
• Continue isotonic strengthening
• May add anti-gravity active extension but no resistance
• May add UBE at very low resistance for conditioning
• May add exercises for shoulder to promote generally upper extremity conditioning

**Outpatient Phase 4: Weeks 12 - 16**

**ROM**
• Continue maintenance flexibility program

**Strength**
• Progressive isotonic resistance including elbow extension
• Progress to functional use

Selected References:


