



BRIGHAM AND WOMEN'S HOSPITAL

A Teaching Affiliate of Harvard Medical School
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Department of Rehabilitation Services
Physical Therapy

Standard of Care: Distal Upper Extremity Fractures

Case Type / Diagnosis:

This standard applies to patients who have sustained upper extremity fractures that require stabilization either surgically or non-surgically. This includes, but is not limited to:

Distal Humeral Fracture	812.4
Supracondylar Humeral Fracture	812.41
Elbow Fracture	813.83
Proximal Radius/Ulna Fracture	813.0
Radial Head Fractures	813.05
Olecranon Fracture	813.01
Radial/Ulnar shaft fractures	813.1
Distal Radius Fracture	813.42
Distal Ulna Fracture	813.82
Carpal Fracture	814.01
Metacarpal Fracture	815.0
Phalanx Fractures	816.0

Forearm/Wrist Fractures

Radius fractures:

- Radial head (may require a prosthesis)
- Midshaft radius
- Distal radius (most common)

Residual deformities following radius fractures include:

- Loss of radial tilt (Normal non fracture average is 22-23 degrees of radial tilt.)
- Dorsal angulation (normal non fracture average palmar tilt 11-12 degrees.)
- Radial shortening
- Distal radioulnar (DRUJ) joint involvement
- Intra-articular involvement with step-offs. Step-off of as little as 1-2 mm may increase the risk of post-traumatic arthritis.

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Types of distal radius fracture include:

- **Colle's (Dinner Fork Deformity)** -- Mechanism: fall on an outstretched hand (FOOSH) with radial shortening, dorsal tilt of the distal fragment. The ulnar styloid may or may not be fractured.
- **Smith's (Garden Spade Deformity)** -- Mechanism: fall backward on a supinated, dorsiflexed wrist, the distal fragment displaces volarly.
- **Barton's** -- Mechanism: direct blow to the carpus or wrist. The comminuted fracture of the volar articular surface is associated with volar dislocation of the carpus.
- **Galeazzi's** -- Fracture of the distal radial shaft with subluxation/dislocation of the DRUJ.

Ulna fractures

- Proximal ulna: Monteggia fracture of the proximal ulna with anterior dislocation of the radial head.
- Midshaft: if concomitant with a radial fracture, may be called a "both bones" fracture.
- Distal: may be concomitant with distal radius fracture

Carpal fractures

Scaphoid

The scaphoid is the most common carpal fractured. Young men are at great risk due to higher energy injuries. Mechanism of injury is FOOSH (falling on an outstretched hand) with the wrist extended and radially deviated, which causes the waist of the scaphoid to compress against the radial styloid. Repeat x-rays may be necessary, as the fracture may not show up on x-ray until two weeks after the injury. On physical exam, there may be pain in the anatomical snuffbox and the radial dorsal aspect of the wrist. The blood supply enters the proximal pole dorsally and in a retrograde fashion, which can lead to necrosis and a high rate of nonunion. Healing may take up to 24 weeks. Indications for operative intervention include excessive flexion at the fracture site, and displacement of the fracture. Associated injuries may include perilunate fracture dislocation and distal radius fracture. Bone grafts are indicated for nonunions. Salvage procedures include partial wrist fusions or proximal row carpectomies.

Lunate

Isolated lunate fractures are rare and account for about 1.4 % of all fractures of the carpus. More common findings are lunate fractures due to pathologic osteonecrotic bone due to Kienbock's disease (avascular necrosis). The mechanism of injury tends to be a high force impact with the wrist in extension. A scapho-lunate ligament rupture with rotary subluxation may occur in conjunction with a lunate fracture. Associated ligament injuries can prolong immobilization for three months and ROM may be limited to 40-50 degrees of active wrist extension and flexion.

Triquetrum

Triquetrum fractures are the second most commonly fractured carpal bone, generally via a fall on an extended and ulnarly deviated wrist. The patient may complain of ulnar-sided wrist pain and tenderness localized to the triquetrum with palpation. Management is based on the extent of the injury, but usually includes immobilization in a short arm cast for 4 weeks.

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Pisiform

The pisiform is a sesamoid bone and represents 1% of all carpal fractures. The most common mechanism of injury is a blow to the hypothenar eminence, or repetitive trauma (i.e. hammering). Complications include nonunion, and post-traumatic piso-triquetral arthritis. Excision is often required secondary to a high rate of nonunion.

Trapezium

The trapezium is the third most common type of carpal fracture with an incidence of 6 % of all carpal fractures. Commonly this occurs in association with fractures of the first metacarpal or radius. The mechanism of injury is axial load along the thumb ray. Conservative treatment includes cast immobilization for 6 weeks.

Trapezoid

Isolated fractures of the trapezoid are rare due to the strong surrounding ligamentous structures. The incidence is less than 1% of all carpal fractures. Mechanism of injury is usually a crush injury or a high-energy force that pushes the index metacarpal into the trapezoid. Treatment is based on stability of the fracture site. Because of the associated high-energy trauma there may be associated soft tissue injuries.

Capitate

The incidence of capitate fractures varies from 1.3% to 14% usually from a direct blow to the dorsal aspect of the wrist, or extreme dorsiflexion during a fall. Trauma to the heads of the index and middle finger MCP joints with the wrist in palmar flexion may be transmitted to the capitate. The blood supply enters the waist of the bone through the palmar aspect and may result in necrosis or nonunion. Treatment is similar to that of the scaphoid and is dependent on stability.

Hamate

Hamate fractures result from direct trauma or from an avulsion injury during aggressive wrist rotation, such as during a baseball swing. Conservative treatment is short arm casting for 6-8 weeks with close monitoring, as some nondisplaced fractures may displace while casted. These may require a hook excision. The most significant impairment is the loss of grip strength.

Hand Fractures

Metacarpal fractures:

- Metacarpal base: if extra-articular this is usually stable.
- Metacarpal shaft: subject to displacement angulation, rotation and shortening. Angulation is typically dorsal.
- Metacarpal neck: most common is the neck of the 4th or 5th metacarpals.
- Boxer's: May be a neck or head fracture. Typically a young male is involved in an altercation or hits a wall with a clenched fist. Splinting with a hand-based or forearm-based ulnar gutter should be clarified with MD and is based on location, fracture stability and patient profile.

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Proximal phalanx fractures:

Usually are proximal or midshaft. The most common complication is extensor lag. As with all phalangeal fractures, alignment is key in fracture management is to prevent rotational mal-alignment (tips of the fingers should face the scaphoid tuberosity).

Proximal interphalangeal (PIP) joint fractures:

PIP joints are the most commonly injured joints in the hand. Fractures may be simple or complex based on the mechanism of injury, angle of impact, and the force of impact. Ligamentous disruption, volar plate avulsion, tendon disruption and articular incongruity resulting from these fractures disrupt the dynamic stability of the joint. Most injuries are complex, and a combination of damaged anatomic structures based on the direction of the force at the time of impact:

- *Laterally Directed PIP Joint Dislocation Forces*
 - In extension: Abd/adduction forces put stress on the collateral ligaments beginning at the insertion of the ligament, then affecting the accessory collateral ligament and volar plate. The border digits, radial greater than ulnar, are most commonly affected.
 - In flexion: May result in a unicondylar fracture.
- *Dorsally Directed Forces* result in PIP hyperextension, volar plate rupture and damage or rupture of the collateral ligaments. Potential complication is a flexion contracture with a pseudo-boutonniere deformity.
- *Palmarly (volarly) Directed Forces* are rare and usually arise from a rotatory longitudinal force on a semiflexed digit. Damage to the central slip or lateral band disruption should be suspected.
- *Axially Directed Forces* or centrally impacted fractures are pilon fractures and are usually high-energy forces occurring while the digit is held in full extension. The entire soft tissue envelope collapses in a dye-punch manner. The concavity causes instability and management is difficult. Trauma to the lateral bands should be suspected.

Middle phalanx fractures:

Most commonly occurring in the distal shaft. These are usually the result of sports injuries in the young and accidental falls in the elderly.

Distal phalanx fractures:

Many distal phalanx fractures are associated with crush injuries.

- Base: Pain and hypersensitivity are common sequelae.
- Shaft: May have a concomitant avulsion of the terminal extensor tendon (Mallet deformity).
- Tuft: This is the most common DIP fracture, and nail bed injury is possible.

Thumb fractures:

- Bennett's: Avulsion fracture of the first metacarpal base. An unopposed APL displaces the metacarpal shaft dorsally and radially.
- Rolando's: Comminuted intra-articular fracture of the first metacarpal base.

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- Shaft 1st metacarpal
- Skier's thumb/gamekeeper's thumb: Injury to the ulnar collateral ligament.

Fracture Classification:

- Fracture location
- Open versus closed fracture
- Fracture pattern: transverse, oblique, spiral etc.
- Simple versus comminuted fracture
- Dorsal or volar angulation
- Joint involvement (intra-articular, extra-articular)
- Stable versus unstable fractures

Fracture Healing:

Factors affecting fracture healing include:

- patient age
- character of fracture
- systemic disorders
- bone disease
- osteoporosis
- osteopenia

Bone Repair:

Early phase (Inflammatory): 1-5 days

- Inflammatory response
- Proliferation of osteogenic cells of periosteum and marrow
- Differentiation of chondroblasts, and osteoblasts which reabsorb dead bone

Intermediate phase (Reparative): 4-40 days

- External callus formation
- New bone replaces cartilaginous callus
- Internal callus if formed by osteogenic cells of endosteum

Late phase (Remodeling): 25-100 days

- External and internal callus joins to bridge fracture deficit
- Remodeling occurs, osteoblasts reabsorb callus

Fracture Management:

Closed non-displaced fracture

- Cast or splint immobilization

Closed, angulated or displaced fracture

- Closed treatment:
 - Reduction and external immobilization (Closed reduction)
 - Percutaneous pinning (CRPP = closed reduction percutaneous pinning)
 - Reduction and external fixation (CREF = closed reduction external fixation)

Open fracture, displaced or intra-articular fractures

- Open Reduction Internal Fixation (ORIF) fixation techniques:
 - K-wire
 - Tension bands
 - Intra-medullary devices
 - Intra-osseus wire
 - Screws/plates
 - Prosthesis
 - Bone graft

Rigid internal fixation restores and maintains length, and allows early post-operative active motion. External fixation preserves length and allows access to bone and soft tissue through percutaneous insertion. Direct manipulation of the fracture is avoided.

Potential complications of both internal and external fixation methods include: angulation, malrotation, mal/non-union.

Indications for Treatment:

- Need for splinting/brace fitting to protect and immobilize healing fracture.
- Knowledge deficit regarding home program, precautions, incision/wound/pin care.
- Upper extremity pain, joint stiffness, weakness, edema.
- Functional impairment in the areas of self-care, home, community, leisure and work activities.

Contraindications / Precautions for Treatment:

- Verify fracture congruity and stability with referring physician and/or imaging report.
- In the case of decreased fracture stability, there should be no movement of involved joint(s), and cast or orthosis should adequately stabilize the joint(s). If removable orthosis is used, verify patient's ability to don/doff orthosis and clean.
- Must assess cognitive status. Cognitively impaired patients may need rigid fracture protection for longer duration or an orthosis that is not removable (ex: cast).

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- Note concurrent soft tissue injury (see below), as this may restrict motion that is usually permitted.
- Monitor for signs of compartment syndrome, which is typically a medical emergency. The most useful, early clinical sign for the presence of a compartment syndrome are inordinate pain, which is usually worsened by passive stretch of the musculature within the compartment. Traditionally, one notes the “5 Ps”: pallor, parasthesias, pulse deficit, paralysis, and pain on passive extension. Immediate attention is necessary to avoid the disastrous effects of muscle necrosis and/or longer-term sequelae (i.e. Volkmann’s ischemic contracture).

Soft tissue injuries that may impact fracture healing and rehabilitation:

- Edema
- Cast/splint impingement
- Infection, osteomyelitis
- Tendon rupture or adhesions
- Adherent scar
- Intrinsic or extrinsic muscle tightness
- Joint capsular tightness
- Web space contractures
- Neurovascular injury, nerve compression, hypersensitivity
- Risk for complex regional pain syndrome (CRPS, -aka- RSD)
- Ligament injury
- Risk for post-traumatic arthritis

Evaluation:

Medical History: Review medical history questionnaire and/or patient’s medical record. Review any diagnostic imaging, tests, work-up and operative reports.

History of Present Illness: Interview patient at the time of examination to review his/her history and any relevant information. If the patient is unable to give a full history, then interview the patient’s legal guardian or custodian. Review mechanism of injury. Determine any past injuries that may be relevant (e.g. history of trauma, history of OA, history of wrist/hand joint related problems.) Thoroughly review the attending physician / surgeon’s notes to determine underlying integrity of the fracture, method of fixation. Review operative report and/or imaging reports for pertinent information regarding surgical findings and/or complications.

Medications: Note names, dosages and purposes of medications taken. Pain medications and or anti-inflammatory drugs are commonly prescribed. It is important to note that certain NSAIDS may slow bone healing.

Social History: Review patient’s home, work, recreational and social situation. Note any upper extremity weight-bearing activity, reaching, lifting or carrying loads that patient typically performs.

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Examination:

This section is intended to capture the most commonly used assessment tools for this case type/diagnosis. It is not intended to be either inclusive or exclusive of assessment tools.

Pain: As measured on the Visual Analog Scale (VAS) or Verbal Rating Scale (VRS), including activities that increase or decrease symptoms, location and quality of symptoms.

Visual Inspection: Note degree of healing of incisions/wounds (if applicable). Note presence and quality of drainage. Note any erythema. Note pin placement with percutaneous pin fixation or external fixation (if applicable). Note any drainage from pin sites. Note any muscle atrophy or imbalance.

Edema: Assess with volumetric or circumferential measurements. Compare to uninvolved side when possible.

Palpation: Palpate the entire wrist/hand/forearm. Focus on the presence and extent of muscle atrophy and swelling.

ROM: Record active and passive goniometric measurements of all involved joints not restricted by post-operative or post-traumatic precautions. Assess muscle-tendon length.

Strength: Early post-operative or post-trauma, strength is assessed only by AROM at joints cleared to move. Resistance is deferred until bone healing has occurred.

Sensation: If subjective assessment is abnormal, or if any trophic changes are noted, further assessment is indicated using Semmes-Weinstein Monofilaments.

Posture/alignment: Primary focus is on hand and upper quarter positioning.

ADL Status: Interview patient regarding self-care, home, work, leisure and child-care activities, noting any functional impairments. Evaluate patient status with specific ADL tasks when indicated. The use of a functional outcome measure such as the QuickDash is used to objectively assess functional status.

Assessment:

Potential Problem List:

- Pain
- Edema
- Decreased ADL / functional Status
- Decreased Range of Motion
- Sensory Deficit
- Strength Deficit
- Knowledge Deficit
- Skin integrity (wound, incision, pin site, potential for scarring)

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Prognosis: Prognosis is typically dependent on joint congruity, age, fracture stability, patient's compliance with post injury / rehabilitation program. Factors that may impede fracture healing include osteoporosis, diabetes and steroids.

Typical Treatment Goals:

- Reduce/eliminate edema and pain.
- Maximize independence with all activities of daily living.
- Maximize independence with home program including donning, doffing of orthosis and any wound care activities.
- Enhance AROM of involved joints.
- Maximize strength.
- Maximize wound healing to prevent infection, minimize functional/cosmetic sequelae of scarring.

Treatment Planning / Interventions:

Established Pathway ___ Yes, see attached. x No

Established Protocol ___ Yes, see attached. x No

Interventions most commonly used for this case type/diagnosis:

- ADL training
- Physical agent modalities (please see modality specific procedural standard of care for specifics)
- Therapeutic exercise
- Therapeutic activity
- Edema, wound and scar management
- Orthotic fabrication and/or fitting
- Patient/family education

Frequency & Duration:

1-3 sessions per week for 8-12 weeks, depending on the severity of impairments, functional deficits and stage of healing.

Patient / family education:

- Fracture precautions
- Splint management
- Wound care, scar management
- Edema management

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- ADL strategies
- Home exercise program

Transfer of Care:

Refer patient to a Certified Hand Therapist (CHT) using the website www.htcc.org if the patient is unable to return to outpatient therapy at Brigham & Women's Hospital because of geographical constraints.

Fracture Management Guidelines	Splint	Range of Motion	Strengthening	Other
<u>RADIUS</u>				
Radial head	Radial head: Options: sling, posterior elbow splint @ 90, hinged elbow brace, or nothing.	Early ROM is preferred due to potential capsular contracture. Variability due to fracture type, stability of fixation, prosthesis.	Progressive resistive exercise (PRE's): 8-12 weeks	
Midshaft	Midshaft: Forearm Fracture brace	Usually initiated within 1-3 weeks.		
Distal	Distal: Wrist splint in neutral			
<u>ULNA</u>				
Proximal	Proximal: posterior elbow splint.	Per MD recommendation.	PRES: 6-8 weeks	
Midshaft	Midshaft: forearm fracture brace	Usually 1-3 weeks		
Distal	Distal: wrist splint in neutral			

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<p><u>CARPALS</u></p> <p>Scaphoid* Capitate Hamate Triquetrum Lunate Trapezium Trapezoid Pisiform</p>	<p>Scaphoid: volar long opponens splint</p> <p>Others: Wrist splint</p>	<p>Scaphoid: Check with MD, as dependent on radiographic healing.</p> <p>Others: Usually 6-8 weeks.</p>	<p>PREs: usually 8 weeks</p>	<p>* Due to its retrograde blood supply, scaphoid healing may take up to 6 months. High rate of non-union.</p>
<p><u>META- CARPALS</u></p> <p>Index-Small (digits 2-5)</p> <p>Thumb</p>	<p>Digits 2-3: Radial gutter</p> <p>Digits 4-5: Ulnar gutter</p> <p>Thumb: Short opponens</p>	<p>Usually 4-6 weeks.</p>	<p>Usually 6-8 weeks</p>	<p>The decision to include the wrist in the splint depends on fracture type, location, stabilization and patient profile.</p>
<p><u>PHALANGES</u></p> <p>Index-Small (digits 2-5):</p> <p>Thumb</p>	<p>Hand based (intrinsic plus position) vs. static digital gutters, based on complexity.</p> <p>Short opponens</p>	<p>Usually 3-6 weeks dependent on type and stability</p>	<p>Usually 6-8 weeks</p>	<p>PIP joint contractures are common sequelae</p>

Recommendations and referrals to other providers:

Screen for cervical and/or shoulder involvement and request referral to PT if needed. Refer to outside work hardening program if needed. Consultation with referring MD as indicated.

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Re-evaluation:

Standard Time Frame: Reassessment of specific targeted areas at each session to determine treatment effectiveness. Monthly reassessment of all functional areas.

Other Possible Triggers: New complaints of sensory changes, dramatic increase in pain, further surgical intervention.

Discharge Planning

Commonly expected outcomes at discharge:

- Achievement of all ROM and strength goals, or plateau of gains despite utilizing all available interventions.
- Independence with home program.
- Normalized use of involved upper extremity in ADL/IADL activities.
- Independence with self-care using minimal adaptive equipment.
- Transfer of Care (if applicable): work hardening program if needed.

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