Distal Radius, Metacarpal & Proximal Phalanx Fractures

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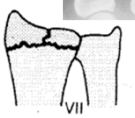
Objectives

1. Identify rehabilitative factors that contribute to fracture healing.
2. Determine optimal positions for immobilization following fracture.
3. Explain the benefits of early, controlled motion following fracture.

Fracture Fixation and Healing

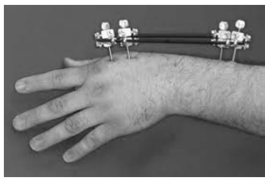
Fracture Classification

- Depth
  - Complete, incomplete
- Angle
  - Transverse, oblique, spiral, longitudinal, stellate
- Complexity
  - simple, comminuted or crushed
- Closed vs. open
- Intra vs. extra articular



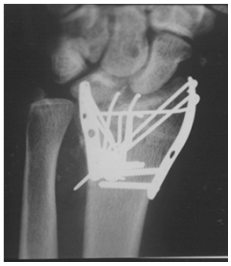
Fracture Fixation

- Closed reduction
  - External fixation (CREF)
  - Percutaneous pinning (CRPP)
  - Stable fractures or those that can be reduced externally



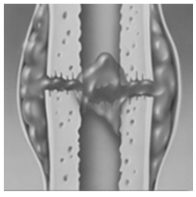
Fracture Fixation

- Open reduction internal fixation (ORIF)
  - Dorsal or volar plating
  - K-wires, screws, plates
  - Fractures that are unstable, require early motion, or have potential for non-union



Fracture Healing

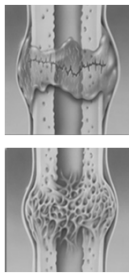
- *Inflammatory Phase*
  - 0-2 weeks
  - Bleeding from fracture site and surrounding tissues creates hematoma
  - Vasodilation allows multiple cells to gradually replace hematoma with granulation tissue
  - Significant localized pain and edema



(Shin, 2011)

Fracture Healing

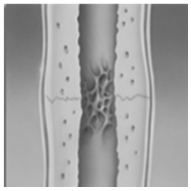
- *Reparative Phase*
  - Within 2 weeks
  - Bone ends not in continuity
    - Formation of bridging (soft) callus
    - Replaced by hard callus (secondary)
  - Bone ends in continuity through rigid fixation
    - Primary bone healing without visible callus
    - Dependent on absolute stability/exact reduction
  - Edema, pain, and tenderness decrease as stability increases



(Shin, 2011)

Fracture Healing

- *Remodeling Phase*
  - 2–6 months
  - Configuration of bone influenced by exposure to stress
  - Woven bone replaced with lamellar bone
  - Remodeling complete when marrow space is repopulated



(Shin, 2011)

Person Factors Affecting Healing

- Age
- Emotional status
- Comorbidities and medications
  - Delay in healing associated with diabetes
- Nutritional factors, alcohol/tobacco use
  - Nicotine increases time to healing, risk of nonunion, and decreased strength of callus
- Ability and willingness to comply

(Shin, 2011)

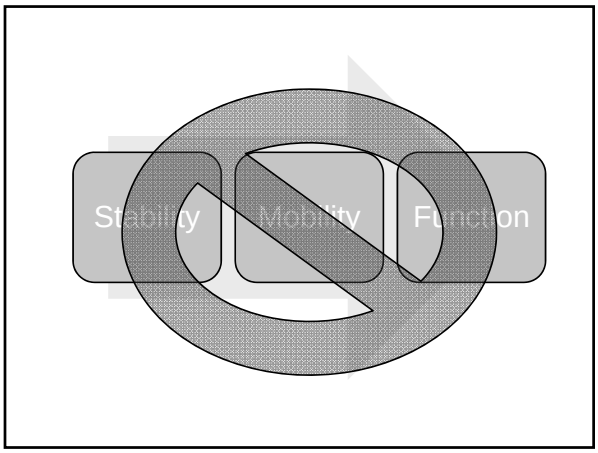
Factors Influencing Structural Strength

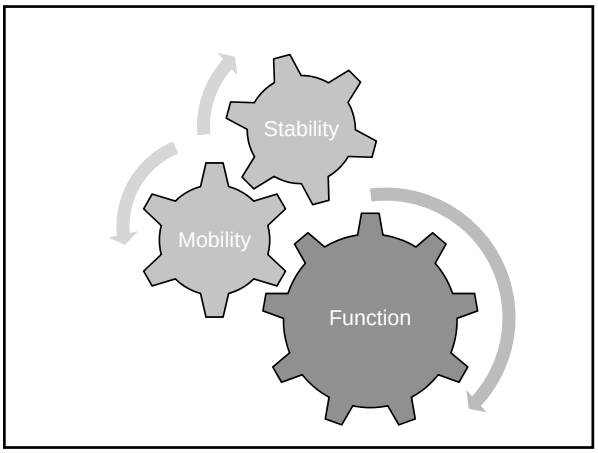
- Location of fracture
- Pattern and displacement of fracture
- Type of reduction and hardware
- Concomitant soft tissue injuries
- Functional demands of patient
- Timing and stage of healing

(Feehan, 2003)

Therapeutic Considerations

- Fracture stability/alignment
- Operative procedures
- Timing for protection, range of motion, and strengthening
- Balancing act between protection (stability) and controlled stress (mobility)





Positioning for Function

- Close-packed position
  - Optimal position for immobilization
  - Ligaments maximally taut
  - Joint surfaces maximally congruent
  - Joint spaced minimized
- *Glenohumeral abduction with external rotation*
- *Wrist extension with ulnar deviation*
- *Maximal MP flexion*
- *Digital PIP/DIP extension*
- *Thumb palmar abduction*
- *Thumb MP/IP extension*

Typical Fracture Progression

- Protection
- Edema management
- Pain management
- Range of motion
  - Tendon gliding
  - Active before passive
- Strengthening
- Functional activities

(LaStayo et al., 2003)

Common Complications

- Non-union/malunion
  - Shortening, angulation, rotation
- Pain
- Edema
- Stiffness (uninvolved joints!!!)
- Tendon adhesions
- Decreased strength
- Nerve entrapments/compressions

Distal Radius Fractures

Distal Radius Fracture (DRF)

- 1/6 of all fractures in patients >50
- Most frequent fractures in the upper limb
  - *(Adani et al., 2008)*
- Up to 1/5 of all patients with DRF experience residual symptoms such as pain, nerve symptoms, and disability after one year
  - *(MacDermid et al., 2003)*

Ideal Fixation

- Stable, fixed-angle fragment-specific support
- Minimal soft tissue disturbance
- Allow safe, early active wrist and distal radioulnar joint mobilization

(Smith, Brou, & Henry, 2004)

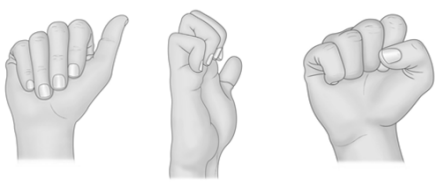
Fixation and Rehabilitation

- Review rehabilitative progression and clinical reasoning based on fixation
- First example highly detailed
- Subsequent examples will assume these details and add differences in approach

Rehabilitation: Closed Reduction

- *Immobilization phase (4-6 weeks)*
  - *Common not to see in therapy during this phase*
- Education
  - Diagnosis, expectations, precautions/permission
- Edema management
  - Elevation, compression, range of motion, ice
- Active motion of uninvolved joints
  - Glenohumeral joint
  - Tendon gliding
- ADL Adaptation

Tendon Gliding



Rehabilitation: Closed Reduction

- *Mobilization phase*
  - Clarification from surgeon regarding anatomical alignment/healing and expectations for motion
- Splinting
  - Wrist cock-up splint; wean rapidly
- Range of motion
  - Active before passive
- Functional activity
  - Graded activity; pain as guide
  - DASH outcome measure

THE DASH OUTCOME MEASURE

DISABILITIES OF THE ARM, SHOULDER, & HAND

This questionnaire asks about your symptoms as well as your ability to perform certain tasks

	No difficulty	Mild difficulty	Moderate difficulty	Severe difficulty	Unable
Open a tight or new jar	1	2	3	4	5
Write	1	2	3	4	5
Turn a key	1	2	3	4	5

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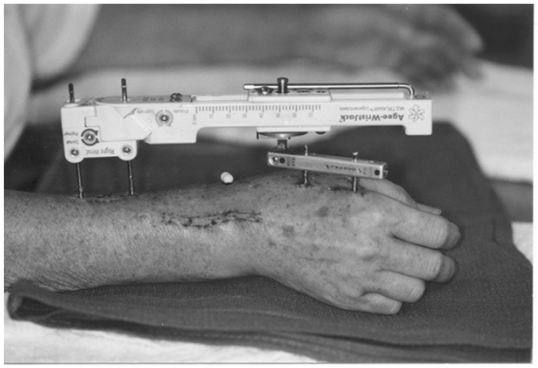
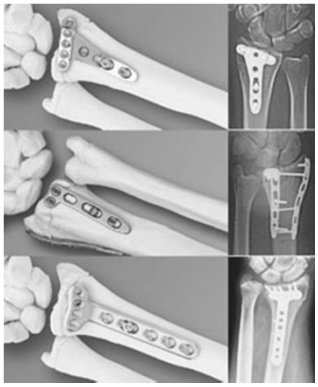


Rehabilitation: External Fixation

- *Fixator in place (4-8 weeks)*
- Education
  - Pin site care
- Pain management
  - Consider effect of appearance on pain
- Edema management
- Desensitization
- Splinting (…and strapping around fixator!)
- Active motion of uninvolved joints
- ADL Adaptation

Rehabilitation: Closed Reduction

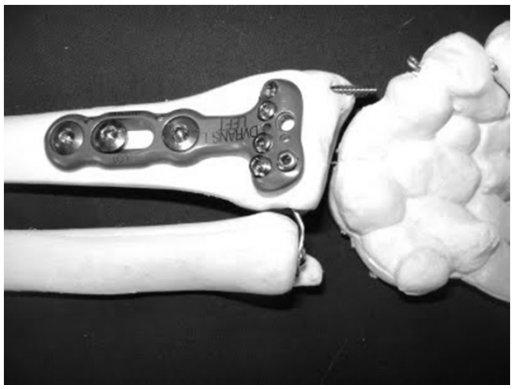
- *Upon fixator removal*
- Splinting
  - Modify; wean rapidly
- Range of motion
  - Frequently throughout day
  - Progress to passive per MD approval
- Functional activity



Rehabilitation: Dorsal Plate

- Education
- Pain/edema management
- Resting wrist splint
- Active motion of uninvolved joints
- Guarded early active wrist motion upon skeletal healing

(Smith, Brou, & Henry, 2004)



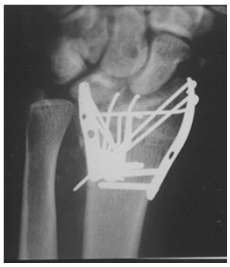
Rehabilitation: Volar Plate

- Education
- Pain/edema management
- Immediate active motion of wrist and uninvolved joints
- Wrist cock-up splint in 30 degrees of extension
- Can use more aggressive ROM, splinting, and functional activity after skeletal healing
  - Typically not necessary

(Smith, Brou, & Henry, 2004)

Complications: Internal Fixation

- Soft tissue injury
- Hardware irritation
- Adhesions
- Tendon ruptures



Pearls: DRF

- Maximize MP flexion
  - Distal palmar crease
- A little resistance goes a long way
  - Tendon gliding through edema and across fracture site
- Address wrist extension with functional tasks that involve gripping

Lyngholn et al., 2005

- Effect of adherence on outcomes following DRF
- n=15
- Therapy attendance, therapist-perceived adherence, home exercise log
- Wrist extension, grip strength, pain, modified Levine questionnaire, Jebson Test of Hand Function
- Adherence, especially home exercise, accounted for 50% of variance in wrist extension, Levine questionnaire, and feeding item on Jebson

Chung & Haas, 2009

- Patient satisfaction as compared to objective outcomes following DRF with a volar plate
- n=125
- Grip strength, pinch strength, wrist ROM, and satisfaction
  - Michigan Hand Questionnaire
- Satisfaction with 65% of grip, 87% of pinch, and 95% of wrist ROM

Valdes, 2009

- Outcomes relative to initiation of motion following volar plate procedures
- n=14: 1 week post-operative
- n=9: 6 weeks post-operative
- Statistically significant decrease in number of therapy visits and number of days to achieve functional range of motion in the group who started active range of motion at one week post-operative

Metacarpal Fractures

Metacarpal Anatomy

- Proximal bases of 2nd and 3rd firmly affixed to the distal carpal row
- More mobile 1st and 5th surround this stable center
- 4th with limited mobility on the hamate
- Deep transverse metacarpal ligament connects heads

Metacarpal Fractures

- Seen primarily in 1st and 5th; often in adolescent males
- 40-50% all hand fractures
  - *(Kamath et al., 2011)*

Metacarpal Head Fractures

- Immobilized in closed packed position
  - "Ulnar gutter"
  - Maintains the length of the collateral ligaments
  - Counteracts the tendency towards a claw deformity
  - Draws the extensor mechanism distally to support the fracture
  - *(McNemar et al., 2003)*

Metacarpal Neck Fractures

(McNemar et al., 2003)

- More typical
  - "Boxer's fracture"
- Conservative immobilization
  - Ulnar gutter with PIP/DIP free to allow active motion
- Minimal displacement and reasonable stability
  - Cuff splint/fracture brace
  - Circumferential pressure
  - Approximation of metacarpals
  - Can add buddy tapes

Rehabilitation: Metacarpal Fractures

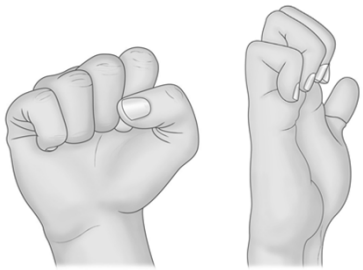
- Education
  - Avoidance of sustained or forceful grasp during the healing phase
- Edema management
- Scar massage
  - Early and often!
- Splinting
  - Per location and stability of fracture
- Active motion of uninvolved joints
- ADL adaptation typically not necessary

Complications: Metacarpal Fractures

- Rotational deformities
  - Scissoring of the digits during active flexion
- Loss of length
  - Possibility of decreased grip strength due to active insufficiency
- Extrinsic extensor adhesions

(McNemar et al., 2003)

Extrinsic Extensor Glides



Pearls: Metcarpal Fractures

- Focus on the anatomy
  - Location of fracture
    - Stability/mobility (splint/range of motion)
  - Proximity of extrinsic extensors to healing fracture and skin
    - Extrinsic extensor glides
    - Scar massage

"Nowhere in the body, the form and function are so closely related to each other than in hand." (Kamath et al., 2011)

Proximal Phalanx Fractures

Proximal Phalanx Fractures: Anatomy

- Proximity of extensor mechanism AND flexor digitorum profundus (FDP) to proximal phalanx

"Too often these fractures are treated as minor injuries and major disabilities occur"
(Kamath et al., 2011)

Proximal Phalanx Fractures: Assumptions

- Potentially unstable, non-displaced extra-articular fracture
- Inherently stable fracture
- Hardware fixation
  - Open reduction internal fixation (ORIF)
  - Closed reduction external fixation (CREF)

(Feehan, 2003)

Rehabilitation: Proximal Phalanx Fractures

- Education
  - Importance of flexion AND extension of digit
- Edema management
- Splinting
- Active motion of DISTAL joints
  - Tendon glide of FDP and extensor mechanism
- ADL adaptation typically not necessary

Proximal Phalanx Fractures: Immobilization

- Hand based, posterior dorsal blocking splint
  - *Freeland et al., 2003*
- Forearm based, posterior dorsal blocking splint
  - *Ebinger et al., 1999*
  - *Freeland et al., 2003*

Proximal Phalanx Fractures: Immobilization in MP Flexion

- Close-packed position
- Moves the extensor hood distally and creates circumferential compression on the fracture
- Prevents MP hyperextension and proximal extensor tendon excursion, translating the force of the EDC to the PIP joint
- Decreases proximity of the flexor tendons to the fracture site
  - *(Freeland et al., 2003)*

Proximal Phalanx Fractures: PIP Range of Motion

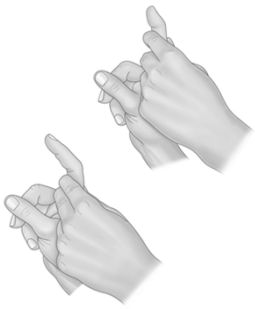
- Creates a dynamic tension-band effect in conjunction with the EDC which facilitates fracture reduction
  - *Henry, 2008*
- Maintains length of joint capsule and increases gliding of soft tissues
  - *LaStayo et al., 2003*
- Functional and physiologic stresses increase quality and rate of healing
  - *Feehan, 2003*

Proximal Phalanx Fractures: DIP Range of Motion

- Flexion isolates FDP; creating excursion across the fracture site
- Extension engages the terminal tendon, creating proximal excursion of the extensor mechanism

Choices for Early Controlled Mobilization

- Number of joints
- Type of motion
- Arc of motion
- Duration of motion
  - *(Feehan, 2003)*



Proximal Phalanx Fractures: Complications

- Scar tissue involves all structures in the zone of injury
  - Extensor mechanism adherence
  - PIP extensor lags
- Following plate fixation, 52% of cases with total active motion of <180 degrees
  - *(Kurzen et al., 2006)*

Pearls: Proximal Phalanx Fractures

- Immobilizing the DIP is a recipe for disaster
  - DIP flexion = FDP tendon glide
- Closely monitor extension of PIP
  - Initiate motion ASAP

Review of Objectives

1. Identify rehabilitative factors that contribute to fracture healing.
   - Stability and mobility; positioning and motion
2. Determine optimal positions for immobilization following fracture.
   - Close-packed position
3. Explain the benefits of early, controlled motion following fracture.
   - Increase quality and rate of healing
   - Edema reduction
   - Tendon glide across fracture site

Thank you!