Distal Radius Fractures: Treatment Options

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Introduction

- **Goal:** recovery of normal function: restore natural bow of the radius to maintain motion and grip strength
  - normalization of length
  - axial alignment
  - rotational alignment

- **Evaluation**
  - Neuro-vascular exam
  - Compartment syndrome of the forearm can occur secondary to injury
    - Tense swelling, pain with passive motion, paresthesias
    - Forearm fasciotomy

- **Radiographs**
  - AP, lateral, oblique [also include wrist, elbow, with special attention to DRUJ.]

- **Etiology**
  - High energy trauma: MVA, fall from height, GSW

Anatomy

- **Articulation of the distal radius with the scaphoid and lunate bones of the carpus**
  - The distal radioulnar joint (DRUJ)
  - Articulation of distal ulna with the triangular fibrocartilage complex (TFC)
    - The TFC articulates with both the lunate and the triquetrum of the carpus. The scaphoid and lunate fossa are two concave articular surfaces separated by a dorsal-volar ridge. A third concave articulation, the sigmoid notch, exists for the head of the ulna.
    - The contact area with the TFC varies with changing degrees of rotation of the wrist. The amount of force transmitted between the TFC and the radius therefore varies with changing degrees of pronation and supination. In supination, the ulnar head displaces volarly in the sigmoid notch, while in pronation it rotates dorsally.

- **Normal Anatomy: Distal Radius**
  - Radial inclination angle: 23 degrees (AP x-ray)
  - Volar tilt (palmar inclination angle): 10 degrees (Lateral x-ray)
  - Ulnar variance (radial length): mean -0.9 mm (AP x-ray)
Classification

- AO/ASIF classification of diaphyseal forearm fracture patterns
  - Open fracture
    - Ratio of open fractures to closed is higher for forearm than other bones except tibia
    - Increased incidence of nerve laceration
    - Debridement, irrigation, rigid fixation
    - ORIF within 24 hours: external fixation, intramedullary nailing, or plating antibiotics
    - Prevention of infection is necessary to avoid malunion, nonunion, loss of function and amputation
  - Comminuted fracture
    - Standard plating
    - Lag-screw fixation of the pieces
    - Defect can be bone grafted

- Frykman Classification System
  - 8 categories
  - Considers ulnar styloid
  - Does not consider direction or amount of displacement of fracture fragments
  - AO Classification System
  - 27 total fracture patterns
  - Highly detailed but unwieldy for easy use and memorization

- Melone Classification System
  - Applicable only to intra-articular fractures
  - Helpful in understanding the ‘die-punch’ lesion

- The Problem with Classification Systems
  - Analyzed inter/intra observer agreement for Frykman, AO, Melone, and Mayo systems
  - None of the systems showed substantial interobserver agreement

Instability


- La Fontaine (1989) criteria:
  - Dorsal tilt >20 degrees
  - Dorsal comminution
  - Intra-articular fracture
  - Associated ulnar fracture
  - Age over 60 years

- 3 or more tended to collapse

Treatment Options
• Tools to work with in achieving best reduction
  □ Plaster
  □ Pins
  □ External fixation
  □ Plates
  □ Screws
  □ Bone graft or filler
  □ Arthroscopy

Criteria for Acceptable Reduction
• Change in volar (palmar) tilt ≤ 10° (ie, neutral or 20 palmar slope)
• Radial shortening ≤ 2 mm
• Change in radial angle ≤ 5°
• When intra-articular fracture is present:
  □ Articular step-off ≤ 1-2 mm

Rationale for the Guidelines
• Intra-articular step-off
  □ 2 mm step-off on AP x-ray greatly increased the risk of symptomatic osteoarthritis at 7 year follow-up
  □ Dorsal tilt and radial length not much affect on outcome

Intra-Articular Incongruency
  □ 3 year follow-up of 52 fx’s
  □ Single most important factor that correlated with outcome was intra-articular gap between fragments
  □ Residual loss of volar or radial tilt did not correlate with outcome
  □ 7 year follow-up of 26 fx’s
  □ All treated with surgery
  □ Residual articular displacement (CT scan and x-ray) correlated with radiographic changes but not with functional outcome

What is Important?
• Does the fracture extend to the opposite cortex of the radius?
i.e., volar cortex for Colles

- Percutaneous fixation alone
  - Extra-articular fracture
  - Younger patient (good bone stock)
  - Good soft tissue envelope
  - Need adjunctive cast/brace

- ‘Kapandji’ Intrafocal Pinning
  - A technique of K-pinning using the pin itself to buttress the fracture site; usually requires ex-fix or cast

- Pin Placement
  - Pins are placed avoiding any contact with flexor tendons

Contraindications

- Significant intra-articular displacement
- Volar cortical comminution
- Inability to obtain an anatomic reduction

Clinical Results

  - 23 patients, 24 unstable fx of distal radius
  - 2 to 3 0.062 K-wires maintained for 4 weeks
  - 6 weeks Short Arm Cast
  - Results:
    - Patients < 65 years of age
    - 79% good or excellent radiologic results
    - Patients ≥ 65 years of age
    - 60% good or excellent radiologic results
    - UNION IN ALL PATIENTS

  - 73 patients
  - Kapandji pinning with or without ex fix
  - All had dorsally displaced extra-articular fx
  - Results:
    - Older patients
      - Range of motion, grip strength & pain relief significantly better w/ ex fix
    - Younger patients
      - w/ comminution of only 1 surface
      - Good results w/ Kapandji pinning alone
      - w/ comminution of ≥ 2 sides
Better results w/ ex fix

- 98 patients with extra-articular distal radius fractures
- Prospective randomized trial
- Results
  - Closed Reduction and Plaster Cast Group
    - 74% good, excellent Cooney score
  - Kapandji-Pinning Group
    - 75% good, excellent Cooney score

**Volar Plating with Extra-articular plates**

1. **Approach**
   - Make longitudinal incision slightly radial to the flexor carpi radialis tendon (FCR). Dissect between FCR and radial artery.

2. **External Fixation**
   - ‘Ligamentotaxis’ pulls on the fracture fragments to reduce and prevent collapse
   - Cannot restore normal volar tilt by pulling straight distally alone, a palmar vector is required
   - External Fixation Advantages
     - Easy to apply
     - Access to wound/pins
     - ‘Neutralizes’ fracture site
     - Frees up the elbow
     - Light
   - External Fixation Disadvantages
     - Does not necessarily reduce the fracture alone
     - Possible pin-tract infection
     - ? more stiffness with excessive distraction

**Non-Joint Spanning Ex-Fix: What’s New?**

- Indications
  - Unstable extra- or intra-articular distal radius fractures (DRF)
  - Failed closed reduction
  - Distal fragment size ≥ 6mm
    - McQueen recommends ≥ 10mm
  - Young patient
  - Good bone stock
- Treatment Options
  - Closed reduction - cast
  - Percutaneous pinning - cast
Pinning - ExFix
ORIF
Dynamic ExFix
Non-joint spanning ExFix

• Patient’s Trauma
  □ 30 year old male sustained right distal radius fracture while snowboarding
    □ Injury occurred 10 days prior to operation
    □ X-ray reveals a minimally displaced right distal radius fracture with a noticeably depressed lunate fossa as well as loss of volar tilt.

Benefits (Non-joint spanning ExFix)
• Rigid anatomic fixation
• Early motion
• Normal carpal load transfer / mobility
• Avoids late stiffness (no ligamentotaxis)

Technical Considerations
• What I use
• Standard proximal pins placement
• Mini C-arm to place distal pins
• Transverse pin placement
• Pins as joy-sticks to control fragment
• Radio-ulnar & volar-dorsal translation
• Both pins dorsally
• Supplement with percutaneous K-wires
• No ligamentotaxis = less stiffness?

Postop Care
• ROM after resolution of postop pain
• Interval splinting for 2-4 weeks (prevent pin tract infection)

Patient’s Trauma
• 46 year old male sustained injury from a fall while roller skating
  □ Sustained markedly displaced, comminuted and impacted fracture of the left distal radius metaphysis with intraarticular extension.
  □ Closed reduction failed to maintain alignment
There was a radial neurapraxia of his left thumb and marked instability with displacement of his distal radius.

Clinical Studies

  - 13 cases
  - All extra-articular fractures
  - All healed by 8.5 weeks
  - Loss of radial length 0.5mm
  - Loss of palmar tilt 2.2 degrees
  - Loss of inclination 1.3 degrees

  - 14 cases
  - 79% excellent / 21% good results
  - 12/14 anatomic X-Ray
  - 2 patients with <2mm step-off

  - Prospective randomized study, 60 cases
  - Significant improvement:
    - Radiographic measurements
    - Functional outcome
  - Results maintained at 1 year

  - 22 cases (all intra-articular fractures)
  - Functional ROM at 4 weeks post fixator removal

  - 20 cases
  - Postop:
    - Volar tilt 4 degrees
    - Radial shortening 1mm
    - Grip strength 74% contralateral limb
    - ROM 80%
  - 1 loss of fixation (dorsal angulation)

17 cases
29 months follow-up findings (avg):
- Radial inclination 24 degrees
- Volar tilt 12 degrees
- Radial length 0mm

Complications
- Pin tract infections
  - increased skin mobility
  - volar interval splinting recommended
  - Fischer JHS (B) 1999
- Sensory nerve injury
  - Nerve more vulnerable with distal radial pins
  - Small skin incision recommended
    Fischer JHS (B) 1999
- Nonunion
- Malunion
  - May be used after radial osteotomy for malunion
  - Posner JHS (1989)
- Extensor rupture
- Carpal tunnel syndrome
- RSD

Conclusion Non-joint Spanning Ex Fix
- Unstable intra- and extra-articular fractures
- Distal fragment at least 6mm length
- Young patient or good bone stock
- Avoids ligamentotaxis
- Early motion
- Late results same or better

Full Open Reduction & Internal Fixation
- The primary indication is severe articular displacement, which if left untreated, may lead to radioulnar or radiocarpal arthritis.

Plates
- Volar buttress plating recommended for fractures that displace volarly
  - Usually the distal screw holes are left open
- Dorsal Plating
  - Recommended by some in lieu of ex-fix and K-pins
Requires extensive dissection
☑ Early motion usually not possible anyway
☑ Plates usually require removal

**Specific Conditions and Treatment**

- **Barton’s Fracture**
  - **Palmar Barton**
    - Ideally treated by a palmar buttress plate.
  - **Dorsal Barton (intra-articular Colles)**
    - Best treated by closed reduction and external fixation if adequate reduction can be maintained.
    - Otherwise, open reduction and percutaneous pins, compressive screws, or a dorsal buttress plate can be used.
    - Arthroscopic reduction of dorsal Barton’s fracture offers an alternative that limits exposure of the dorsal carpus and that may help maintain blood supply to the dorsal fracture components. Skill in arthroscopy is required for this procedure.

- **Smith’s Fracture**
  - Open reduction and internal fixation (or external fixation) is the treatment of choice for palmar displaced fractures.
  - External fixation for open Smith’s fractures is acceptable for wound considerations.
  - It is rarely necessary to have distal screws in using the buttress plate for most Smith fractures, and there is risk of screws penetrating either the radiocarpal joint or extruding dorsally to affect the wrist and finger extensor tendons. A mini fragment plate is the exception to the general rule.

- **Both-bone forearm fracture**
  - ORIF within 48 hours of injury
  - Best achieved with 3.5mm compression plating, which is not removed after fracture healing.

- **Galleazzi fracture. “fracture of necessity”**
  - Disruption of the DRUJ
  - Occurs in 3-6% of forearm fractures
  - Axial loading upon pronated forearm
  - Key features are isolated distal radius fracture with:
    - ulnar styloid fracture
    - widened DRUJ on AP of wrist
    - apex dorsal fracture and subluxation/dislocation of radius on ulna (lateral view)
    - shortened distal radius >5mm relative to distal ulna
ORIF: radius is plated through an anterior approach. If the ulnar head is stable, the arm is held in supination for 4 weeks. If the head remains unstable, it is pinned to the radius for 4 weeks. If the RU is unreducible, the joint should be opened dorsally, inspected for interposed tendon or loose bodies and reduce.

**Outcomes and Complications**

- ORIF with 3.5mm dynamic compression plate achieves a union rate of 95-98%
- Schemitsch and Richards (1992)
  - demonstrated 84% of patients managed with plating had an excellent, good or acceptable functional result 6 years post-op.
  - Restoration of the normal radial bow was related to the functional outcome.
  - A good functional result (more than 80% of normal rotation of the forearm) and recovery of grip strength were associated with restoration of the normal amount and location of the radial bow.
- Complications
  - related to the severity and classification of the fracture.
    - demonstrated a rate of 13% for nerve injuries (9% radial, 2% median, 2% ulna) and 2% incidence of vascular injuries.
  - Radioulnar synostosis has been reported in 2% of forearm fractures (Vince, 1987)
  - Complication of a Galeazzi fracture:
    - nerve injury to the dorsal sensory branch of the radial nerve
Operative vs. Nonoperative management in the elderly


- Case/control w/ 90 patients > 65 y/o, 82 treated operatively / 74 treated non operatively
- initially treated with closed reduction / splinting
- surgical management: volar locked plate or bridging external fixation
- nonsurgical management: treated until healing via cast immobilization
- 24 week f/u: surgical cohort showed better wrist extension
- 1 year f/u: no difference in wrist extension, but grip strength better for surgical management
- At all follow-ups: No difference is seen in DASH or pain scores
- No difference between groups with regard to complications

REFERENCES


