The Problem of Distal Radius Fractures

Common injury: >450,000/yr. in USA
High potential for functional impairment and frequent complications
Introduction

Distal radius fractures occur through the distal metaphysis of the radius. May involve articular surface, frequently involving the ulnar styloid. Most often result from a fall on the outstretched hand.

- forced extension of the carpus,
- impact loading of the distal radius.

Associated injuries may accompany distal radius fractures.
Introduction

Classified by:

– presence or absence of intra-articular involvement,
– degree of comminution,
– dorsal vs. volar displacement,
– involvement of the distal radioulnar joint.
Diagnosis: History and Physical Findings

History of mechanism of injury
A visible deformity of the wrist is usually noted, with the hand most commonly displaced in the dorsal direction.

Movement of the hand and wrist are painful.

Adequate and accurate assessment of the neurovascular status of the hand is imperative.
Diagnosis: Diagnostic Tests and Examination

Evaluation of the injured joint, and a joint above and below

Radiographs of the injured wrist
Radiographs of other areas, if symptoms warrant.

CT scan of the distal radius in selected instances.
Treatment Goals

Preserve hand and wrist function

Realign normal osseous anatomy
  – Articular surface
  – Alignment of radial platform in space

Promote bony healing

Allow early finger and elbow ROM
Osseous Anatomy

Distal radius – 80% of axial load
- Scaphoid fossa
- Lunate fossa

Distal ulna – 20% axial load

Sigmoid notch – DRUJ
Anatomy

scaphoid and lunate fossa
  – Ridge normally exists between these two
sigmoid notch: second important articular surface
triangular fibrocartilage complex (TFCC): distal edge of radius to base of ulnar styloid
Radiographic alignment

Radial inclination = 22°

Radial length
– 12mm height of radial styloid
– ulnar neutral

Palmar tilt = 11-14°

Scapho-lunate angle
– 47° +/- 15°
Measurement of Radial Length and Inclination

Inclination = 23 degrees

Normal $x = 11-12$ mm
range 8-18 mm
PALMAR TILT

Normal = 11-12°
palmar (+) tilt
range 0-28°
Scapholunate angle measured between lines 2 and 3
(normal 47 ± 15 degrees)

1: Line connecting dorsal and volar tip of lunate
2: Line perpendicular to lunate
3: Line along axis of scaphoid
Computed Tomography

**Indications:**

- Intra-articular fxs with multiple fragments
- Centrally impacted fragments
- DRUJ incongruity

19 consecutive fx, CT had better sensitivity for intraarticular fragments

*management change in 5 pts*

Classification of Distal Radius Fractures

Ideal system should describe:

- Type of injury
  - Severity
- Evaluation
- Treatment
- Prognosis
Common Classifications

Frykman
Weber (AO/ASIF)
Melone
Column theory
Fernandez
(mechanism)
Frykman Classification

Extra-articular

Radio-carpal joint

Radio-ulnar joint

Both joints

Same pattern as odd numbers, except ulnar styloid also fractured

Importance of sigmoid notch articular surface
AO/OTA Classification

Group A:
Extra-articular

Group B:
Partial Intra-articular

Group C:
Complete Intra-articular

Volar and dorsal Barton fxs
Column Theory

3 Columns: lateral, intermediate, medial

Rikli & Regazzoni, 1996
Classification – Fernandez (1997)

I. Bending-metaphysis fails under tensile stress (Colles, Smith)

II. Shearing-fractures of joint surface (Barton, radial styloid)

importance of mechanism and energy level of injury
Classification – Fernandez (1997)

III. Compression - intraarticular fracture with impaction of subchondral and metaphyseal bone (die-punch)

IV. Avulsion- fractures of ligament attachments (ulna, radial styloid)

V. Combined complex - high velocity injuries
Assessment of X-rays

Assess involvement of dorsal or volar rim
  – is comminution mainly volar or dorsal?
  – is one of four cortices intact?

Look for “die-punch” lesions of the scaphoid or lunate fossa.

Assess amount of shortening

Look for DRUJ involvement
Dorsal angulation and comminution
Volar subluxation of carpus with fracture fragment
Options for Treatment

Casting
- Long arm vs. short arm
  - Sugar-tong splint

External Fixation
- Joint-spanning
- Non bridging

Percutaneous pinning

Internal Fixation
- Dorsal plating
- Volar plating
- Combined dorsal/volar plating
- focal (fracture specific) plating
Indications for Closed Treatment

- Low-energy fracture
- Low-demand patient
- Medical co-morbidities
- Minimal displacement- acceptable alignment

*Match treatment to demands of the patient*
Closed Treatment of Distal Radial Fractures

Obtaining and then maintaining an acceptable reduction

**Immobilization:**
- long arm (cast or sugar-tong for high demand)
- short arm adequate for elderly patients

Frequent follow-up necessary in order to diagnose re-displacement.
Technique of Closed Reduction

**Anesthesia**
- Hematoma block
- Intravenous sedation
  - Bier block

**Traction:** finger traps and weights

**Reduction Maneuver** (dorsally angulated fracture):
- hyperextension of the distal fragment,
- Maintain weighted traction and reduce the distal to the proximal fragment with pressure applied to the distal radius.

Apply well-molded “sugar-tong” splint or cast, with wrist in neutral to slight flexion.

_Avoid Extreme Positions!_
Acceptable Reduction Criteria

- Dorsal angulation < 10°
- > 15 ° of inclination
- Articular step-off < 2mm
- < 5 mm shortening
- DRUJ congruent
After-treatment

Watch for median nerve symptoms
– parasthesias common but should diminish over few hours
– If persist release pressure on cast, take wrist out of flexion
– *Acute carpal tunnel*: symptoms progress; CTR required

Follow-up x-rays needed in 1-2 weeks to evaluate reduction.

Change to short-arm cast after 2-3 weeks, continue until fracture healing.
Management of Redisplacement

Repeat reduction and casting
  – high rate of failure
Repeat reduction and percutaneous pinning
External Fixation
  ORIF
Treatment Choice

Depends on assessment of fracture stability

Indicators of instability are:
  – Patient age
  – Metaphyseal Comminution
  – Shortening: ulnar variance

Mackenney, McQueen, Elbton, JBJS 2006 Sep;88(9):1944-51.,
Prediction of instability in distal radial fractures
Indications for Surgical Treatment

- High-energy injury with instability
- Open injury
- Radial inclination < 15°
- Articular step-off, or gap > 2mm
- Dorsal tilt > 10°
- DRUJ incongruity
Operative Management of Distal Radius Fractures
External fixation:
The treatment of choice for distal radius fractures in the 1980’s

*Has fallen out of favor*
A spanning fixator is one which fixes distal radius fractures by spanning the carpus; i.e., fixation into radius and metacarpals.
Pin Placement

45° dorsal-radial
Pin Placement: proximally – open incision

Identify SRN

Between ECRL and ECRB
45 deg dorsal-radial position of fixator

Wrist in neutral

Allows retropulsion of thumb
Can place percutaneous pins easily
Can Remove Ex Fix or Pins Sooner if Needed
full finger motion
Non-spanning

A non-spanning fixator is one which fixes distal radius fracture by securing pins in the radius alone, proximal to and distal to the fracture site.
Limited indications

But literature shows good results
Early ROM permitted
Can pin to ulna to stabilize the DRUJ
Factors Affecting Functional Outcome

McQueen (1996): carpal alignment after distal radius fractures is the main influence on final outcome
- malalignment has significant negative effect on function
- failure to restore volar tilt predisposes to carpal collapse and carpal malalignment
Reduction Tactics

DePalma (1952) introduced traction / distraction as means of reducing distal radius fractures.

Spanning fixator relies on distraction as principle method of reducing fracture fragments.

Distraction (Ligamentotaxis) excellent for restoring length.
Ligamentotaxis

Bartosh, J Hand Surg 15A, 1990

19 cadaver hands with distal radius osteotomy

Ligamentotaxis with 10# and 20# of traction @
10°, 20° and 30° of flexion

volar tilt of distal radius could not be re-established
Ligamentous Anatomy

Volar ligaments
- Straight fibers
- Stout
- Tighten readily

Dorsal ligaments
- Zigzag
- Elastic
- Tighten slowly
WRIST LIGAMENTS

Volar ligaments more stout

Dorsal ligaments more lax, zigzag
Non-Spanning vs. Spanning Fixator

McQueen, JBJS-B, 1998

Prospectively studied 30 spanning vs. 30 non-spanning fixator patients

Non-spanning better preserved volar tilt, prevented carpal malalignment, gave better grip strength and hand function (all with $p<.001$)

Complication rate 50% lower
Volar tilt more directly corrected
Complications

Complication rates high in almost all reported series

- Pin track infection
- RSD Finger stiffness
- Loss of reduction; early vs. late
  - Tendon rupture

But do not throw away the external fixator
Indirect reduction and percutaneous fixation versus open reduction and internal fixation for displaced intra-articular fractures of the distal radius: a randomized, controlled trial.
Kreder, Hanel et al., JBJS Br, 2005 Jun;87(6):829-36.

179 adult patients with displaced intra-articular fractures of the distal radius was randomized
- indirect percutaneous reduction and external fixation (n = 88)
  - open reduction and internal fixation (n = 91)

During the first year functional scores, pinch strength and grip strength improved significantly in all patients.
No difference in the radiological restoration of anatomical features or the ROM
At 2 years
- Ex Fix patients had a more rapid return of function and a better functional outcome than ORIF group
- provided that the intra-articular step and gap deformity were minimized.
Spanning Plate
“Internal Ex Fix”
Indications

High energy comminuted fractures
ICU patients where perc pins are undesirable
Pts that can’t tolerate an external fixator

Courtesy Doug Hanel, MD
Pins Out 6wks
Plate Out 16Weeks

Courtesy Doug Hanel, MD
Percutaneous Pinning-Methods

variety described
most common radial styloid pinning ± dorsal-ulnar corner of radius pinning
supplemental immobilization with cast, splint
in conjunction with external fixation
(Augmented external fixation)
Percutaneous Pins
Percutaneous Pins
Percutaneous Pinning

2 radial styloid pins, (Mah and Atkinson, J Hand Surg 1992)
  – excellent anatomic 82%
  – good-excellent functional results 100%

Crossed Pins - (Clancey JBJS 1984)
  – prospective study
  – 30 pts excellent anatomic results in 90%
Percutaneous Pinning-Kapandji

intrafocal pinning through fracture site
buttress against displacement
good results in literature

-Greatting & Bishop, OCNA 1993
Internal Fixation of Distal Radius Fractures

elevation of depressed articular fragments required if articular fragments can not be adequately reduced with percutaneous methods

Volar approaches most common

*Significant increase in use over last 5 years
Selection of Approach

Based on location of fracture and displacement

**Volar approach** for volar rim fractures and comminuted fractures that can be reduced

**Radial styloid approach** for buttressing of styloid

**Dorsal approach**
- Occasionally for dorsally displaced fractures that can’t be reduced from volar approach

**Combined approaches** needed for high-energy fractures with significant axial impaction.
WHICH APPROACH?

DORSAL

1-2\textsuperscript{nd} DC
Classical Henry approach

Extended carpal tunnel approach

Useful for volar ulnar corner fragment or Fxs associated with CTS
Distal Radius- “volar Barton”

64 y.o. M, MVA, contralateral tibial shaft Fx
Carpal subluxation
Volar – Henry Approach

Courtesy Diego Fernandez, MD
Radial to FCR

Courtesy Diego Fernandez, MD
Elevate Pronator Quadratus

Courtesy Diego Fernandez, MD
Primarily Dorsal Fracture
CT Scan
Dorsal Plating, PCP and Ex Fix
Joints aligned
plates removed
Volar Plating for Dorsal Fractures

- less tendon irritation than dorsal plating
- indirect reduction
- better tolerated than Ex fix
Fixed angle locked screws
Three Column Theory

Radial Column
Lateral side of radius

Intermediate Column
Ulnar side of radius

Ulnar Column
distal ulna
Fragment Specific System
Radial and Ulnar Columns

- Pin plates
- 90-90 plating technique
Focal Plating

Radial Styloid Fragment
Dorsal ulnar fragment

70 - 90 degrees apart
Dorsal Fracture

Radial Styloid and dorsal-ulnar corner
Dorsal Case: focal plating
Radial shortening, comminution

Dorsal angulation

Possible Indication for Volar and Dorsal Plating
Volar approach, application buttress plate
Dorsal approach, application of 2 “L” buttress plates
EPL Tendon
Extensor retinaculum repaired beneath EPL to prevent irritation from plate - EPL left transposed.
Advanced Techniques
Arthroscopic-Assisted

reduce articular incongruities
also diagnose associated soft tissue lesions
minimally invasive
Arthroscopic-Assisted

Culp and Osterman, OCNA 26(4) 1995
Malunion of Distal Radius Fractures

Changes load-bearing patterns on the distal radius and load sharing between the radius and ulna.

Can lead to arthrosis.
Injury X-Ray

X-ray 4 months later shows malunion
Normal loading patterns

11 Degrees of Volar Tilt (Original Position)

DORSAL

RADIAL

ULNAR

PRESSURE: > 3.4 N/MM² (> 500 PSI)

PRESSURE: 2.4 TO 3.4 N/MM²

PRESSURE: 1.4 TO 2.4 N/MM²
Malunion: loading patterns

28 Degrees of Dorsal Tilt

Pressure:
- Greater than 3.4 N/MM² (greater than 500 PSI)
- 2.4 to 3.4 N/MM²
- 1.4 to 2.4 N/MM²
Altered Load through Ulna with Radial Shortening
Malunion of Distal Radius Fractures

Requires osteotomy, bone grafting and fixation

Dorsal plating traditionally done

Volar plating now performed with indirection reduction of fragment

- +/- bone graft
- Cancellous or synthetic injectable grafts
New Technologies

Variable angle locking plates

– Distal screws have +/- 15° spread with locking capability

Better contour to distal radius

Lower profile plates with smaller screws
Variable angle locking screws allow accurate placement in distal segment.
Conclusions

Need to be able to use all tools for treatment of distal radius fractures

Both external fixation and ORIF are useful.

- ORIF better in high-energy fractures associated with depression of articular surface
- ORIF gives better anatomic restoration, although not necessarily higher patient satisfaction.
Conclusions

External fixators still have a role in the treatment of distal radius fractures

Spanning ex fix unable to correct fracture deformity by itself

Should usually combined with percutaneous pins (augmented fixation)
Bibliography


Conclusions

New plating techniques allow for accurate and rigid fixation of fragments

Plating allows early wrist ROM

Volar, smaller and more anatomic plates are better tolerated

*Combination treatment is often needed*

If you would like to volunteer as an author for the Resident Slide Project or recommend updates to any of the following slides, please send an e-mail to ota@ota.org