Current Concepts in Adult Distal Radius Fractures

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Distal Radius Fractures

- Very common fracture
- Wide range of complexity
  - Simple to extremely difficult
Historical Notes

• Pouteau (1783)
• Colles (1814)
  – “At some remote period again enjoyed freedom of motion and be completely exempt from pain”
High Energy Injuries

- Modern civilization
  - High velocity transport
  - Extreme sports
  - Falls from heights
High Energy Injuries

• Increase in severe fractures
  – Severe comminution
  – Associated injuries
• Mostly seen in young males
Anatomy: 3 Articular Surfaces

- Lunate Facet
- Scaphoid Facet
- Sigmoid notch
Non-displaced Fractures

- Usually very stable
- Immobilize 4-6 wks
- Late EPL ruptures!
EPL Rupture

- Roth JHS May 2012
  - 61 Non-displaced distal radius fractures
  - 3 EPL Ruptures (5%)
    - Other studies report an incidence of 0.3-2%
  - All females
EPL Rupture

• Roth JHS May 2012
  – Average rupture 6.6 weeks after fracture

• Etiologies
  – attrition
  – entrapment by callous,
  – compartment syndrome due to hematoma and subsequent tendon necrosis
AGE

• Patient age affects decision making
• Young, active patients do best when the anatomy is restored by any means possible
• Low demand, elderly patients can tolerate significant deformity with good preservation of function and patient satisfaction
DVR vs Non-surgical treatment of Distal Radius Fractures >65 years

• Arora JBJS 2011
  – Prospective randomized trial of 73 patients randomized to DVR (36) vs CR and cast (37)
  – Cast group: 100% malunion rate
  – At 12 months, both groups had equivalent rom, level of pain, PRWE and DASH Scores
  – OTIF group had better grip strength overall by 102% vs 92% at 12 months
Volar-Radial Approach

- Through the tendon sheath of FCR
- Elevate pronator quadratus muscle
- Release insertion of BR in floor of 1st DC
- Avoid release of volar capsular insertion
Volar-Radial Approach

• Accurate reduction of thick volar cortex
• Improves fracture stability
• Decreases need for bone graft
Volar-Ulnar Approach

- Extended carpal tunnel incision
- FCU sheath (limited approach)
Volar-Ulnar Approach

- Excellent visualization of volar-ulnar corner
- Improved ability ORIF volar rim fractures
- Complete median nerve decompression
DVR Plate Placement

• Insert distal screws within 3mm of subchondral bone
• DVR placement distal to the “watershed line” increases risk of flexor tendon ruptures
• Watershed line: volar rim attachment of the volar wrist capsule and transition in slope creates a sharp edge
DVR Plate Placement

Tanaka JHS 2011

• FPL at greatest risk when dvr plate is positioned distal to the “watershed line”
DVR Plate: Distal Screws

• Distal locking screws of DVR should not penetrate the dorsal cortex
• Extensor tendon injury may occur
DVR Plate: Distal Screws

- Dorsal distal radius has a convex surface
- Difficult to assess screw lengths in the lateral view
- Go 2-3 mm shorter than measured to prevent inadvertent screw penetration
DVR Plate: Distal Screw Lengths

- Wall JHS 2012
  - Biomechanical study of DVR plating of osteoporotic distal radius bone models
  - Locking distal screw of 75% length produced the same construct stiffness as bicortical fixation.
  - Shortening the distal screw length reduces extensor tendon injury risk without sacrifice of fracture stability.
Tilt Views of DR Fractures

- Eliminates overlap of articular surfaces that occurs in the standard projections
- Improves assessment of articular surface reduction and intra-articular hardware
Joseph JHS 2011

- “Dorsal Horizon View” in 15 cases of OTIF with DVR
- 4 cases of dorsal screw penetration only detected with dorsal horizon view
- Recommend oblique and dorsal horizon view intra-operatively to detect screw protrusion
Radiographic Assessment

- Ozer JHS May 2012
  - 4 radiographic views of cadaver distal radii
  - Screw penetration of 1-3 mm
    - Standard lateral
    - 45° supination
    - 45° pronation
    - Dorsal tangential
• Routine lateral: failed to detect all screw penetrations
• Oblique views: screw penetration to the 2\textsuperscript{nd} and 4\textsuperscript{th} DC
• Dorsal tangential: best to detect screw in 3\textsuperscript{rd} DC
Arthroscopic Assisted DR Fx Treatment

- Direct assessment of articular reduction
- Visualize hardware penetration
- Diagnosis and repair of associated ligamentous injuries
- Technically difficult
Arthroscopic Assisted DR Fx Treatment

Geisler JBJS 1996

• Arthroscopy of 60 wrists with intra-articular DR Fx
• High incidence of occult soft tissue injury:
  – 49% TFCC
  – 32% SLIL
• Ability to clear osteochondral debris from the joint
Geissler JBJS 1996

- Ideal: fresh simple articular fractures amenable to PCP
- Arthrocopy tower that maintains traction in any position to facilitate both arthroscopy and fluoroscopy
- Prevent fluid extravasation
Dry Arthroscopy: del Piñal JHS 2011

- 2.7 mm / 30° scope best in 6R portal
  - Scope in 3-4 portal blocks attempts at reduction
OTIF DR Fx with Dry Arthroscopy

- del Piñal JHS 2011
- Technical tips from > 700 dry wrist arthroscopies
- Dry arthroscopy prevents fluid extravasation
- OTIF with locking plates possible since no fluid to leak from the open incisions
Dry Arthroscopy: del Piñal JHS 2011

- Apply DVR with elliptical hole to allow adjustment
- Insert distal locking screws in DVR plate once articular reduction confirmed arthroscopically
The Volar-ulnar Corner: Volar Rim Fragment

- Short radiolunate ligament
- Occurs in 26% of intra-articular fractures (Mandziak JHS 2011)
- Not fixed will result in volar carpal subluxation
The Volar-ulnar Corner: Volar Rim Fragment

- Keystone fragment in intra-articular fractures.
- Small distal fragments need low profile devices
- Best addressed with a volar-ulnar approach
Distraction Plating

- Excellent results reported by Ginn JBJS 2006
- Option for severe joint and metaphyseal comminution
- “Internal external fixator”
  - Ligamentotaxis facilitates reduction
- Biomechanically stronger than ex-fix
Distraction Plating

- Reduces many risks of external fixation
- More durable than ex fix pins
- Eliminates the risk of pin tract infections
- Allows digit rom
Distraction Plating: Technique

• 3 limited dorsal incisions:
  – 2\textsuperscript{nd} or 3\textsuperscript{rd} metacarpal
  – dorsal to the fracture at 3\textsuperscript{rd} compartment
    • epl transposition
    • May perform limited fixation and bone grafting
  – radius at least 4 cm proximal to the fracture
Distraction Plating: Technique

- Use 3.5 DCP or 2.4 mm distal radius plate (AO)
- Slide the plate distal to proximal and secure
• 22 patients with highly comminuted fractures of the distal radius treated with 3.5mm distraction plate to 3rd metacarpal
• Limited OTIF articular surafce
Distraction Plating

- All fractures united by 110 days, hwr: 124 days
- One year: fl/ext = 57° / 65°, p/s = 77° / 76°
- Grip 69% vs contralateral
- Final radiographic results: 4.6° palmar tilt, ulnar variance = 0 mm
- 21/22 pts had articular step-off < 2mm
Richard JHS 2012

- Distraction plating of highly comminuted distal radius fractures
- 33 patients > 60 y/o (Mean age 70)
- Mean follow-up: 47 weeks
- Good maintenance of reduction
  - Wrist f/e=46° / 50° ; P/S= 79° / 77°
- All fractures healed
- HWR avg 119 days after fracture (70-280 days)
- Effective management of osteoporotic comminuted distal radius fractures in elderly patients
DRUJ Assessment

• Always evaluate stability of DRUJ after fixation of distal radius in all positions of forearm rotation

• Splint in most stable position of forearm rotation (supination) if laxity identified.
DRUJ Assessment

• If unstable in all forearm positions:
  • consider TFCC or ulnar styloid repair
  • If still unstable, cross pin DRUJ
DRUJ Assessment

- If unstable in all forearm positions:
  - consider TFCC or ulnar styloid repair
- If still unstable, cross pin DRUJ
CTS

- Median nerve symptoms prevalent with DR Fx
- Most resolve after closed reduction
- Strongly consider CTR if performing OTIF and any numbness present since injury
- Badia: e-ctr in ALL distal radius OTIF
Complications of Distal Radius Fracture Treatment

- CRPS / RSD
- Malunion
- CTS
- Infection
- Tendon ruptures
- Nonunion
- DRUJ instability
Vitamin C Prevents RSD?

• Zollinger: 2 prospective randomized studies
  – **Lancet 1999**: prospective randomized study
    • vitamin C reduced the risk of CRPS by unknown mechanism
  – **JBJS 2007**: 416 patients with 427 wrist fractures randomized to placebo, 200mg, 500mg and 1,500 mg per day
    • Placebo group 10.1% incidence CRPP and 2.4% in the vitamin C group
    • 200 mg group same as placebo
    • 500 mg group same as 1,500 mg group
Vitamin C Prevents RSD?

- Consider using Vitamin C 500 mg / day x 50 days to prevent CRPS in distal radius fracture
  - Minimal risk
  - Minimal expense
  - Why not??
DISTAL RADIUS FRACTURES

• Wide variety of types and personalities
• Revolution in techniques over the last decade have improved our ability to treat these challenging fractures
The best radiographic projection of the wrist that can be used intra-operatively to detect dorsal cortical screw penetration when applying a volar locking distal radius plate is:

A: AP view, in full supination
B: Lateral view
C: Lateral view with $22^0$ radial tilt
D: Dorsal tangential view
E: Supinated oblique
The best radiographic projection of the wrist that can be used intraoperatively to detect dorsal cortical screw penetration when applying a volar locking distal radius plate is:

CORRECT ANSWER D: Dorsal tangential view

Discussion: The dorsal tangential view allows visualization of the dorsal cortex of the distal radius and sigmoid notch and is sensitive in the detection of dorsal cortical screw penetration.

Reference: Joseph SJ, Harvey JN, The Dorsal Horizon View: Detecting Dorsal Screw Protrusion at the Distal Radius, JHS (Am) 2011
Spanning internal fixation (“bridge plating”) of distal radius fractures may be indicated in highly comminuted fractures, poly-trauma injury and severe associated soft tissue injury. When choosing which metacarpal to apply the spanning plate, important factors include:

A: Application of the spanning plate to the 2nd metacarpal is preferred as it reduces the risk of injury to the superficial radial nerve.
B: Application of the spanning plate to the 3rd metacarpal may increase the risk of digital extensor tendon entrapment and rupture.
C: If there is a volar lunate facet fracture, the plate should be applied palmarly to the 3rd metacarpal to ensure a solid buttress of the fragment.
D: The 2nd metacarpal is preferred as the plate can be applied laterally, avoiding all extensor tendons.
E: Application of the plate to the 4th metacarpal is preferred for Galeazzi type fractures.
Spanning internal fixation ("bridge plating") of distal radius fractures may be indicated in highly comminuted fractures, poly-trauma injury and severe associated soft tissue injury. When choosing which metacarpal to apply the spanning plate, important factors include:

CORRECT ANSWER: B

B: Application of the spanning plate to the 3rd metacarpal may increase the risk of digital extensor tendon entrapment and rupture.

Discussion: Although application of the spanning plate to the third metacarpal results in a linear plate and easy passage of the plate. However, the plate must pass through the 4th dorsal extensor compartment with risk of extensor tendon entrapment or rupture. Application of the plate to the 2nd metacarpal passes the plate through the 2nd extensor compartment with little risk to the digital extensor tendons but may contact the SRN.

When applying a locking screw in the distal row of a distal radius volar locking plate:

A: Bi-cortical screw fixation is essential for a secure construct that can tolerate early rehabilitation.

B: The length of the screw must be carefully measured to ensure lag effect on the fracture.

C: Inserting a locking screw of 75% measured length produces construct stiffness equal to bi-cortical fixation.

D: The screw should be just long enough to capture the volar cortex.

E: The screw should be 50% of measured length to avoid flexor tendon injury.
When applying a locking screw in the distal row of a distal radius volar locking plate:

**CORECT ANSWER C:** Inserting a locking screw of 75% measured length produces construct stiffness equal to bicortical fixation.

**Discussion:** This study allows us to select a screw that is less than the measured length. This practice prevents extensor tendon injury from dorsal screw penetration without compromising the stiffness of the volar locking plate construct.

In performing ORIF of the distal radius, positioning the volar locking plate distal to the watershed line:

A: Maximizes tensioning of the distal oblique band of the interosseous membrane
B: Increases the risk of flexor tendon attrition and rupture
C: Optimizes distal screw placement
D: Facilitates a minimally invasive approach
E: Requires simultaneous carpal tunnel decompression
In performing ORIF of the distal radius, positioning the volar locking plate distal to the watershed line:

Correct Answer B: Increases the risk of flexor tendon attrition and rupture

Discussion: The watershed line on the volar lip of the distal radius represents a source of ligament attachment and an abrupt change in the gentle slope of the volar distal radius from proximal to distal. Positioning of volar locking plates distal to this line results in volar displacement of the construct and increasing the risk of flexor tendon rupture, with flexor pollicis longus tendon ruptures most frequently reported.

Thanks!