Distal Radius Fractures

Hans P. Van Lancker MD FRCSC FAAOS

Impact of Distal Radius Fractures

- Common injury: 650,000+/yr in USA, ~17% of all fractures
- Increasing as population ages
- High potential for functional impairment and complications

Introduction

- Fractures through the distal metaphysis of the radius
- May involve articular surface (50%)
- Often involve the ulnar styloid
- Often result from a fall on the outstretched hand
  - forced extension of the carpus
  - impact loading of the distal radius
- Bimodal old low energy, younger high energy
- Associated injuries may accompany distal radius fractures
  - TFCC, DRUJ, SLL, LTL.

Diagnosis: History

- Mechanism of injury
- Handedness
- Type of work the patient does
- Pre-existing carpal tunnel symptoms
- Assessment of pain
    - Compartment syndrome is a possibility in high energy injuries

Acute Compartment Syndrome

- Diagnosis of physical exam
  - Pain on passive stretch and out of proportion with injury are key symptoms not to miss
  - Also assess for acute carpal tunnel syndrome
- Compartment pressure needle assessment in unconscious or otherwise difficult to examine patient with concern (high energy or swollen arm)
  - positive finding of pressure delta between compartment and diastolic <30
- Pallor, pulselessness and paresthesias are late symptoms

Diagnosis: Physical Exam

- Visible deformity of the wrist is usually noted
  - hand most commonly displaced in the dorsal direction
- Movement of the hand and wrist are painful
- Adequate assessment of the neurovascular status of the hand is imperative
  - concomitant acute carpal tunnel syndrome is possible and should be addressed
- Evaluation of the injured joint and joints above and below

Image courtesy of Khare Wilson PA-C

Diagnosis: Diagnostic Tests and Examination

- Radiographs of the injured wrist
- Radiographs of other areas, if symptoms warrant.
- CT scan of the distal radius in cases with complex intra-articular injury or unclear DRUJ involvement

Treatment Goals

- Preserve hand and wrist function
- Length, alignment and rotation of normal osseous anatomy
  - Articular congruency
  - DRUJ alignment
- Achieve complete bony healing
- Early active finger and elbow ROM

Osseous Anatomy

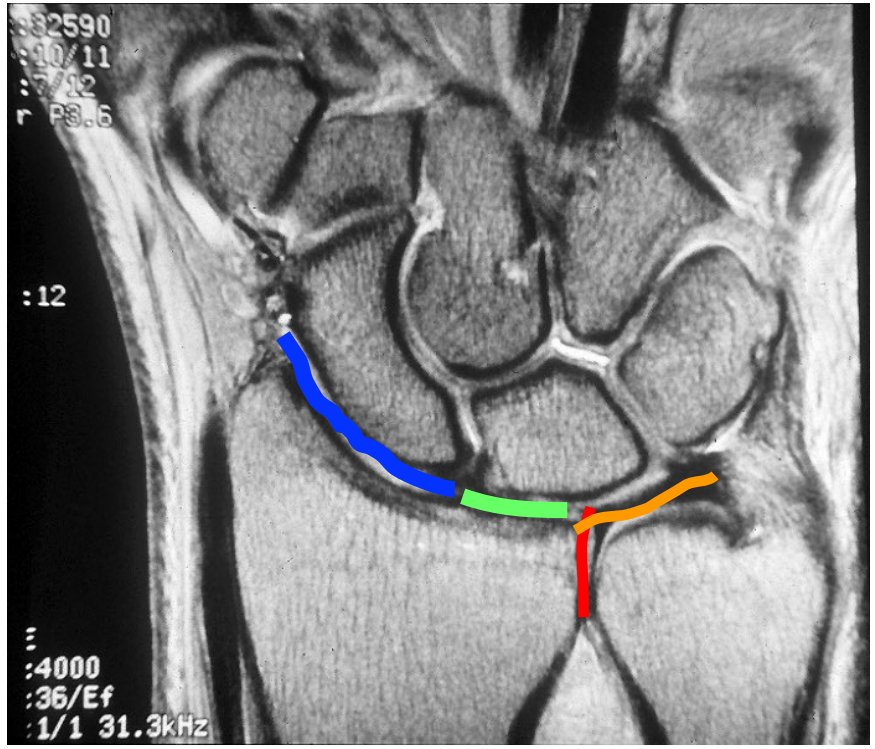
- Distal radius – 80% of axial load
  - Scaphoid fossa
  - Lunate fossa

- Distal ulna – 20% axial load

- Sigmoid notch – DRUJ

Anatomy

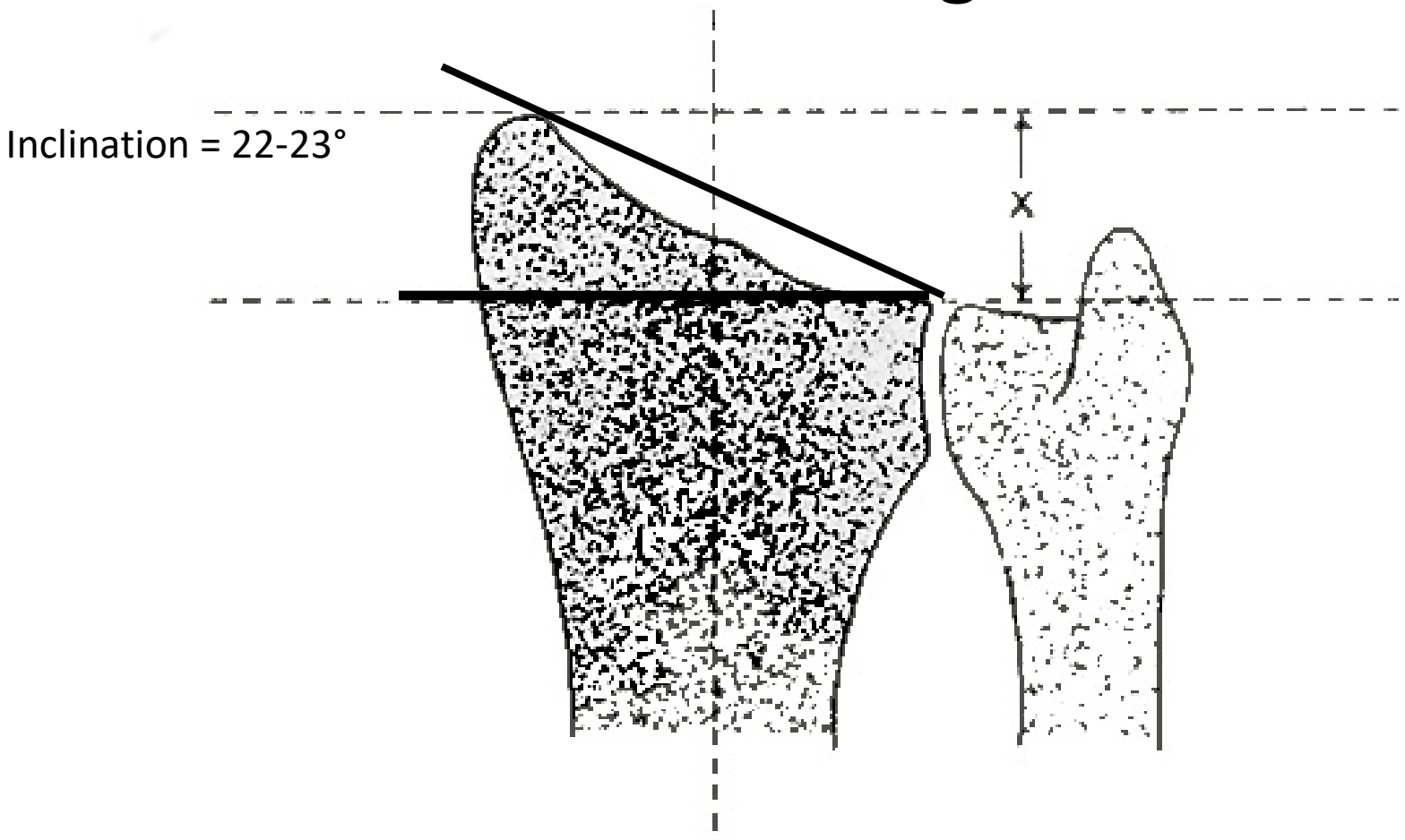
- Scaphoid and lunate fossa
  - small ridge normally exists between these two
- Sigmoid notch: second important articular surface
- Triangular fibrocartilage complex(TFCC): distal edge of radius to base of ulnar styloid



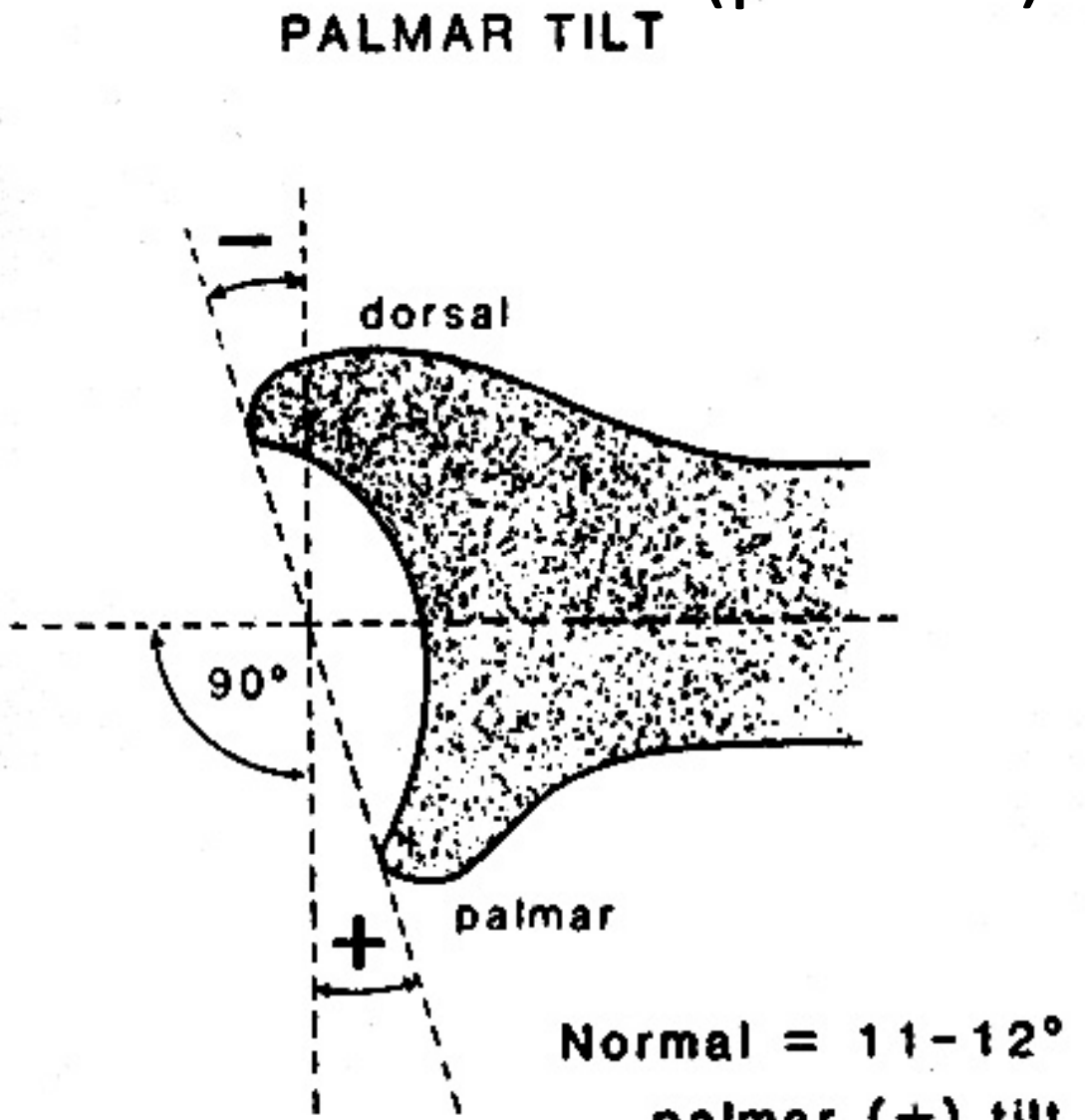
Radiographic alignment

- Radial inclination = 22°
- Both radial length and volar tilt ~11°
    - Radial length (terms “height” and “length” used interchangeably)
        - 11-12mm height of radial styloid
        - ulnar neutral
    - Volar (palmar) tilt = 11-14°
- Scapho-lunate angle
    - 47° +/- 15°

Measurement of Radial Length and Inclination



Measurement of Volar(palmar)-Dorsal Tilt



Assessment of x-rays

- Assess articular involvement
  - Comminution of dorsal rim
  - Fracture of volar rim
- Look for compression (die-punch) lesions of the scaphoid or lunate fossa
- Assess shortening
- Look for DRUJ involvement
- Decide need for CT assessment

Dorsal (apex volar) angulation and comminution

Volar subluxation of carpus with fracture fragment

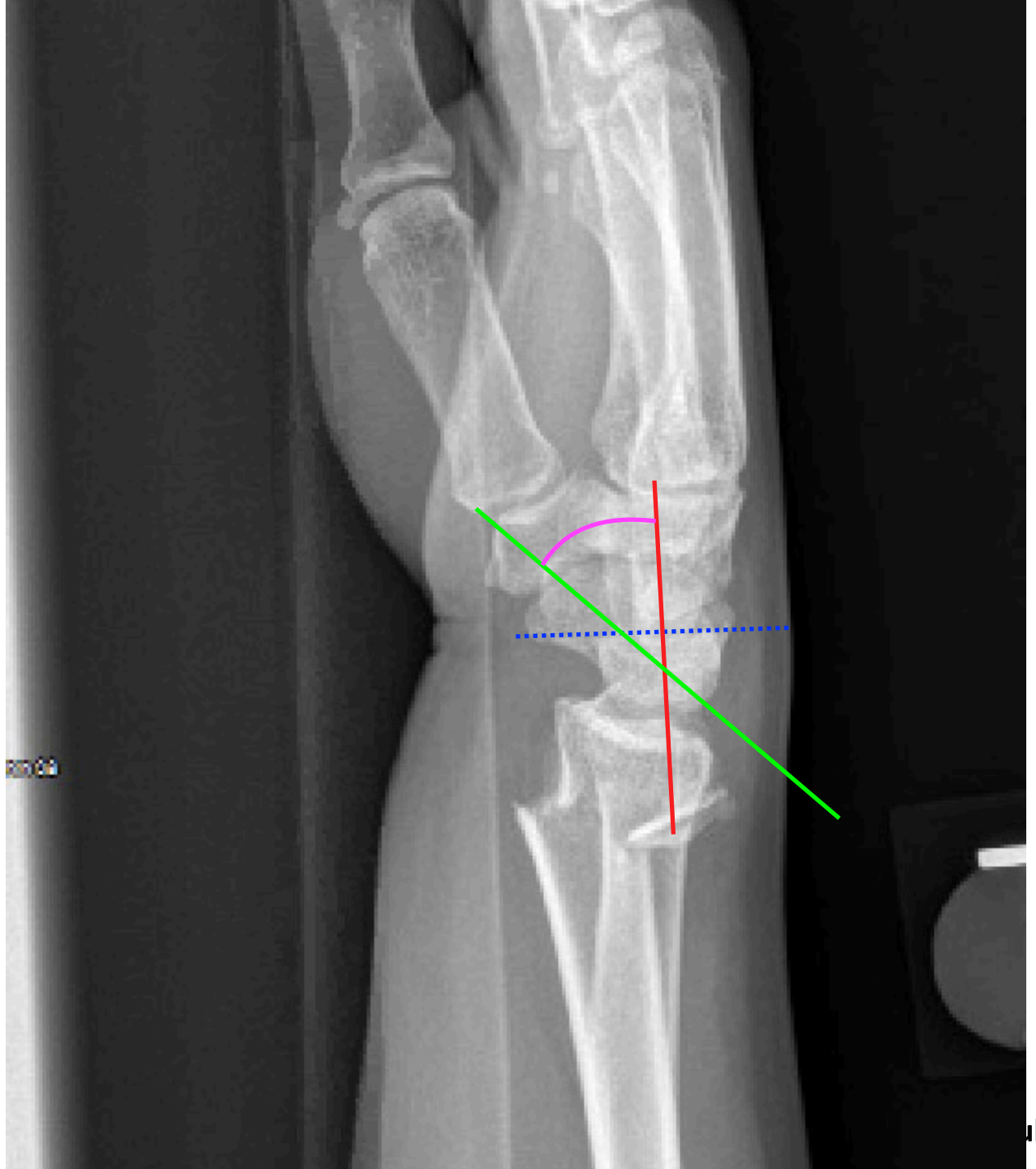
Scapholunate angle measured between lines 2 and 3

(normal 47 ± 15 degrees)

1: Line connecting dorsal and volar tip of lunate

2: Line perpendicular to lunate

3: Line along axis of scaphoid



Signs of possible DRUJ injury on x-ray

- Fracture at base of ulnar styloid
- Widening of DRUJ space on PA x-ray
- >20° of dorsal angulation
- >5mm of proximal displacement of the distal part of the radius

- Distal Radioulnar Joint Instability Author: Robert M. Szabo, MD, MPH Journal: JBJS Volume: Vol. 88-A, No. 4, April 2006, pp 883-894 https://www.ncbi.nlm.nih.gov/pubmed/16615200

Indications for Obtaining CT Scan:

- Intra-articular fxs with multiple fragments
- Articular impaction
- DRUJ incongruity

Classification of Distal Radius Fractures

Classified by:

- Intra-articular involvement
- degree of comminution
- dorsal vs. volar displacement
- involvement of the distal radioulnar joint.

Treatment decided by:

- Type of injury
- Severity Evaluation
- Patient Discussion
- Surgical Options
- Prognosis

Common Classifications

- Weber (AO/ASIF) – comprehensive but complex
- Frykman – based on joint involvement, styloid involvement
- Melone – divides intra-articular fractures into 4 types based on displacement
- Fernandez – based on mechanism of injury

Eponyms

Die-Punch Fracture	Depressed fracture of lunate fossa of articular distal radius
Barton's Fracture	Fracture dislocation of radial carpal joint involving volar or dorsal lip
Chauffer's Fracture	Radial Styloid Fracture
Colles' Fracture	Low energy dorsally displaced
Smith's Fracture	Low energy volarly displaced

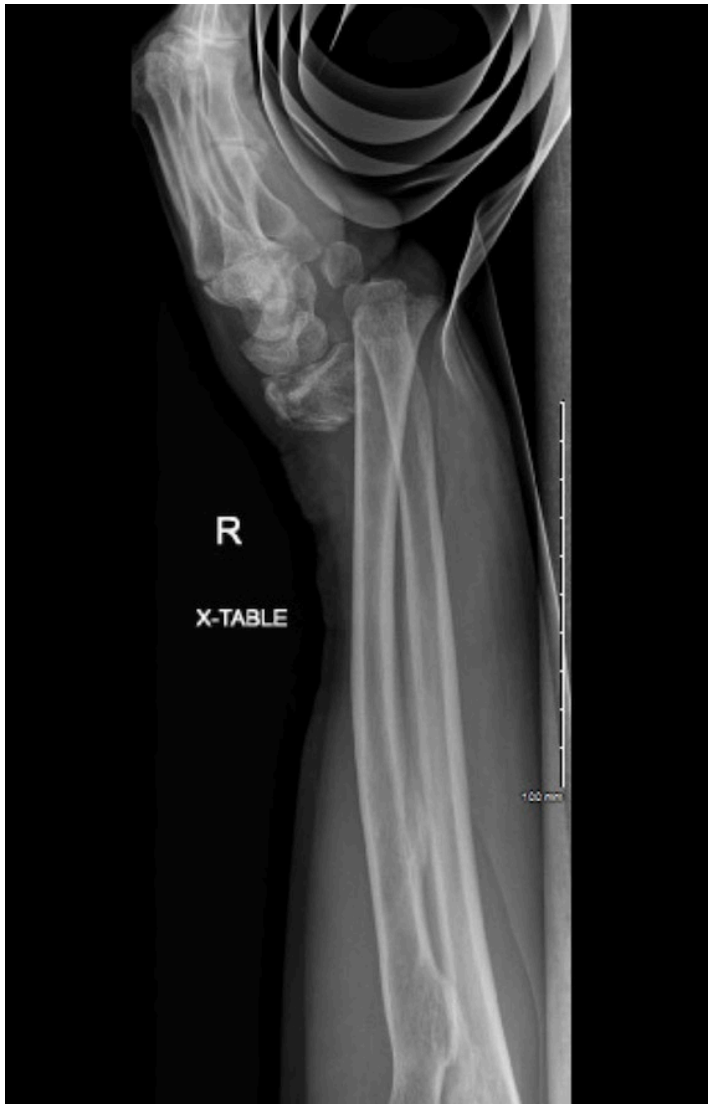
Die-Punch

Colles'

Chauffer's

Radio-carpal fracture dislocation

- Not your typical distal radius fracture
  - High energy
- Needs early attention and reduction
  - Acute carpal tunnel
  - Stiffness



Images courtesy of Khare Wilson PA-C

Options for Treatment

Casting/Splinting

- Long arm vs. short arm
- Sugar-tong or volar/dorsal splint

External Fixation

- Joint-spanning
- Non bridging

Percutaneous pinning

Internal Fixation

- Dorsal plating
- Volar plating
- Combined dorsal/volar plating
- Dorsal bridge plating
- Focal (fracture specific) plating

Images from:
https://otaonline.org/book/2573/chapter/207609774/principles-of-nonoperative-management-of-fractures#tornetta9-tornetta-9-tornetta-ch009-topic018

Predictors of Instability:

- Depends on assessment of fracture stability
- LaFontaine Criteria https://pubmed.ncbi.nlm.nih.gov/2592094/
- Indicators of instability are:
  - Patient age
  - Metaphyseal comminution
  - Shortening: ulnar variance
- Consider patient level of function and medical comorbidities
- https://www.trauma.co.uk/wristcalc

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

Standard of Care

- Trial of nonop management after adequate reduction
  - ORIF if reduction is lost
- Early collapse often predicts ongoing collapse

Images courtesy of Nicholas Elisseou MD

Malunion

- Treatment depends on patient factors and alignment
- Malunion can be functional and tolerated in some patient
  - > age 65, low demand
  - Poorly tolerated in young patients
- Assess risk with McQueen/LaFontaine criteria https://pubmed.ncbi.nlm.nih.gov/2592094/

LaFontaine Criteria

- Dorsal Angulation > 20
- Dorsal Comminution > 50%
  - Palmar comminution
  - Intra-articular Comminution
- Initial Displacement >1cm
- Radial shortening >5mm
- Associated ulnar fracture
- Severe Osteoporosis

AAOS Guidelines

- https://www.aaos.org/globalassets/quality-and-practice-resources/distal-radius/drfcpg.pdf

- AAOS Appropriate Use Criteria Calculator
  - https://www.orthoguidelines.org/go/auc/auc.cfm?auc_id=224789

Indications for Closed Treatment

- Low-energy fracture
- Low-demand patient
- Medical co-morbidities
- Minimal displacement = acceptable alignment
- *Match treatment to demands of the patient*

https://otaonline.org/video-library/45036/procedures-and-techniques/multimedia/16731335/closed-reduction-of-distal-radius-fractures

Closed Treatment of Distal Radial Fractures

Goal is to obtain and maintain an acceptable reduction

Immobilization:

- initially maintained with splinting or a split cast to accommodate for swelling and prevent cast compartment syndrome
  - Citation: *Management of Limb Injuries, during disasters and conflicts*, Editor: Harold Veen, 2016, AO Foundation
- short arm cast or splint often adequate
- long arm (cast or sugar-tong) for high demand patients

Frequent follow-up necessary in order to diagnose re-displacement.

- weekly for first 3-4 weeks to ensure maintained reduction

Technique of Closed Reduction

Anesthesia
- Hematoma block
- Intravenous sedation (ketamine + propofol, versed + fentanyl)
- Bier block

Traction: finger traps and weights

Reduction Maneuver (dorsally angulated fracture):
- hyperextension of the distal fragment (in direction of deformity)
- Maintain traction and reduce the distal to the proximal fragment with 3 point moulding applied to the distal radius

Apply well-molded volar/dorsal splint or cast, with wrist in neutral to slight flexion.

https://otaonline.org/video-library/45036/procedures-and-techniques/multimedia/16731335/closed-reduction-of-distal-radius-fractures

Avoid extreme positions of splinting

Perform neurovascular exam after reduction and splinting

After-Reduction

Watch for median nerve symptoms

- parasthesias can occur with blocks but should diminish over next few hours
- If pain or parenthesis persist- release pressure on cast, take wrist out of flexion
- *Acute carpal tunnel*: if symptoms progress; ORIF and CTR required

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

Transition to short-arm cast after 2-3 weeks, continue until fracture healing (est. 6 weeks for most)

Management of Redisplacement

- Repeat reduction and casting
  - *high rate of failure*

Schermann H, Kadar A, Dolkart O, Atlan F, Rosenblatt Y, Pritsch T. Repeated closed reduction attempts of distal radius fractures in the emergency department. Arch Orthop Trauma Surg. 2018 Apr;138(4):591-596. doi: 10.1007/s00402-018-2904-2. Epub 2018 Feb 16. PMID: 29453642.

- Repeat reduction and percutaneous pinning
- External Fixation
- ORIF
- Discussion with patient regarding outcomes and risks of surgery vs nonop tx

Factors Affecting Functional Outcome

McQueen (1996): carpal alignment after distal radius fractures is the main influence on final outcome

- malalignment = negative effect on function
- failure to restore volar tilt predisposes to carpal collapse and carpal malalignment

Indications for Surgical Treatment

- High-energy injury with instability
- Open injury
- Radial shortening >3mm
- Articular step-off, or gap > 2mm
- Dorsal angulation > 10 °
- DRUJ incongruity
- Carpal mal-alignment

American Academy of Orthopaedic Surgeons. The treatment of distal radius fractures. Guideline and evidence report. Rosemont, IL: American Academy of Orthopaedic Surgeons, 2020. https://www.aaos.org/globalassets/quality-and-practice-resources/distal-radius/drfcpg.pdf

Operative Management of Distal Radius Fractures

OR setup

- Position- Supine
- Table- Jackson or standard table with radiolucent hand table
- Height - Sitting or Standing
    - Standing when addressing other injuries as well
- Fluoroscopy - Mini or full size c-arm
    - Pay attention to radiation dose with either
- Tourniquet
    - WALANT technique shown to be effective
    - Blood loss same with and without tourniquet
    - Ahmad AA, Yi LM, Ahmad AR. Plating of Distal Radius Fracture Using the Wide-Awake Anesthesia Technique. J Hand Surg Am. 2018 Nov;43(11):1045.e1-1045.e5. doi: 10.1016/j.jhsa.2018.03.033. Epub 2018 Jun 14. PMID: 29866390.
    - Possible relationship between micro-vascular injury and CRPS
    - Coderre TJ, Bennett GJ. A hypothesis for the cause of complex regional pain syndrome-type I (reflex sympathetic dystrophy): pain due to deep-tissue microvascular pathology. *Pain Med*. 2010;11(8):1224-1238. doi:10.1111/j.1526-4637.2010.00911.x

External Fixation

- An option for distal radius fractures with metaphyseal displacement but a congruous joint
    - Observed better functional, clinical and radiographic outcomes when treated with immediate ex-fix and optional k-wires vs casting
    - https://otaonline.org/video-library/45036/procedures-and-techniques/multimedia/16776579/external-fixation-of-the-distal-radius

- A Randomized, Controlled Trial of Distal Radius Fractures With Metaphyseal Displacement but Without Joint Incongruity: Closed Reduction and Casting Versus Closed Reduction, Spanning External Fixation, & Optional Percutaneous K-wires Author: Hans J. Kreder, MD,* Julie Agel, MA,† Michael D. McKee, MD, FRCS(C),‡ Emil H. Schemitsch, MD, MPH, FRCS(C),‡ David Stephen, MD,* & Douglas P. Hanel, MD† Journal: JOT Volume: Vol. 20, No. 2, Feb 2006, pp 115-121

External Fixation

- Good option for open, contaminated injuries, medically unstable patients, poly-trauma stabilization.
- Relies on ligamentotaxis for stability.
- Good for restoring length but not angulation or articular surface.
- Can be supplemented with pins
- Pitfalls
  - Overdistraction, assoc. with CRPS
  - Extensor Tendon Adhesion
    - Kaempfe FA, Wheeler DR, Peimer CA, Hvisdak KS, Ceravolo J, Senall J. Severe fractures of the distal radius: effect of amount and duration of external fixation distraction on outcome. J Hand Surg. 1993;18A:33-41.

Spanning Plate
i.e. the "Internal Ex Fix"

Indications for Wrist Spanning Plate:

- High energy comminuted fractures
  - Radio-carpal fracture dislocation
  - Pilon/Impaction fractures
    - fragment elevation/grafting
- ICU patients or others where perc pins are undesirable
- Patients that will not tolerate an external fixator

Sarah Lewis, Amir Mostofi, Milan Stevanovic, Alidad Ghiassi,
Risk of Tendon Entrapment Under a Dorsal Bridge Plate in a Distal Radius Fracture Model,
The Journal of Hand Surgery, Volume 40, Issue 3, 2015, Pages 500-504,
ISSN 0363-5023,
https://doi.org/10.1016/j.jhsa.2014.11.020.
(https://www.sciencedirect.com/science/article/pii/S0363502314016086)


Lossy

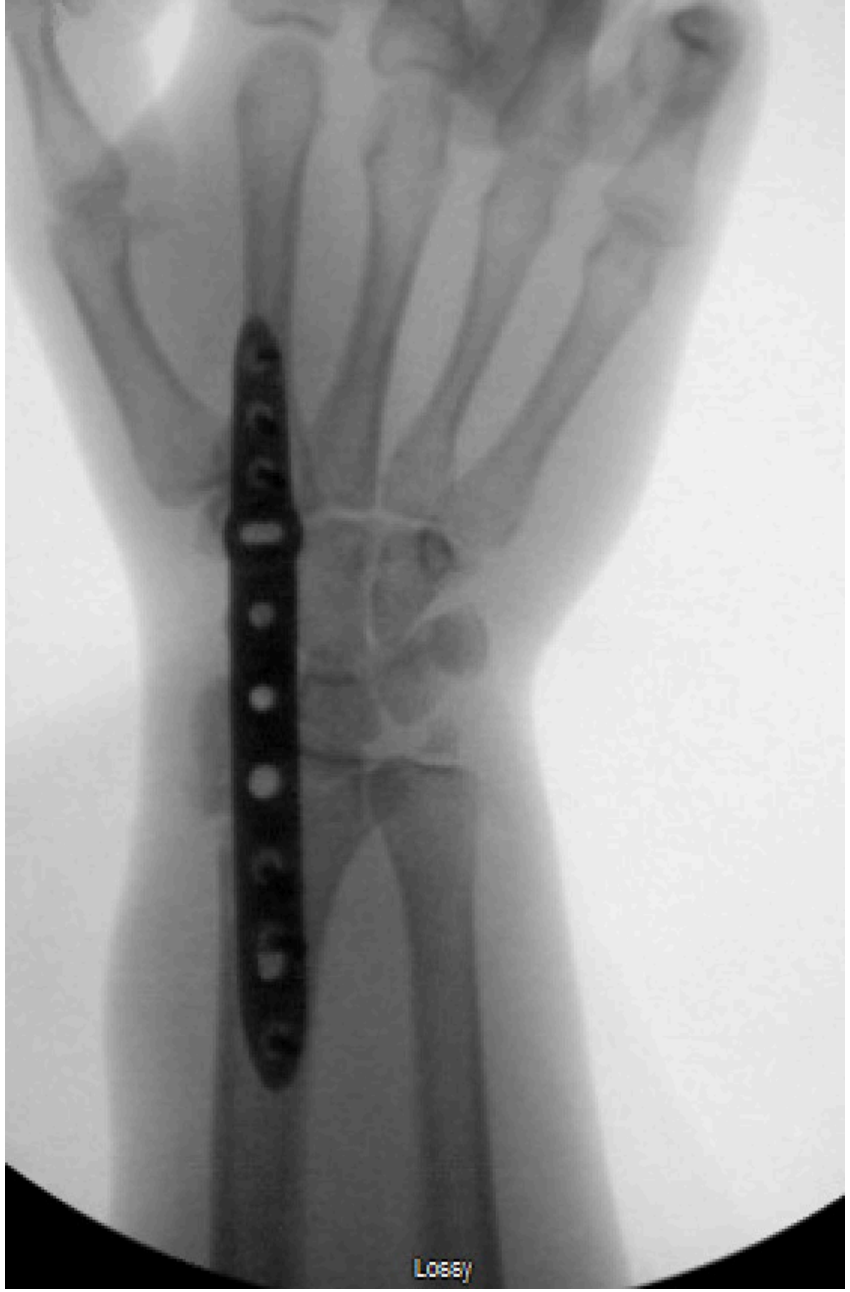

Lossy

Plate out at 3-4 months

Percutaneous Pinning - Methods

- Various techniques 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)*
- Kapandji = Pinning through fracture site to aid reduction

Strohm PC, Müller CA, Boll T, Pfister U. Two procedures for Kirschner wire osteosynthesis of distal radial fractures. A randomized trial. J Bone Joint Surg Am. 2004 Dec;86(12):2621-8. doi: 10.2106/00004623-200412000-00006. PMID: 15590845.

Percutaneous Pins

Percutaneous Pins

Open Reduction and Internal Fixation of Distal Radius Fractures

- Better for elevation of depressed articular fragments
- Required if articular fragments can not be adequately reduced with percutaneous methods
- Volar approach is most common
- *Primary means of treating displaced and unstable distal radius fractures

ORIF vs ExFix

- Plate fixation is better than external fixation combined with perc pinning for the treatment of intra-articular distal radius fractures
- ORIF yields better functional outcomes, DASH, supination, bony anatomy, less infection
- Ex-Fix results in better grip strength and flexion

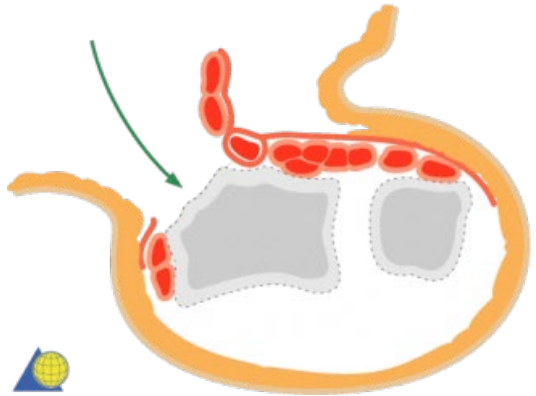
- Comparison of external and percutaneous pin fixation with plate fixation for intra-articular distal radial fractures. A randomized study. Author: Leung F, Tu YK, Chew WY, et al. J Bone Joint Surg Am. 2008 Jan;90(1):16-22.
- External fixation versus internal fixation for unstable distal radius fractures: a systematic review and meta-analysis of comparative clinical trials. Author: Wei DH, Poolman RW, Bhandari M, et al. J Orthop Trauma. 2012 Jul;26(7):386-94.
- External Fixation versus Open Reduction with Plate Fixation for Distal Radius Fractures: A Meta-Analysis of Randomized Controlled Trials. Author: Esposito J, Schemitsch EH, Saccone M, Sternheim A, Kuzyk PR. Injury. 2013 Apr; 44(4):409-16

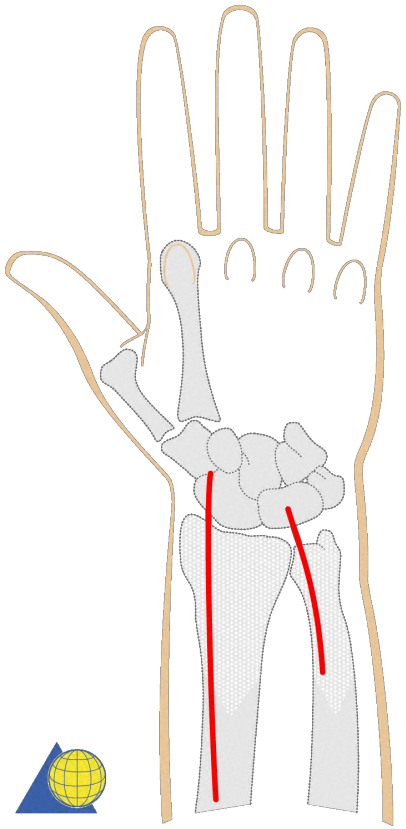
Selection of Approach

- Based on location of fracture and displacement
- Volar approach (most common) 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 cannot be reduced or maintained from volar approach
- Combined approaches needed for high-energy fractures with significant axial impaction

Dorsal Approach

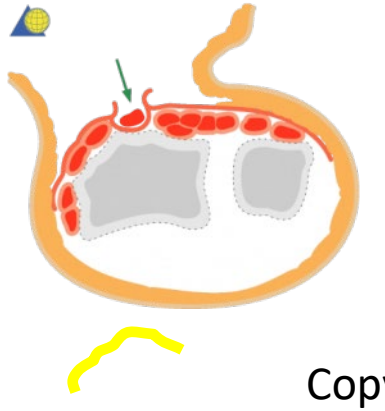
1-2nd DC





3rd DC –EPL

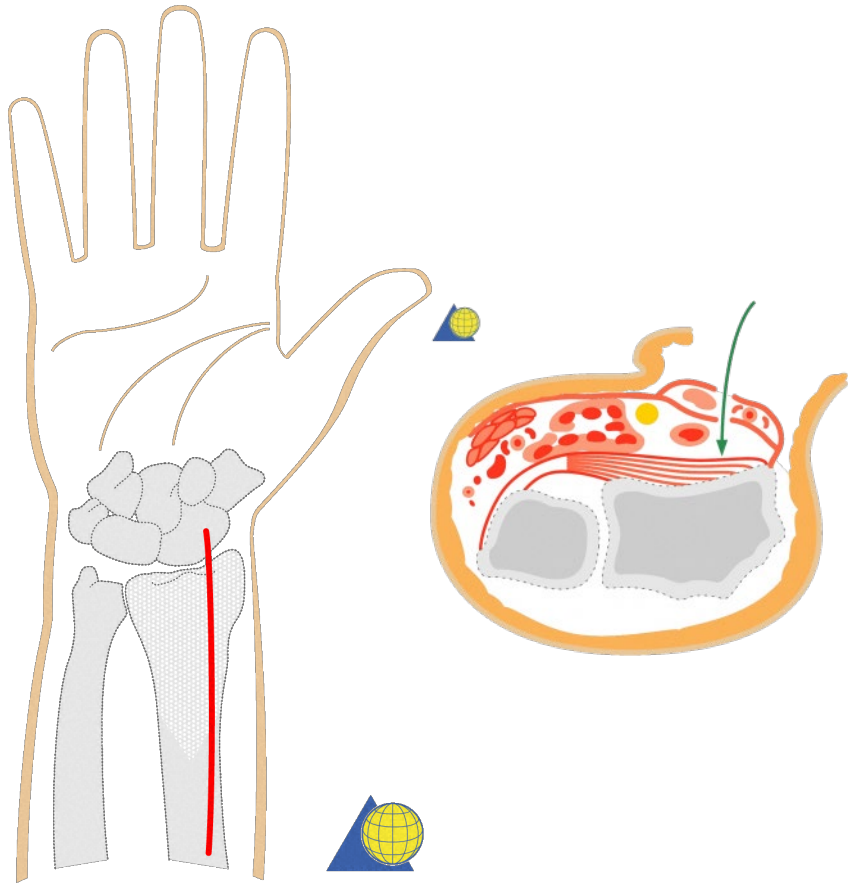
(extensile)



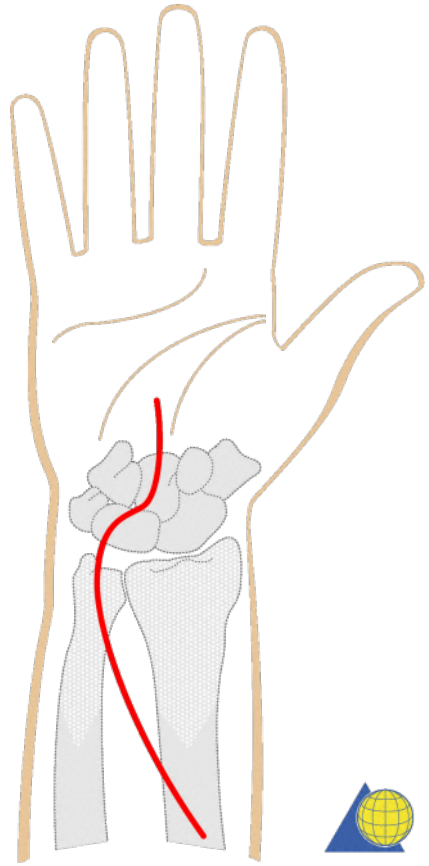
- Interval used is best chosen based on what portion of the radius you are looking to see
    - 1st and 2nd for radial styloid
    - 3rd for metaphysis
    - 5th and 6th for ulnar styloid

Volar Approaches

1. Classical Henry approach



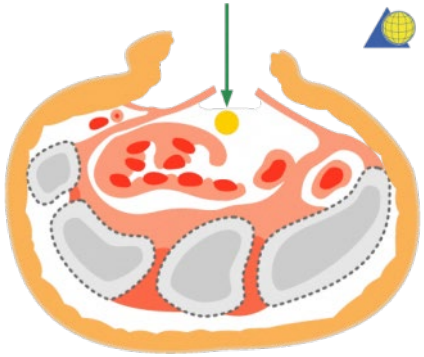
2. Extended carpal tunnel approach



Useful for:

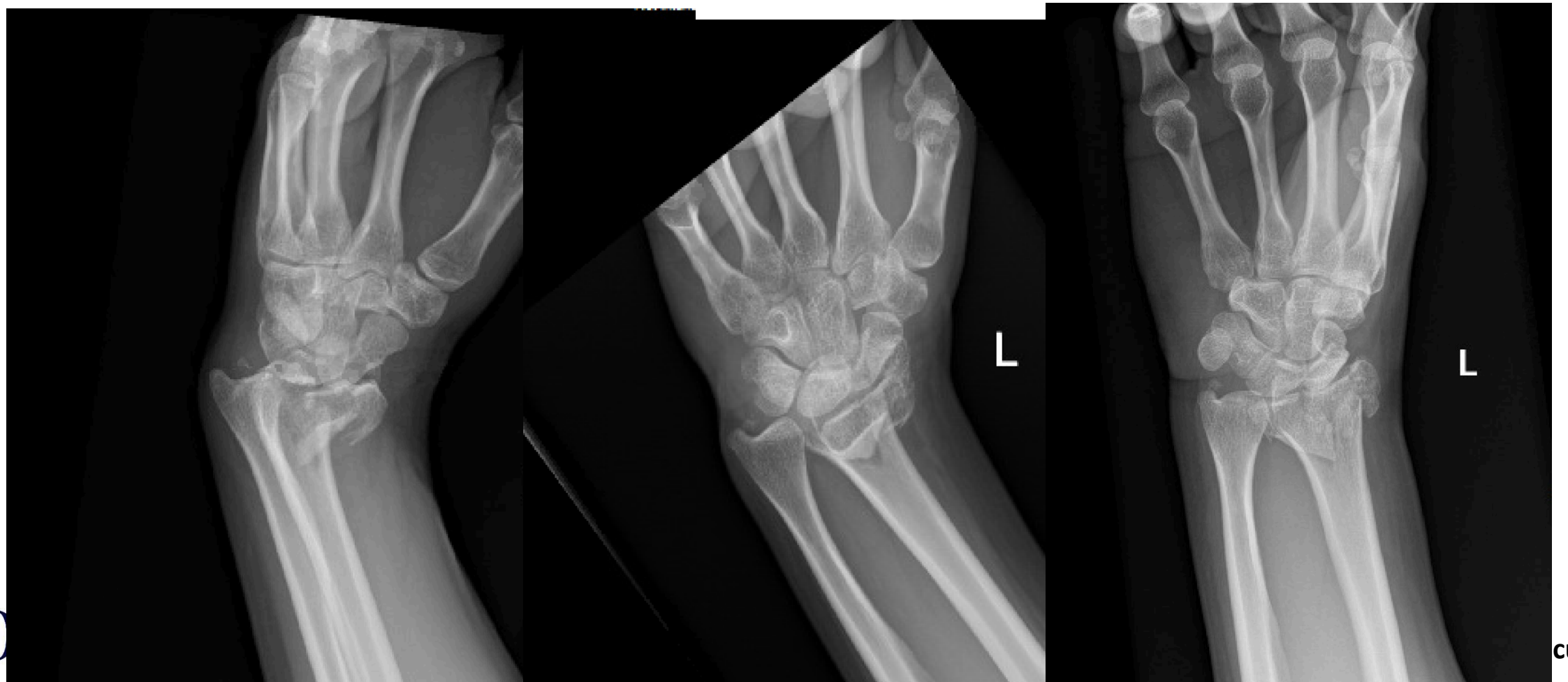
volar ulnar corner fragment

Fxs associated with CTS



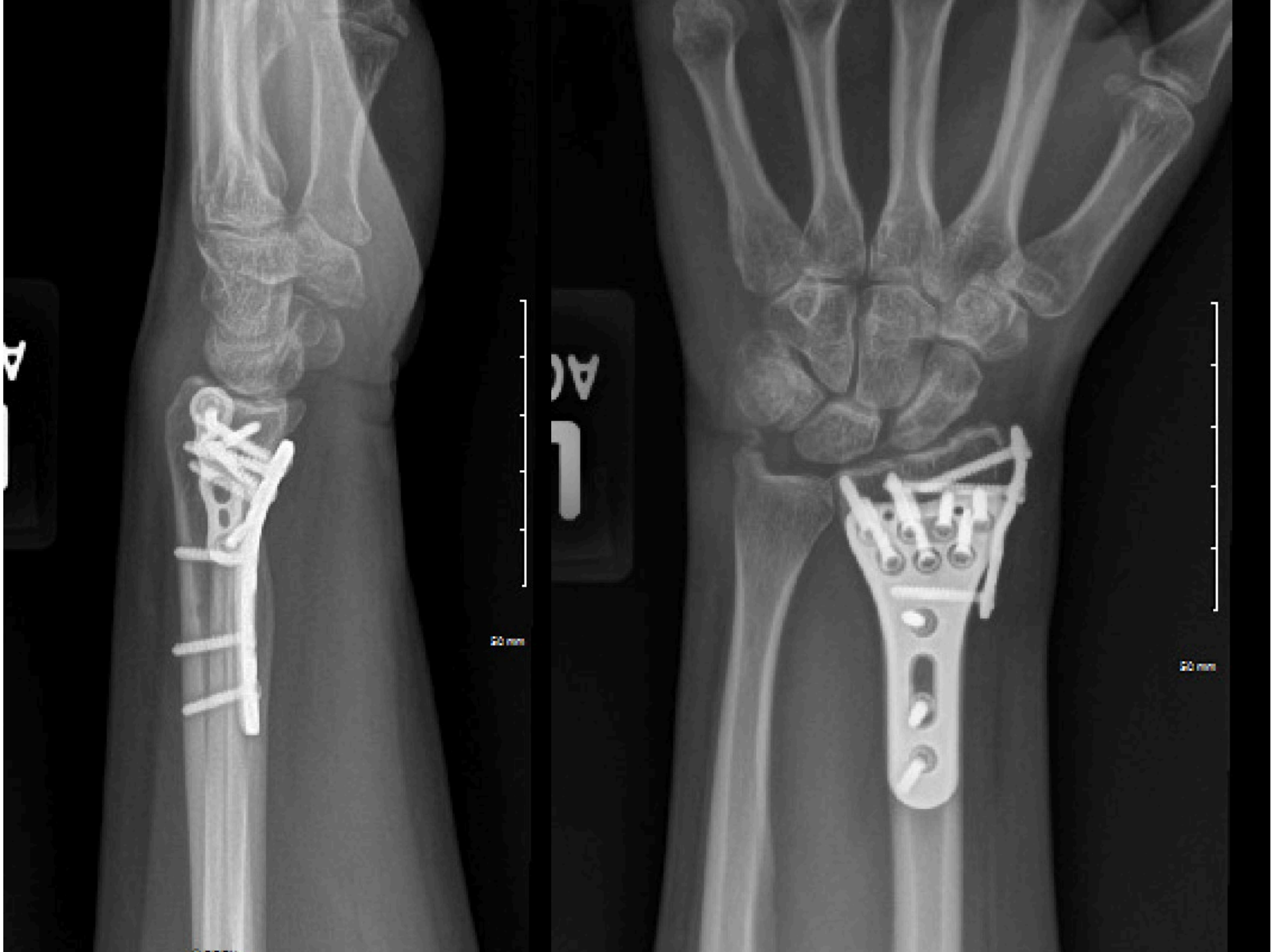
Distal Radius- volar Barton

35 y.o. M, MVC




L

With volar Barton’s fracture, it is critical to place the buttress fixation ulnar enough to maintain located reduction of fragment and carpus.



Volar Plating

- Workhorse for ORIF of distal radius fractures
- Reliable, reproducible outcomes
- Lower complication rates when compared to other surgical options
  - Alter, Todd H. BS1; Ilyas, Asif M. MD1,a Complications Associated with Volar Locking Plate Fixation of Distal Radial Fractures, JBJS Reviews: October 2018 - Volume 6 - Issue 10 - p e7 doi: 10.2106/JBJS.RVW.18.00004
- Good soft tissue coverage, low profile
- Most plates offer variable angle locking with 15° spread

https://otaonline.org/video-library/45036/procedures-and-techniques/multimedia/16776671/volar-locked-plating-of-the-distal-radius

Volar Plating for Dorsal Fractures

- Less tendon irritation than dorsal plating
- Indirect reduction
- Better tolerated than Ex fix

Capture of dorsal fragments enabled by locked screws or pegs

https://otaonline.org/video-library/45036/procedures-and-techniques/multimedia/16776647/dvr-plating

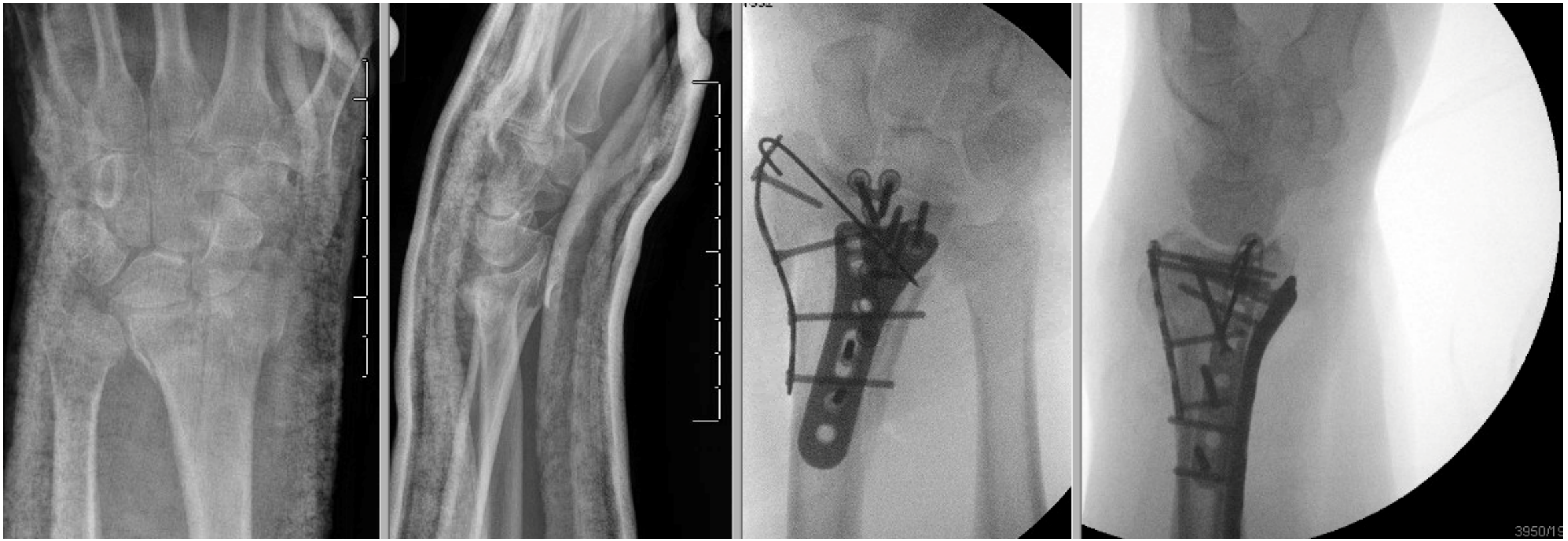
Dorsal Plating

- Select cases with specific dorsal fractures/instability
- Issues with tendon irritation and stiffness
  - Tendon rupture is possible complication

https://otaonline.org/video-library/45036/procedures-and-techniques/multimedia/18007831/dorsal-approach-for-dorsal-impaction-distal-radius

Credit: Jacqueline Geissler, MD

Fragment Specific and Focal systems

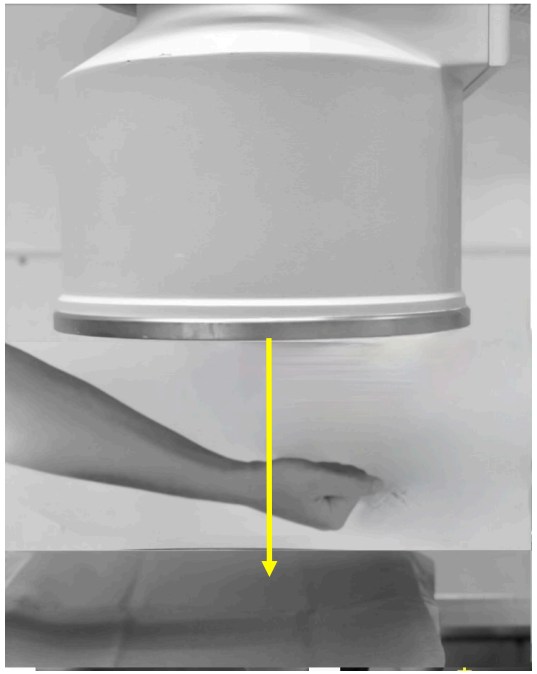


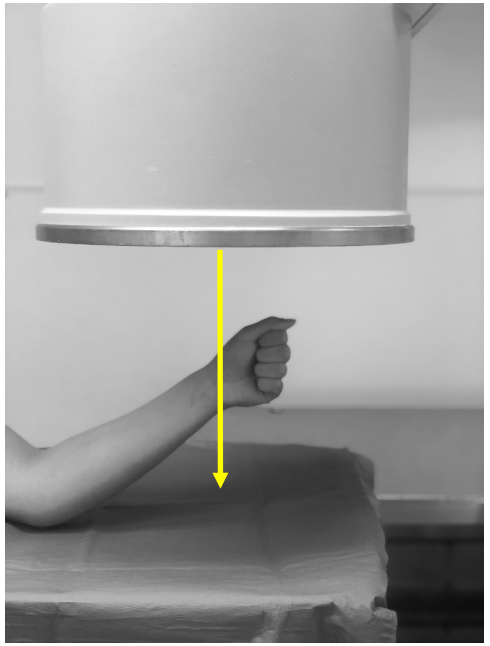
Credit: Jacqueline Geissler, MD

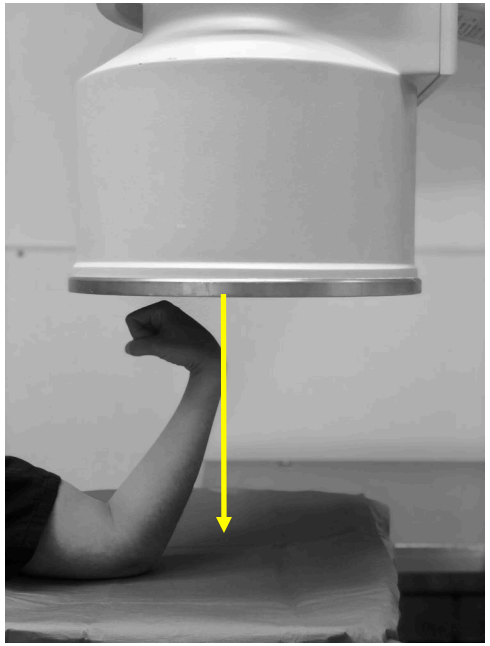
Fragment specific fixation via multiple incisions

Plating Pearls

- Check SL, DRUJ
- Xrays
  - AP xray with elbow elevated in relation to the wrist
  - Lateral xray with wrist elevated in relation to the elbow
  - Tangential notch view to assess screw tips
  - Semi-supinated for volar ulnar corner, semi-pronated for dorsal ulnar corner







Plating pitfalls

- Avoid plate proximal to watershed line
  - https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3828490/
- Unicortical screws distal, Bicortical proximal

Example of distal bicortical screws

Examples of plates distal to watershed line

Image courtesy of J Orbay MD

Based on Three Column Theory

Radial Column

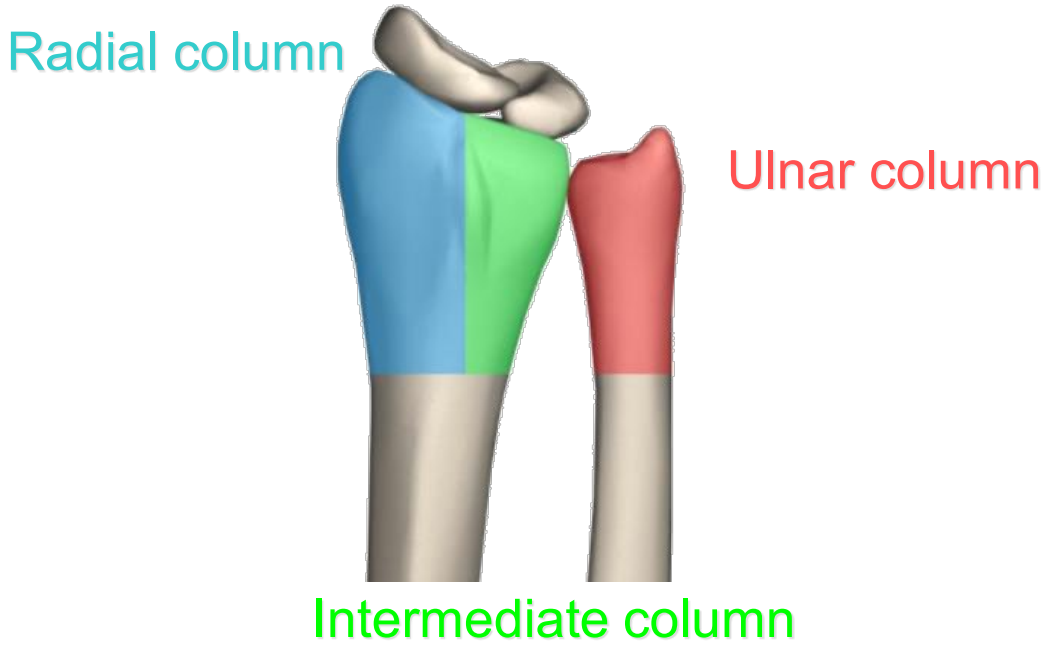
Lateral side of radius

Intermediate Column

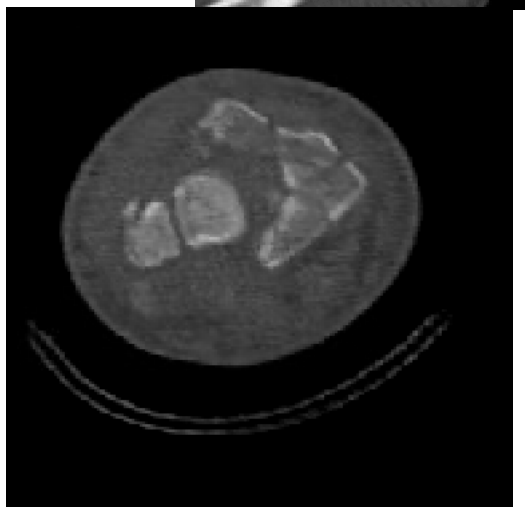
Ulnar side of radius

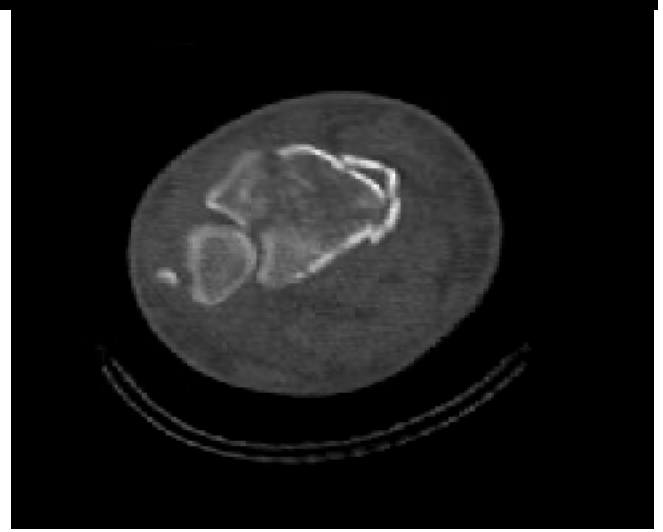
Ulnar Column

Distal ulna



Intra-articular Fracture





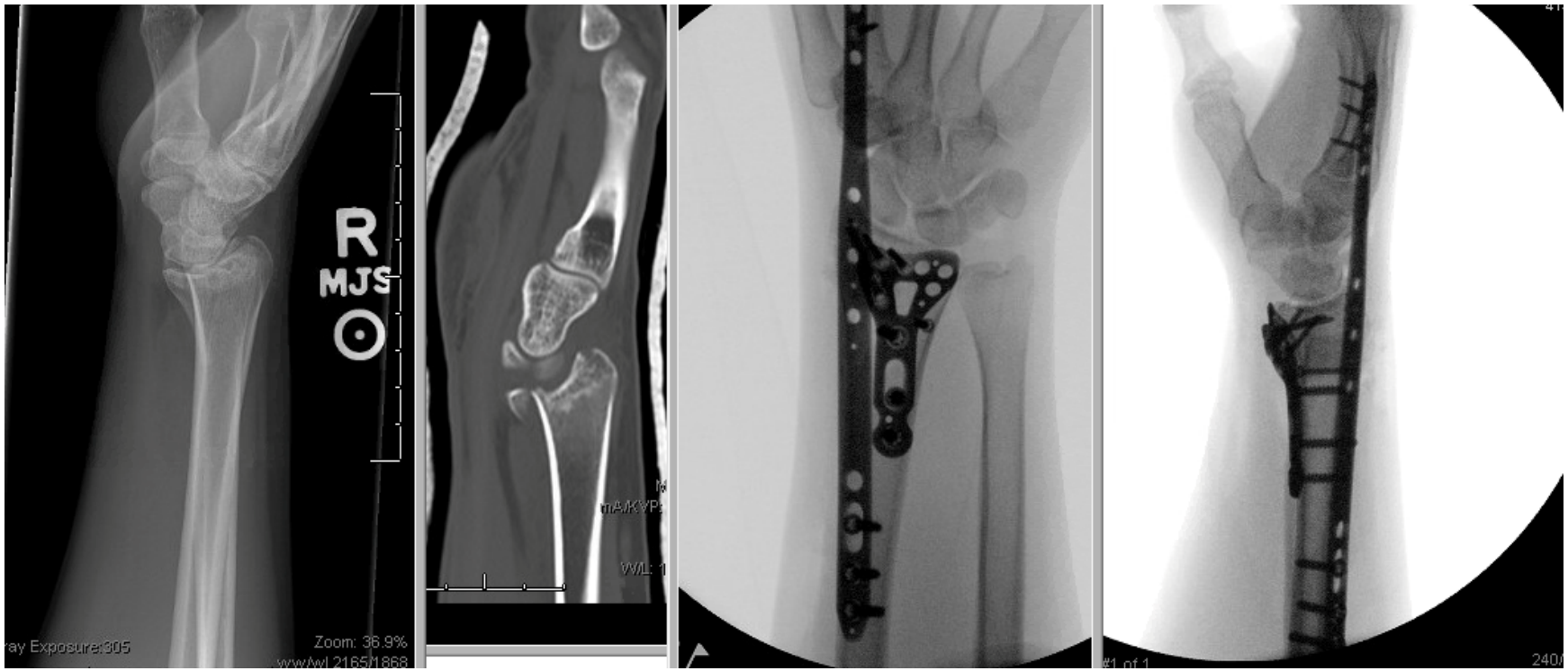
Multi-fragmentary intra-articular fracture

Focal plating

Combined dorsal and volar plating

- Reserved for very complex fractures
- Second operation for implant removal is common
- Increased risk of tendon rupture

Credit: Jacqueline Geissler, MD



- Volar Plate Position and Flexor Tendon Rupture Following Distal Radius Fracture Fixation. Author: Kitay A, Swanstrom M, Schreiber JJ, Carlson MG, Nguyen JT, Weiland AJ, Daluiski A J Hand Surg Am. 2013 Jun;38(6):1091-6.

Anchor Repair of Radiolunate Ligaments for: radiocarpal dislocation cases to restore stability

Credit: Jacqueline Geissler, MD

Kyle C. Bohm, Jacqueline A. Geissler, Christina M. Ward, Volar Radiocarpal Ligament Repair with Suture Anchors for Radiocarpal Fracture Dislocations: Case Series, J Wrist Surg , DOI: 10.1055/s-0040-1718915, Publication Date: 04 November 2020 (online)
https://www.thieme-connect.com/products/ejournals/abstract/10.1055/s-0040-1718915

Advanced Techniques
Arthroscopy-assisted

- Reduce articular incongruities
- Diagnose and treat associated soft tissue lesions
- Minimally invasive

Malunion of Distal Radius Fractures

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

Often leads to arthrosis

Diego L. Fernandez, Reconstructive Procedures for Malunion and Traumatic Arthritis, Orthopedic Clinics of North America, Volume 24, Issue 2,1993,Pages 341-363,ISSN 0030-5898,

https://doi.org/10.1016/S0030-5898(21)00022-5.

https://www.sciencedirect.com/science/article/pii/S0030589821000225

Malunion of Distal Radius Fractures

- Not a considerable issue in older patients >60y/o
    - Functional outcomes not significantly different

- The impact of patient activity level on wrist disability after distal radius malunion in older adults. Author: Nelson GN, Stepan JG, Osei DA, et al. J Orthop Trauma. 2015 Apr;29(4):195-200.
- A prospective randomized trial comparing nonoperative treatment with volar locking plate fixation for displaced and unstable distal radial fractures in patients sixty-five years of age and older. Author: Arora R, Lutz M, Deml C, et al. J Bone Joint Surg Am. 2011 Dec 7;93(23):2146-53.

- May require osteotomy and revision fixation (younger patients)
- Plating depending on malunion
    - +/- bone graft

Nonunion of Distal Radius Fractures

- Rare
- Internal Factors
    - Poor reduction or fixation
- External Factors
    - Nutrition
    - Patient compliance

- Prommersberger, Karl-Josef MD*; Fernandez, Diego L MD† Nonunion of Distal Radius Fractures, Clinical Orthopaedics and Related Research: February 2004 - Volume 419 - Issue - p 51-56

Smoking

- Important part of the patient history
- Best if patients can quit smoking
- Low intensity ultrasound (bone stim) can accelerate healing in smokers

- Acceleration of Tibia and Distal Radius Fracture Healing in Patients Who Smoke Author: Stephen D. Cook, PhD*; John P. Ryaby**; Joan McCabe, RN**; John J. Frey, PhD; James D. Heckman, MD; and Thomas K. Kristiansen, MD Journal: CORR Volume: No. 337, pp 198-207, 1997

Specific complications of distal radius fracture ORIF

- Tendon rupture
    - Extensor or flexor, most common EPL or FPL
    - Screw tips or volar plate within 3mm of articular surface
- Nerve injury
    - Median or superficial radial
- CRPS/RSD
- Vitamin C may not be of benefit, though still AAOS guideline

Özkan, Sezai MD; Teunis, Teun MD, PhD; Ring, David C. MD, PhD; Chen, Neal C. MD What Is the Effect of Vitamin C on Finger Stiffness After Distal Radius Fracture? A Double-blind, Placebo-controlled Randomized Trial, Clinical Orthopaedics and Related Research: October 2019 - Volume 477 - Issue 10 - p 2278-2286 doi: 10.1097/CORR.0000000000000807

Conclusions

Many options for treatment of distal radius fractures

Patient factors must be included when considering treatment options

Important to maintain proficiency with and understand all of them as many have specific applications

Continuously evolving

Conclusions

Plating techniques allow for more accurate and rigid fixation of fragments with more reliable outcomes.

Plating allows for early wrist ROM

Volar, smaller and more anatomic plates are better tolerated

Combination treatment and wrist spanning options can be useful in specific instances.

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