Operative Techniques for Scaphoid Fractures

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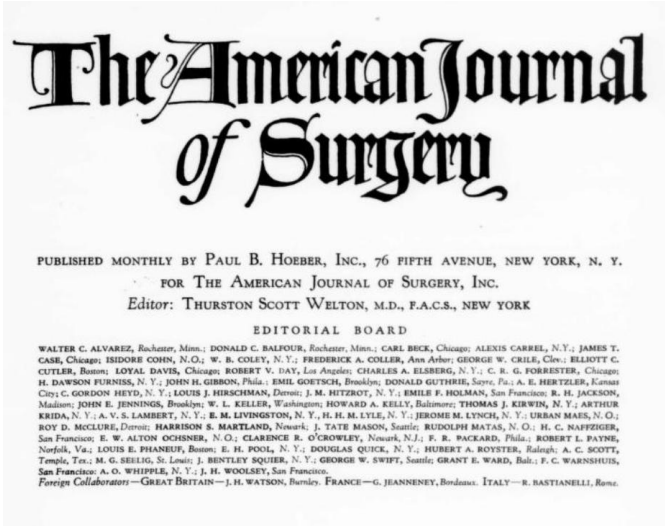
Scaphoid Fxs are trouble

- Gaining notoriety for troublesome healing
- Edward Cravener and Donald McElroy, in their 1939 article *Fractures of the Carpal (Navicular) Scaphoid* tried to clarify factors contributing to the scaphoid nonunion.
- Based their system on age and location.
- "In discussing scaphoid fractures, we must first arrive on a common ground. Is the fracture through the tuberosity, the waist, or the body? If it is through the tuberosity we can practically neglect it, for it will heal. If it is through the body it will not heal easily"- E.K Cravener



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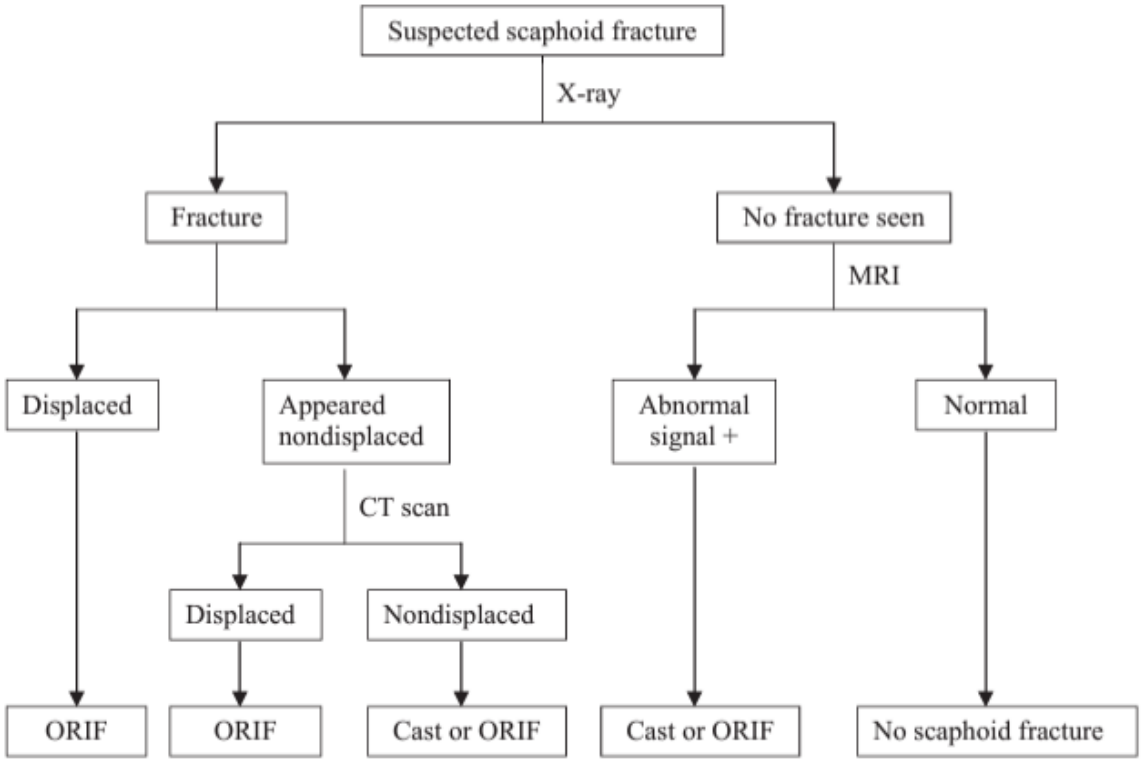


FIGURE 1: Algorithm for suspected scaphoid fracture management. ORIF, open reduction internal fixation.

Summary- Scaphoid Fxs- Techniques

- Make the DX
- Treat with cast for nondisplaced fxs waist/ distal pole
- Treat with dorsal limited open screw fixation for stable fx and for all prox pole fxs
- Treat late fxs (nonunion) or those with volar comminution and humpback flexion deformity with volar approach
- Correct deformity and get volar radial BG to support volar cort defect
- Get guide wire down central axis
- Screw length should be 2 mm shorter than measured

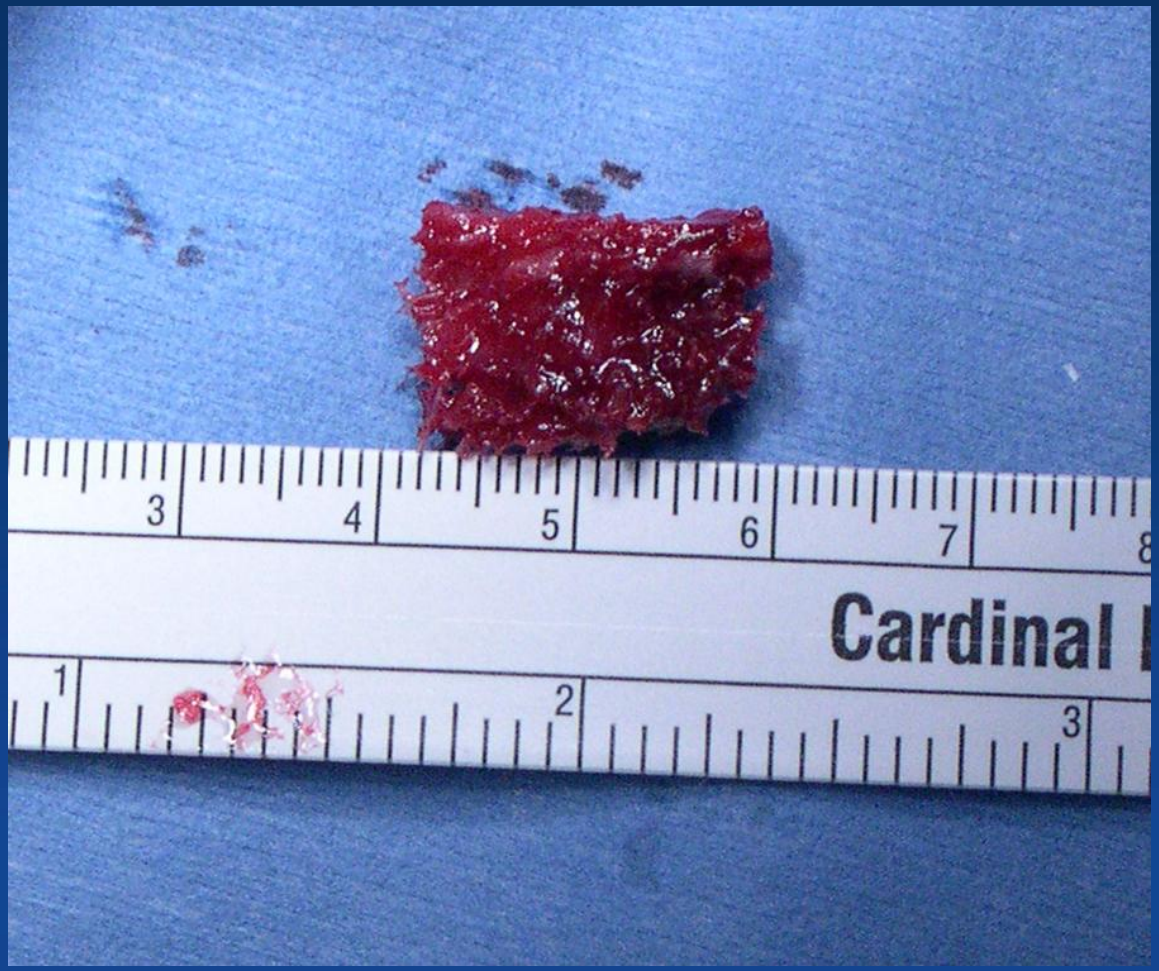
Scaphoid Fractures : My opinions

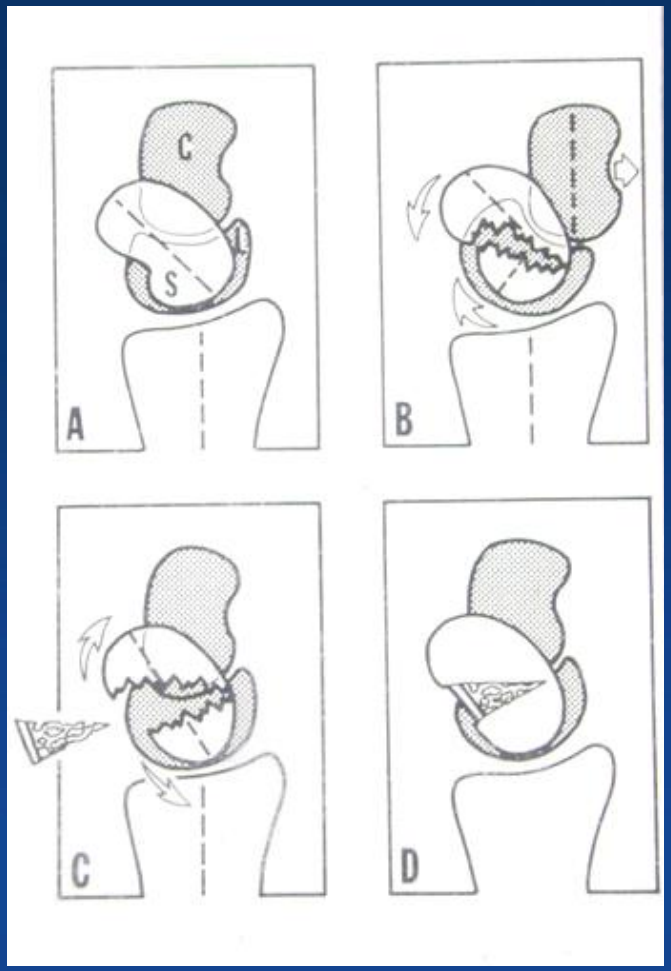
- Firstly any scaphoid fracture that can be seen with an x-ray alone is probably displaced at least 1-2 mm
- Truly nondisplaced fractures need CT or MR diagnosis to confirm
- Distal pole fractures do well and rarely need surgery
- Proximal pole fractures are difficult and require fixation
- Most common waist fractures usually treated with surgery but can be treated with prolonged casting to a good result
- 2 approaches: dorsal and volar both need to mastered
- Percutaneous techniques good for fresh fxs minimal displacement

Reductions- How to

- Minimally displaced fxs just push up on distal pole
- More displaced fractures use K wires as joy sticks
- Assess reduction with fluoroscopy
- If you are an arthroscopist you can fine tune reduction through arthroscopic assist via mid carpal portal
- Rare to need bone graft in acute injury
- Occasionally cortical wedge graft if very comminuted and high energy with volar bone deficit
- I use autogenous cortical cancellous graft from volar distal radius

Radius BG - Cortico-cancellous compression tolerant- supports headless screw



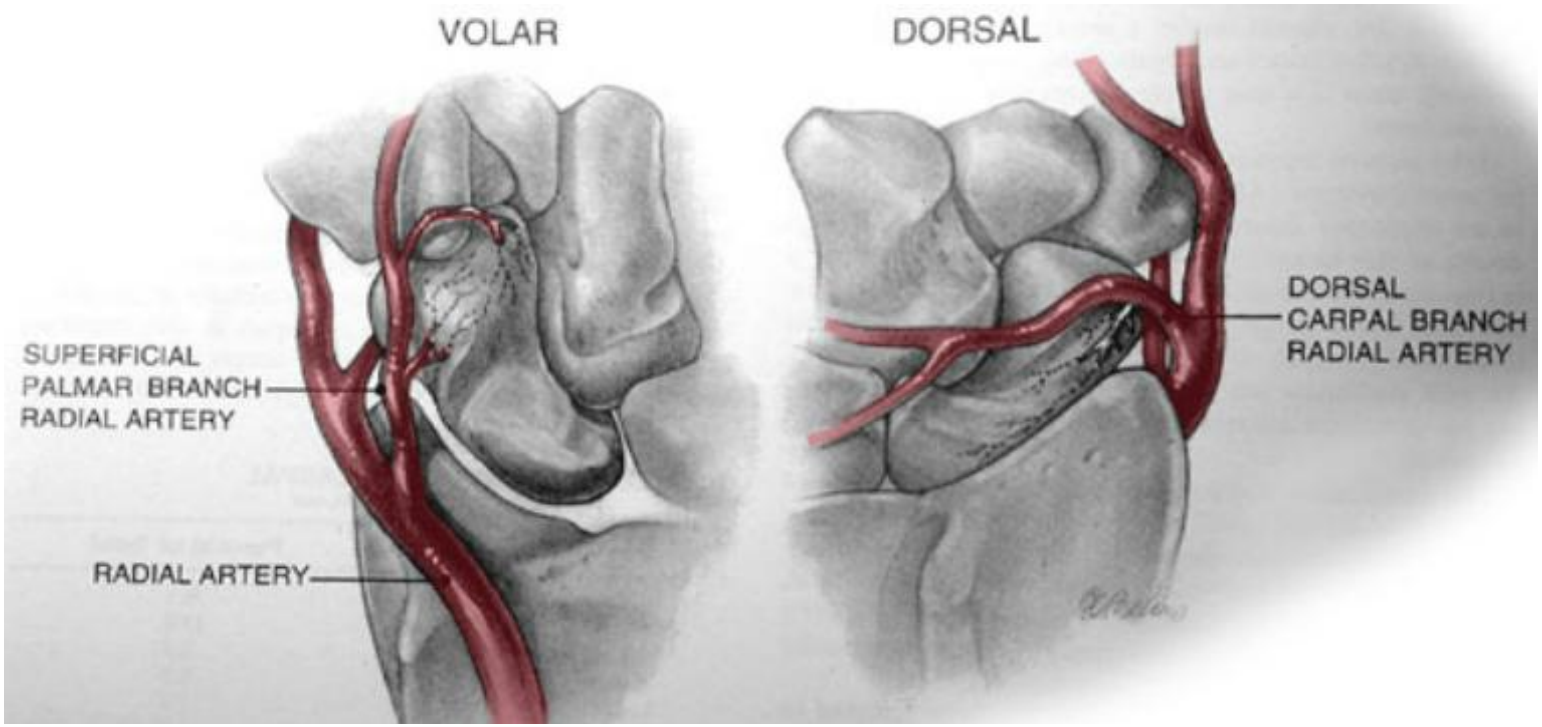


Volar approach

- Good for acute and delayed fracture treatment
- Can correct humpback deformity secondary to comminution of volar cortex
- It preserves blood supply to scaphoid which is dorsal and distal
- Must hyperextend wrist to access the distal pole screw entry point
- Rarely is it necessary to do partial trapeziectomy to get access to central axis of scaphoid
- Partial release of the scaphotrapezial ligament improves access for screw axis
- Still hard to get central axis in scaphoid for guide wire

Vascular Supply- Dorsal/Distal

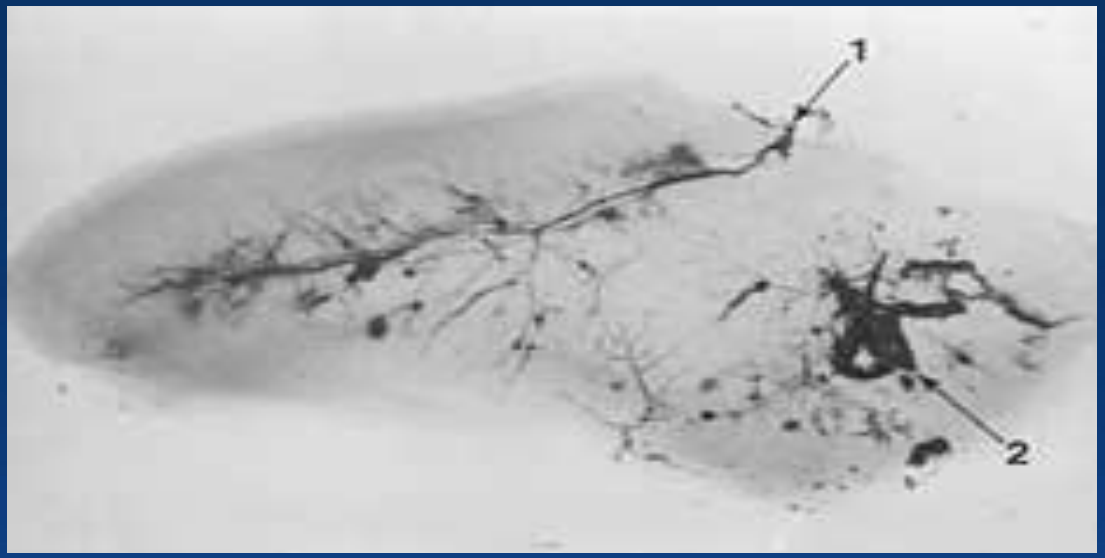
- Major blood supply to the scaphoid is the dorsal carpal branch (branch of the radial artery).



Vascular Anatomy

Dorsal

Proximal



Distal

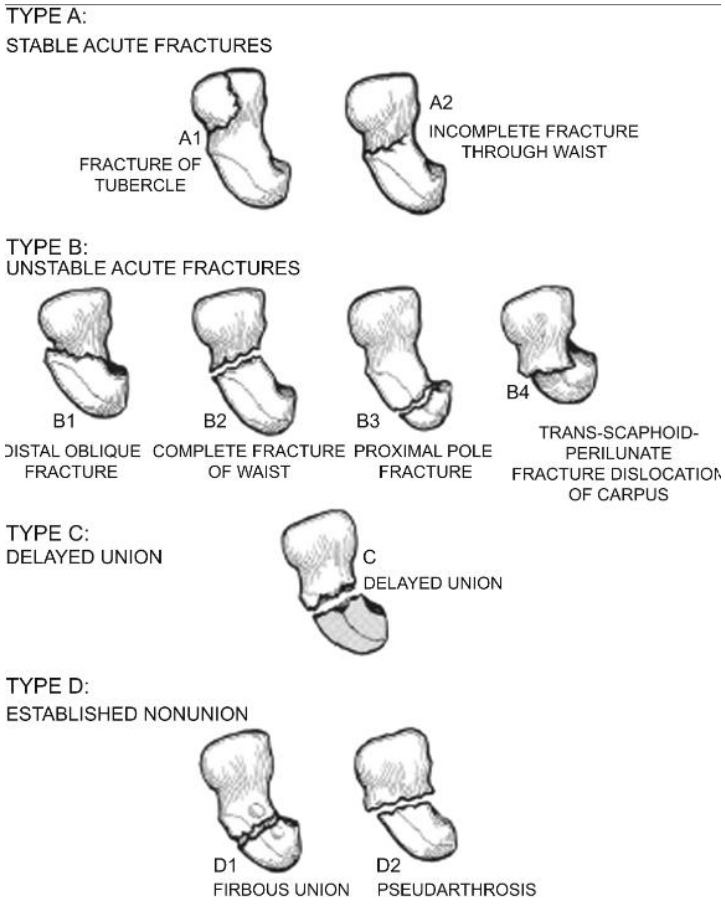
Volar

- Volar artery (branch of superficial palmar)
  - supplies remainder and distal pole
  - No anastomosis between dorsal and palmar vessels

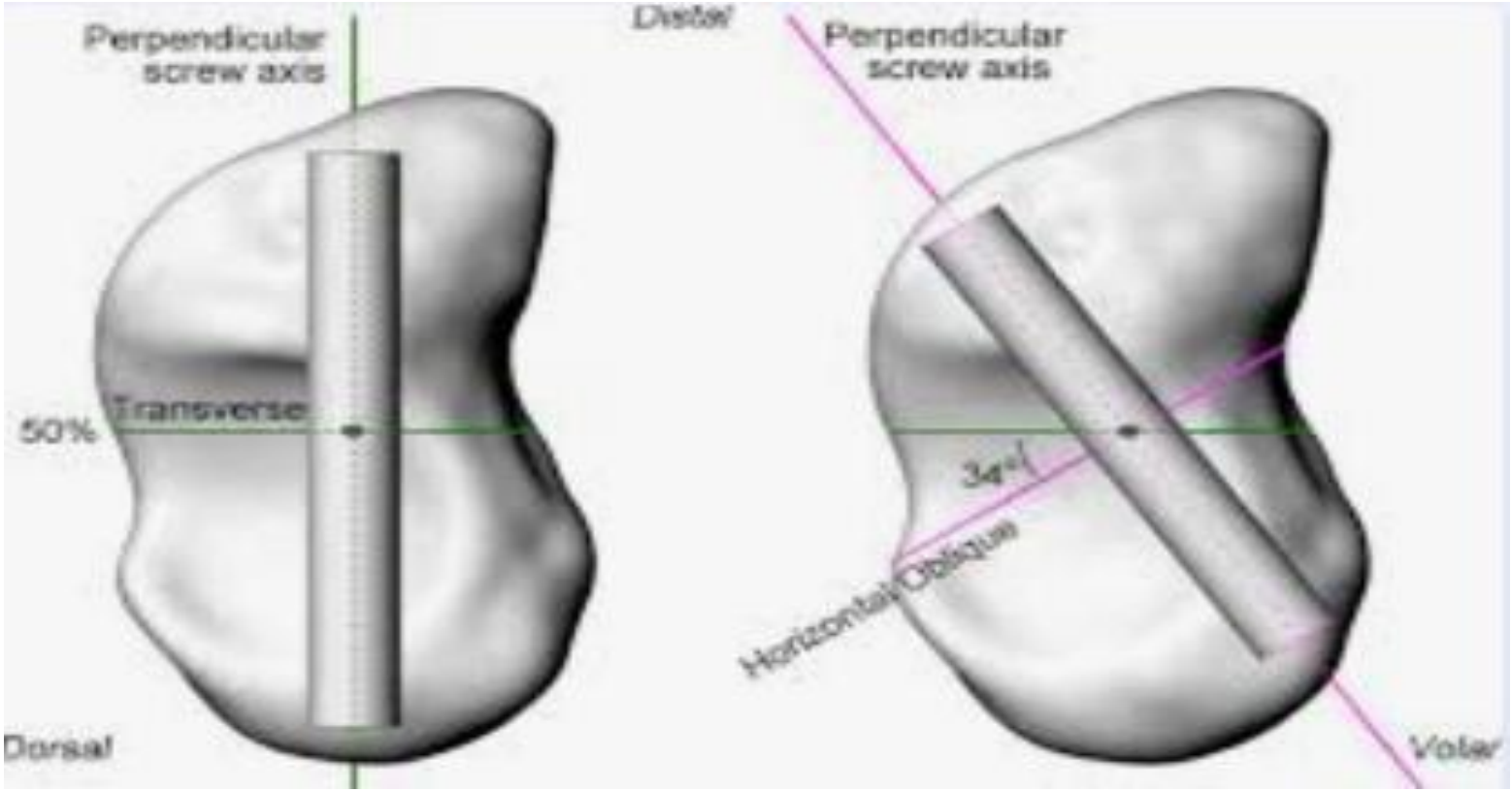
Gelberman RH. Menon J. *The Vascularity of the Scaphoid Bone.* Journal of Hand Surgery. 5(5):508-13, 1980 Sept.

Herbert and Fisher Classification

- Fracture patterns demonstrate the fracture line orientation
- This is important if you want to get your screw axis as close to perpendicular as possible



Central Axis for screw may not be optimal for all fx patterns



Diagnosis of Occult Scaphoid Fractures

A Cost-Effectiveness Analysis

John W. Karl, MD, MPH, Eric Swart, MD, and Robert J. Strauch, MD

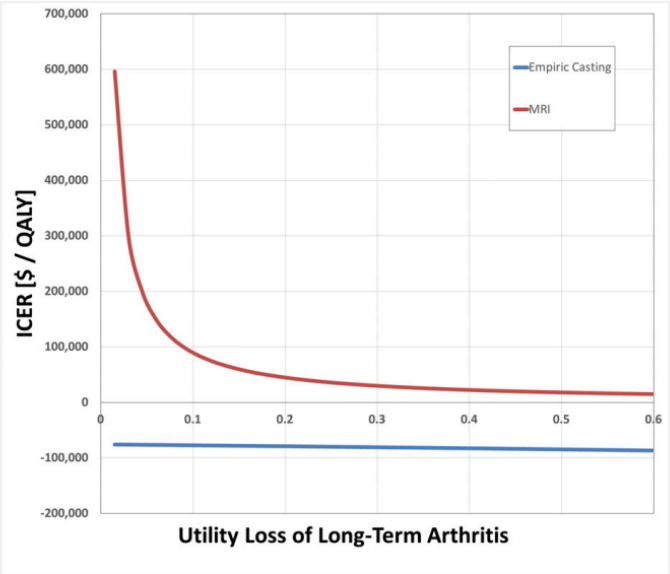
Investigation performed at the Columbia University Medical Center, New York, NY

- Study by Dr. Strauch published in JBJS 2015 compared cast immobilization and repeat radiographs at 2 weeks, immediate CT scan and immediate MRI for occult scaphoid fractures.
- Also evaluated the costs of lost worker productivity and surgical costs of nonunion surgery.

TABLE IV Relative Costs and Clinical Effectiveness of Different Strategies*

Strategy	Cost per Case	Effectiveness *(QALY)*
Immediate CT	$411	54.9968
Immediate MRI	$526	54.9995
Empiric cast immobilization	$1227	54.9907

*The incremental cost-effectiveness for immediate CT relative to immediate MRI was $42,574/QALY and immediate imaging was dominant over empiric cast mobilization.



- What Dr. Strauch found is that advanced imaging for suspected scaphoid fractures in the setting of negative radiographs represents a cost-effective strategy.
- Advanced imaging would have to increase in cost to more than $2000 or decrease in sensitivity to <25% for CT or <32% for MRI, for empiric cast immobilization to be cost-effective.

How do you know

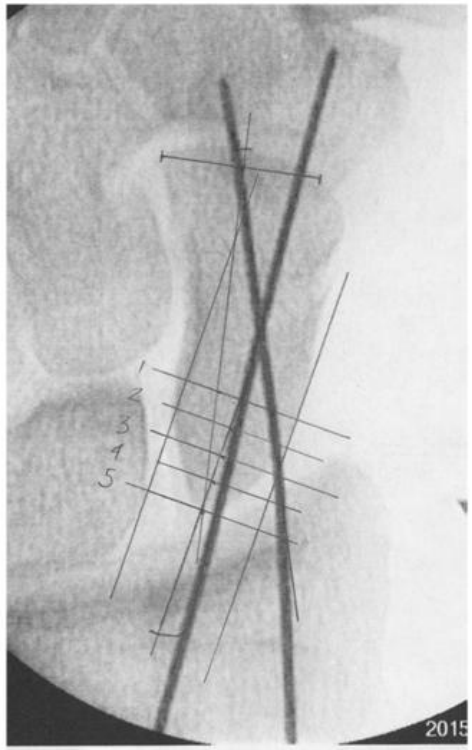
Results

•K-wires placed down the scaphoid "barrel" aiming at the center of the distal articular "circle" were an average of 81% off the center of the proximal pole in the coronal plane

•These k-wires aimed down the "barrel" usually missed the most proximal pole entirely

•K-wires aimed radially were an average of 25% off the center of the proximal pole in the coronal plane.

Figure 3. *Fluoroscopic AP view of scaphoid showing grid system used to determine relative placement of k-wires to the center of the proximal pole.*



Hitting the C… A…

Jason M. McKean[1] MD, F…

[1]Trauma… Colur…

Introduction

Proximal pole scaphoid fractures frequently require surgical fixation due to risk of nonunion and avascular necrosis. Percutaneous screw fixation preserves important ligaments and tenuous blood supply, and has been shown to improve outcome. Biomechanical studies have shown that screws placed centrally through the scaphoid provide stronger, more secure fixation. To best achieve central percutaneous pin placement through the proximal pole via a dorsal approach we hypothesize that it is better to fluoroscopically aim at the radial corner of the distal scaphoid instead of down the central anatomic "barrel" of the scaphoid. **1, 2**

Materials and Methods

•5 fresh frozen cadaveric specimens were used.
•Wrists were placed on mini c-arm receiver, ulnarly deviated to superimpose the proximal and distal ends of the scapoid on the "y" axis and then flexed to view scaphoid as a "barrel".
•Two 0.035 K-wires were dorsally placed percutaneously through a guide: one down the "barrel" aiming at the center of the distal pole, and one after pronating the wrist to superimpose the radial corner of the scapoid over the center of the "barrel".
•Radiographic markers were used to calculate distances on the images and the distance of each k-wire from the center of the proximal pole in the coronal and sagittal planes.

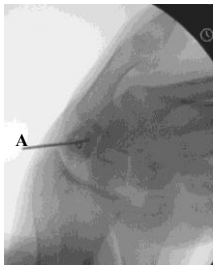


Figure 1. *Fluoroscopic view of wrist flexed and pronated after placement of first k-wire (A) down the "barrel". The small circle is formed from large guage needle used as a k-wire guide.*

Figure 2. *(A… rotating rad… center of th…*

•K-wires p… "circle" we…

•These k-… missed th… most proximal pole entirely

•K-wi…s aimed radially were an average of 25% off th… center of the proximal pole in the coronal pla…e.

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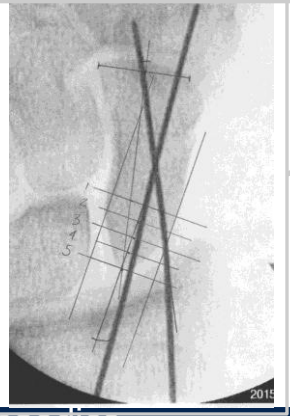
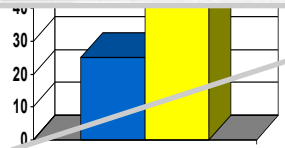




Percentage off Center

Graph 1. *Aiming for the radial corner of the scaphoid achieved more central placement (25% off from center) in the proximal pole versus aiming down the "barrel" (81% off from center).*

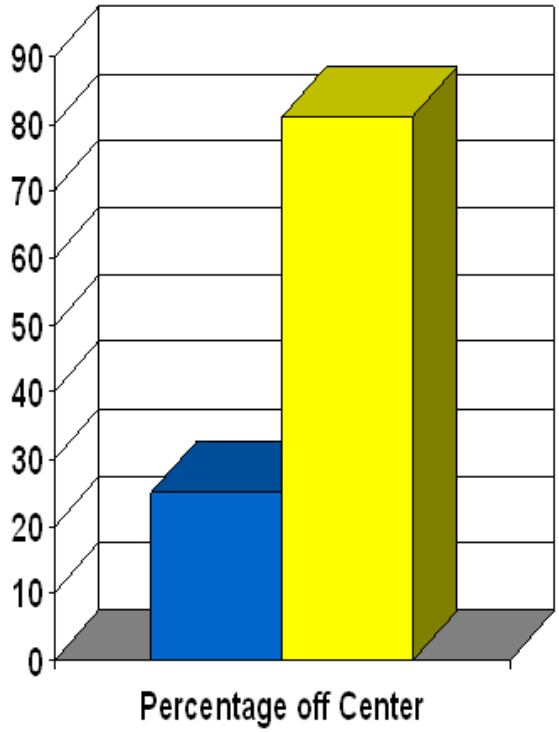
References

1. Bond CD, Shin AY, McBride MT, Dao KD Percutaneous screw fixation or cast immobilization for nondisplaced scaphoid fractures. J Bone Joint Surg Am 83A:483-488, 2001.
2. McCallister WV, Knight J, Kaliappan R, Trumble TE. Central placement of the screw in simulated fractures of the scaphoid waist: a biomechanical study. J Bone Joint Surg Am 85:72-77, 2003.

Discussion

• While using a dorsal approach, a more central pin placement in the scaphoid proximal pole will be achieved by aiming at the radial corner of the distal scaphoid instead of at the center of the distal articular surface when viewing the flexed scaphoid as a barrel.

• Pronation of the wrist plays an essential role in positioning the scaphoid for central placement of k-wire, and ultimately screw, in the proximal pole of the scaphoid.



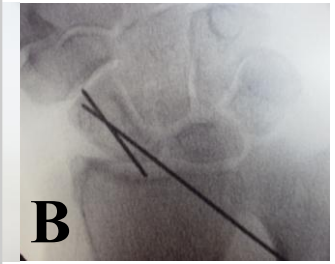
Graph 1. *Aiming for the radial corner of the scaphoid achieved more central placement (25% off from center) in the proximal pole versus aiming down the "barrel" (81% off from center).*

re the guide wire is?

roximal Scaphoid Pole:
nsiderations

P. Rosenwasser[1] MD, Robert Strauch[1] MD

ment of Orthopaedic Surgery,
Center New York, NY, USA



the "barrel" of the flexed scaphoid without
*(**B**) Short K-wire centrally placed misses the*
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25%
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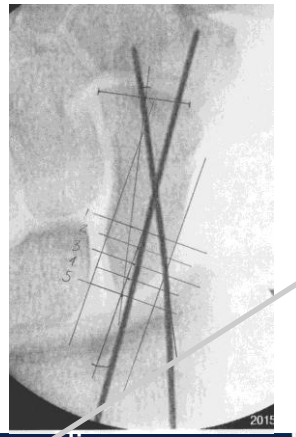

nopaedics

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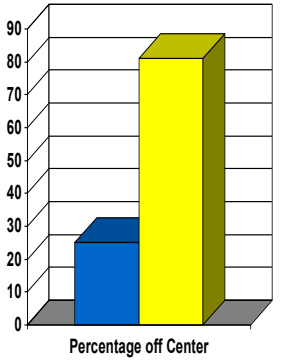

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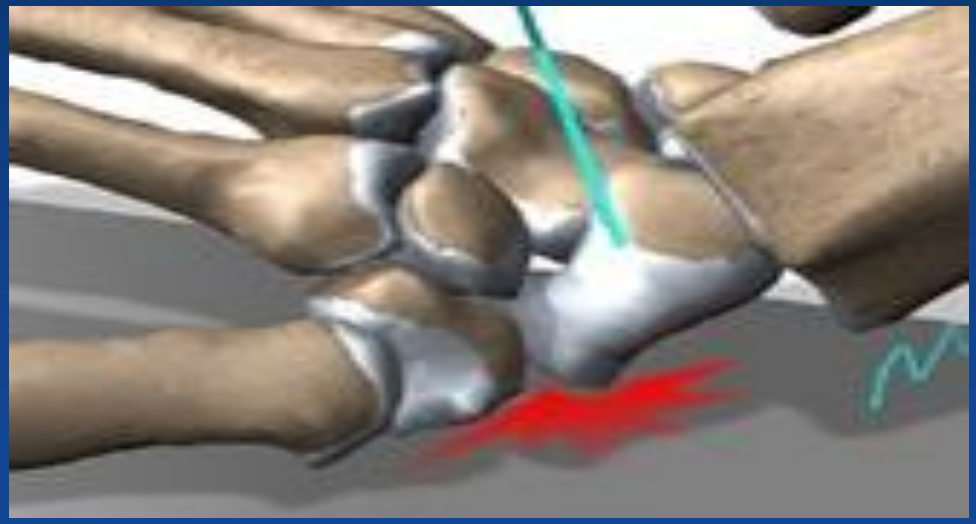
Null Hypothesis in Force for radio-carpal wrist pain

- Pain over scaphoid either dorsal, volar, snuff box
- All wrist pain S/P fall a fx until proven otherwise

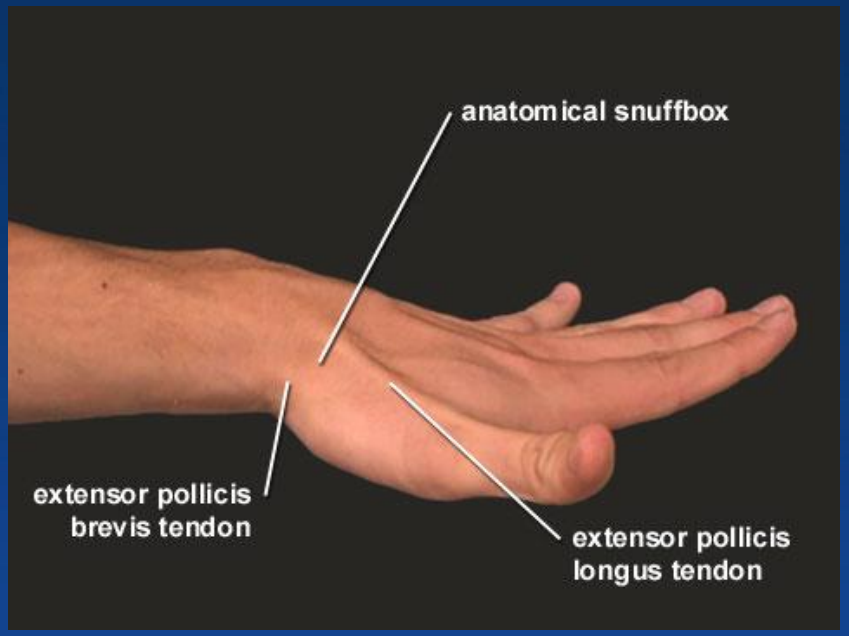


COMBINING THE CLINICAL SIGNS IMPROVES DIAGNOSIS OF SCAPHOID FRACTURES

A prospective study with follow-up

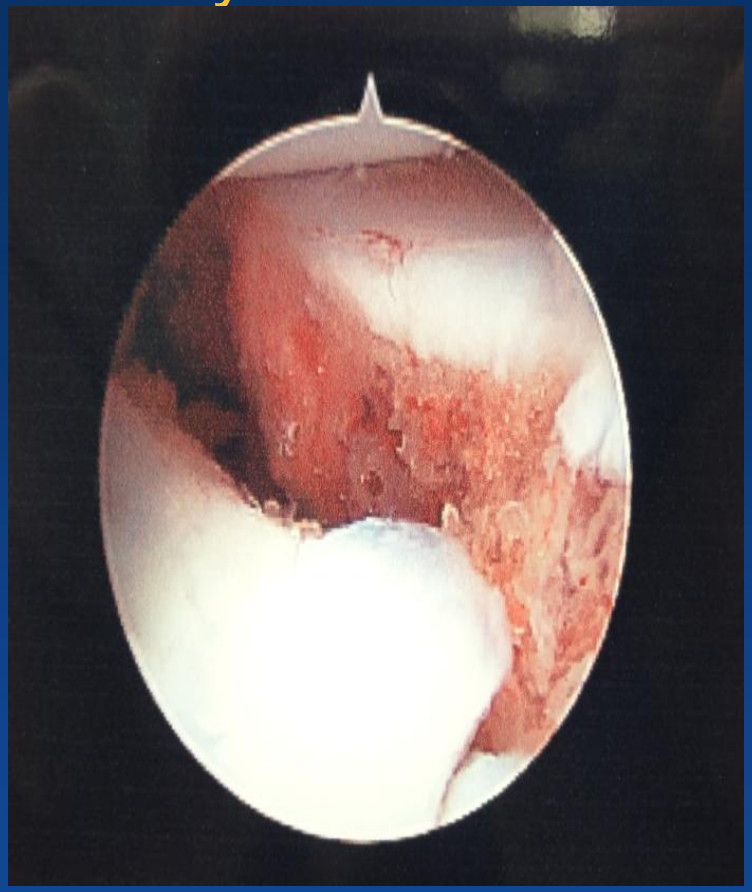
J. PARVIZI, J. WAYMAN, P. KELLY and C. G. MORAN

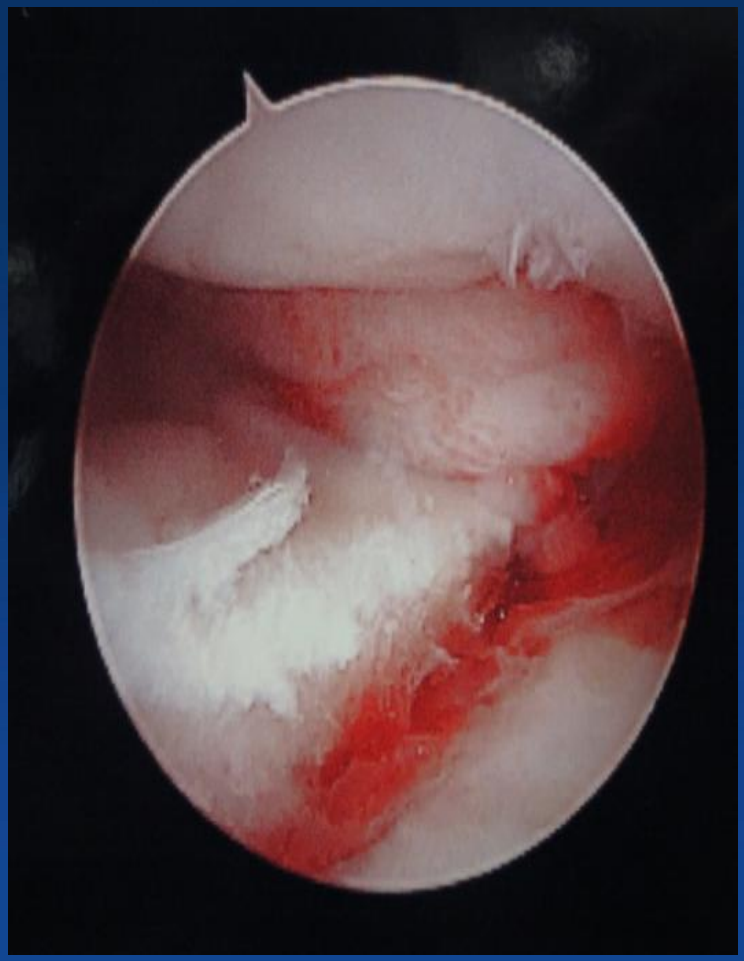
- Snuff Box Tenderness
  - 100% sensitive, 9% specific
- Scaphoid Tubercle Tenderness
  - 100% sensitive, 30% specific
- Axial Compression of the Thumb
  - 100% sensitive, 48% specific
- Used in Combination
  - 74% specific



JHS Br 1998

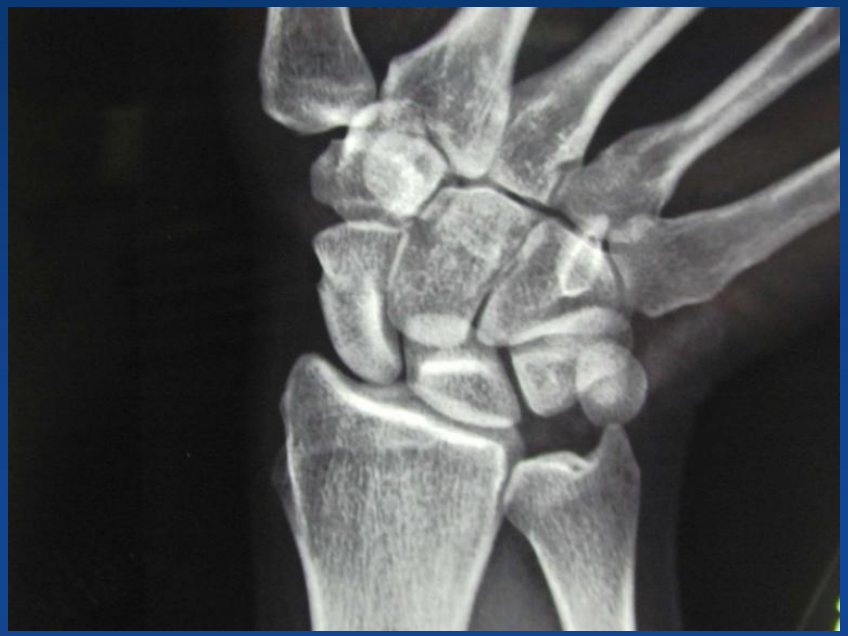
Mid Carpal arthroscopy
This is a displaced fracture and may not be seen on initial xray

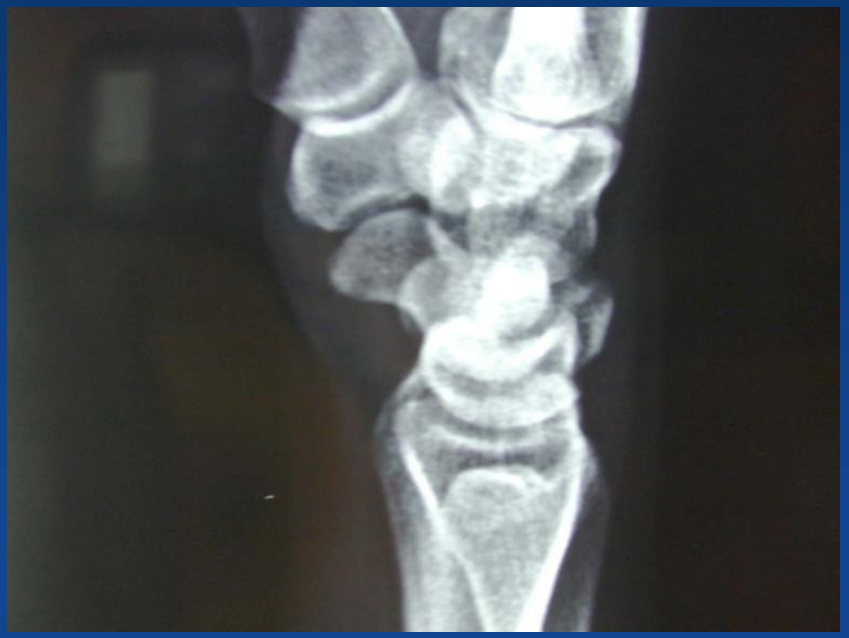




X Rays

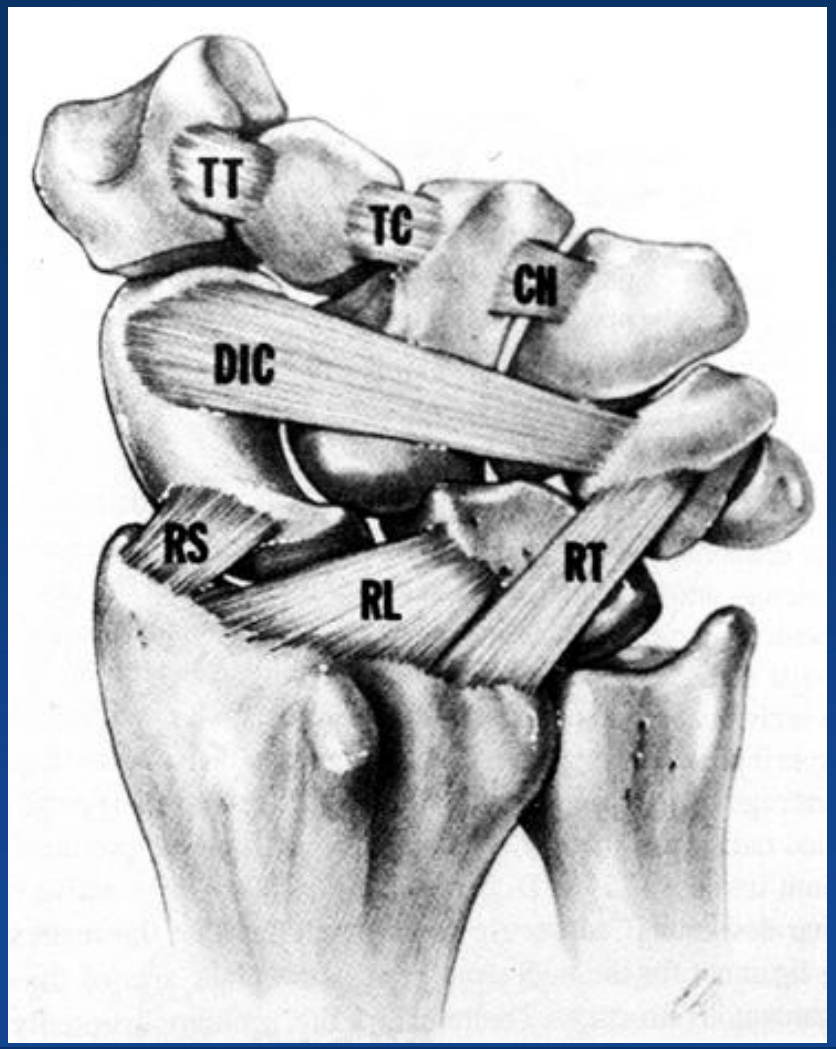
- PA with wrist in neutral
- True Lateral
- 45° Pronation and Supination
- **Scaphoid view (ulnar deviation) brings fx in horizontal plane**



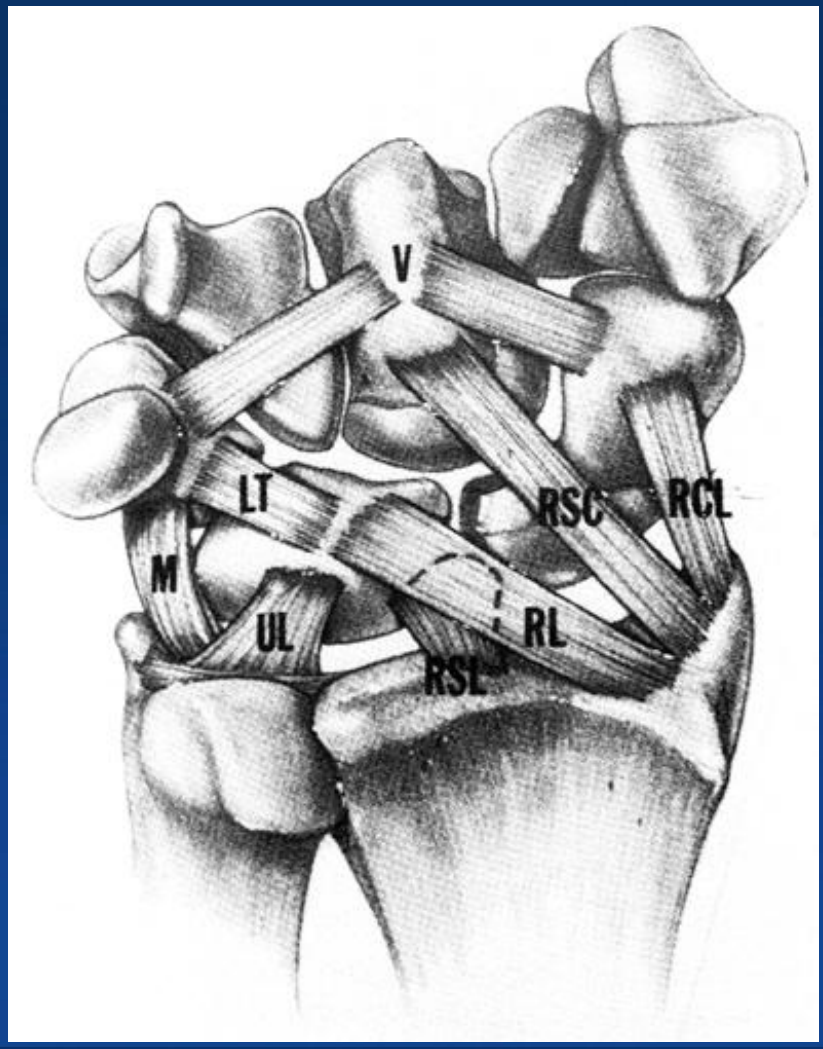


Approaches should protect ligaments- Splitting

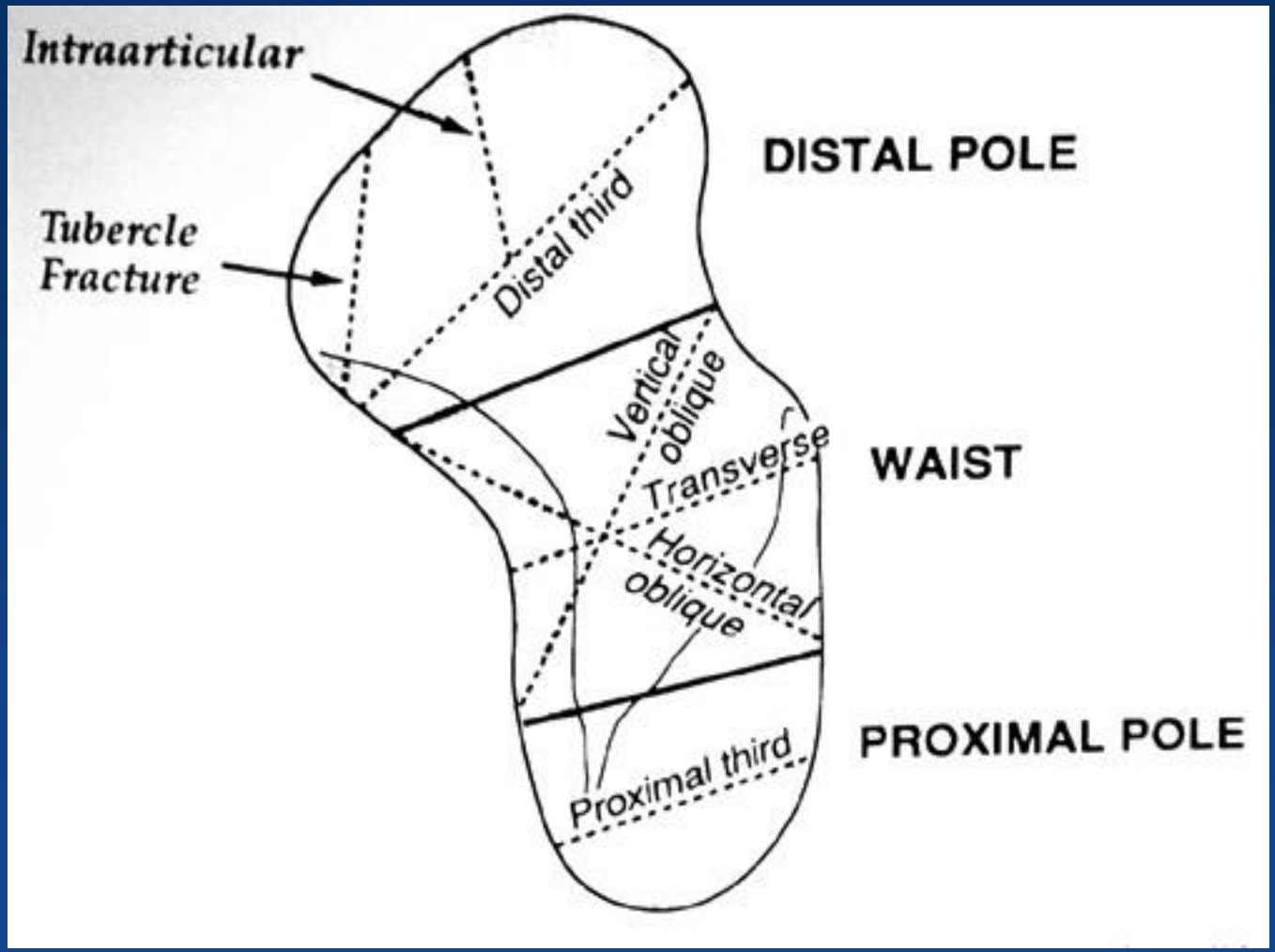
Dorsal



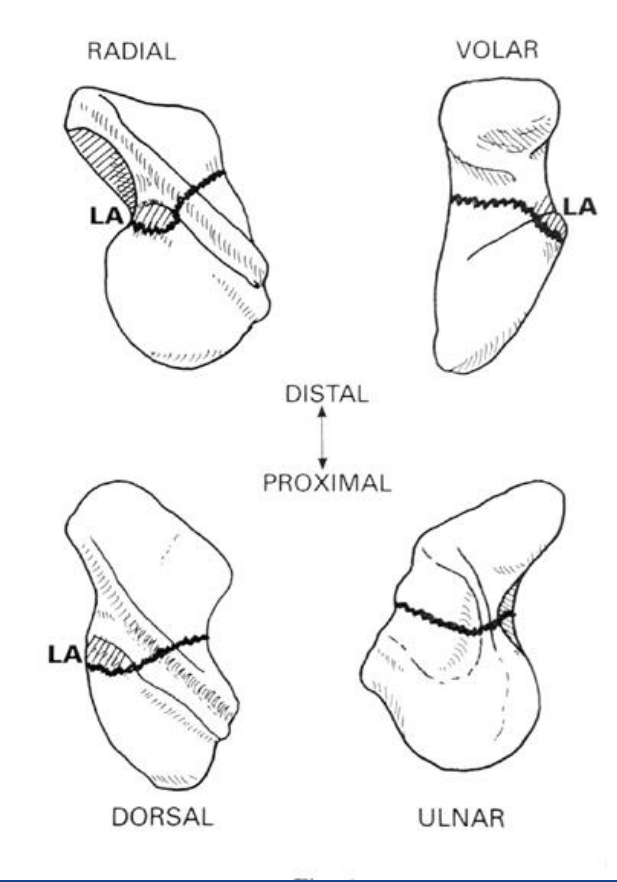
Volar

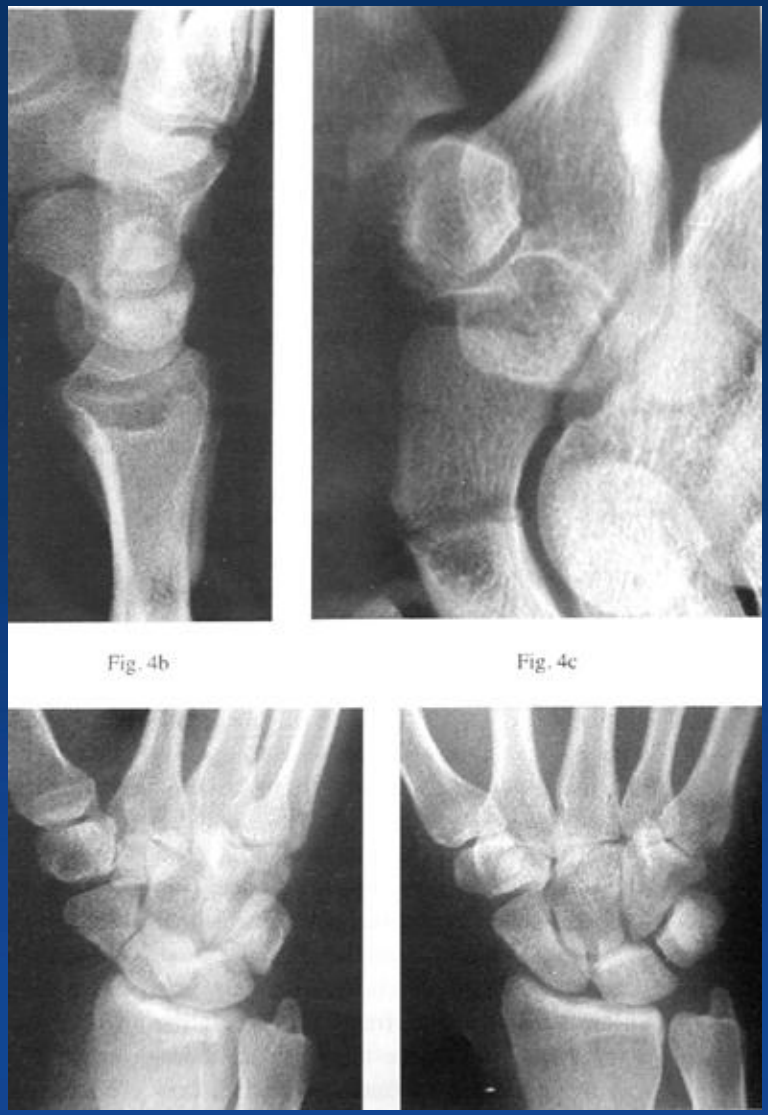


Fracture Patterns

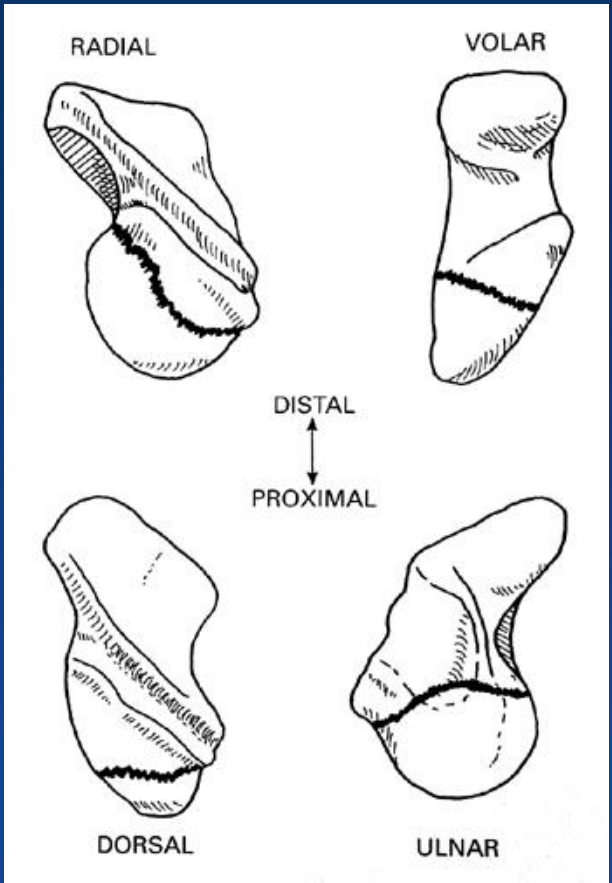


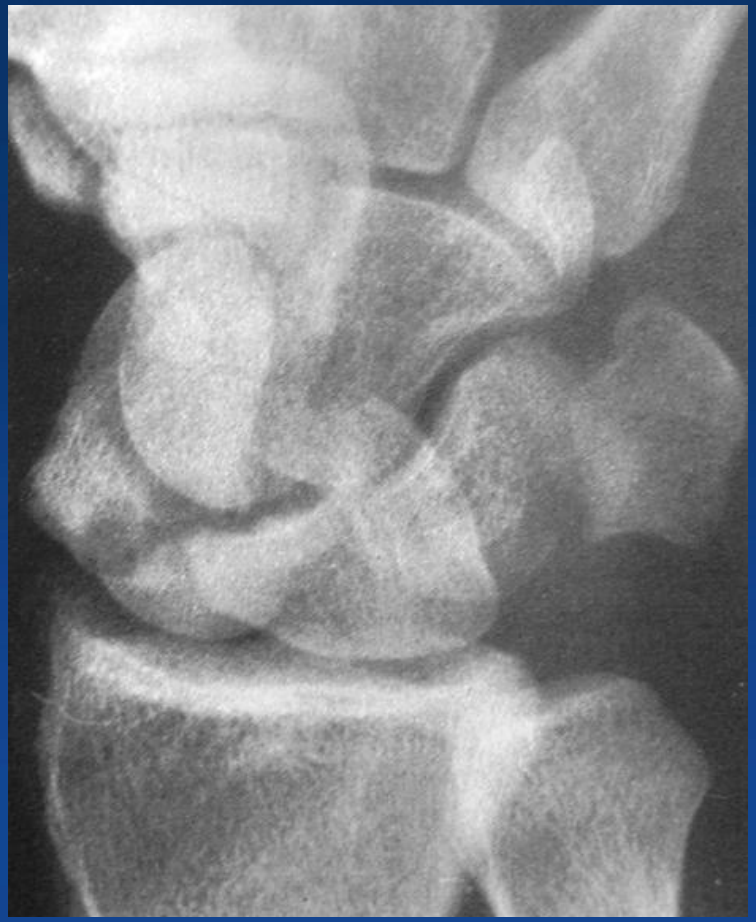
Waist Fxs
good
prognosis with RX

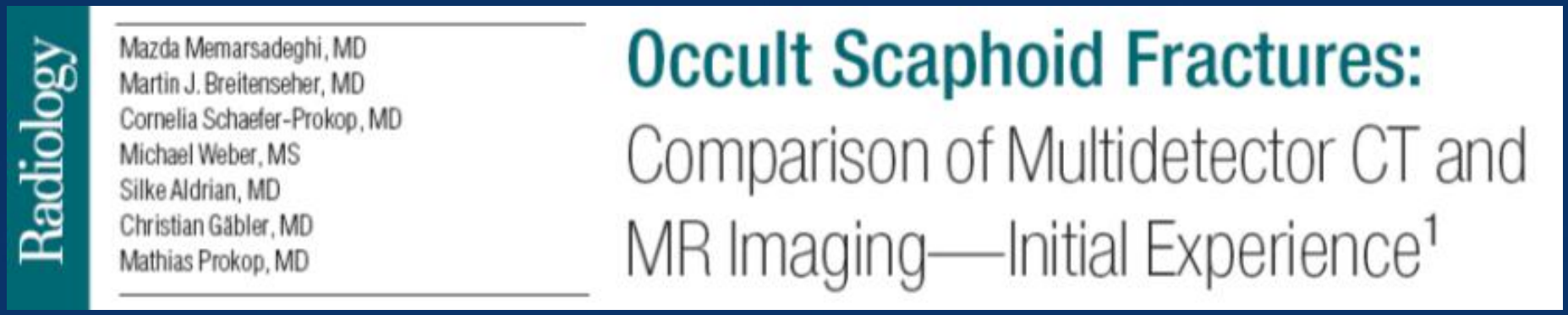




Prox pole fx worse prognosis



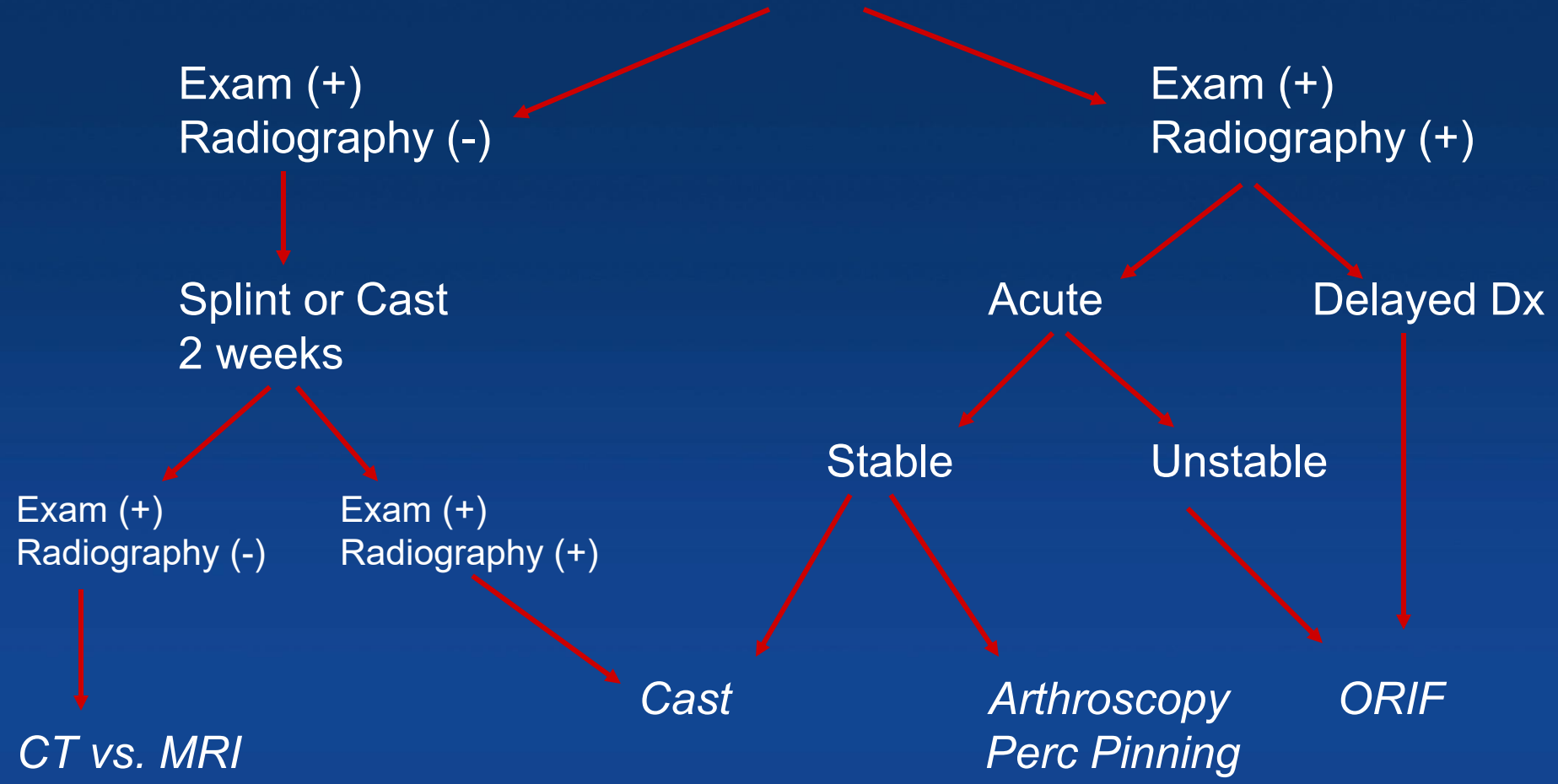




- 29 patients underwent CT and MRI within 6 days after trauma
  - 2 radiologists analyzed the CT and MRI images
- CT identified all 'cortical' fx but failed to show some 'trabecular' fx
- MRI picked up all fractures but did not distinguish 'cortical' from 'trabecular' fx
- Trabecular fx within substance of scaphoid – bone bruise but stable

Radiology 2006

Suspected Scaphoid Injury- Clinical guidelines



Should Acute Scaphoid Fractures Be Fixed?

A Randomized Controlled Trial

By J.J. Dias, MD, FRCS, C.J. Wildin, FRCS(Orth), B. Bhowal, FRCS(Orth), and J.R. Thompson, PhD

Investigation performed at the Department of Orthopaedic Surgery, Leicester Royal Infirmary, University Hospitals of Leicester, Leicester, United Kingdom

- 88 patients, prospective randomized controlled – UK
  - All types of scaphoid fractures
- Herbert Screw vs. Short arm cast
- Grip Strength, Range of Motion, Union, Pain, Disability
- Up to 1 year

JBJS 2006

Should Acute Scaphoid Fractures Be Fixed?

A Randomized Controlled Trial

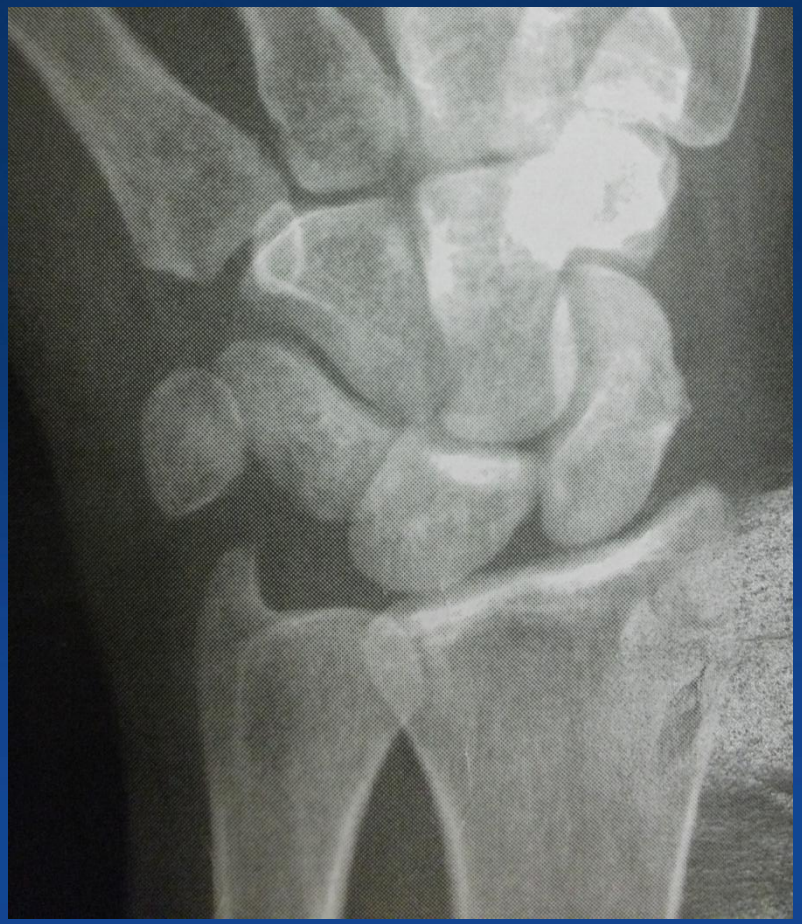
- All measures same except increased ROM and strength at 8 and 12 wks for operative group
- No difference in return to work
- 77% nonoperative healed in 12 weeks, if not to OR for ORIF
- 13 complications in operative (all minor)

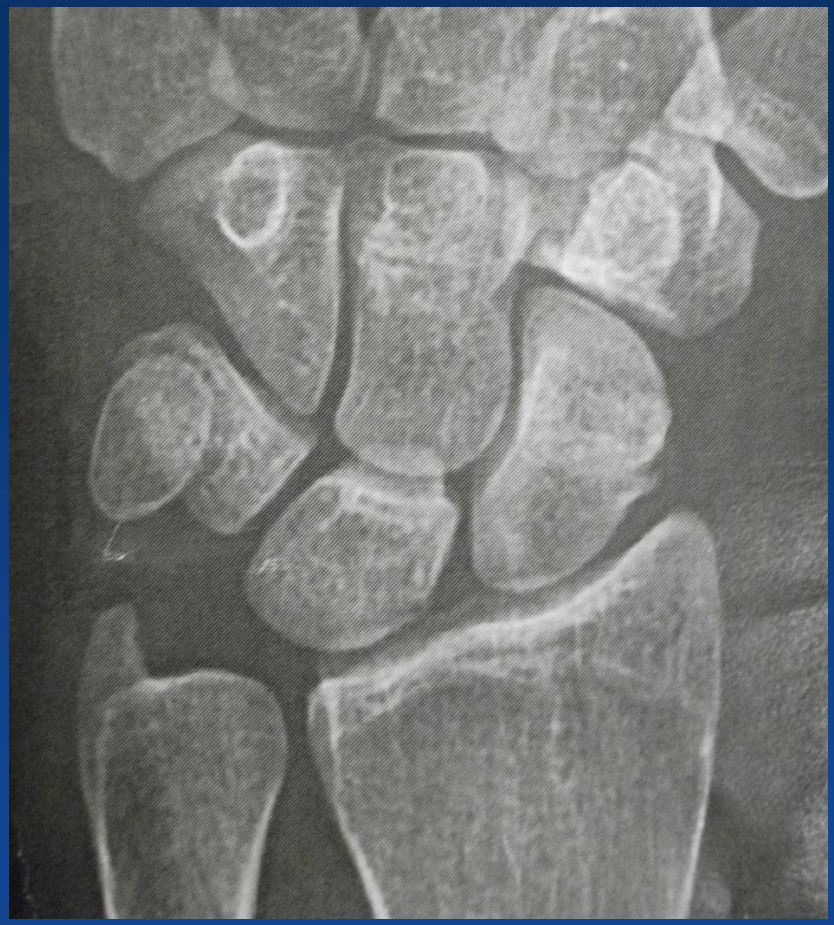
Author's conclusion: Nonoperative treatment unless cannot tolerate 8 weeks of cast

JBJS 2006

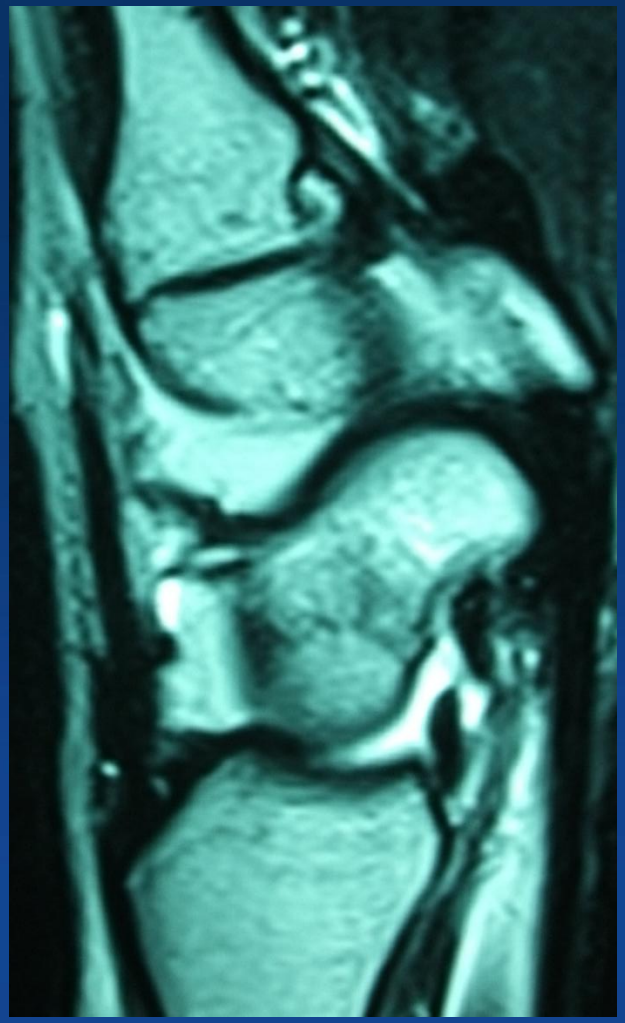
Case Obvious fx- What RX?

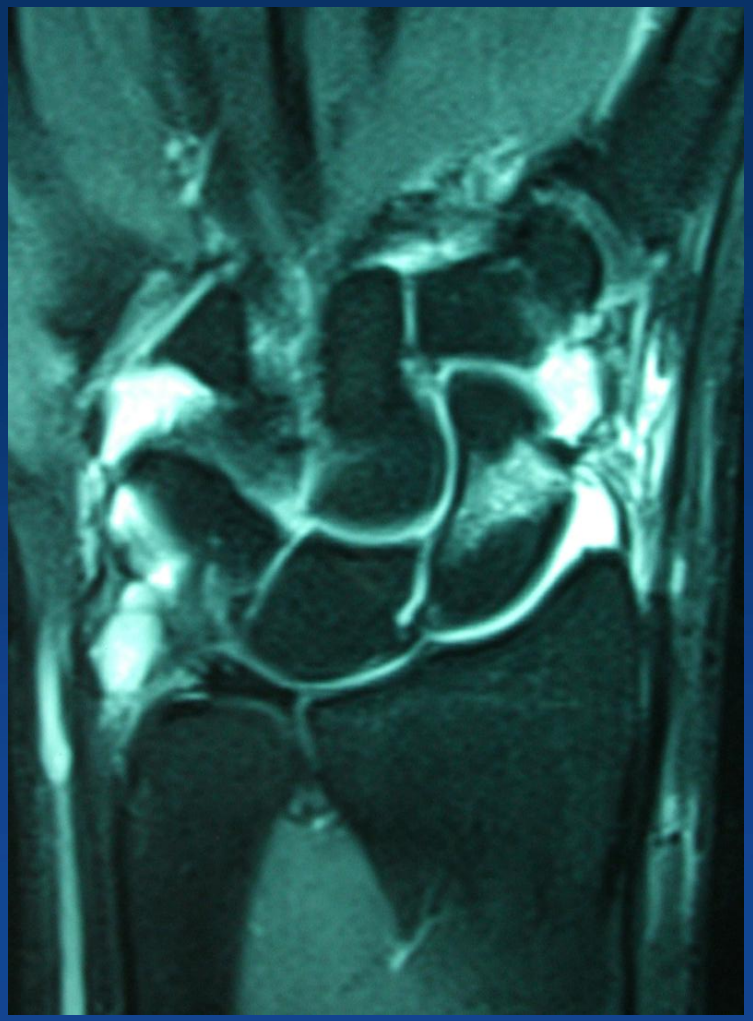
- 21 year-old woman fell off 7inch heals, landing on her L wrist



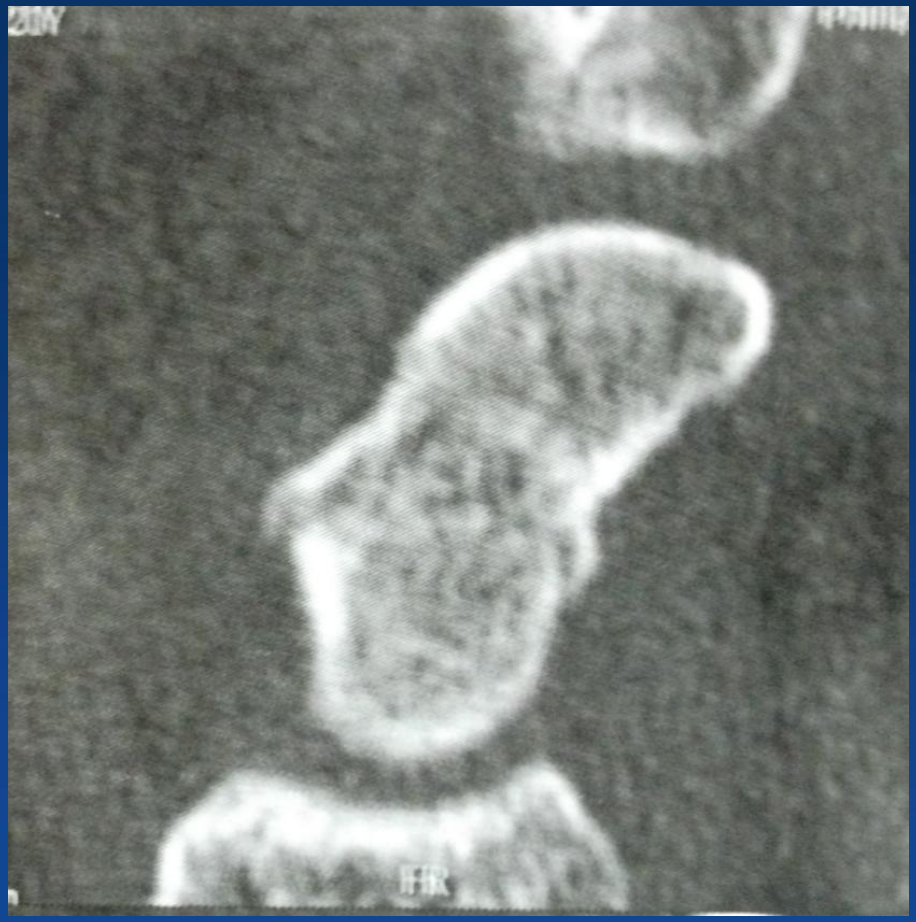


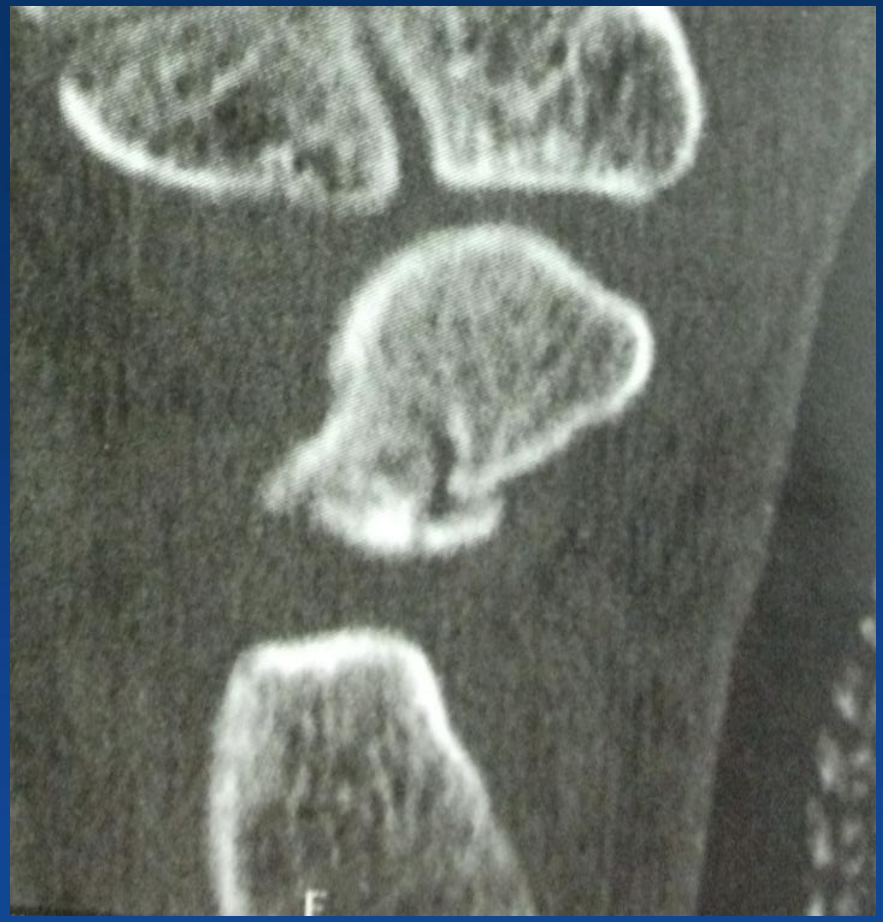
Injury MR cortical disruption



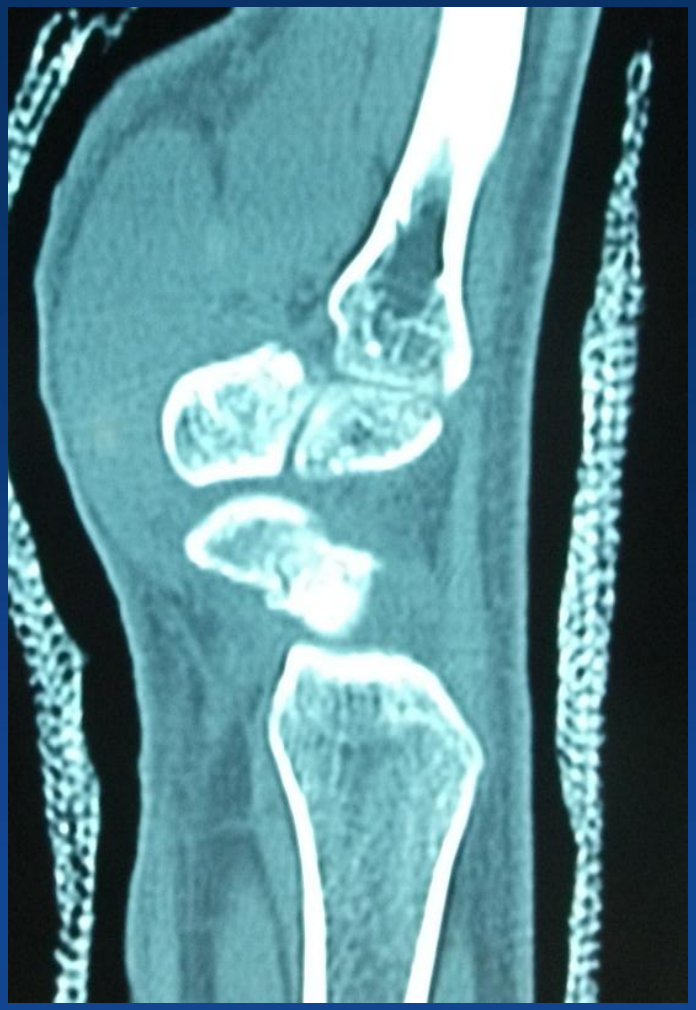


3 Day CT to assess bony stability potential for collapse

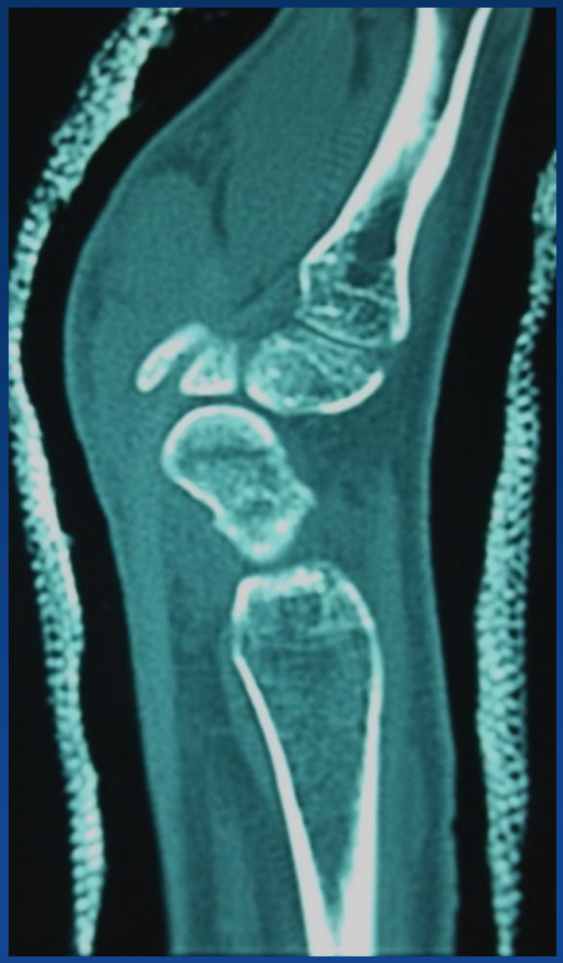


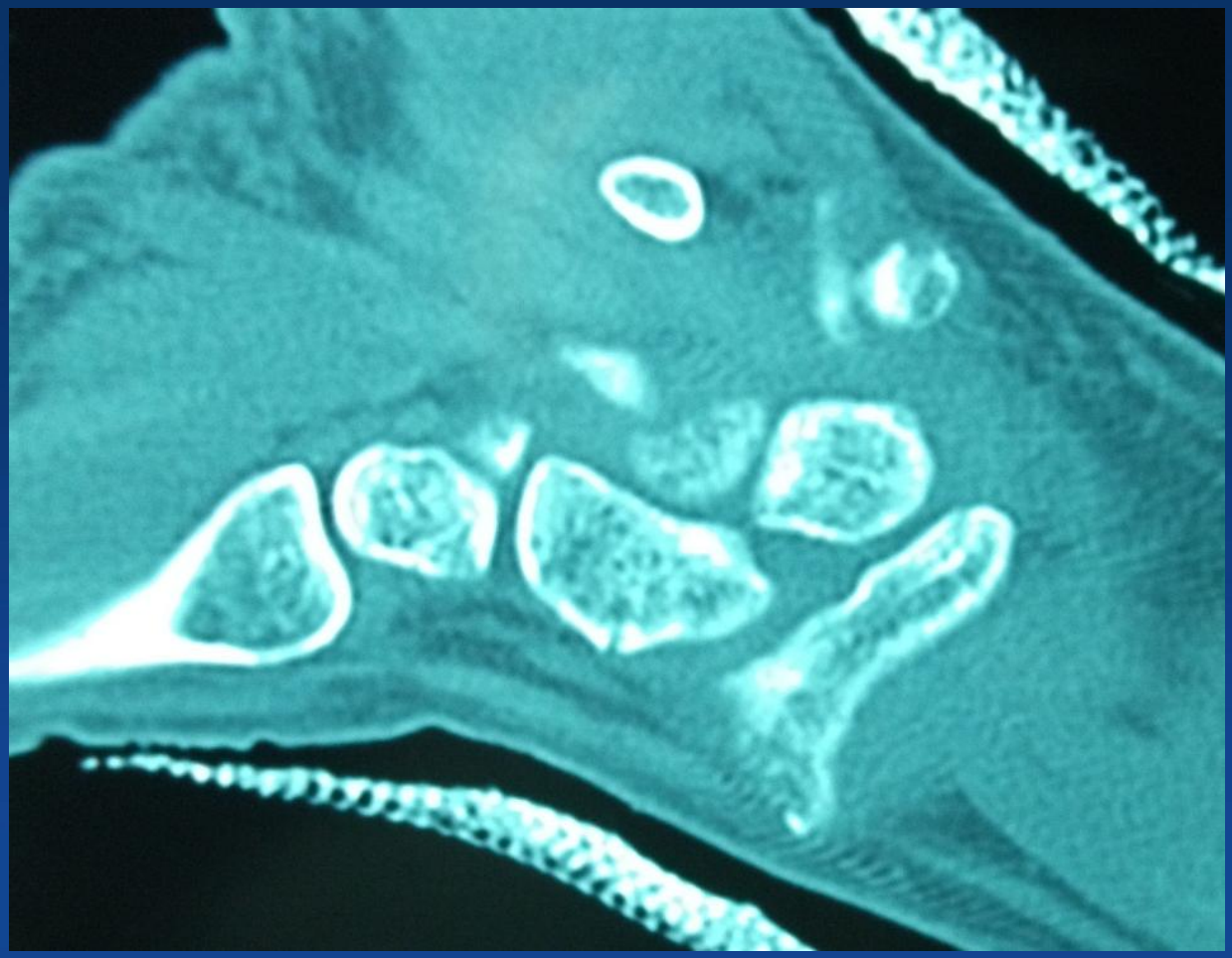


6 Week FU stable and consolidating



2.5 Month FU healed





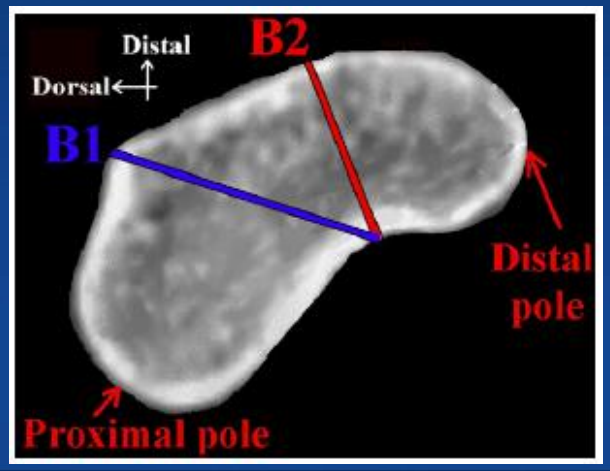
Percutaneous Fixation

- Nondisplaced Fx- avoid casting, back to work, ? sports
- Minimally displaced easy to reduce with upward pressure on distal pole
- Minimizes injury to ligaments and blood vessels
- ? Lessens scarring, stiffness
- Limited open may be better to avoid numerous punctures trying to get the optimal central starting point for the guide wire

Comparison of Percutaneous Dorsal Versus Volar Fixation of Scaphoid Waist Fractures Using a Computer Model in Cadavers

Marc Soubeyrand, MD, David Biau, MD, Cesar Mansour, MD, Sabri Mahjoub, MD, Veronique Molina, MD, Olivier Gagey, MD, PhD

- Biomechanical study of 12 upper limbs
- Compared screw placement for B1 and B2-type fracture via CT scan
- For B2 fractures, screw placement equal from volar or dorsal
- For B1 fractues, dorsal approach with maximal wrist flexion offered best placement



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Percutaneous Screw Fixation for Scaphoid Fracture: A Comparison Between the Dorsal and the Volar Approaches

In-Ho Jeon, MD, Ivan D. Micic, MD, Chang-Wug Oh, MD, Byung-Chul Park, MD, Poong-Taek Kim, MD

- 41 consecutive patients with acute scaphoid fx
  - 19 fixed volar, 22 fixed dorsal
- Placement in Scaphoid Axis on X-ray
  - No difference in screw placement on PA and Lateral views
  - Dorsal approach had better placement on Oblique view
- Placement Relative to Fracture Line
  - Dorsal screws more perpendicular on all 3 views
- No difference in fracture healing
- No difference in Mayo score

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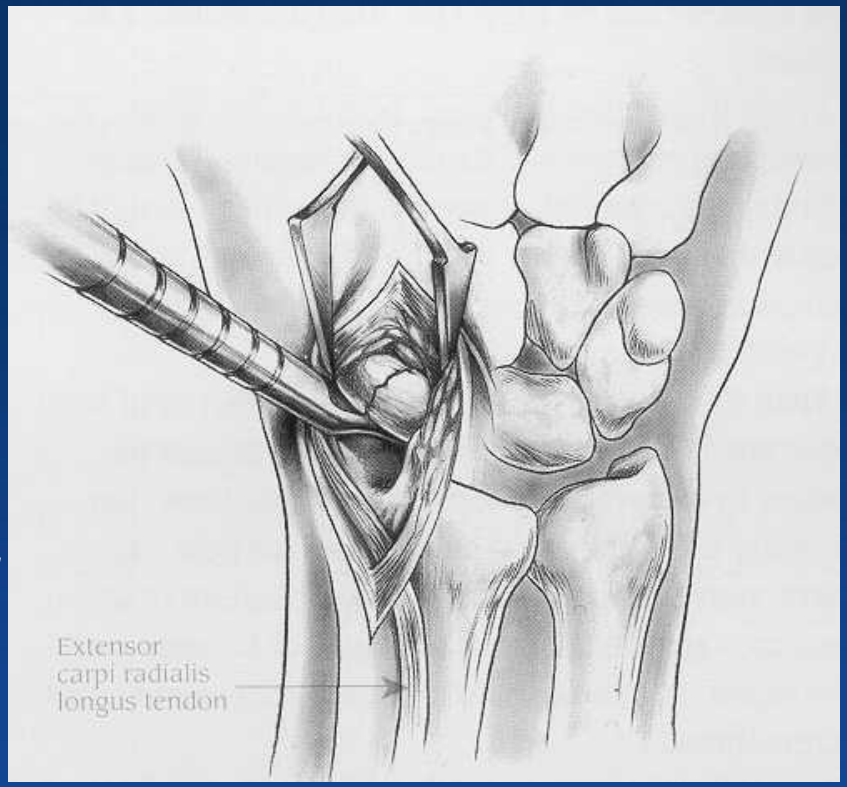
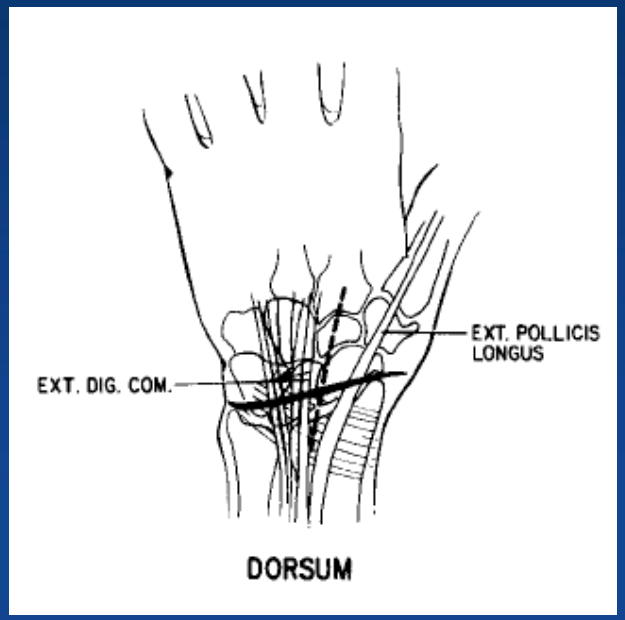
Dorsal Approach- Limited Open displaced fxs

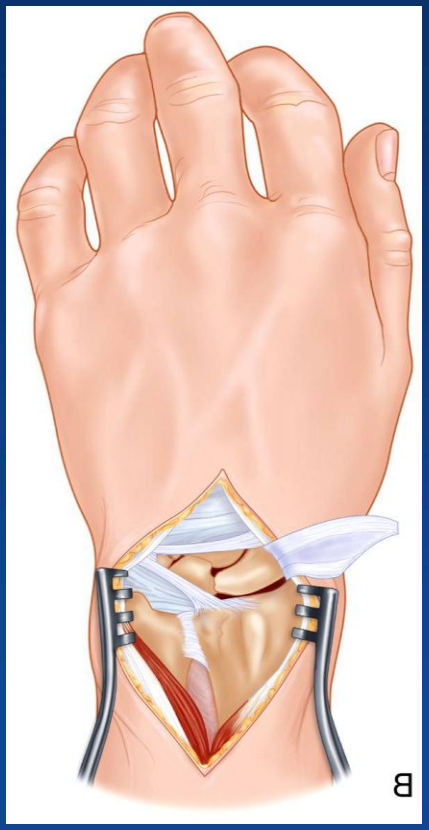
- Proximal or waist fractures
- Central placement of screw
- Lessens chance of distraction across prox pole
- Percutaneous or limitied open tech pref to avoid many passes of guide wire



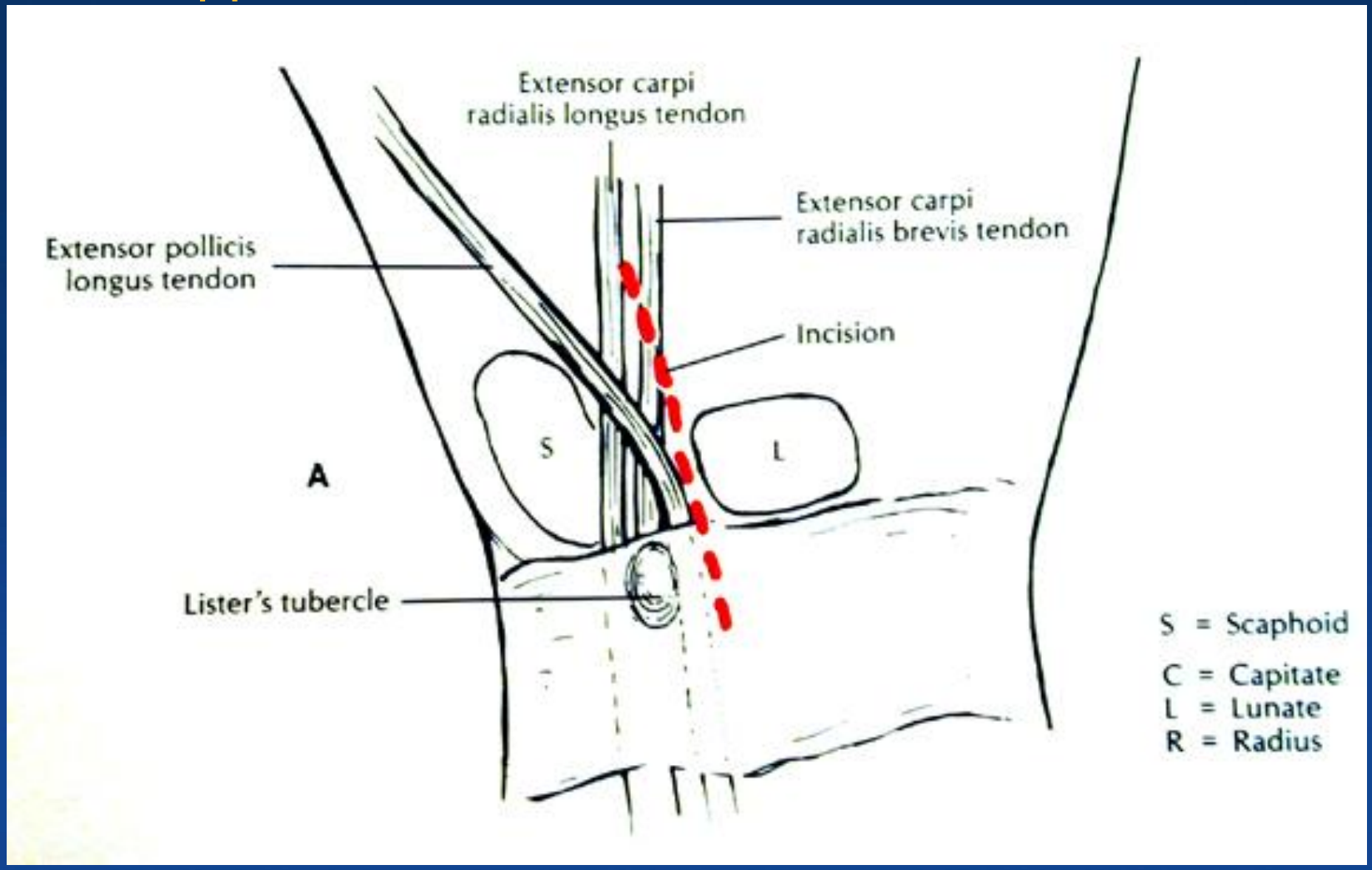
Dorsal Approach- See Proximal Pole

- 3-4 dorsal interval
- EPL retracted radially and
- transverse capsulotomy to protect DIC
- EDC retracted ulnarward



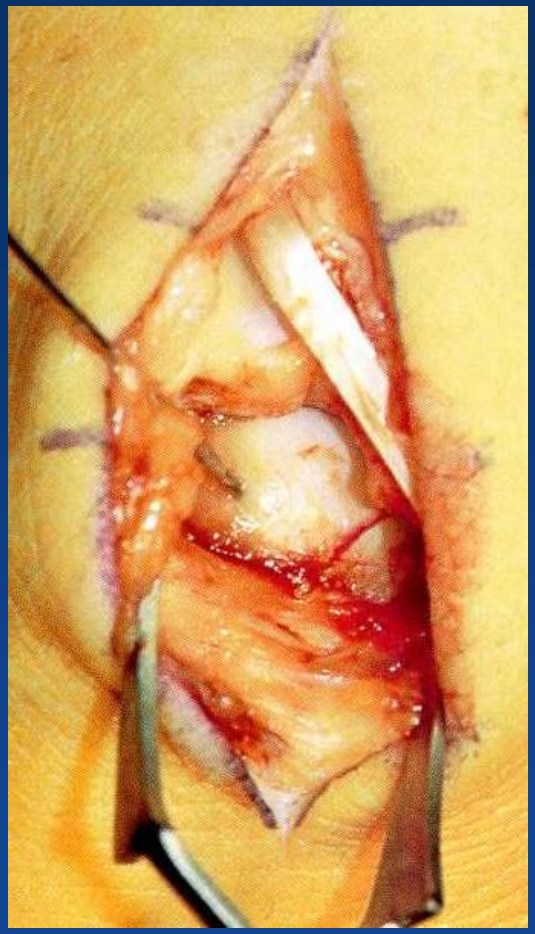


Dorsal Approach 3-4 Interval

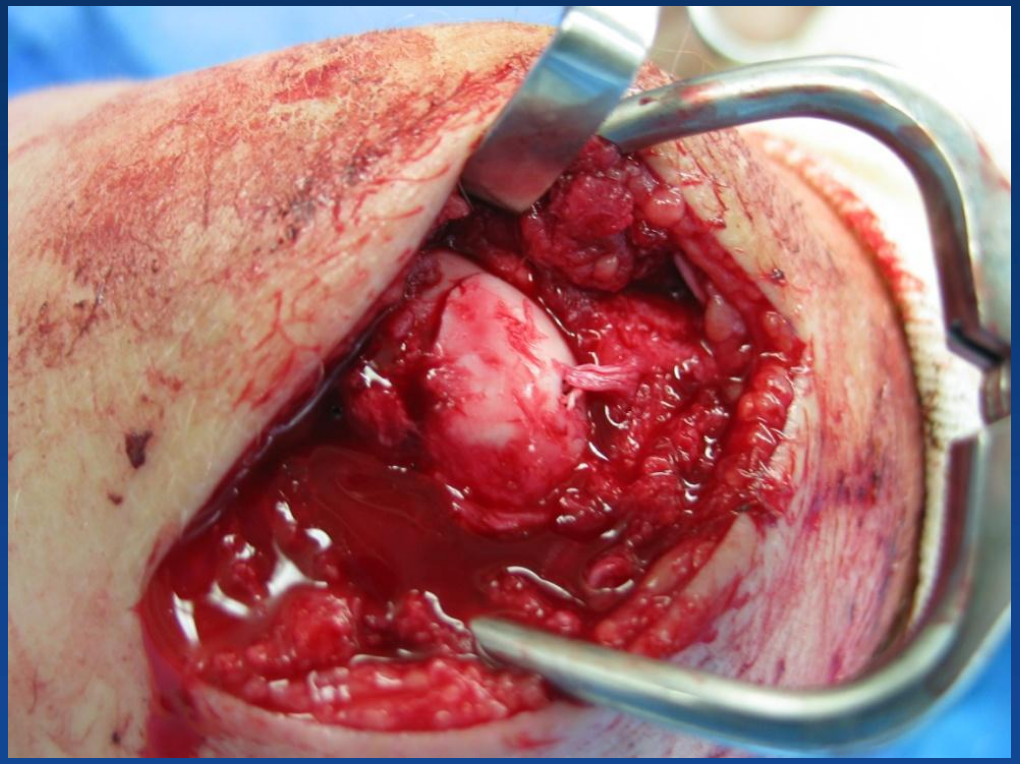


Dorsal Approach

- Expose the proximal pole
- Guide wire dead center
- Pronated flexed wrist –best image
- Cannulated headless screw
- Exact measurement
  - Select 2mm shorter- no penetration

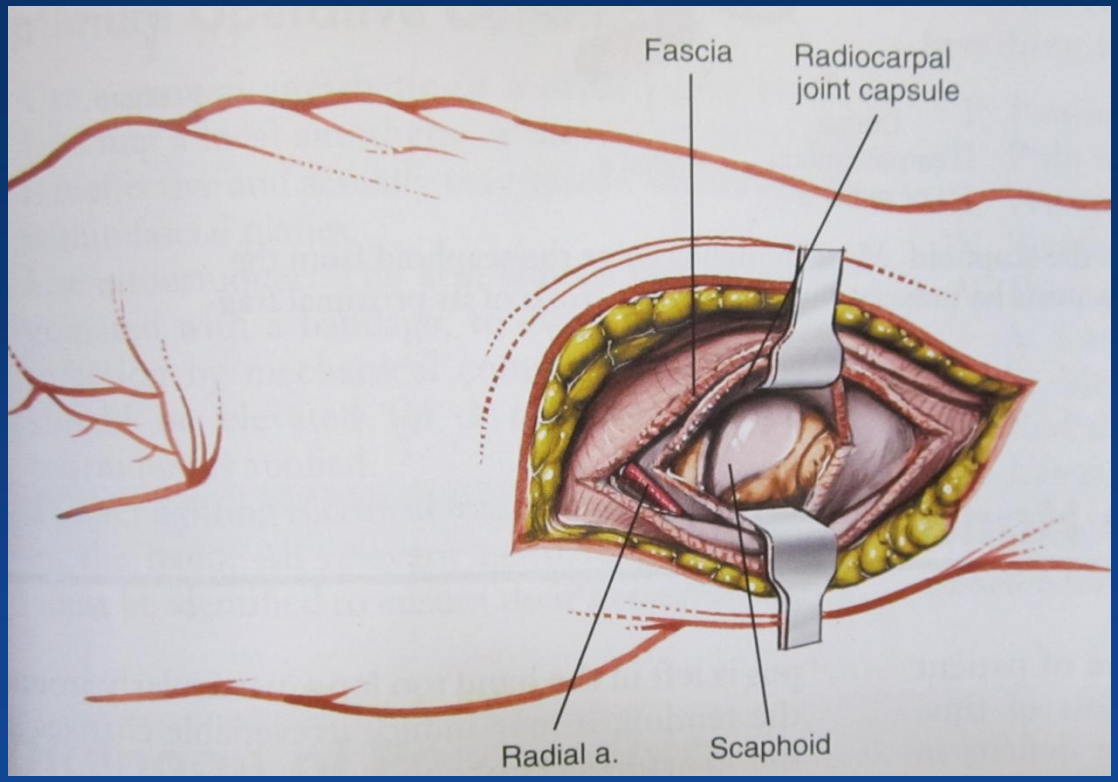


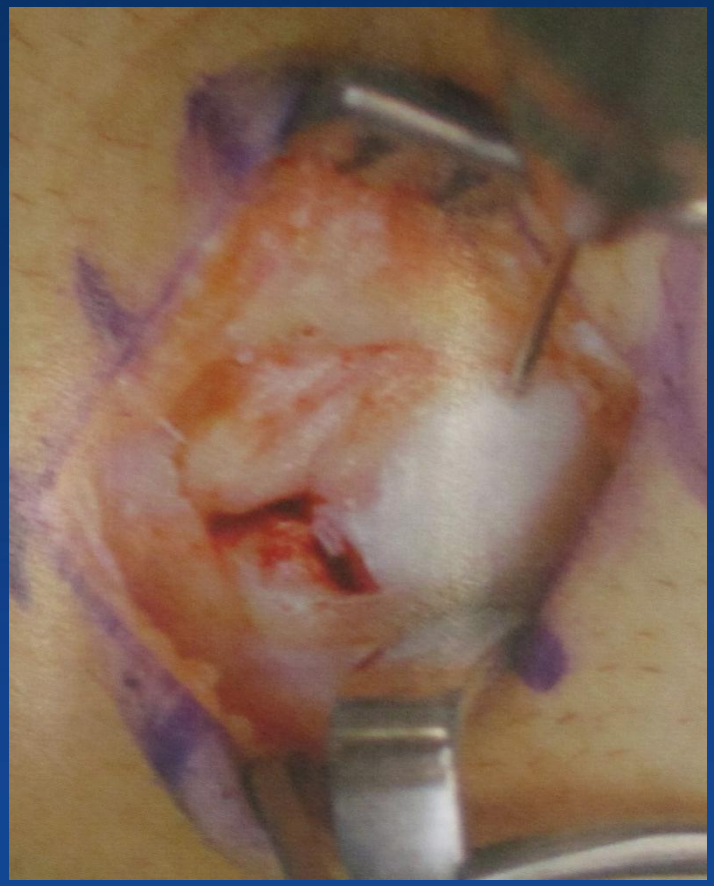
Dorsal Approach

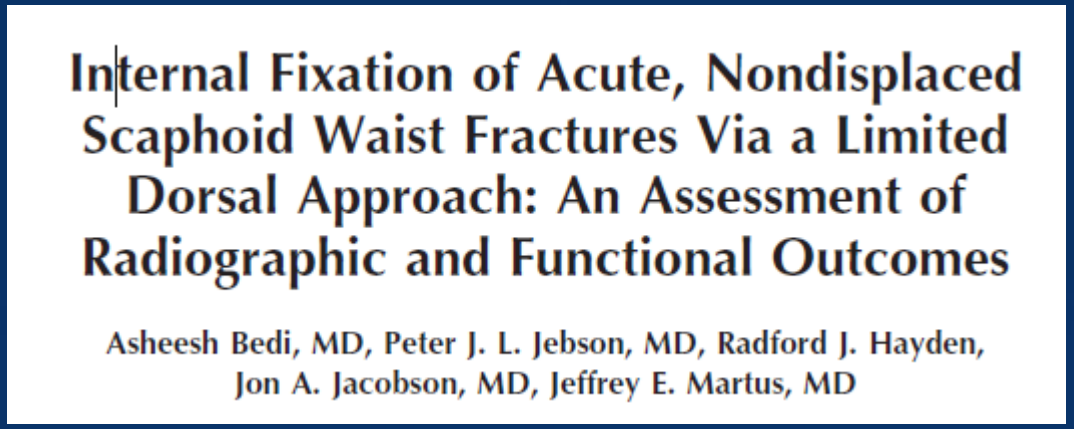


- Comminuted Fx
- Start guide wire close to SL
- Dead center PP scaphoid
- Wrist is hyperflexed
- Image is obtained with wrist in 30 deg pronation

Dorsal Approach







- 18 patients with non-displaced waist fractures treated via a limited dorsal approach
- 17 of 18 cases heal at a mean duration of 8 weeks
  - No cases of proximal pole AVN

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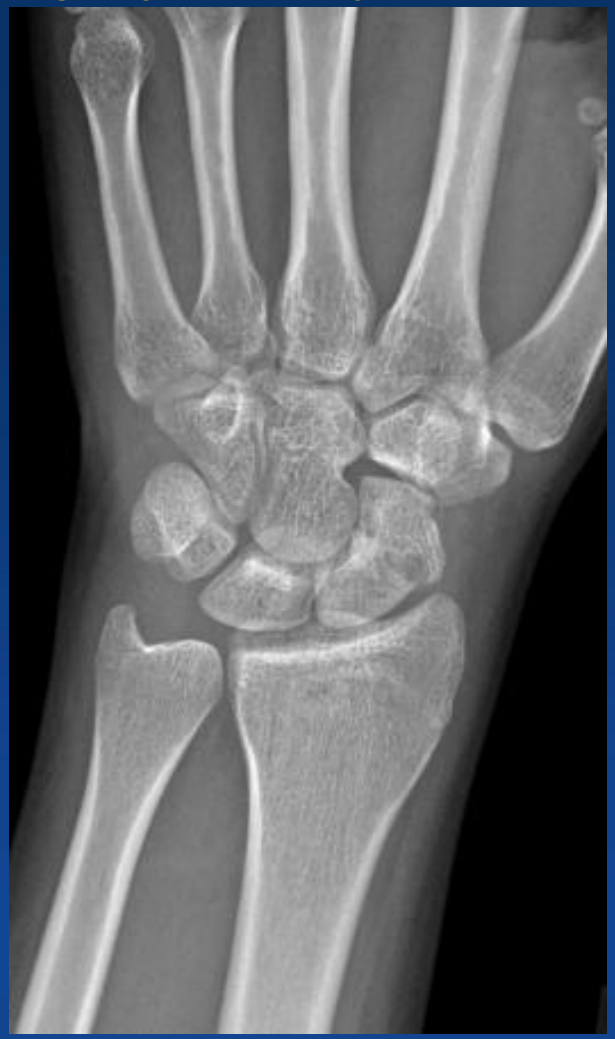
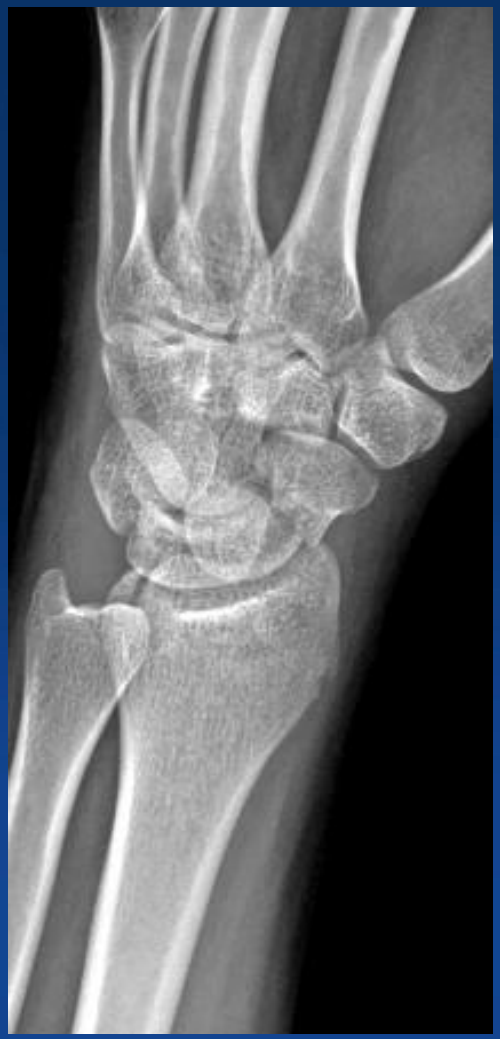
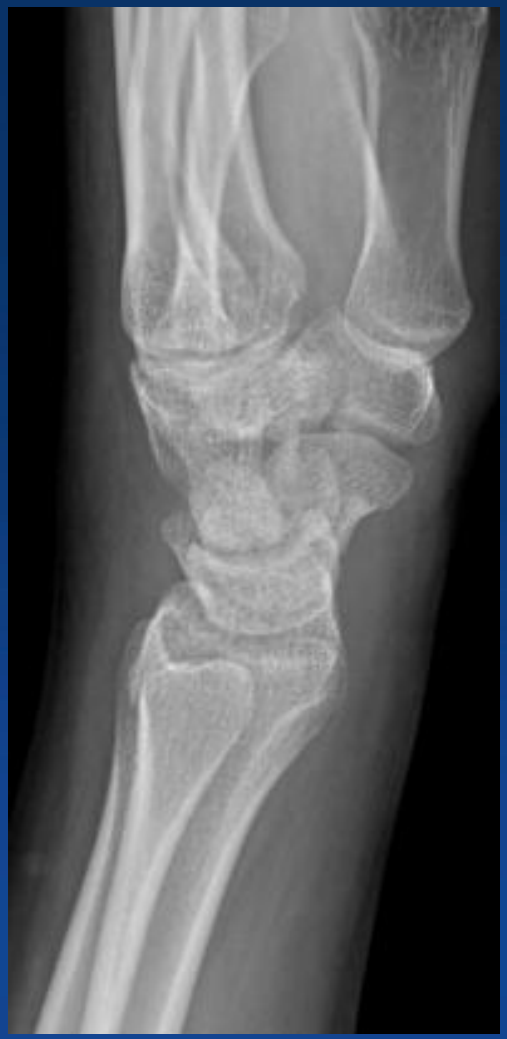
Case_ Dorsal Approach

- 20 year-old woman injured while jumping from a cliff into a lake
  - b/l calcaneal fractures
  - L scaphoid fracture

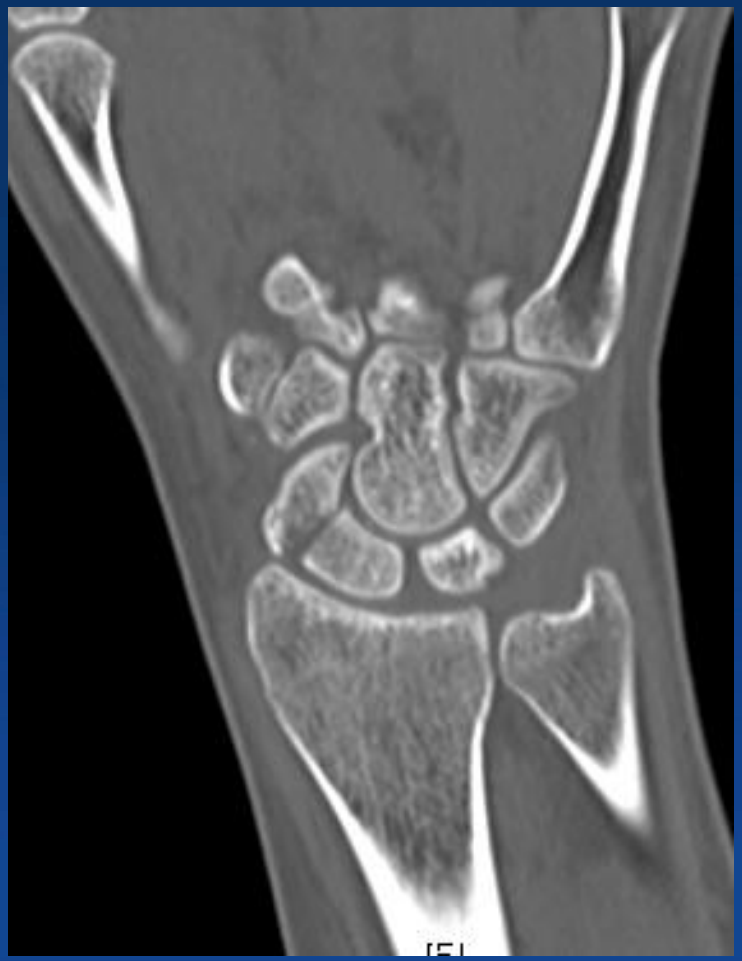
Injury X-Rays

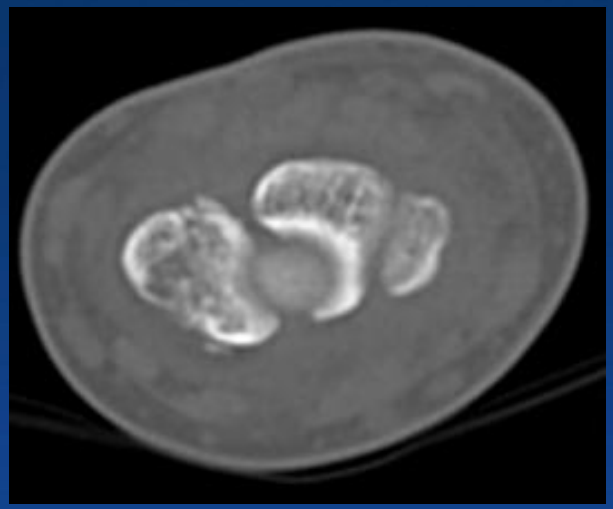


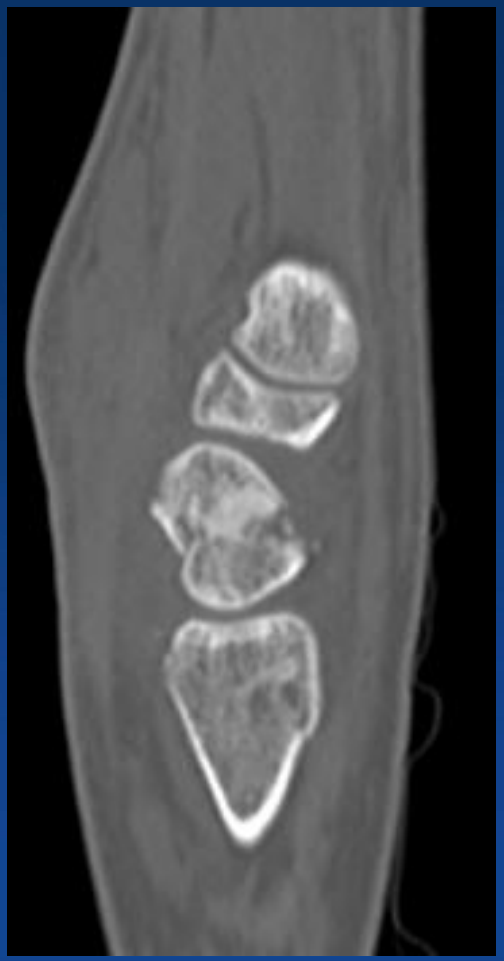




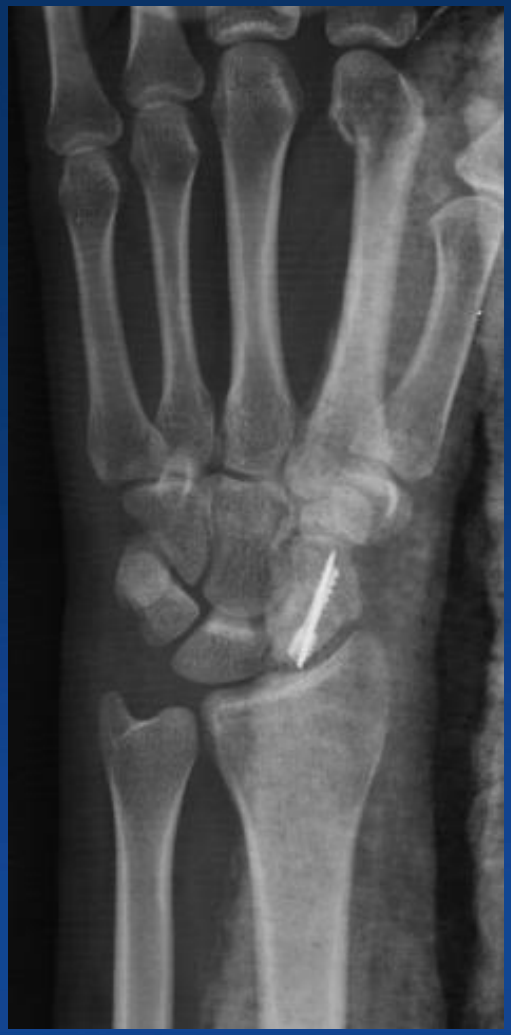
Pre-Operative CT

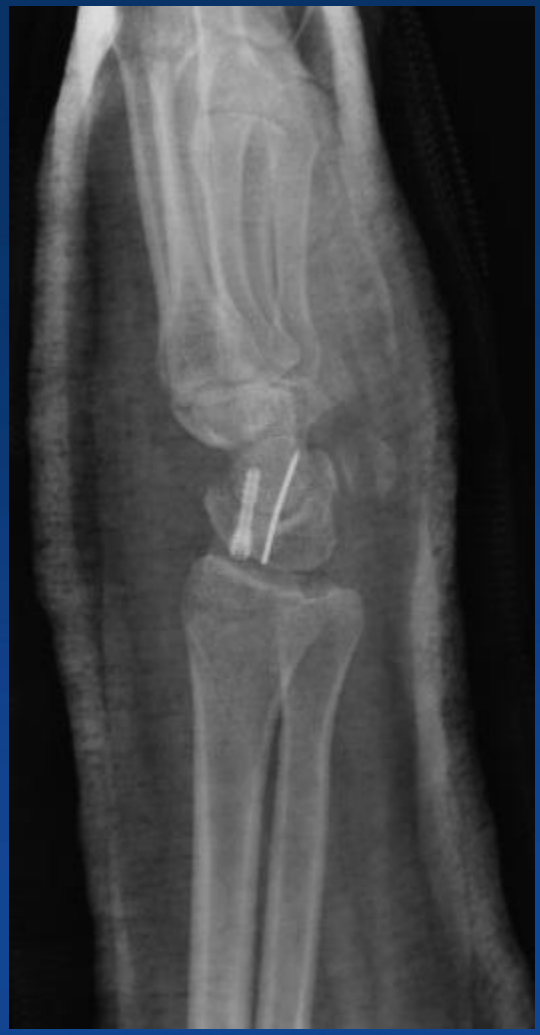




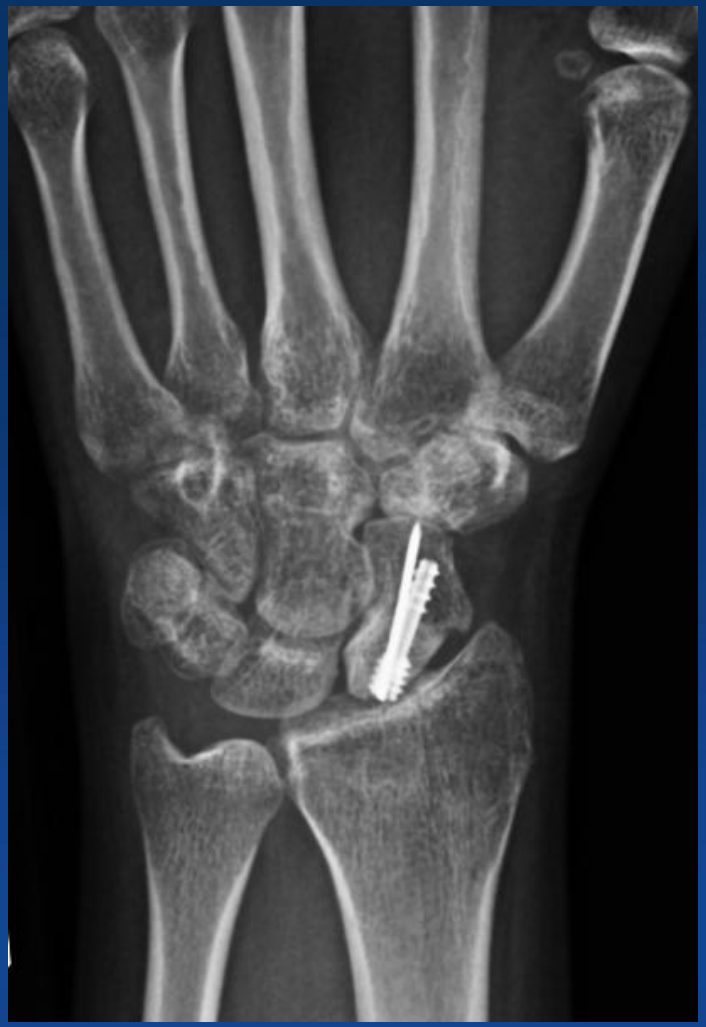


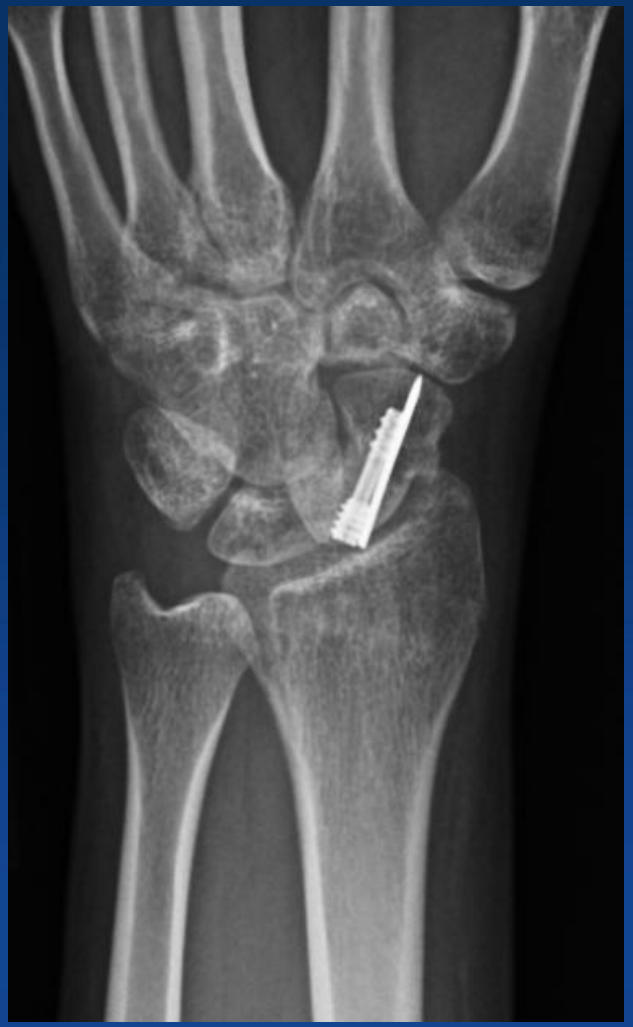
Screw and buried K wire for more stability

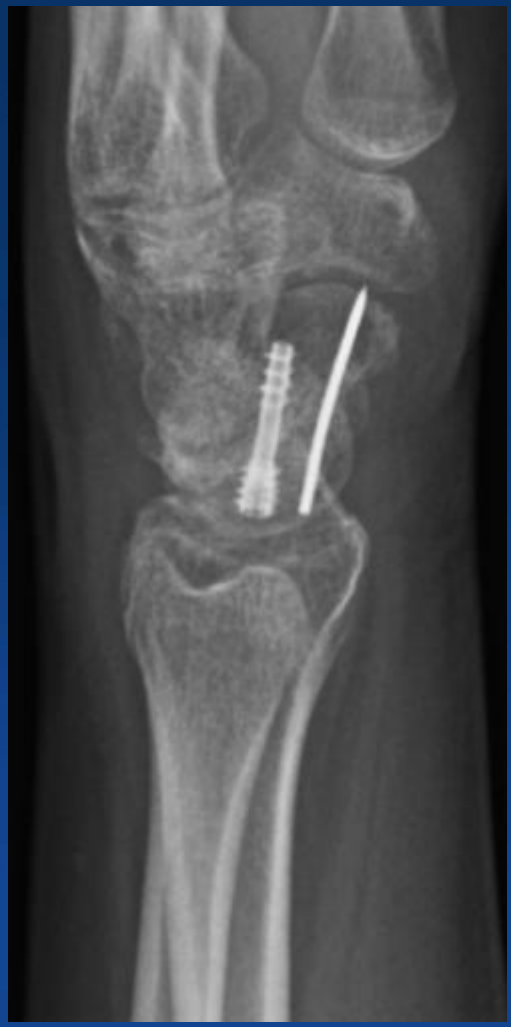




11 Week Follow-Up- healed

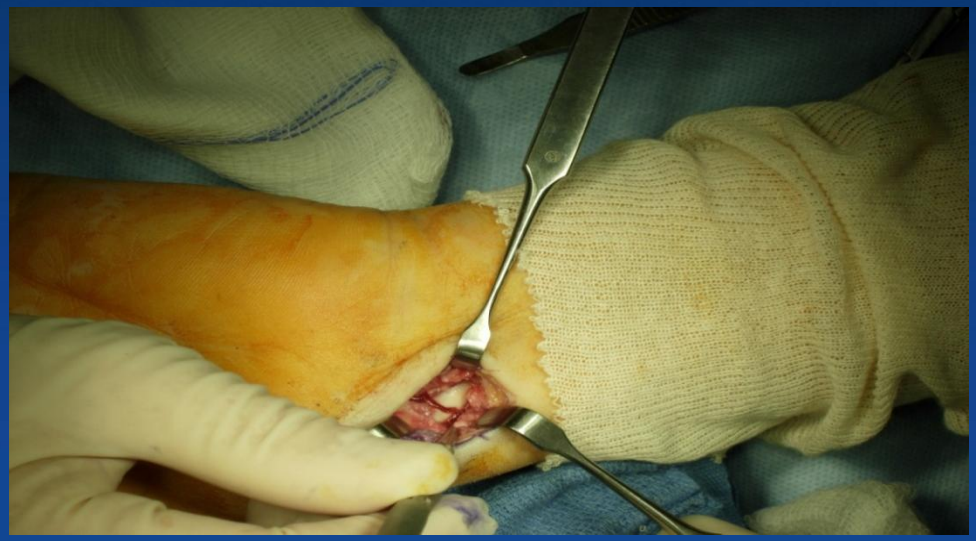




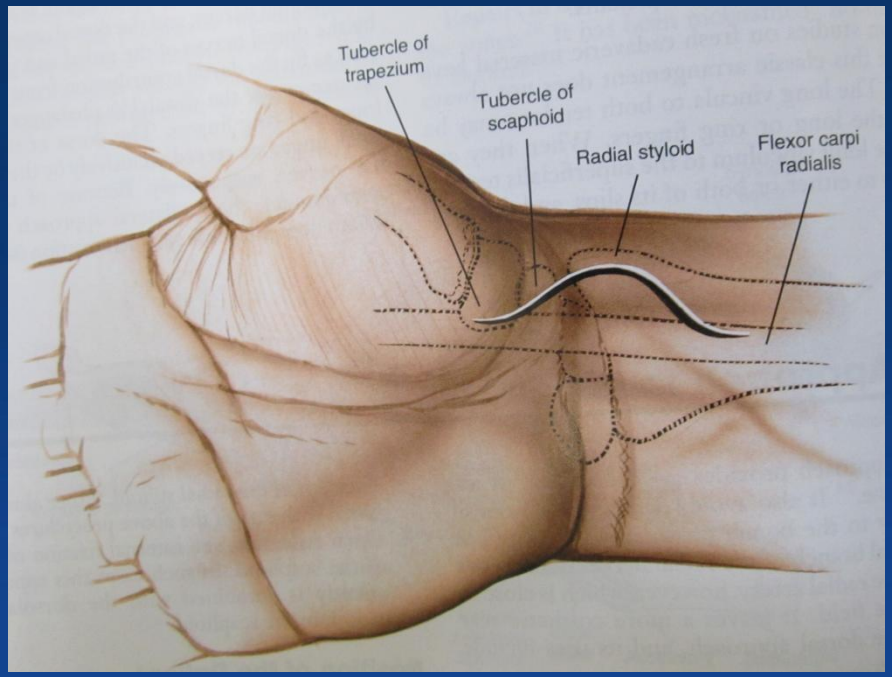


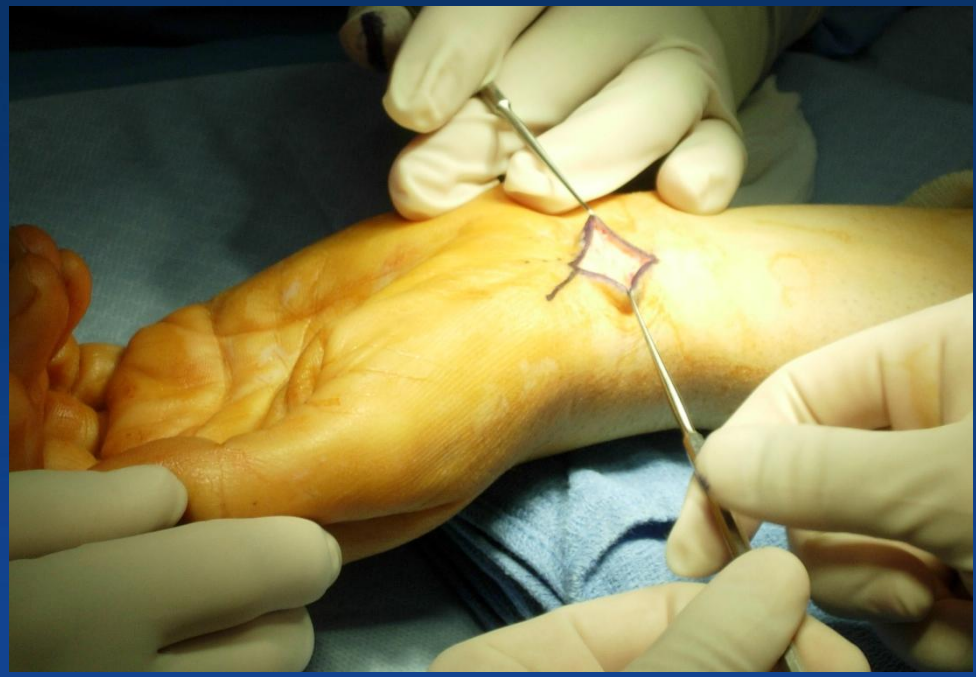
Volar Approach

- Comminuted Waist and Distal Fractures
- Preserves dorsal blood supply
- Easier to perform reduction on displaced fxs or older fxs
- Incision parallel to FCR and extending to base of ST joint (Henry App)

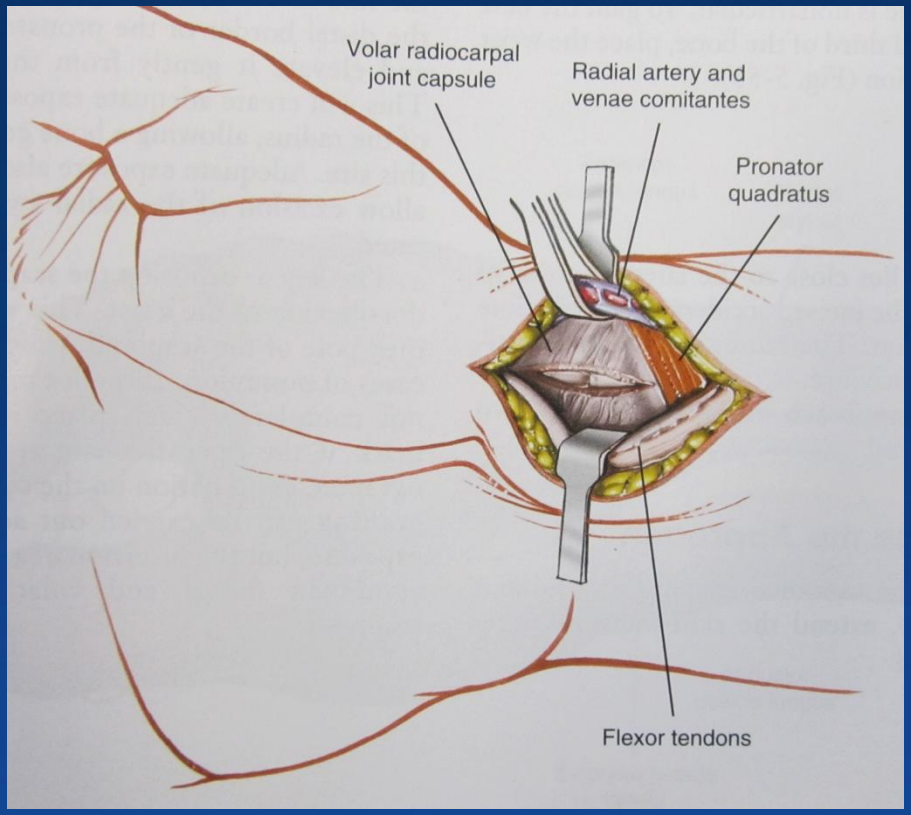


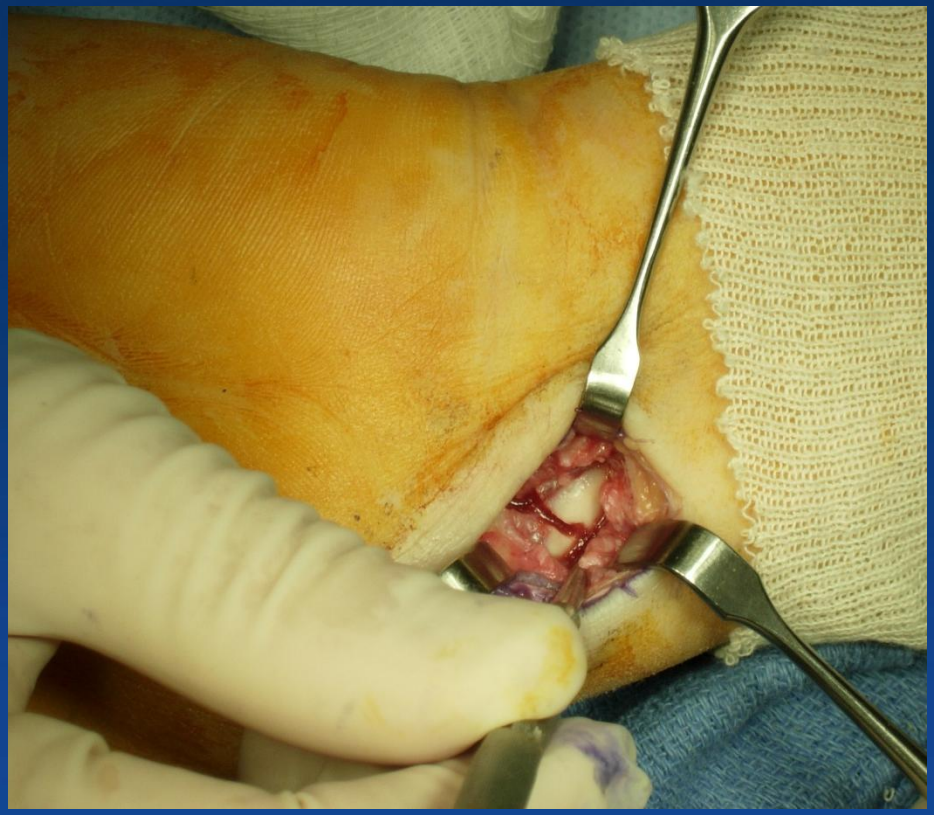
Volar Approach



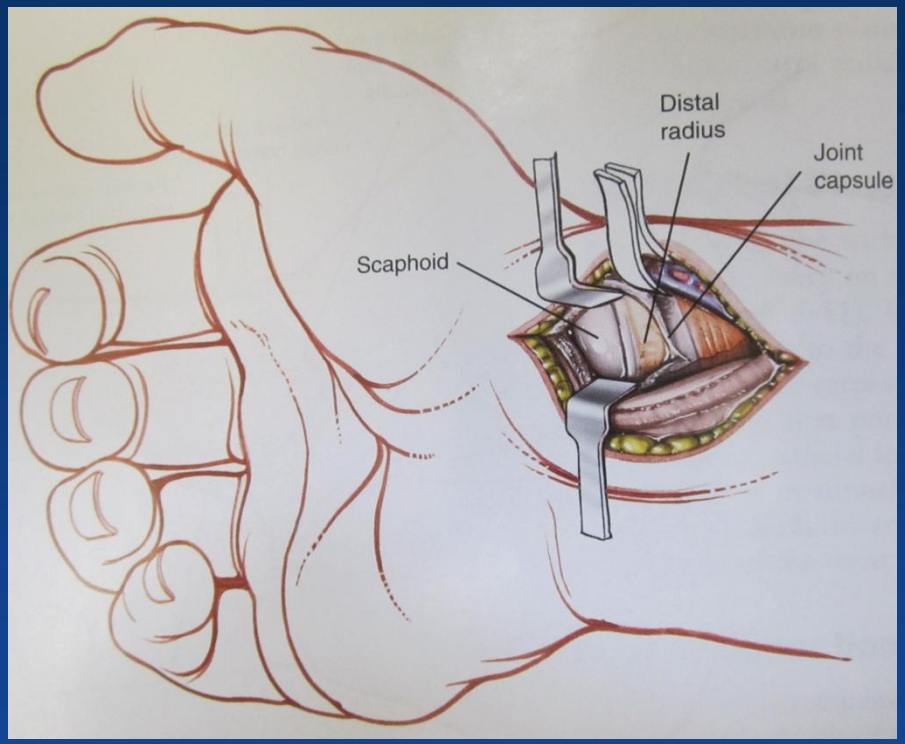


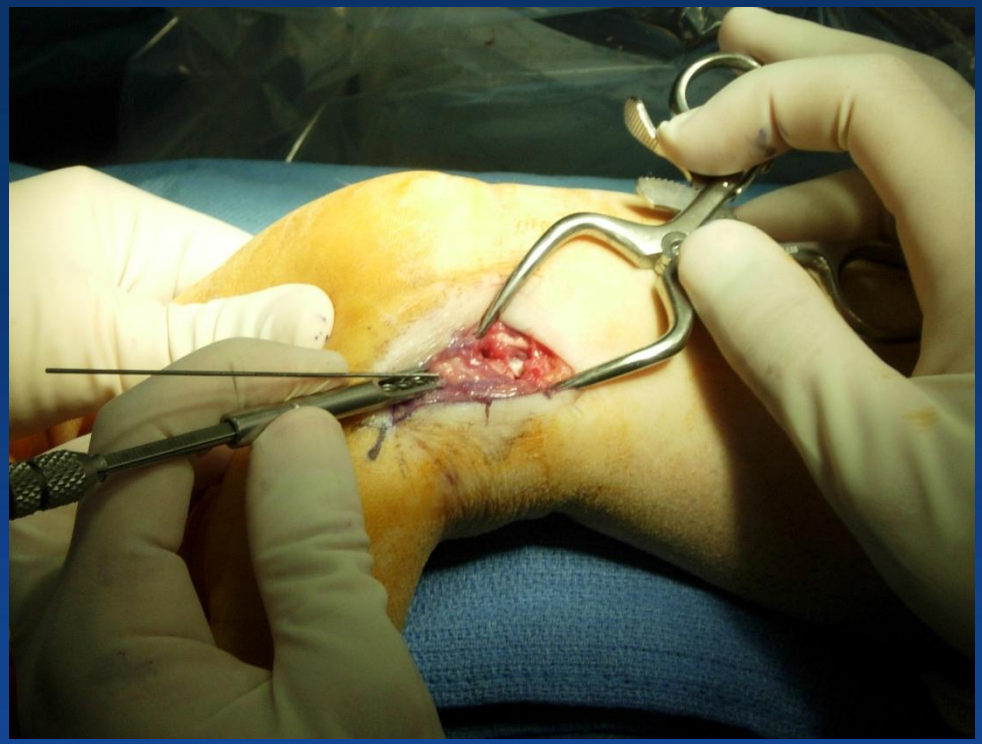
Volar Approach



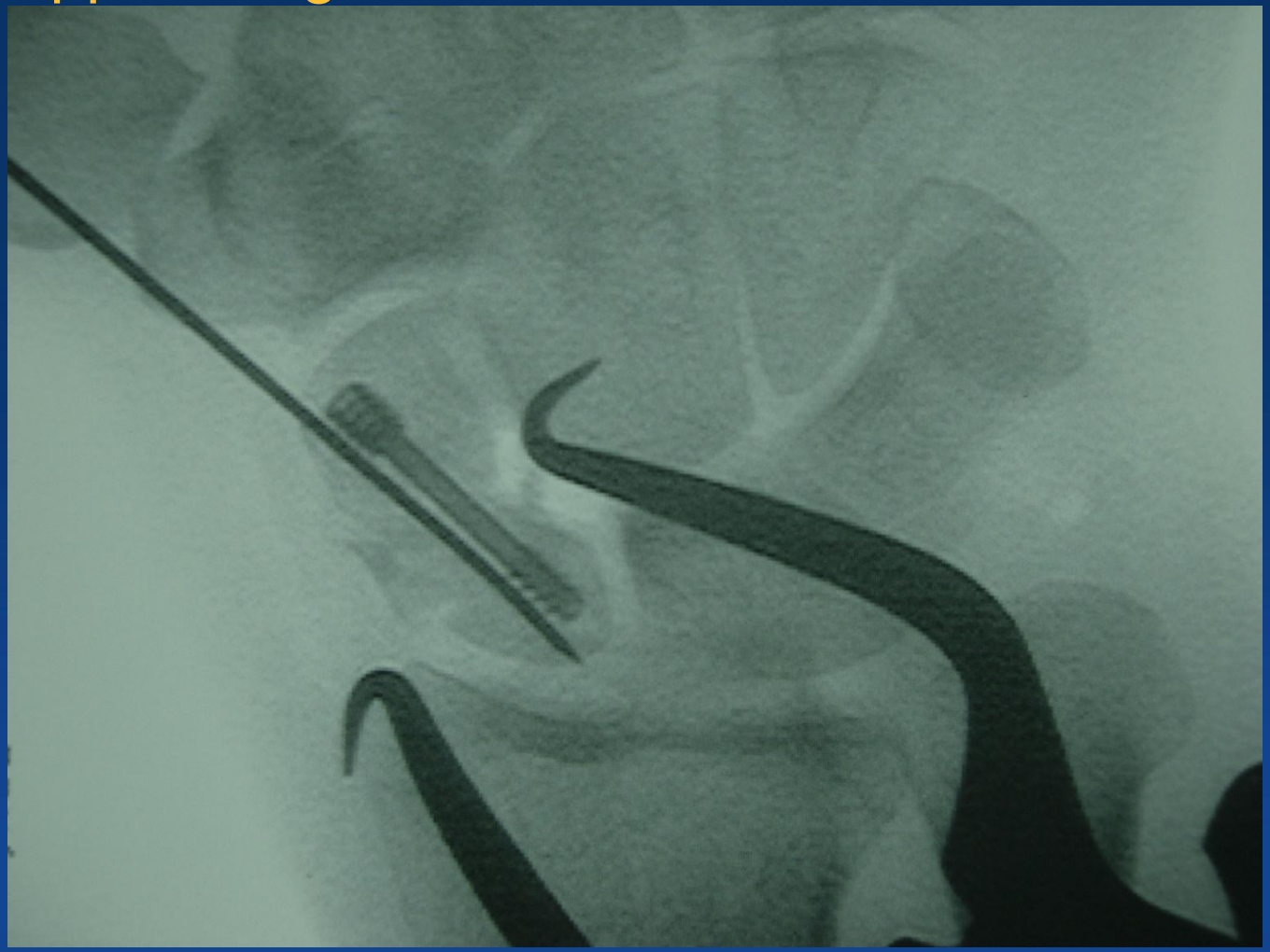


Volar Approach





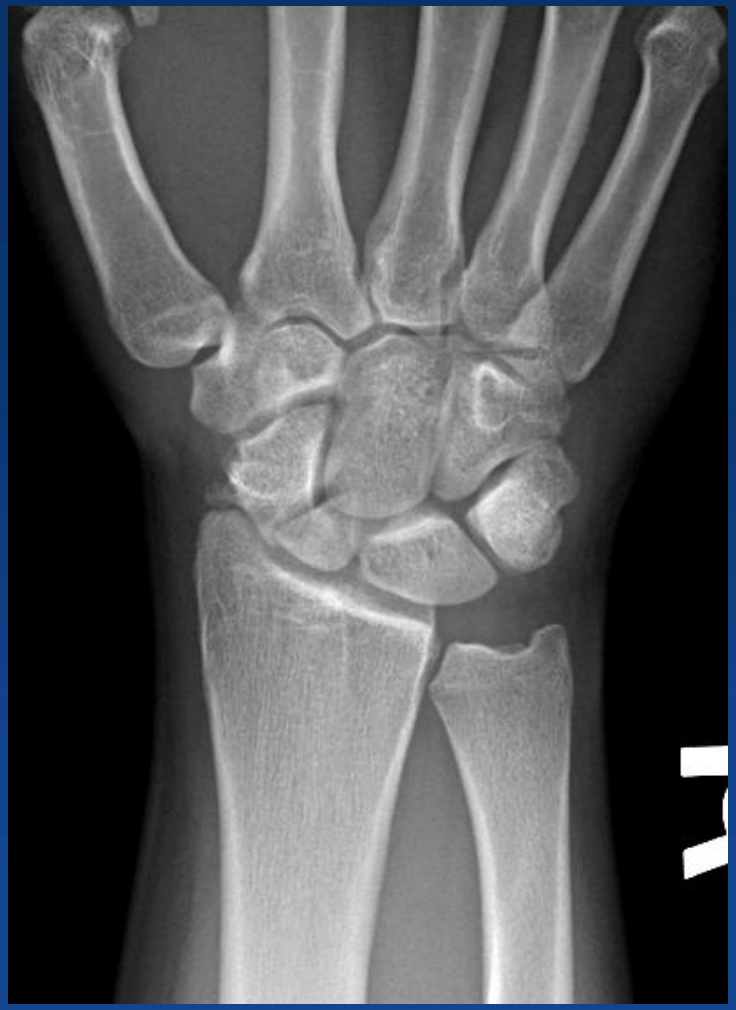
Volar Approach guide wire outside of central screw axis

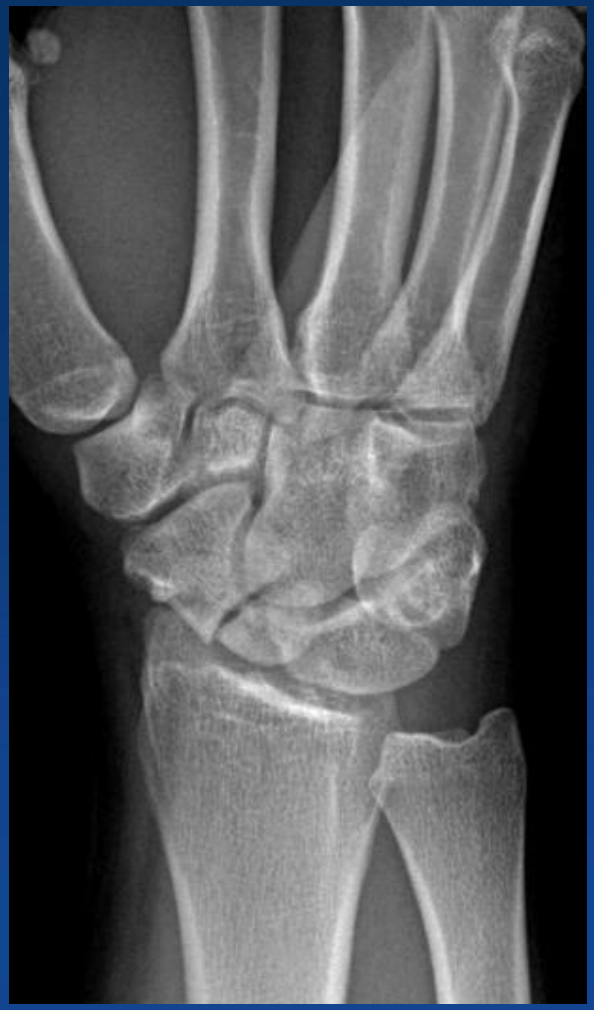


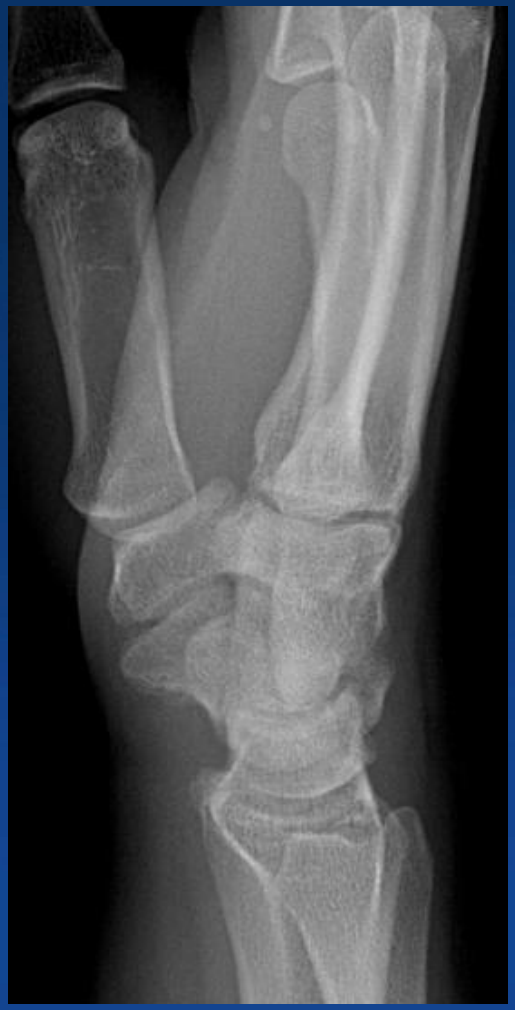
Case Volar Approach

- 20 year-old college football player, injured during the season
  - Initially diagnosed as a sprain and treated with NSAIDS
  - Diagnostic X-ray delayed until following season
  - Patient wished to continue playing and did so in a brace
  - Sought treatment at the conclusion of his senior season

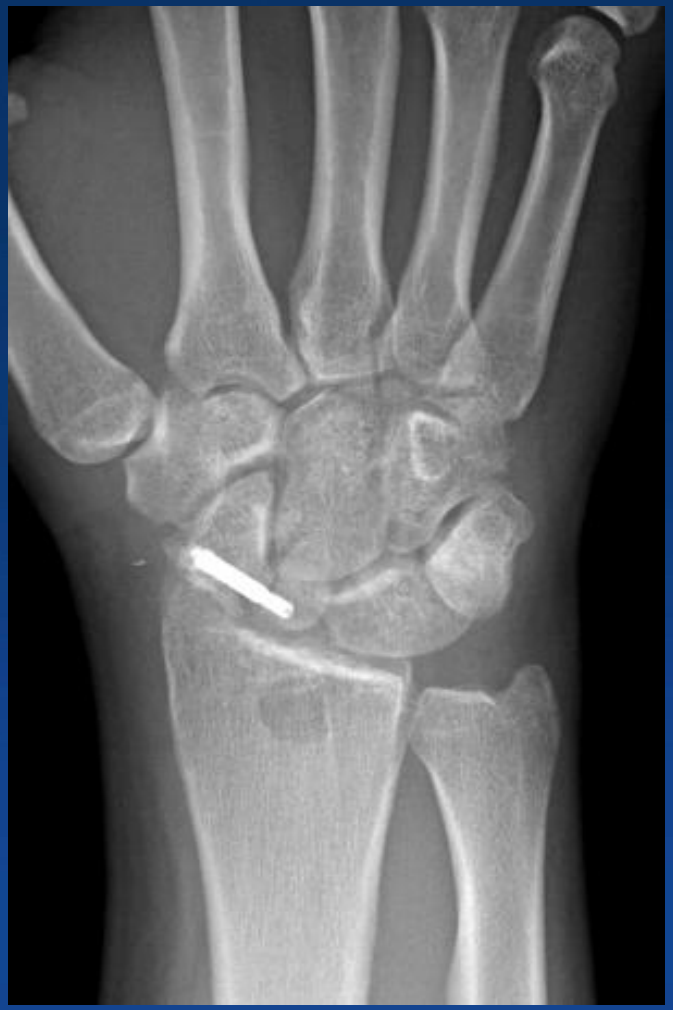
Pre-Operative X-Rays

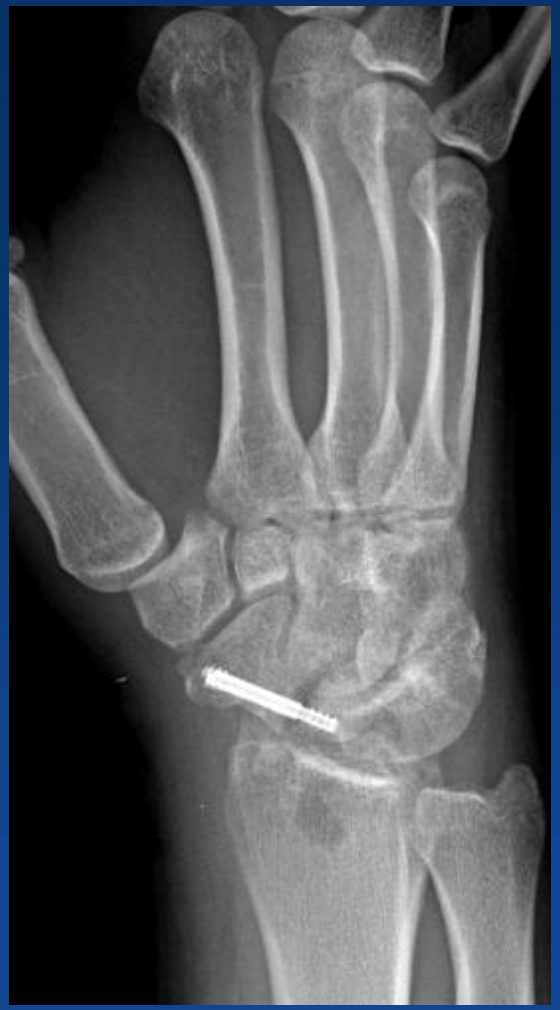


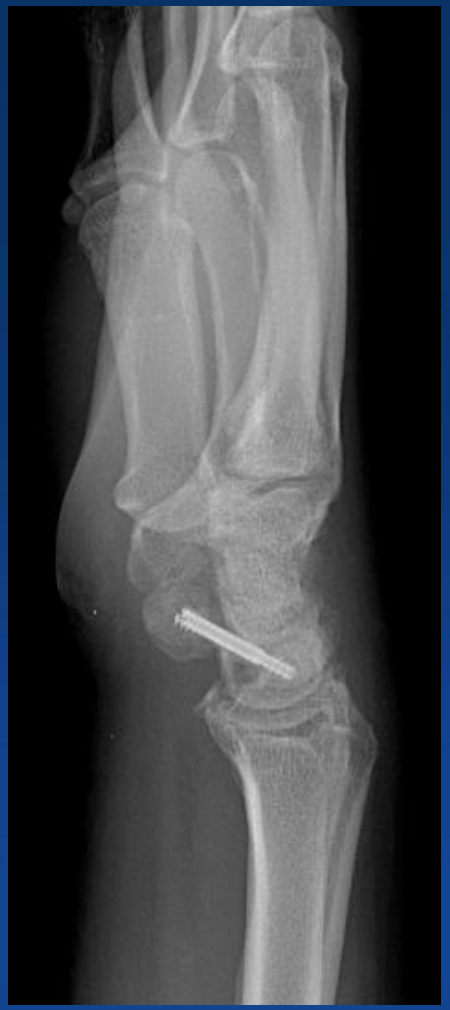




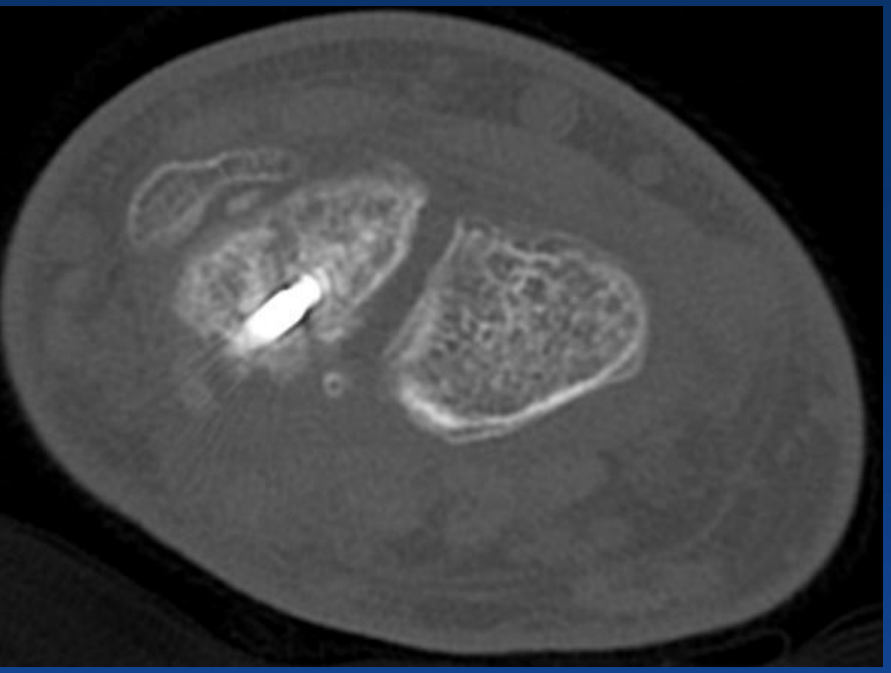
6 Week Follow-Up

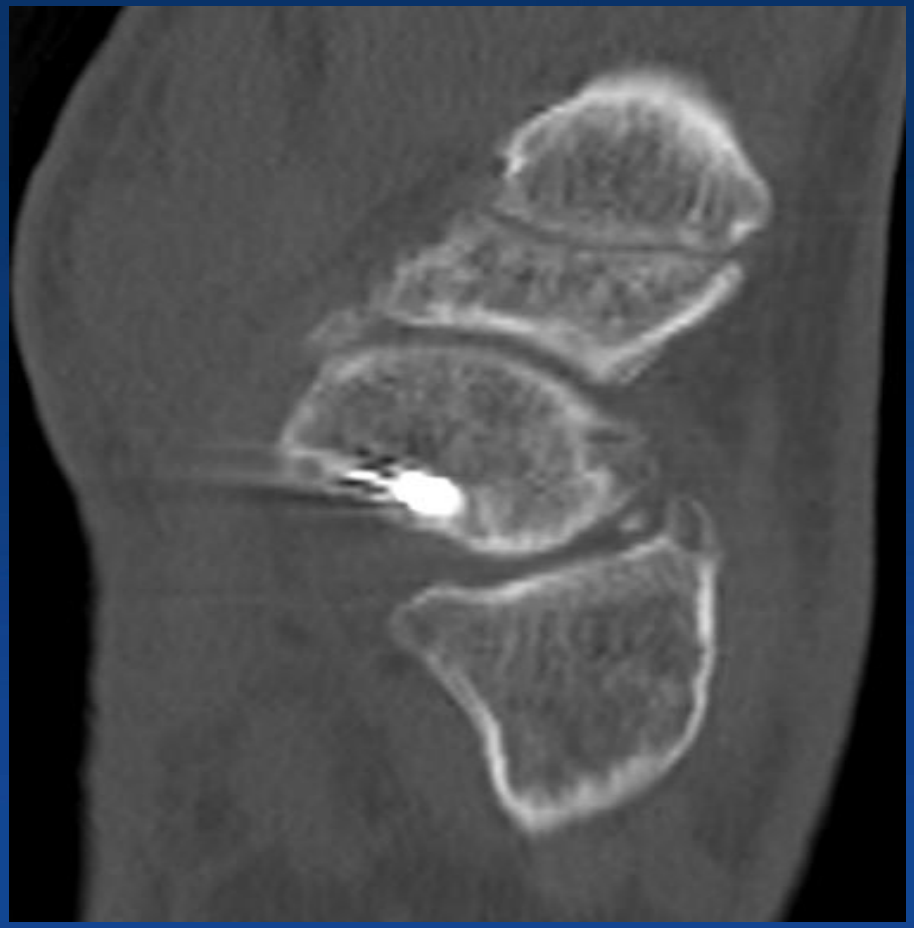






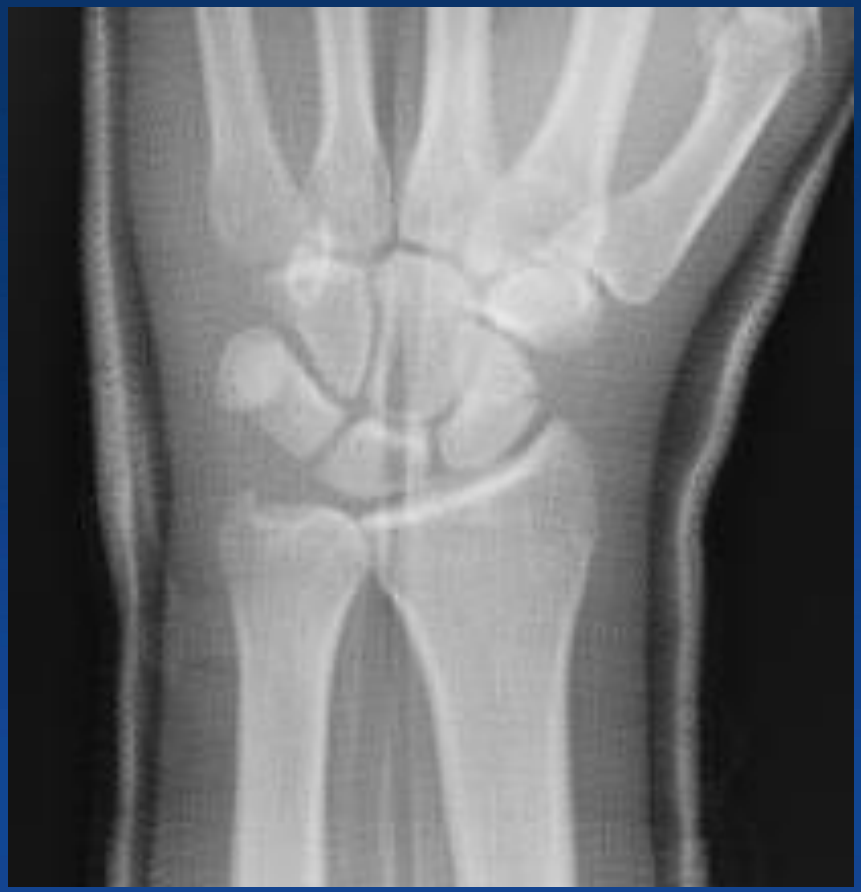
6.5 Months healed

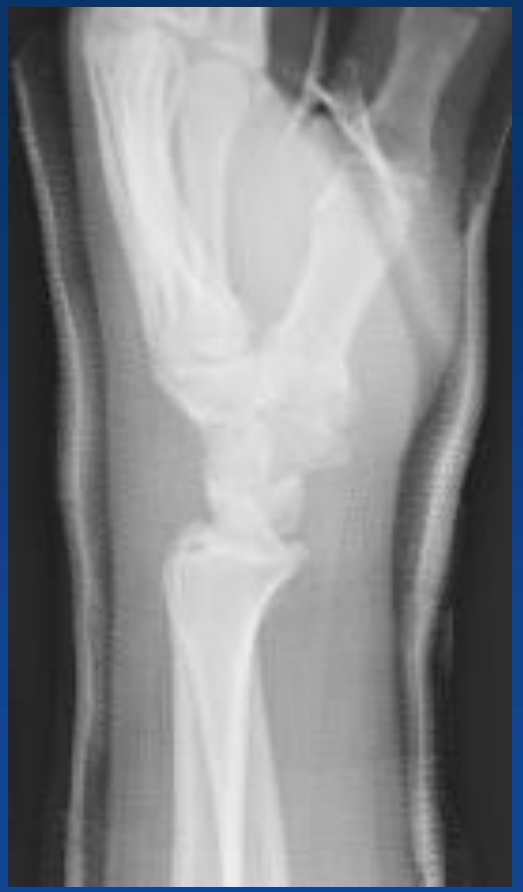




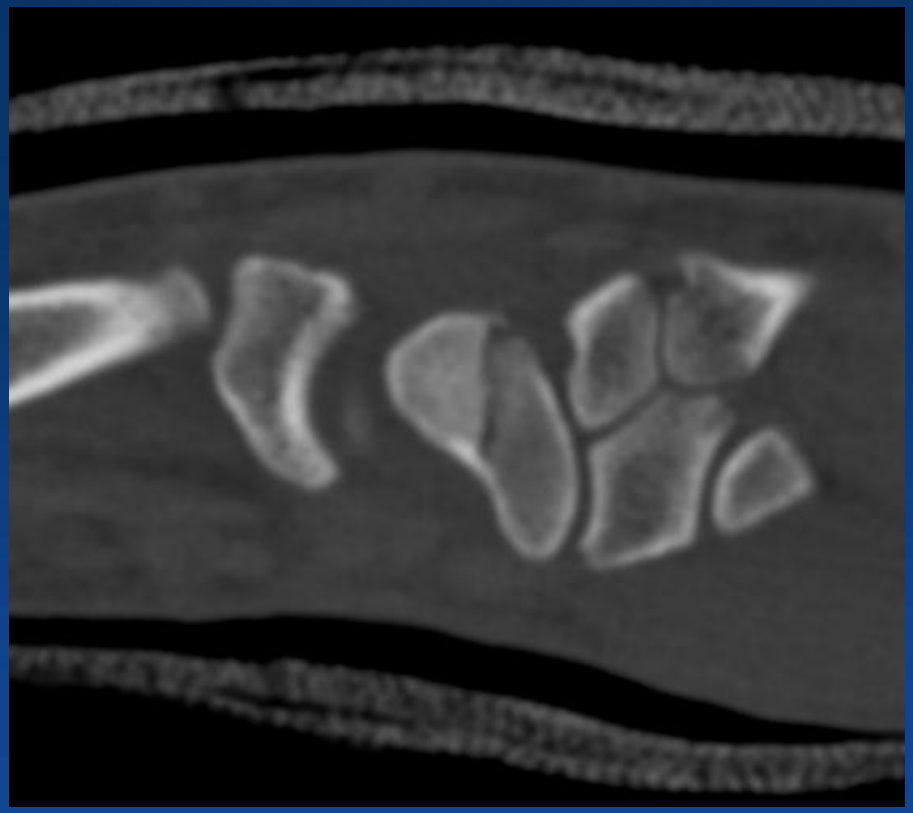
Case

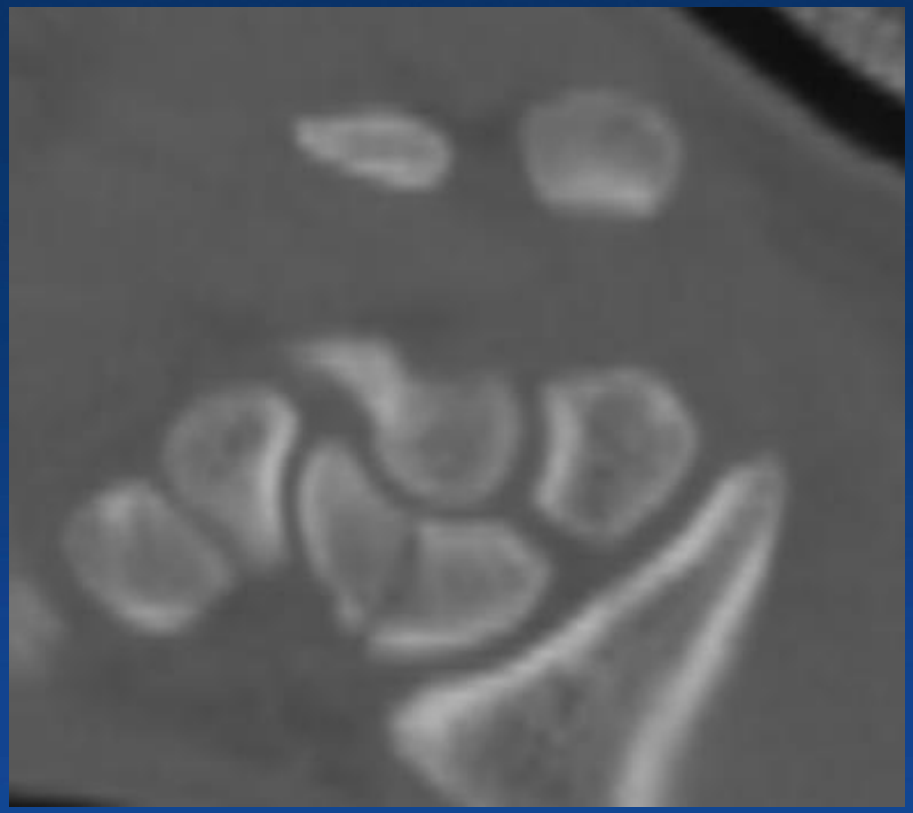
- 24M had wrist injury during an assault and robbery while visiting Miami. Initially splinted before coming back to NYC for definitive treatment



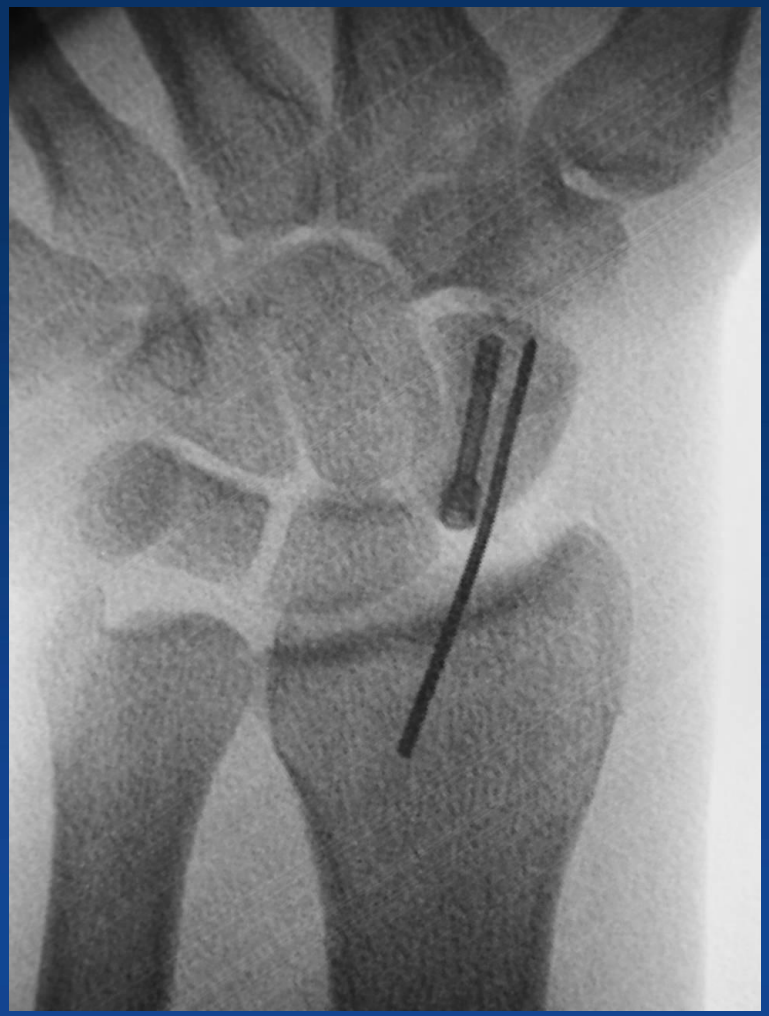


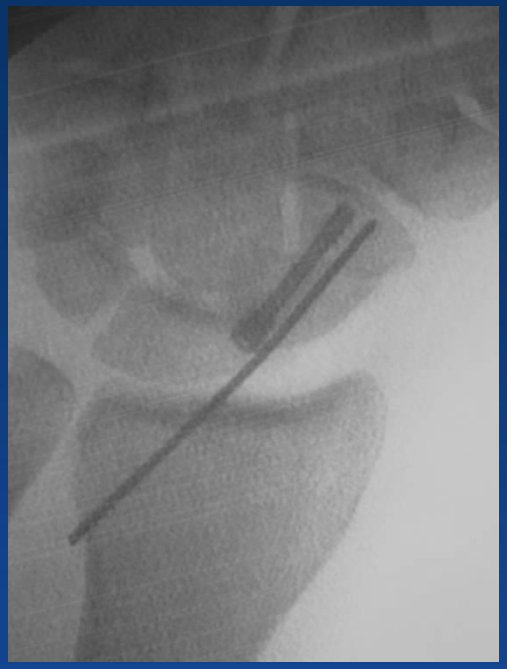
CT Fixation ? Dorsal or Volar

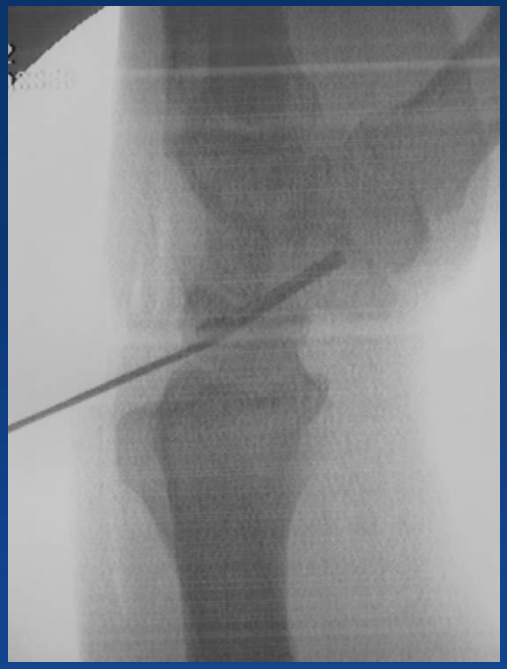




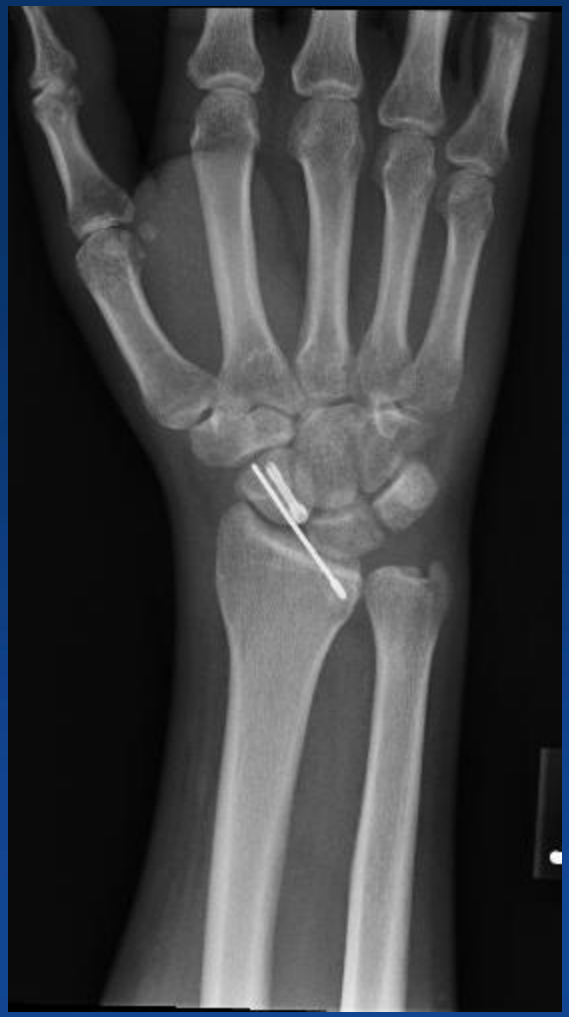
ORIF with K-wire + screw fixation

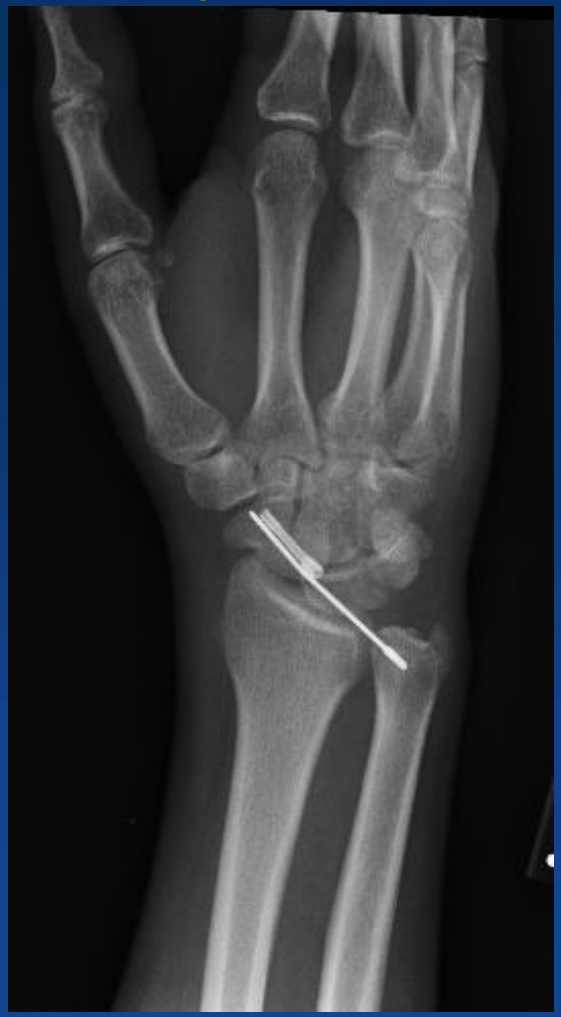


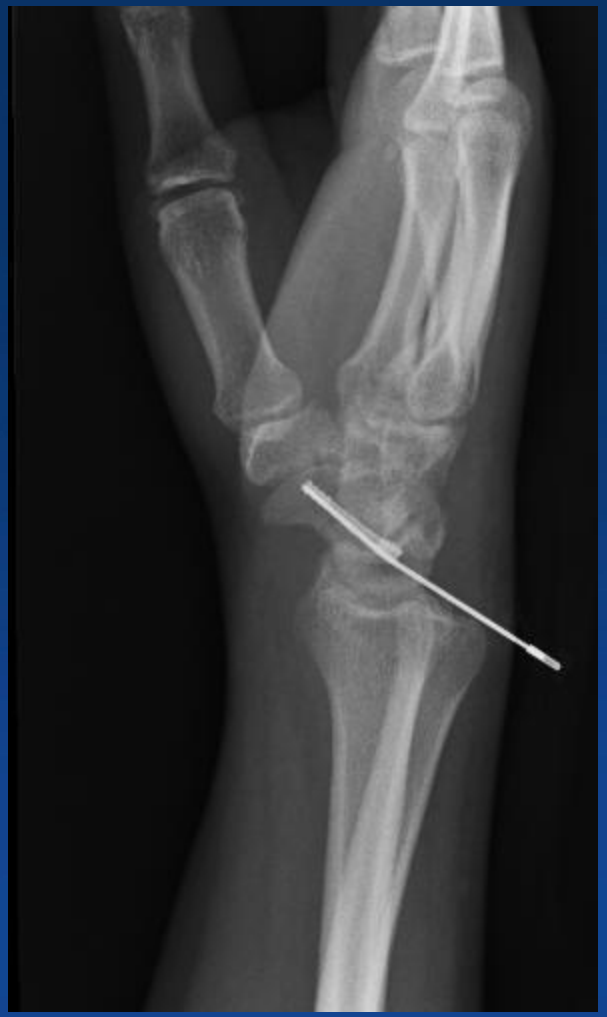




Dorsal approach and adjunctive percut K wire







Summary- Scaphoid Fxs- Techniques

- Make the DX
- Treat with cast for nondisplaced fxs waist/ distal pole
- Treat with dorsal limited open approach and screw fixation for stable fx and for all prox pole fxs
- Treat late fxs (nonunion) or those with volar comminution and humpback flexion deformity with volar approach
- Correct deformity and get volar radial BG to support volar cort defect
- Get guide wire down central axis unless fx pattern very oblique
- Screw length should be 2 mm shorter than measured

Hilltop Park- First Home of the N.Y. Yankees

Site of the Present Day Columbia Univ Medical Center