Distal Radius Fractures

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John T. Capo, MD; Revised January 2006
Original Author: Thomas F. Varecka, MD; March 2004

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

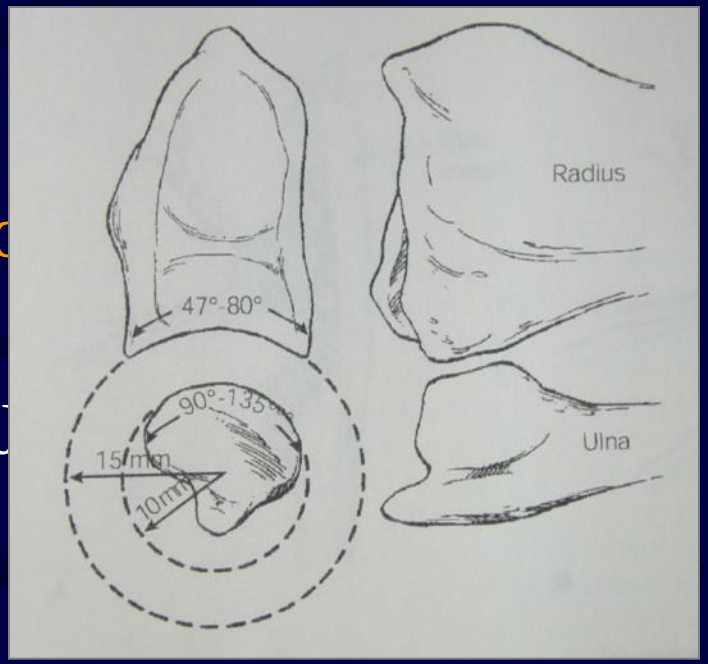
Osseous Anatomy

Distal radius – 80% of axial load

- Scaphoid fossa
- Lunate fossa

Distal ulna – 20% axial lo

Sigmoid notch – DRU



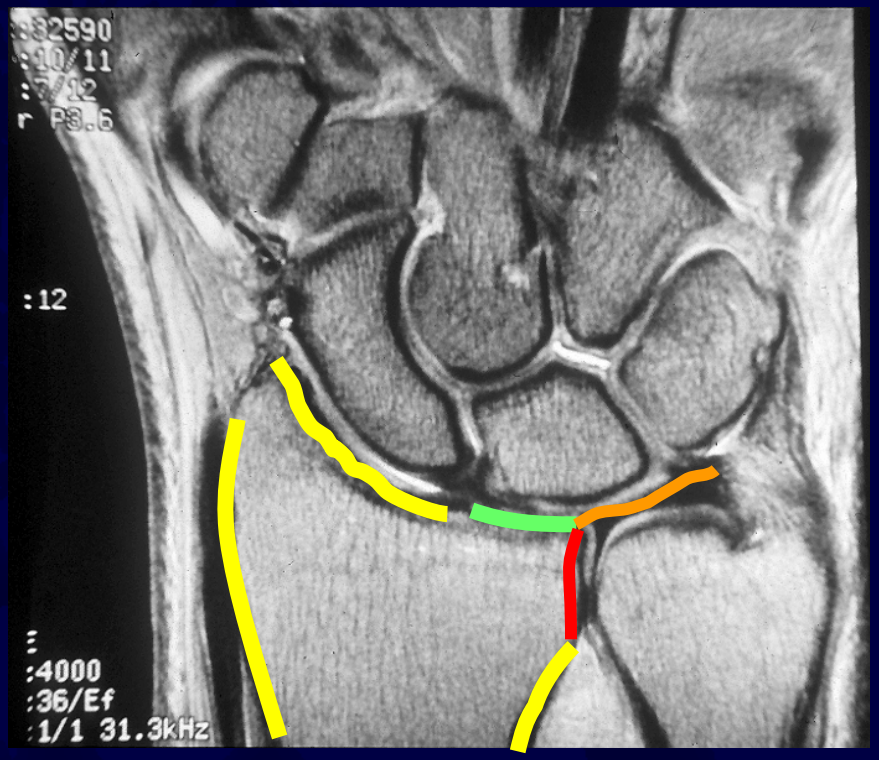
Anatomy

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

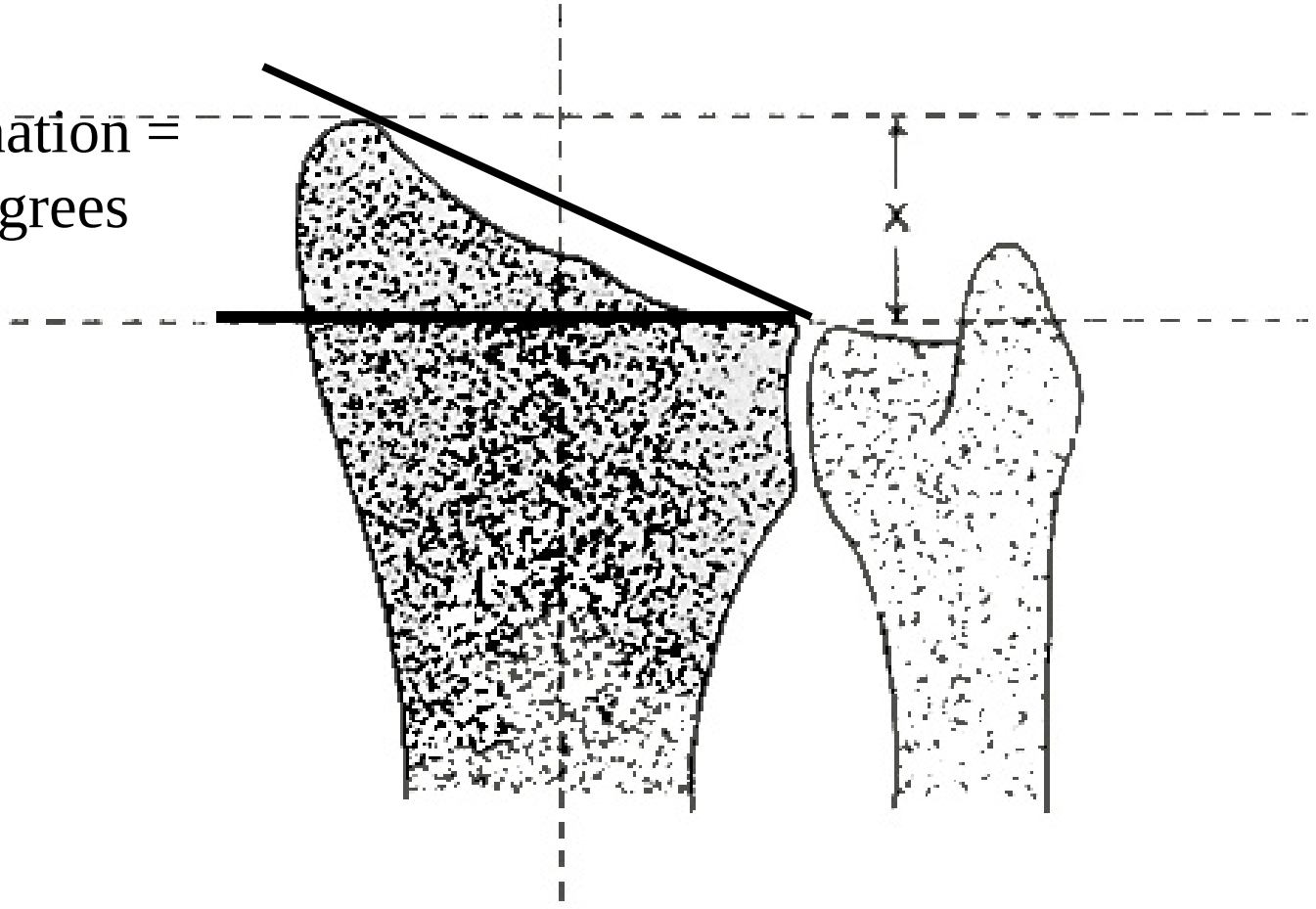
Palmar tilt = 11-14°

Scapho-lunate angle

- 47° +/- 15°

Measurement of Radial Length and Inclination

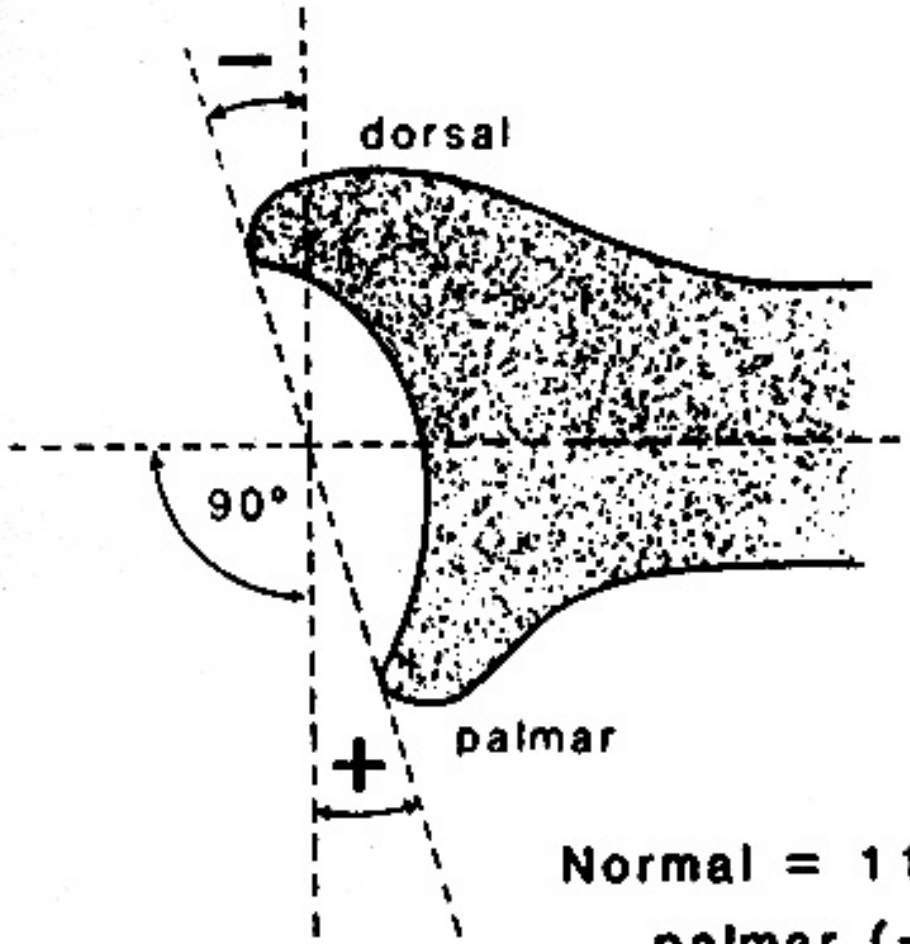
Inclination =
23 degrees



Normal x = 11 – 12 mm

range 8 – 18 mm

PALMAR TILT



Normal = 11-12°

palmar (+) tilt

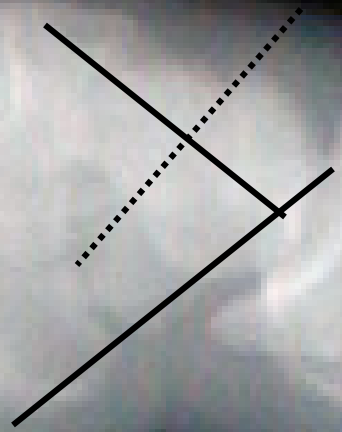
range 0-28°

Scapholunate angle measured between lines 2 and 3

(normal 47 ± 15 degrees)

2: Line perpendicular to lunate

1: Line connecting dorsal and volar tip of 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

Cole et al: J Hand Surg, 1997

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)

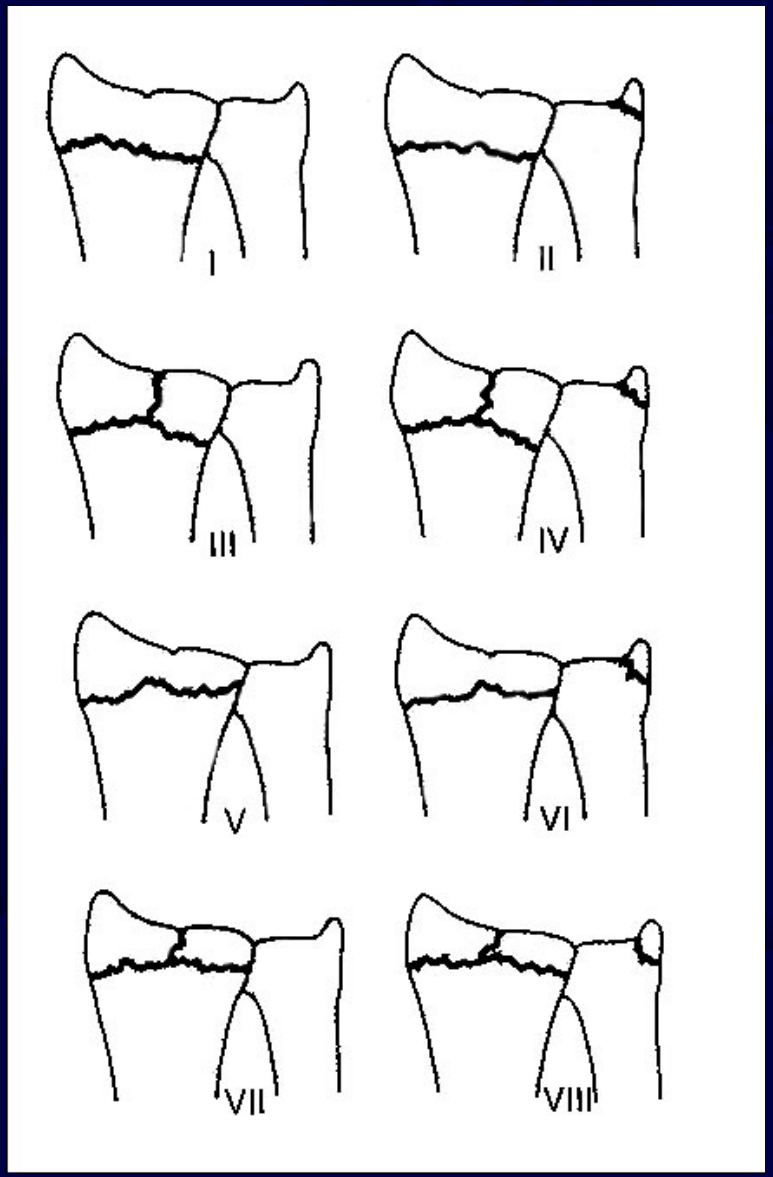
Frykman Classification

Extra-articular

Radio-carpal joint

Radio-ulnar joint

Both joints



Same pattern as odd numbers, except ulnar styloid also fractured

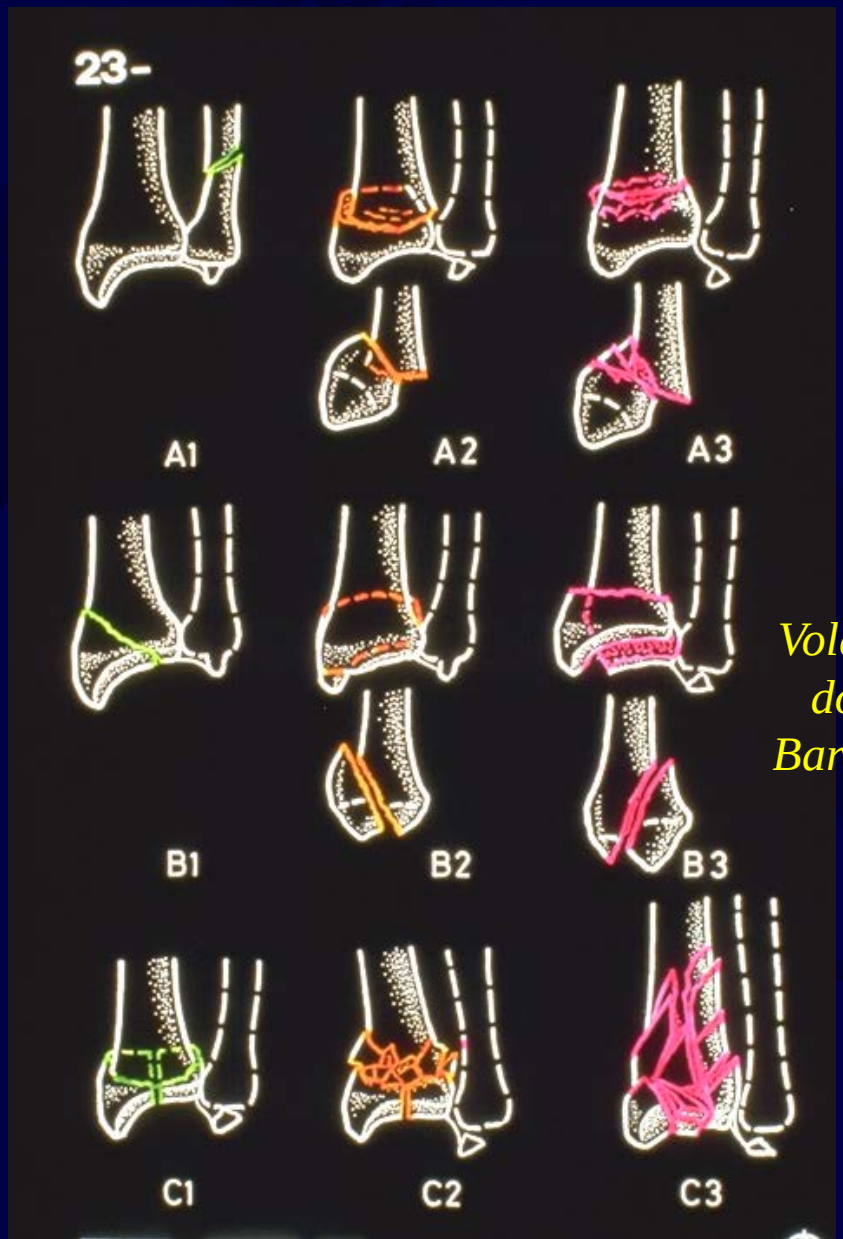
Importance of sigmoid notch articular surface

AO/ OTA Classification

Group A:
Extra-articular

Group B:
Partial Intra-articular

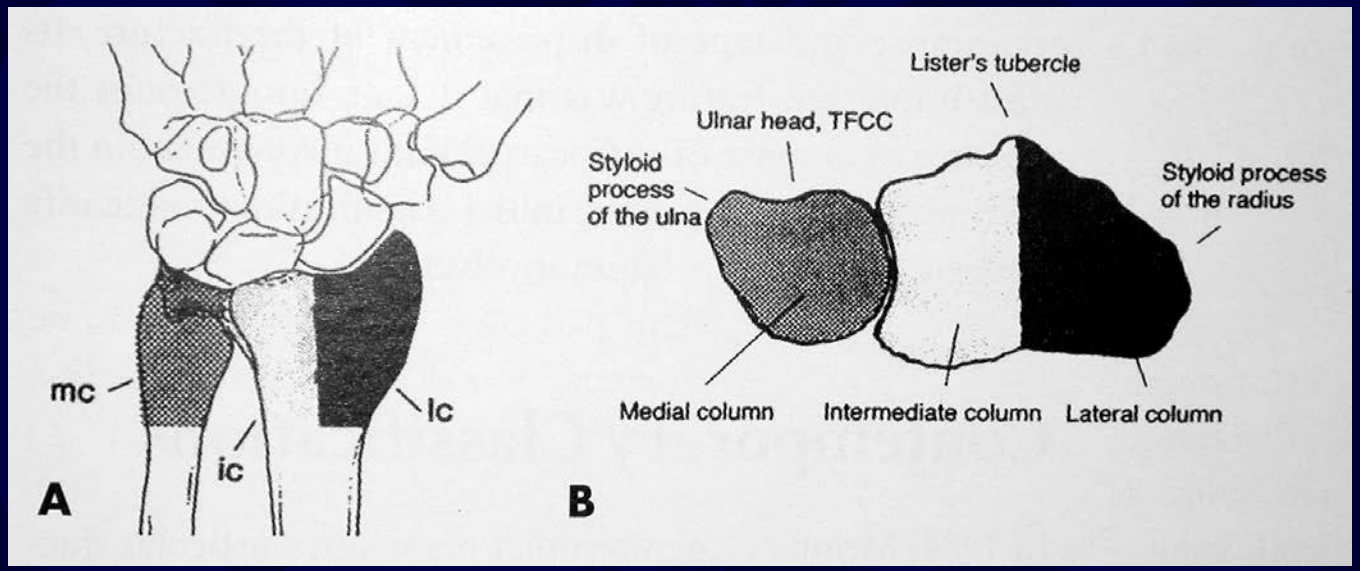
Group C:
Complete Intra-articular



Volar and dorsal Barton fxs

Column Theory

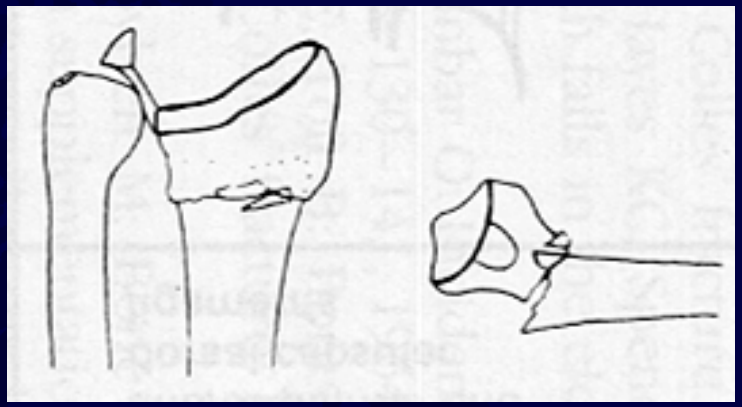
3 Columns: lateral, intermediate, medial



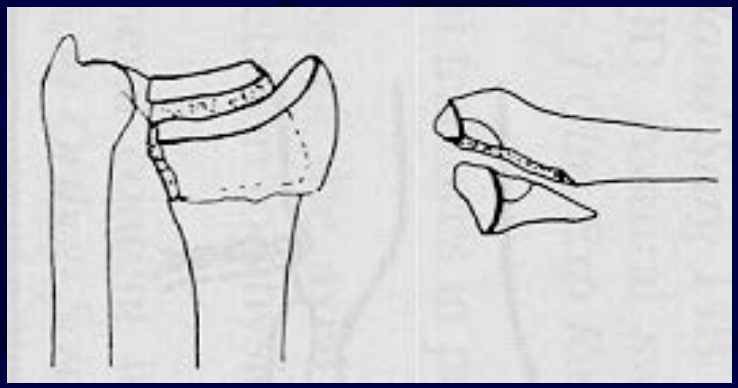
Rikli & Regazzoni, 1996

Classification – Fernandez (1997)

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



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



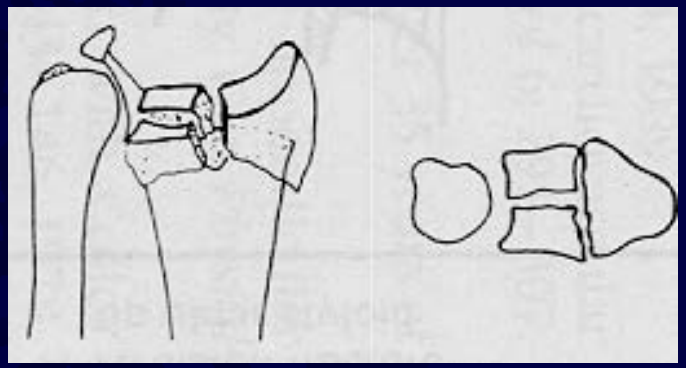
importance of mechanism and energy level of injury

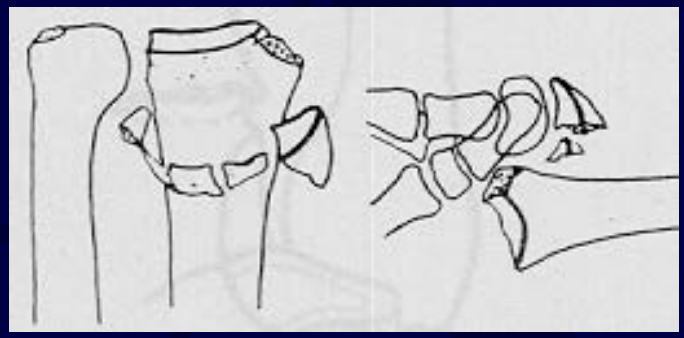
Classification – Fernandez (1997)

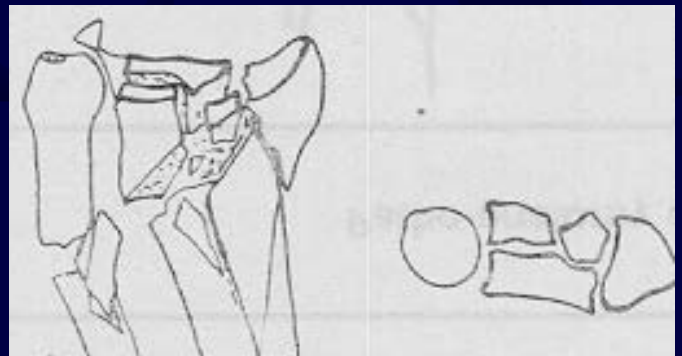
III. Compression - intraarticular fracture with impaction of subchondral and metaphyseal bone (die-punch)

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

V. Combined complex - high velocity injuries







Assessment of X-rays

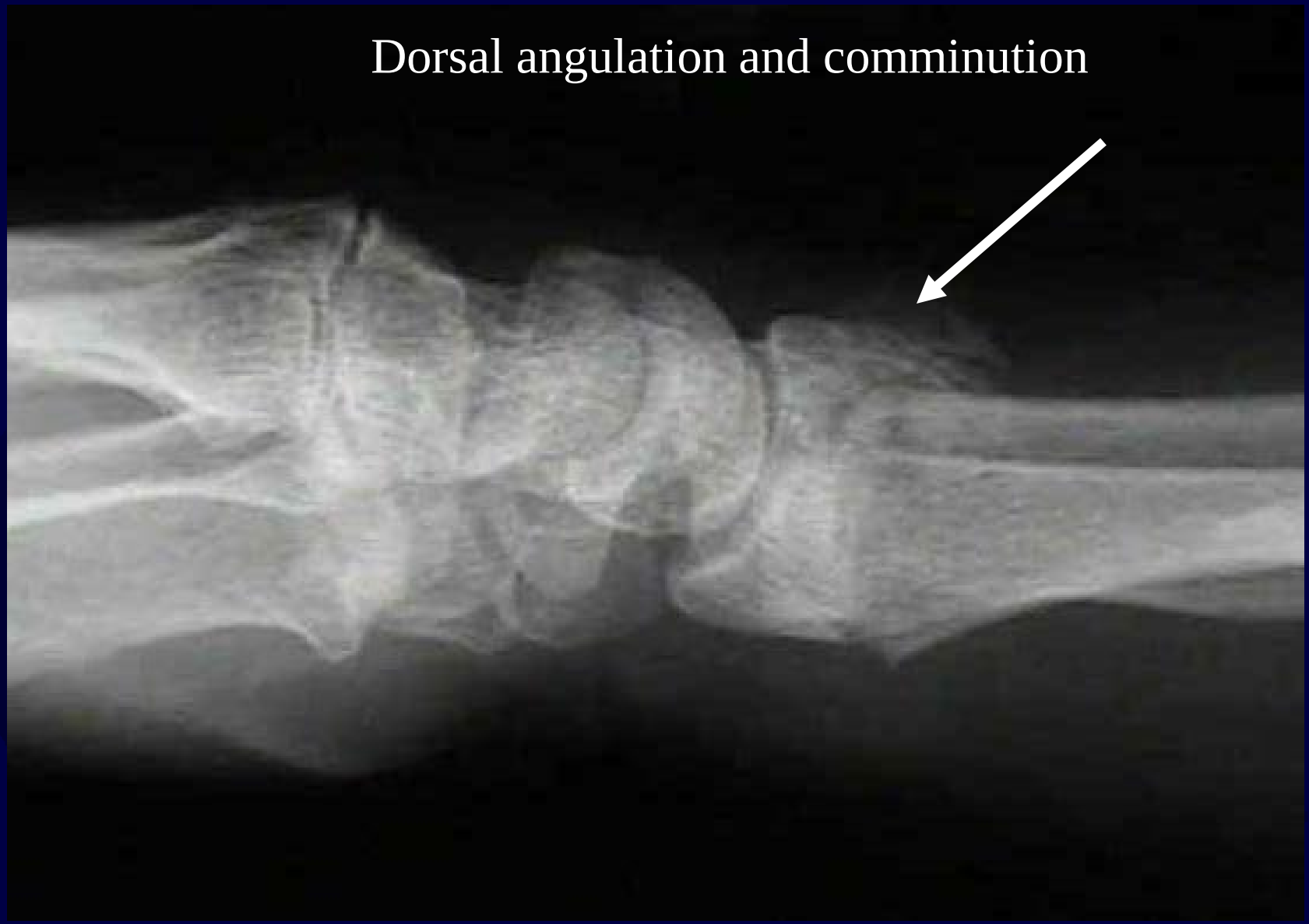
Assess involvement of dorsal or volar rim

- 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

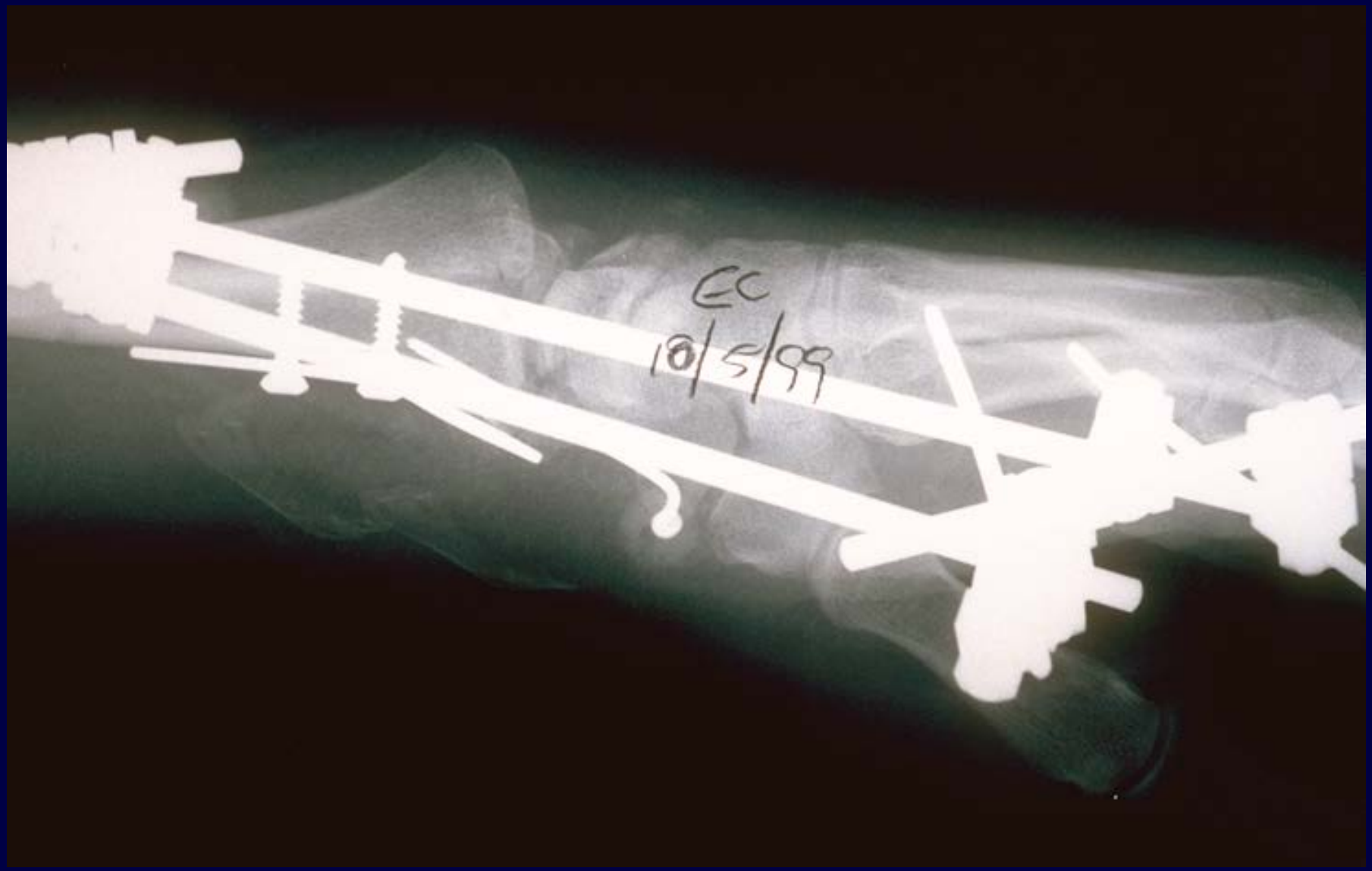
External fixation:

The treatment of choice for distal radius fractures in the 1980's

Has fallen out of favor


EC
9/24/99


EC
9/24/99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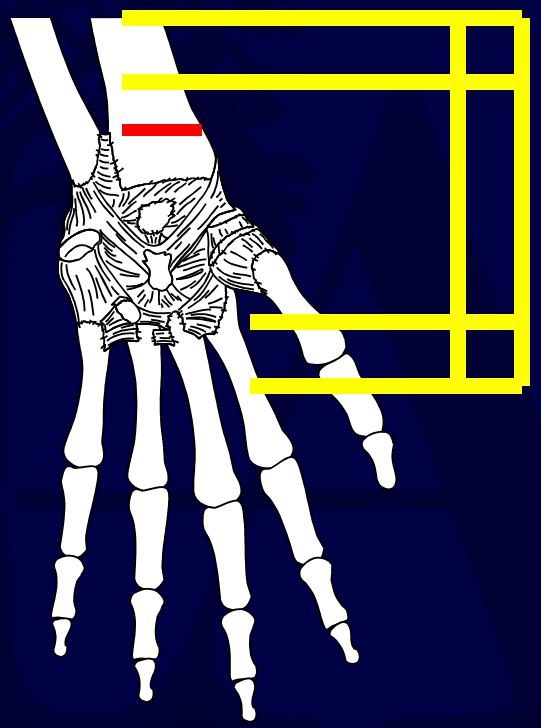
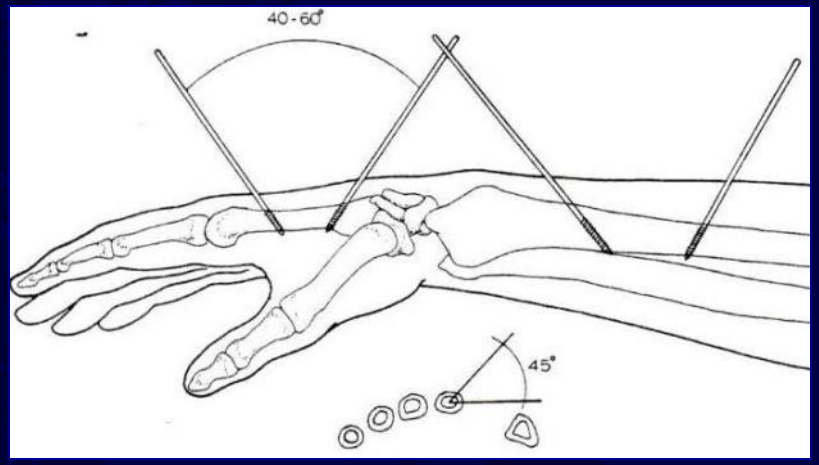
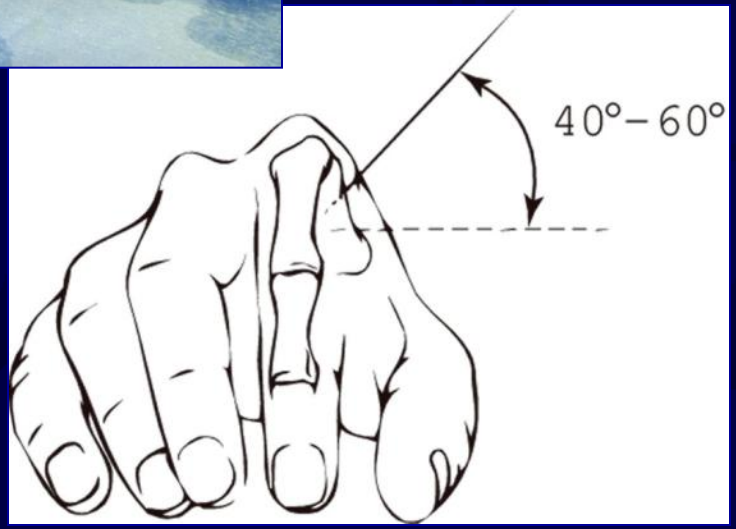
Spanning

A spanning fixator is one which fixes distal radius fractures by spanning the carpus; I.e., fixation into radius and metacarpals



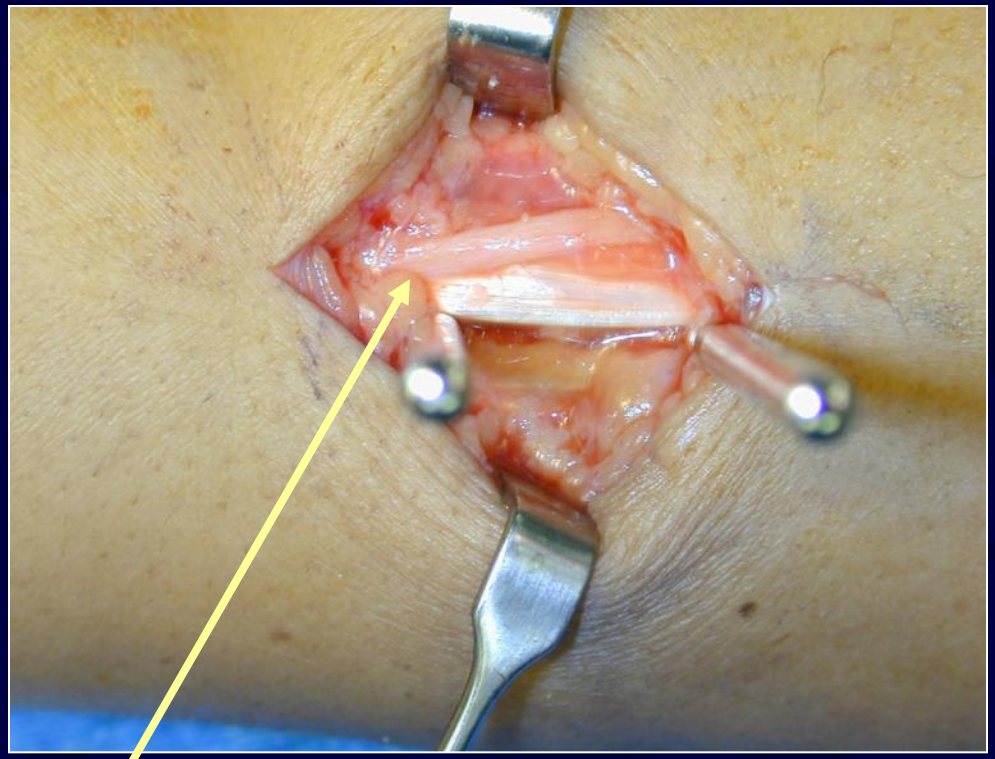
Pin Placement





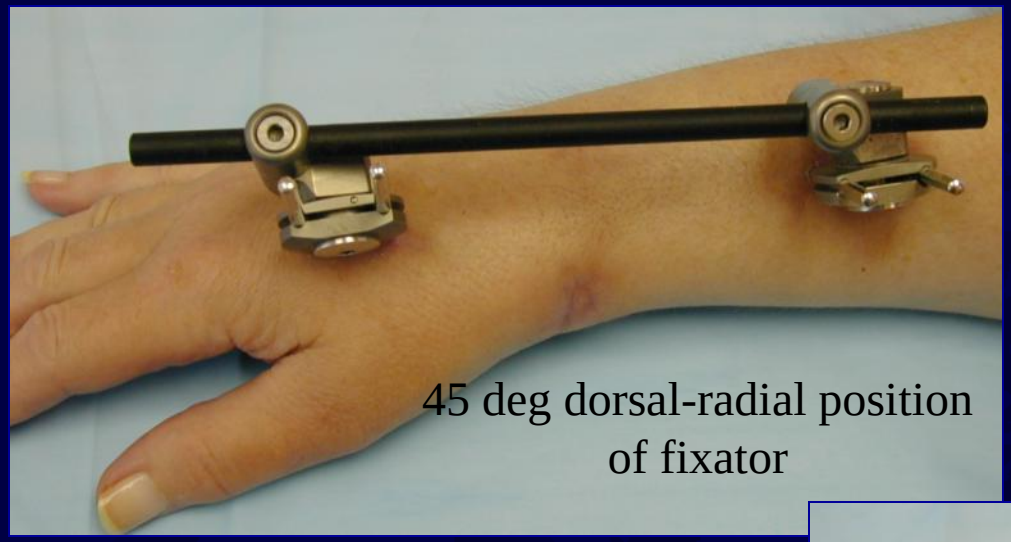
45° dorsal-radial

Pin Placement: proximally –open incision

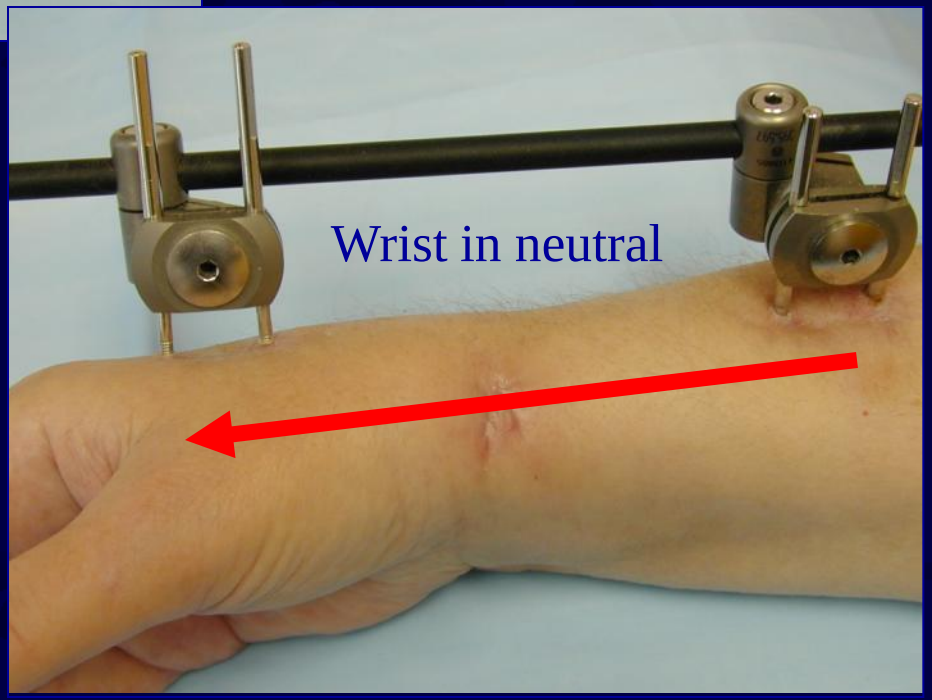


Identify SRN

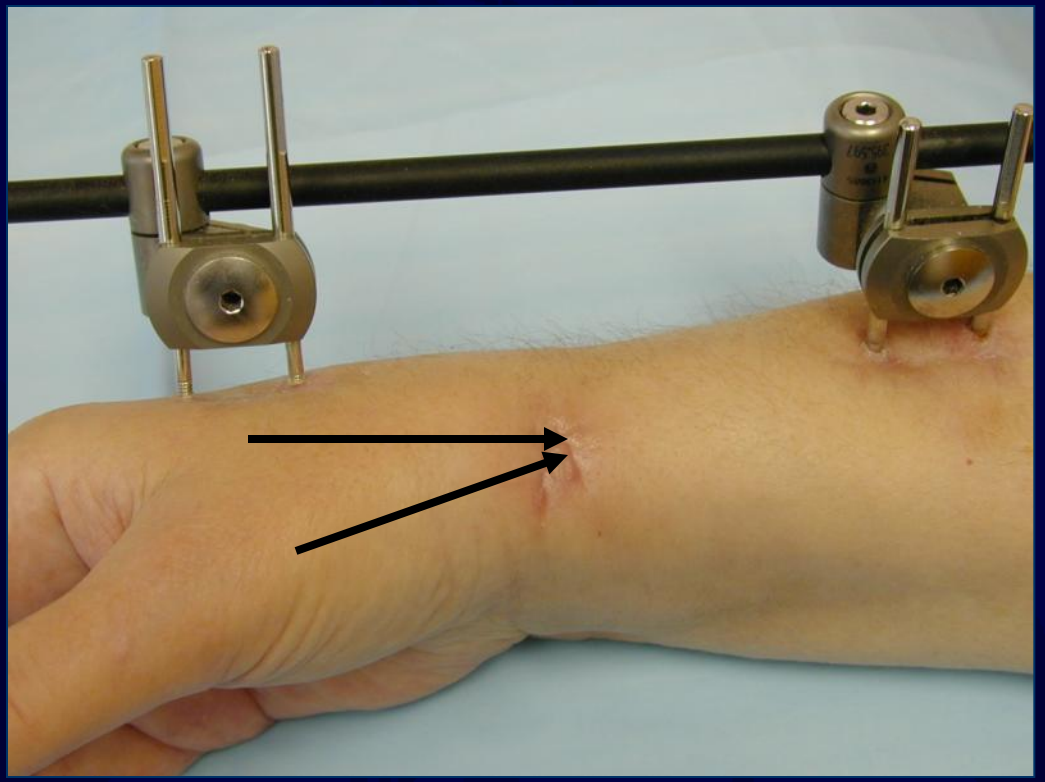
Between ECRL and ECRB



Allows retropulsion of thumb

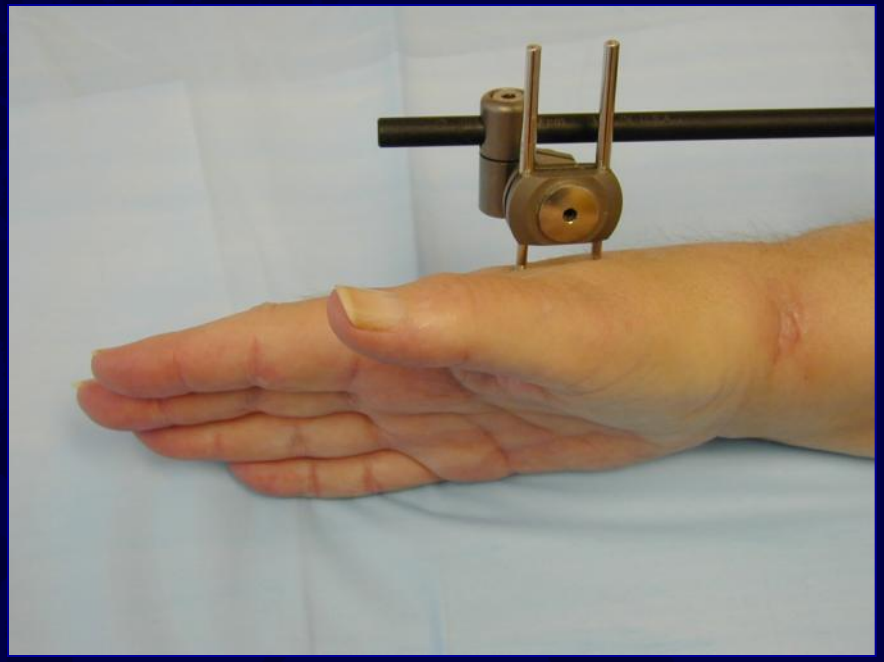


Ex fix and supplementary Pins



Can place percutaneous pins easily

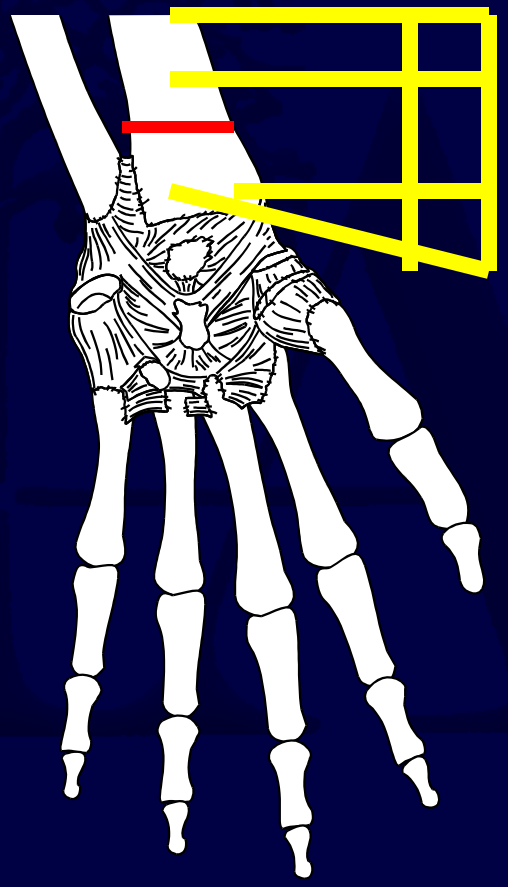
Can Remove Ex Fix or Pins
Sooner if Needed



full finger motion

Non-spanning

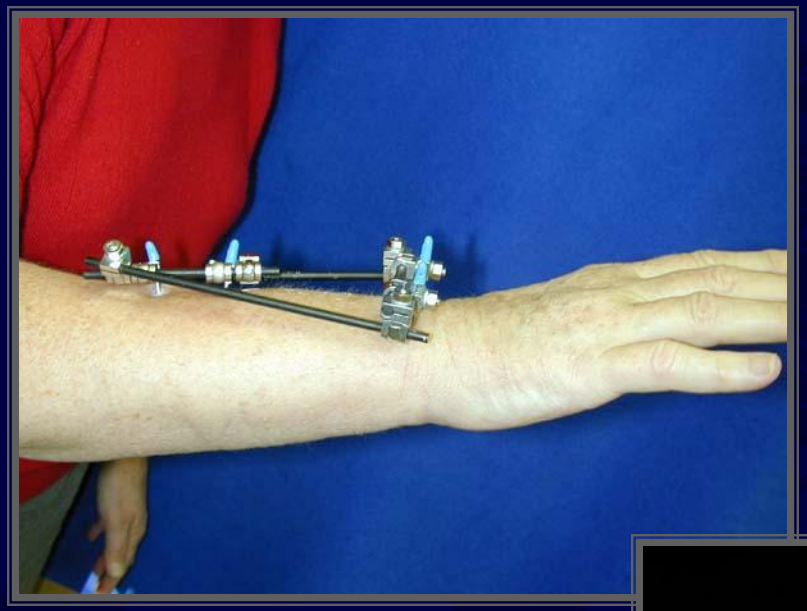
A non-spanning fixator is one which fixes distal radius fracture by securing pins in the radius alone, proximal to and distal to the fracture site.

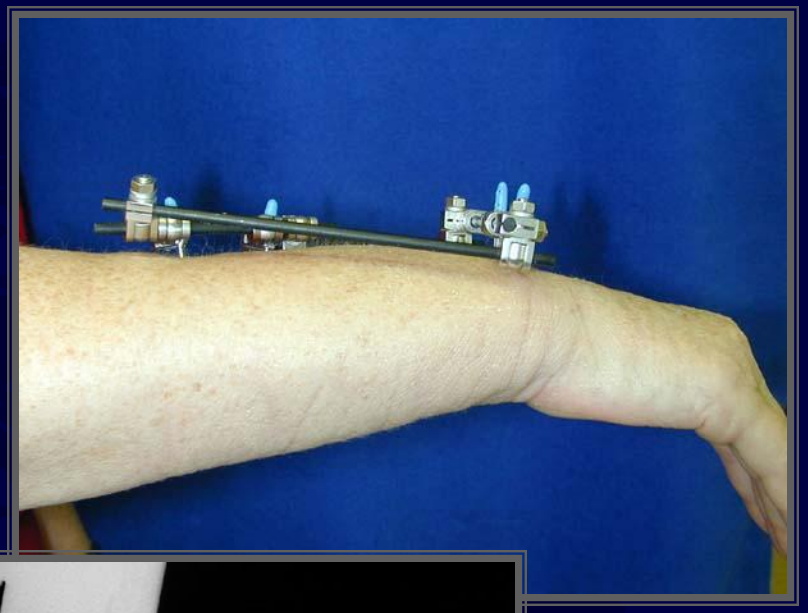



KH
9/22/99

Limited indications

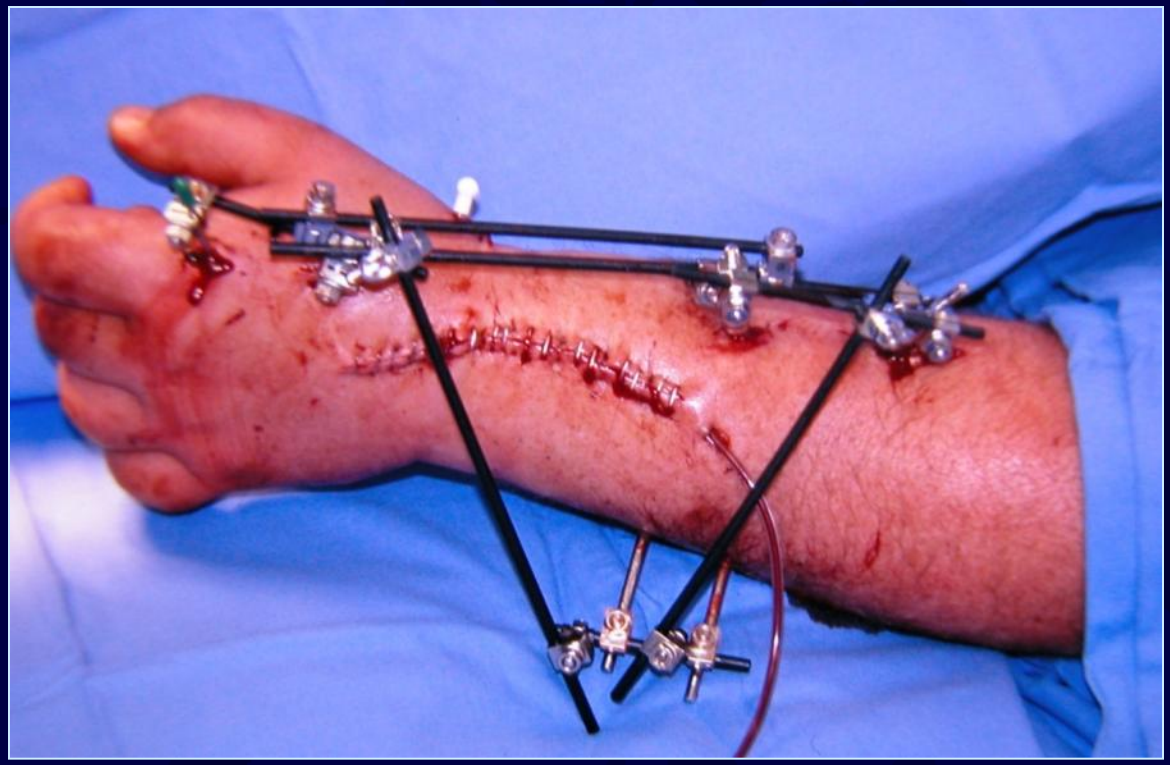
But literature shows good results





Early ROM permitted

Courtesy of Hill Hastings,MD



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 @ 10^0, 20^0 and 30^0 of flexion

volar tilt of distal radius could not be re-established

Ligamentous Anatomy

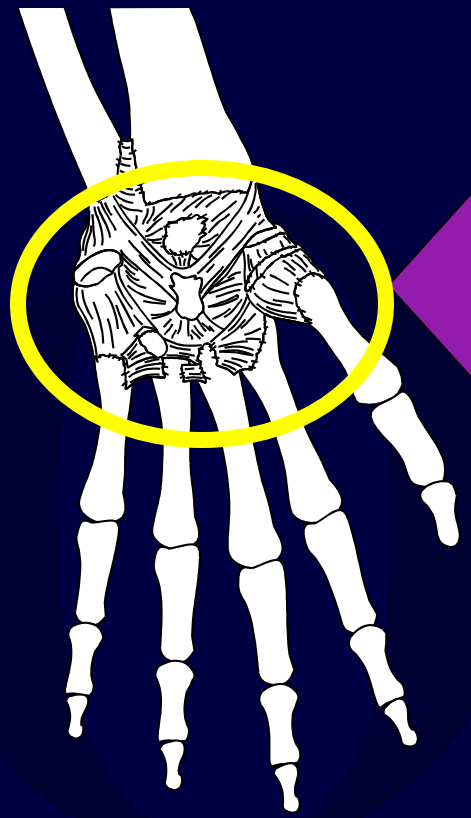
Volar ligaments

- Straight fibers
- Stout
- Tighten readily

Dorsal ligaments

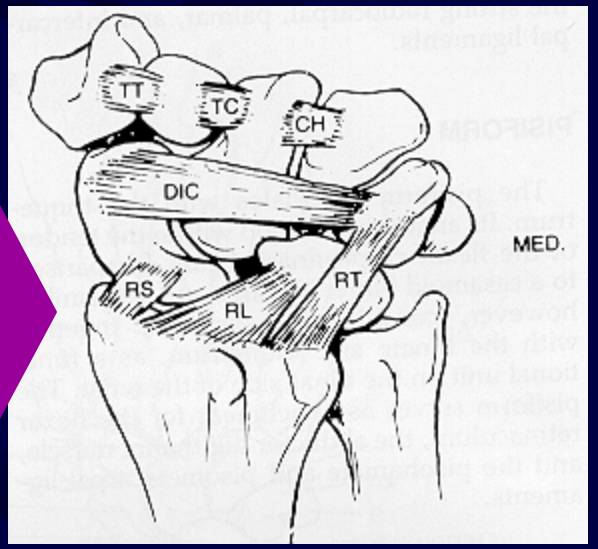
- Zigzag
- Elastic
- Tighten slowly

WRIST LIGAMENTS



VOLAR LIGAMENTS MORE STOUT

Dorsal ligaments more lax, zigzag



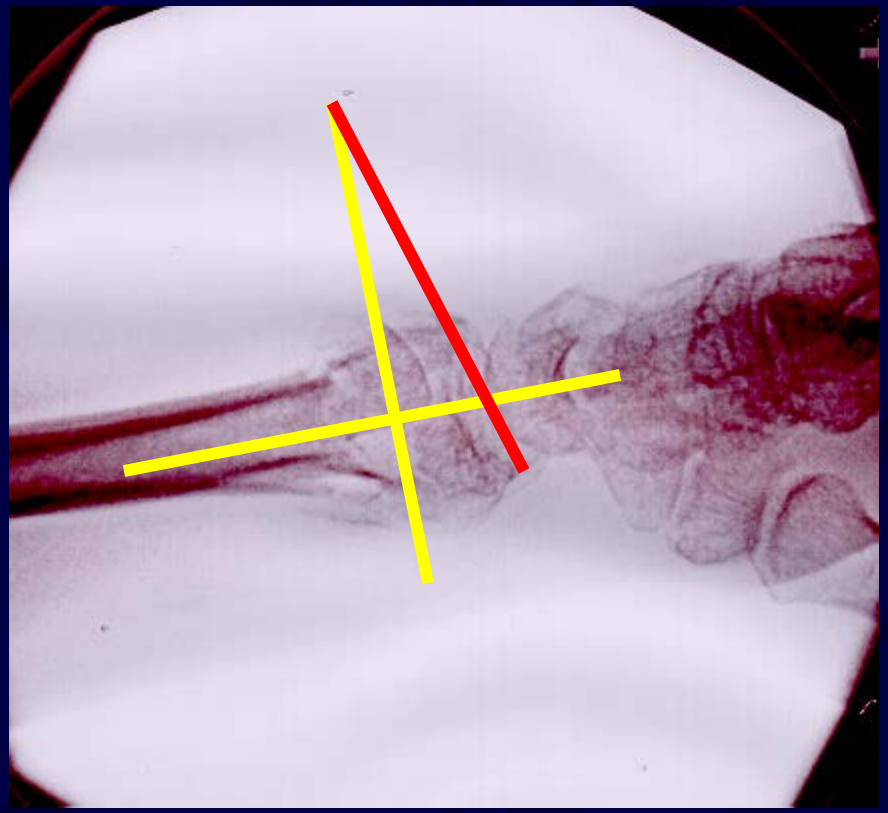
Non-Spanning vs. Spanning Fixator

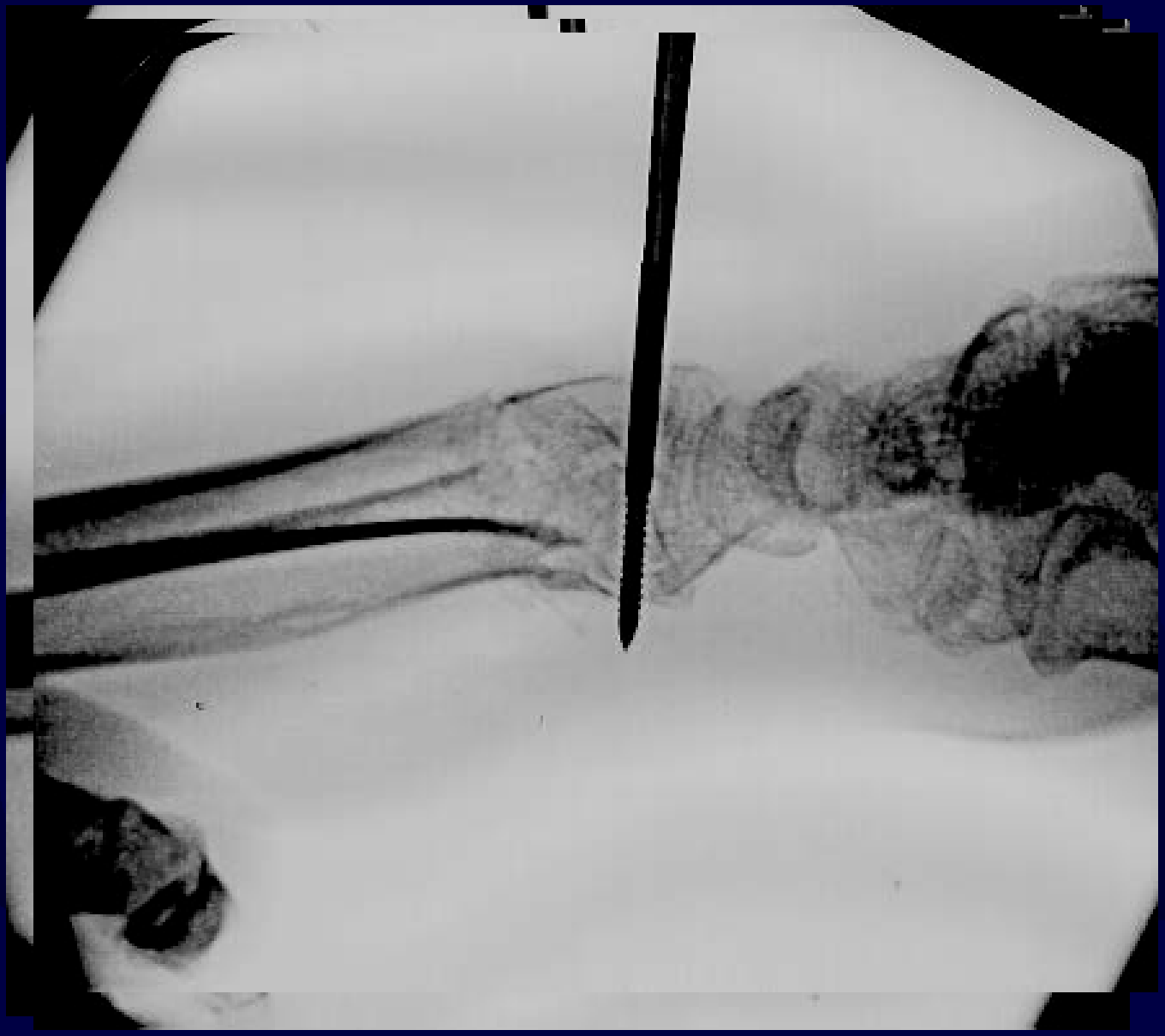
McQueen, JBJS-B, 1998

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”

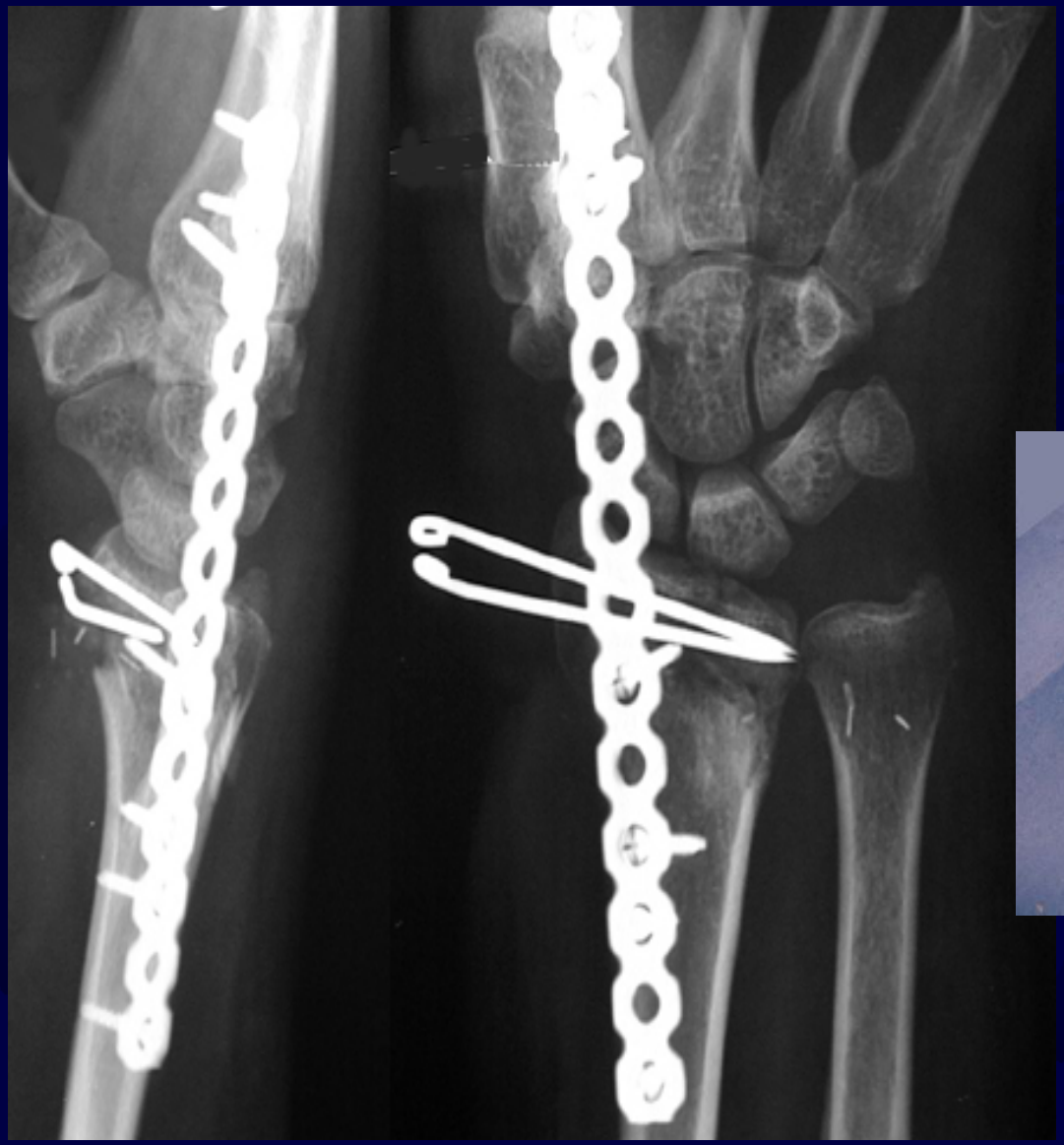
Indications

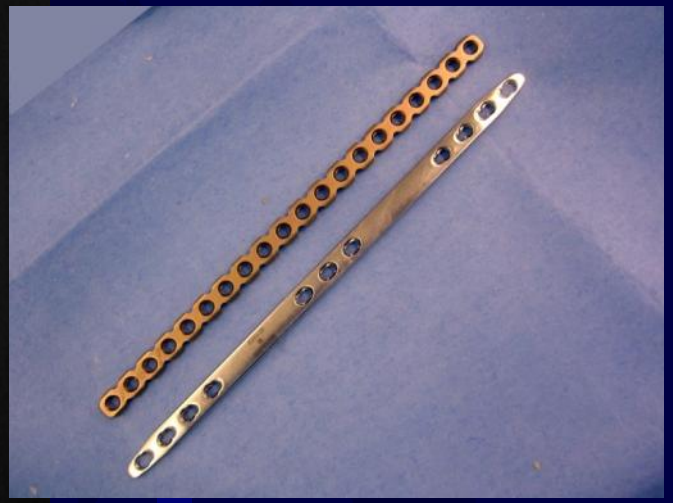
High energy comminuted fractures

ICU patients where perc pins are undesirable

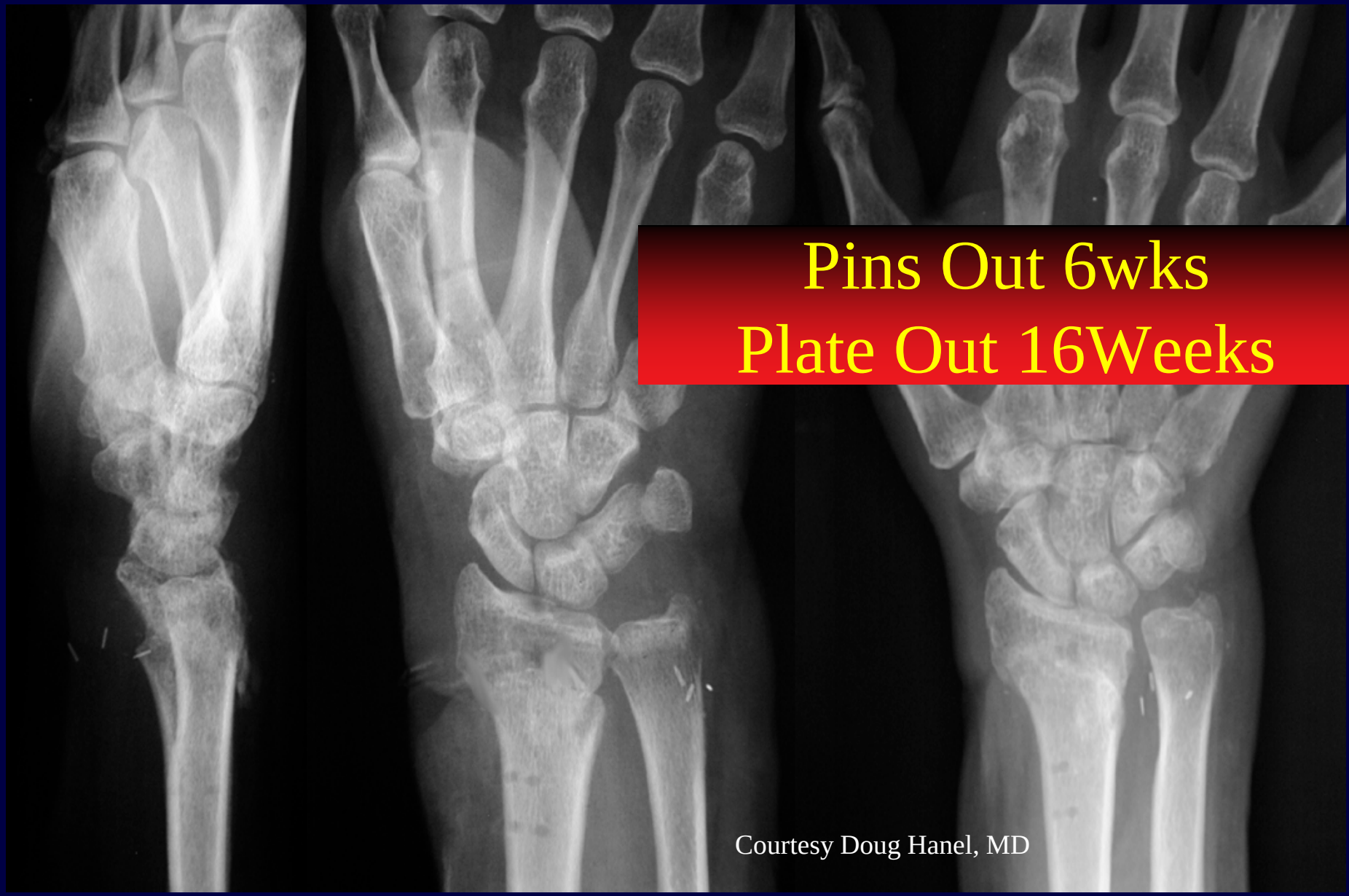
Pts that can’t tolerate an external fixator

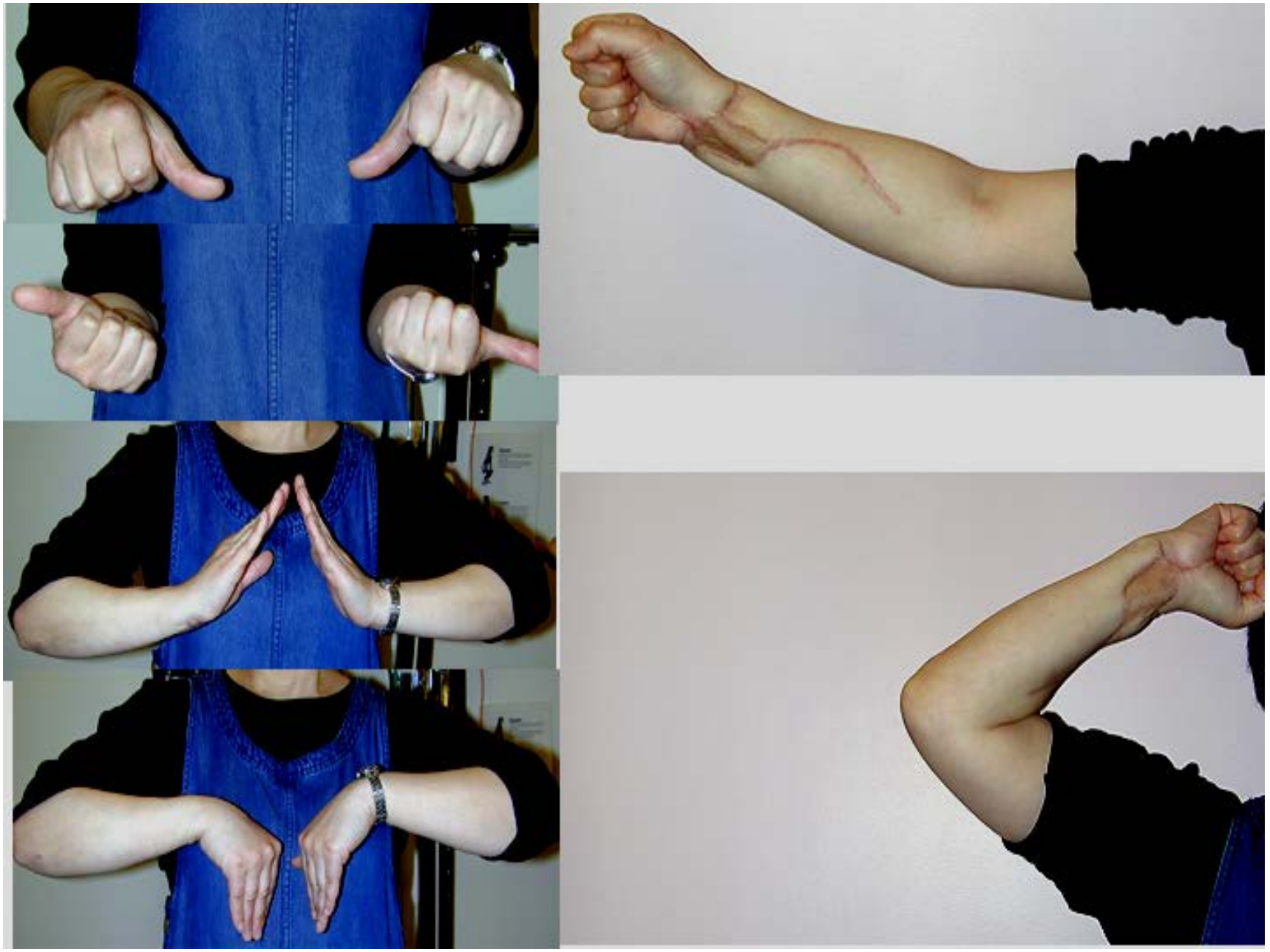
Courtesy Doug Hanel, MD





Courtesy Doug Hanel, MD


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



Courtesy Doug Hanel, MD

Percutaneous Pinning-Methods

variety described

most common radial styloid pinning ± dorsal-ulnar corner of radius pinning

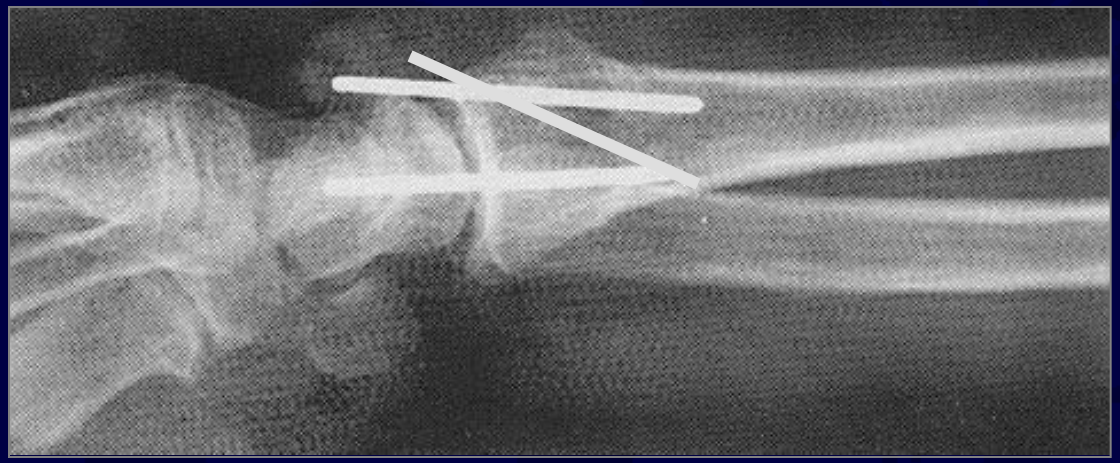
supplemental immobilization with cast, splint

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%

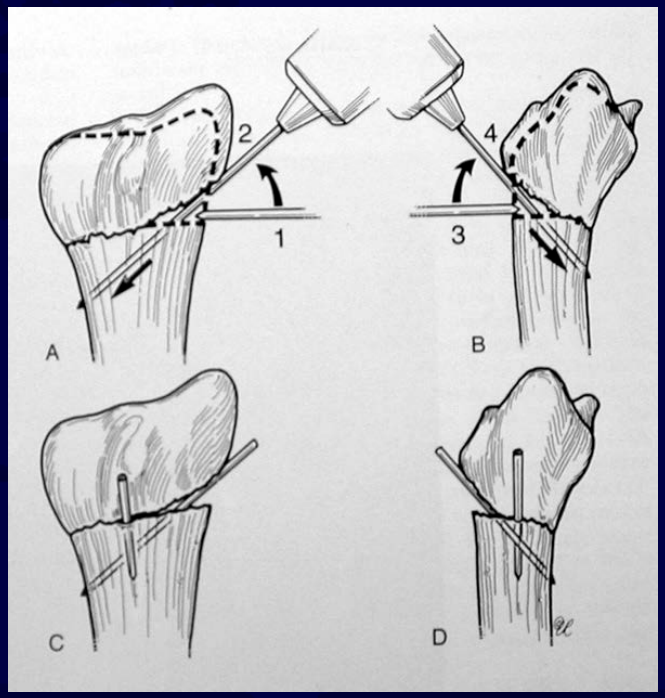
Percutaneous Pinning-Kapandji

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

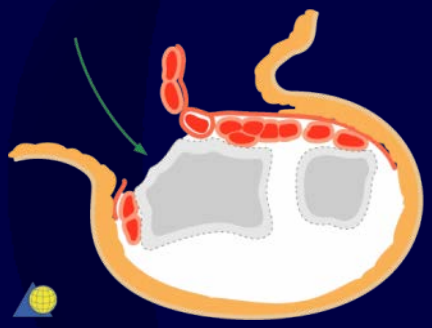
- Occasionally for dorsally displaced fractures that can' be reduced from volar approach

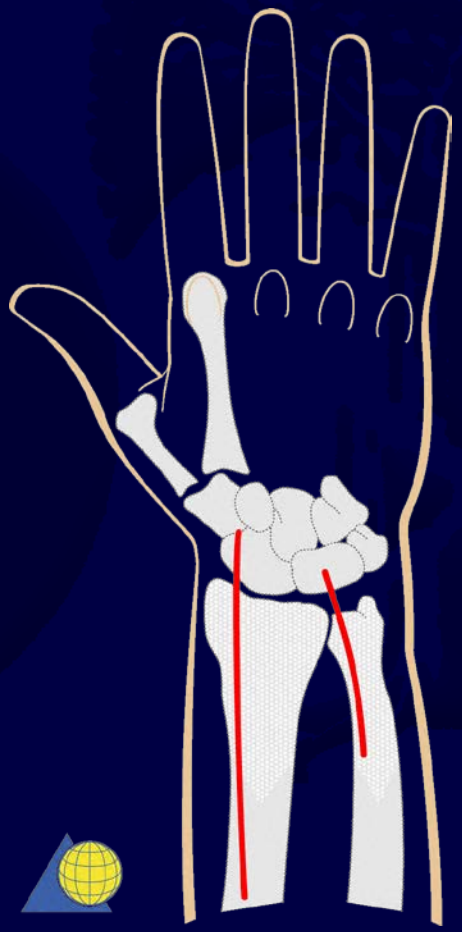
Combined approaches needed for high-energy fractures with significant axial impaction.

WHICH APPROACH?

DORSAL

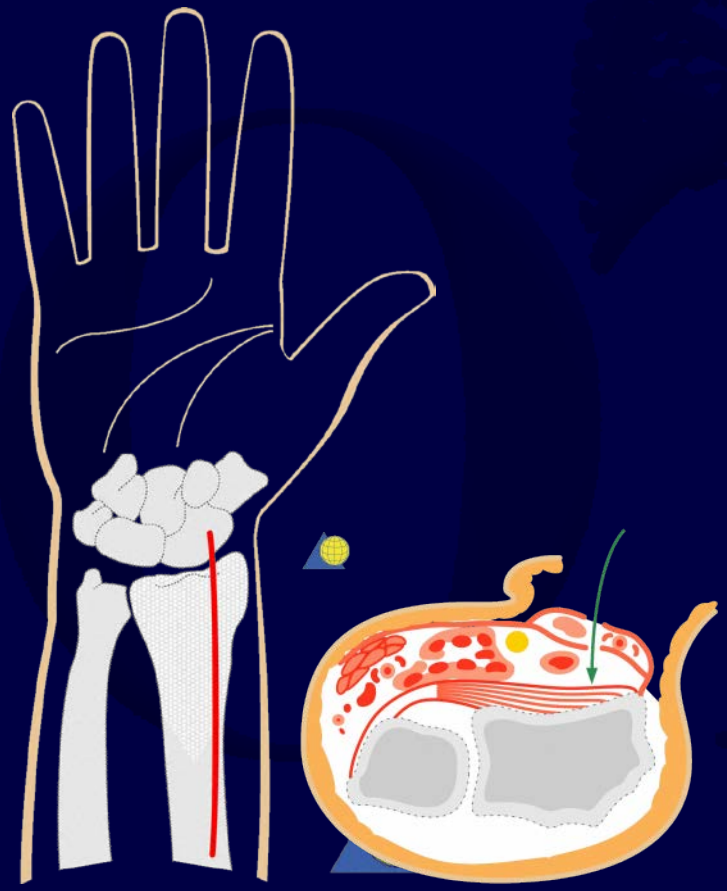
1-2nd DC



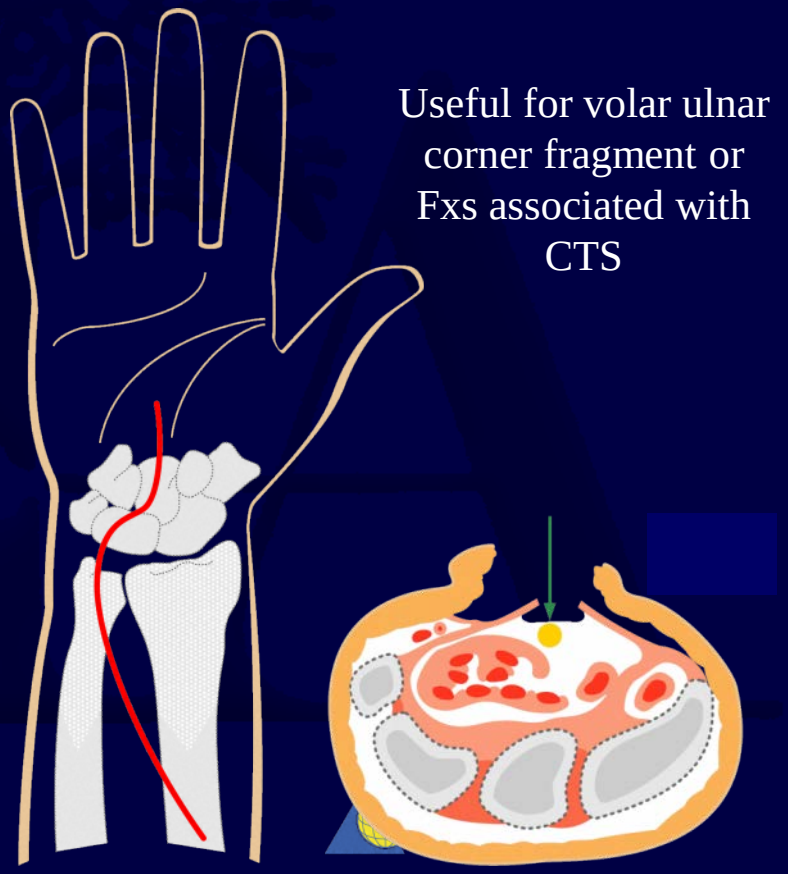


VOLAR

Classical Henry approach



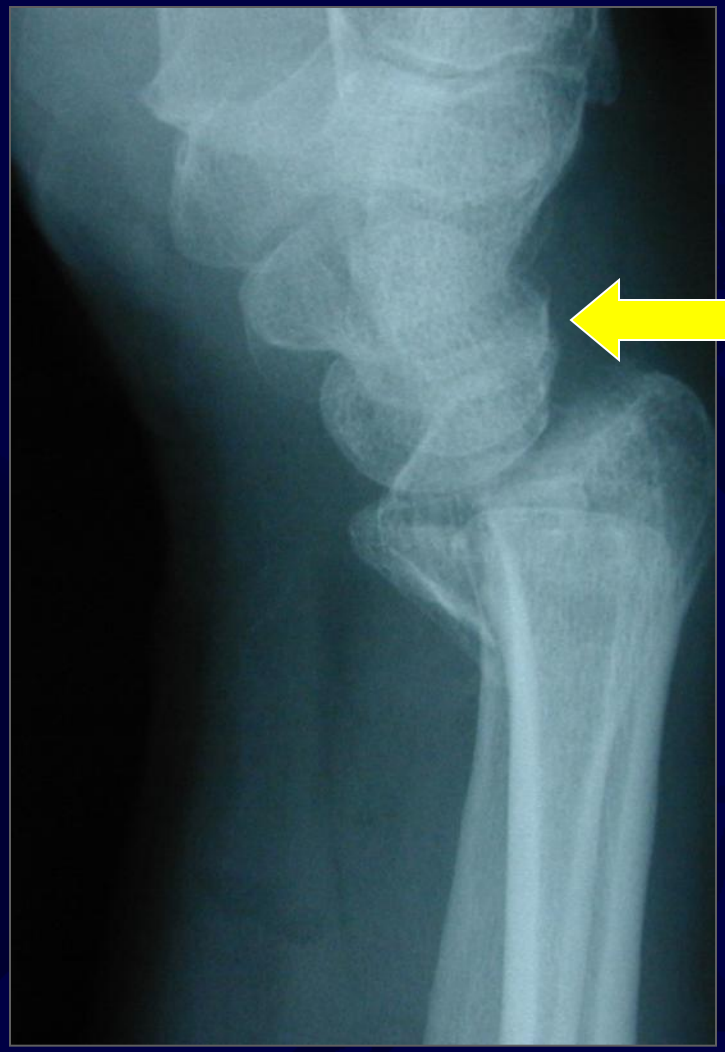
Extended carpal tunnel approach



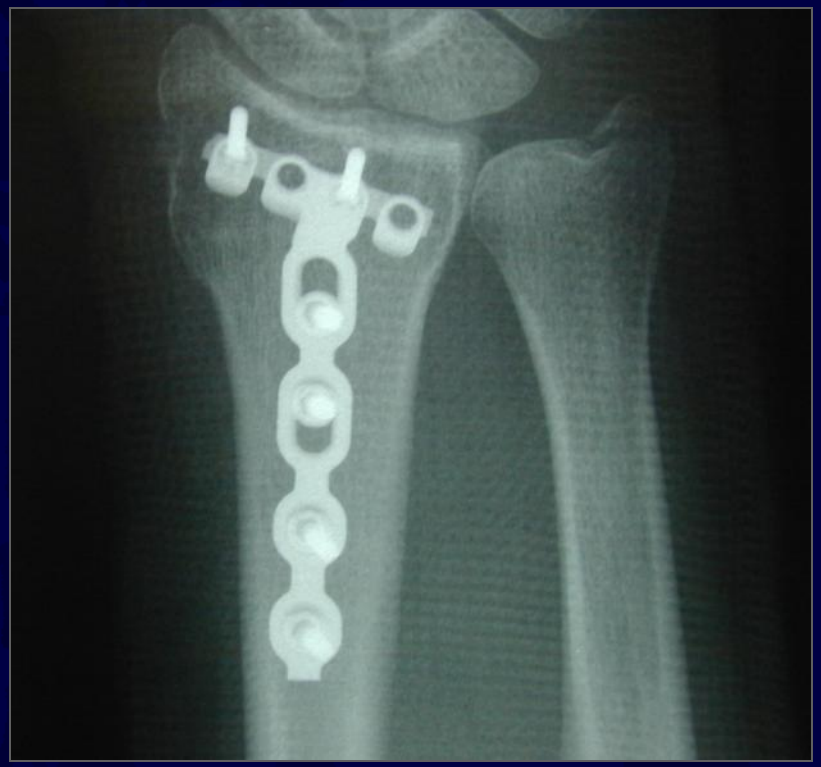
Useful for volar ulnar corner fragment or Fxs associated with CTS

Distal Radius- “volar Barton”

64 y.o. M, MVA, contralateral tibial shaft Fx

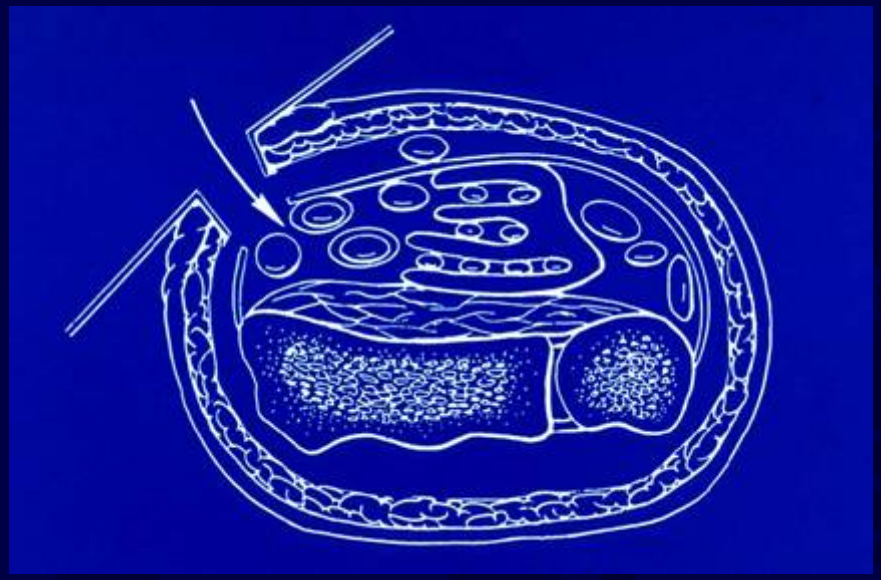


Carpal subluxation

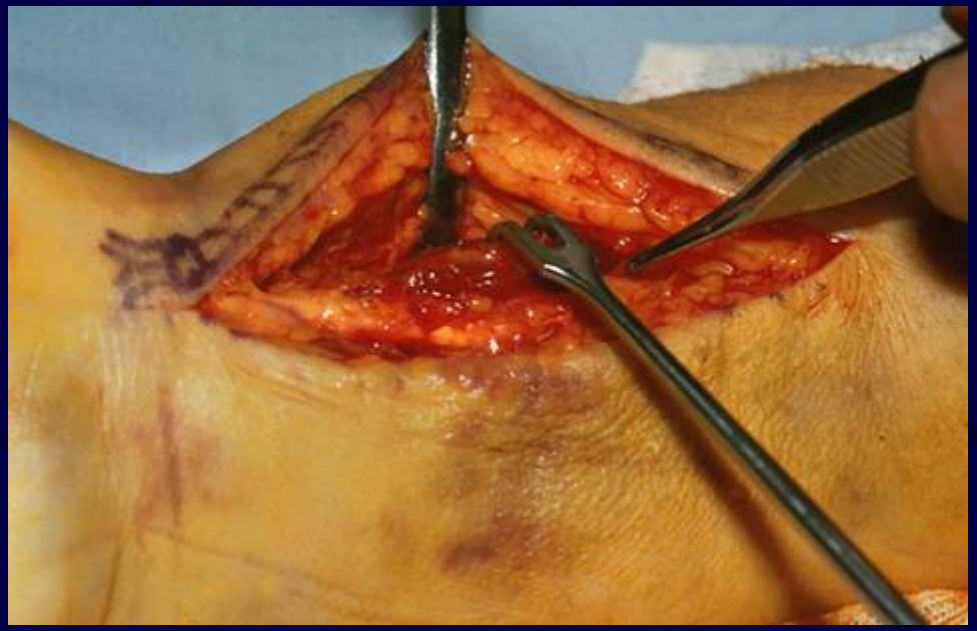


Courtesy Diego Fernandez, MD

Volar –Henry Approach



Radial to FCR



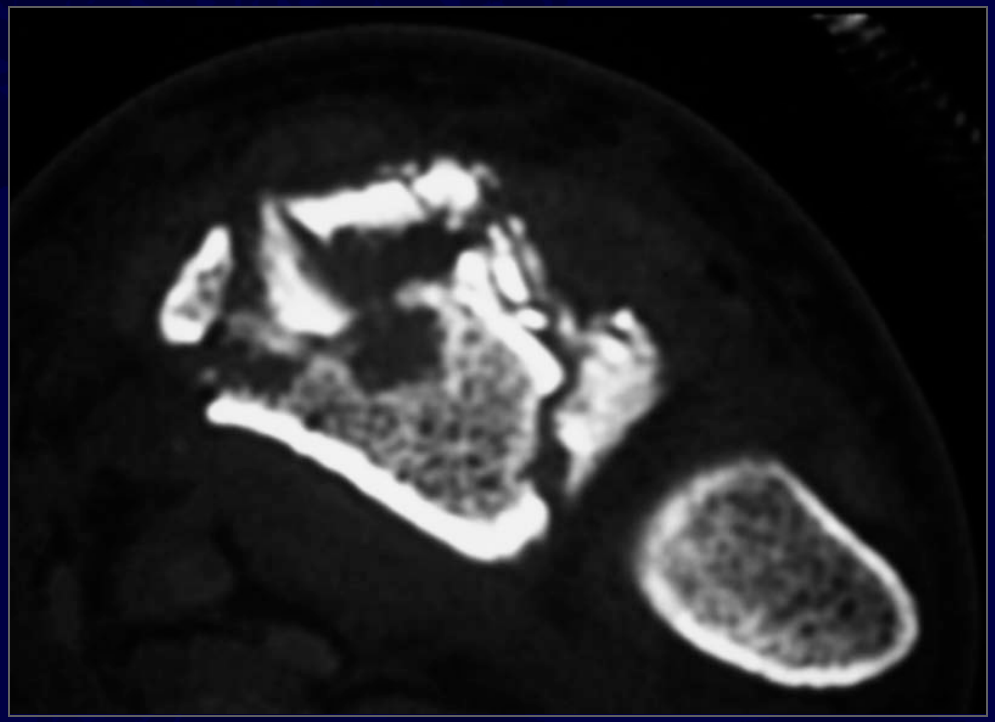
Courtesy Diego Fernandez, MD

Elevate Pronator Quadratus

Courtesy Diego Fernandez, MD

Primarily Dorsal Fracture

CT Scan



Dorsal Plating, PCP and Ex Fix

Joints aligned
plates removed


UNION PARK


UNION PARK

Volar Plating for Dorsal Fractures

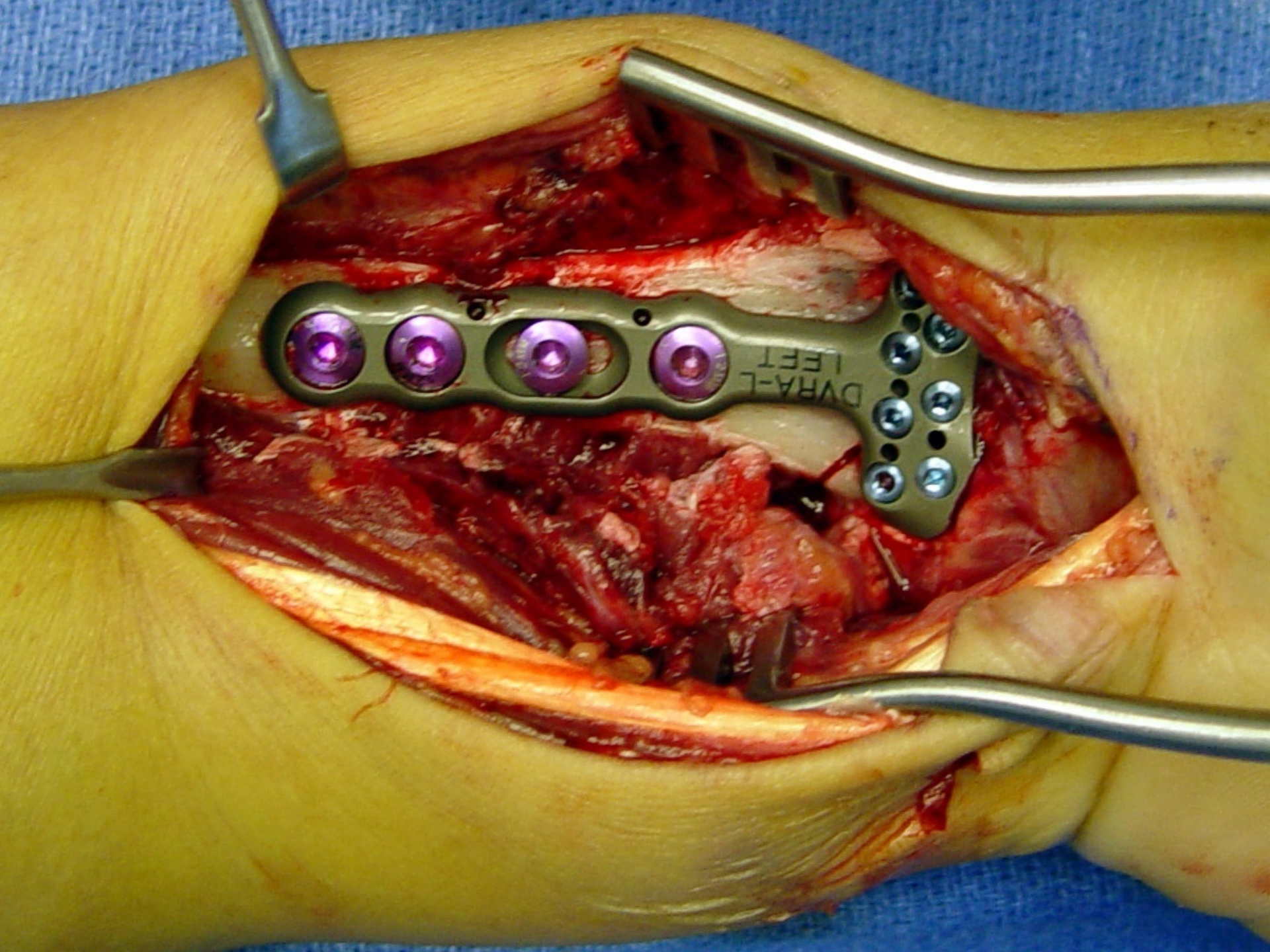
-less tendon irritation than dorsal plating

- indirect reduction

-better tolerated than Ex fix

Fixed angle locked screws

Courtesy Jorge Orbay, MD


DVR A-L
LEFT

Courtesy J. Orbay, MD

Three Column Theory

Radial Column

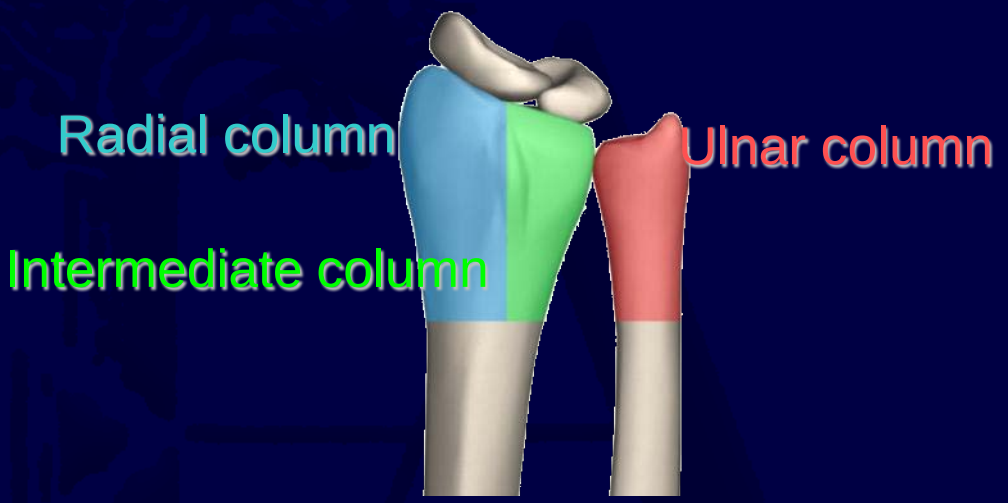
Lateral side of radius

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

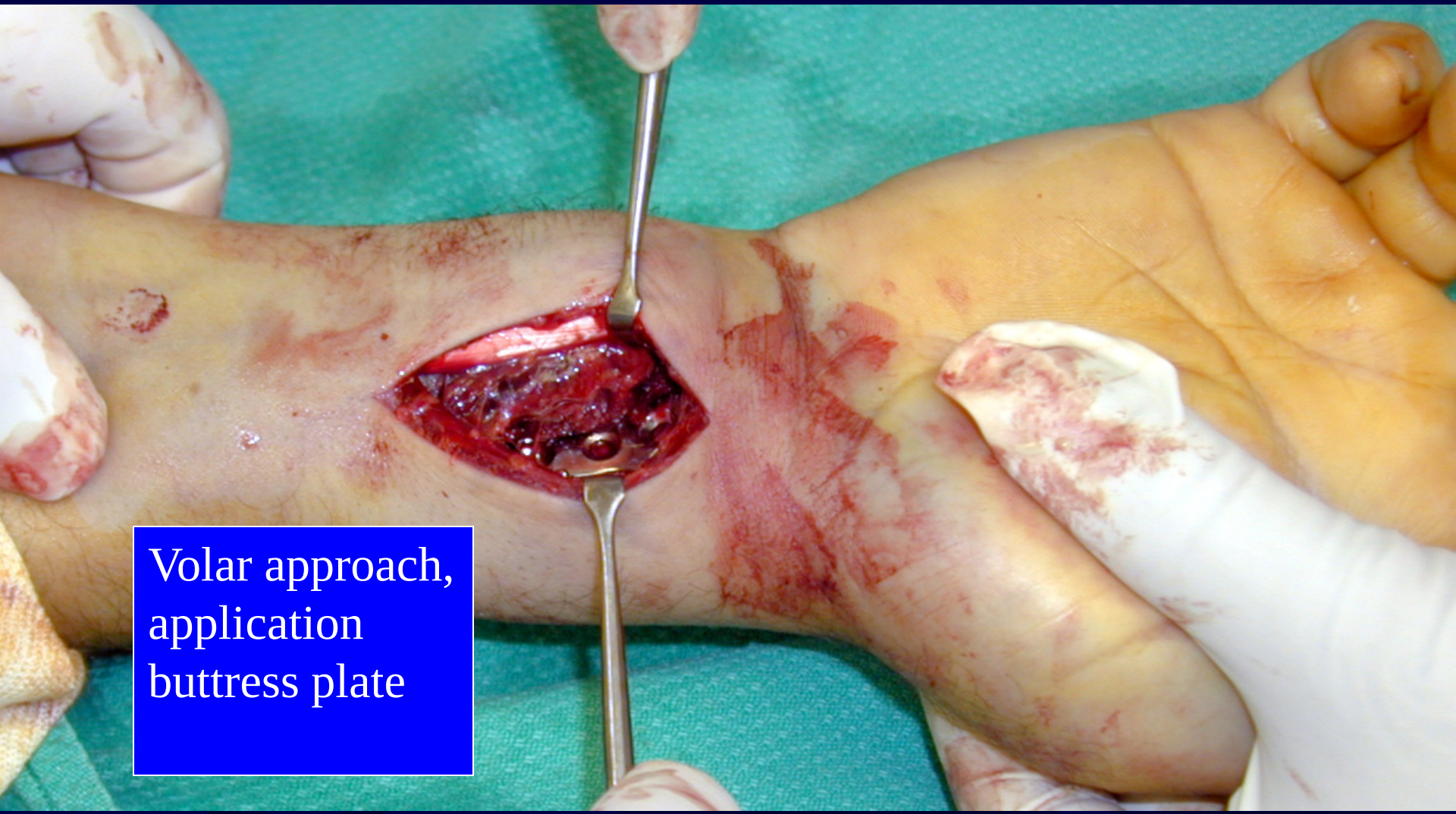
Radial Styloid and dorsal-ulnar corner

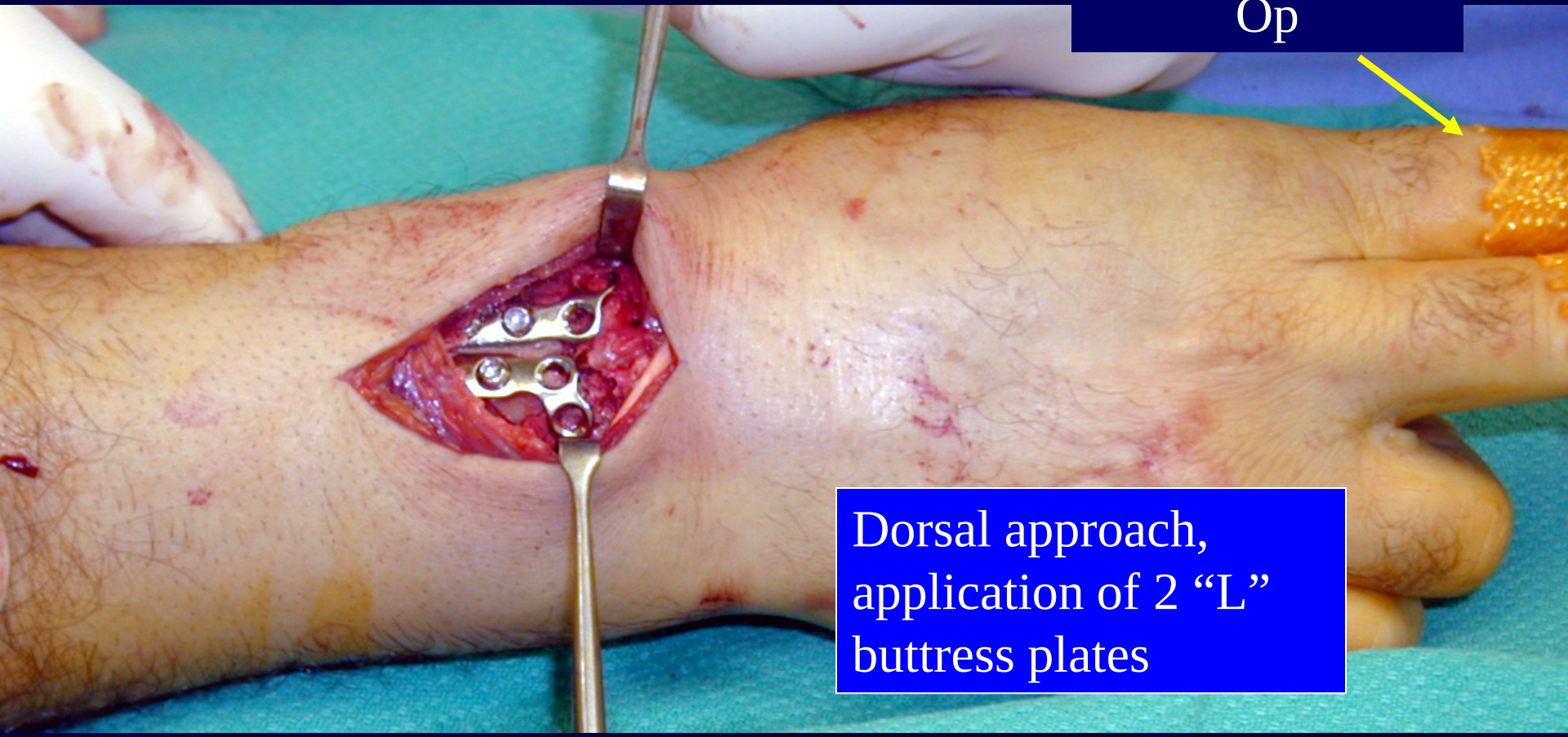
Dorsal Case: focal plating

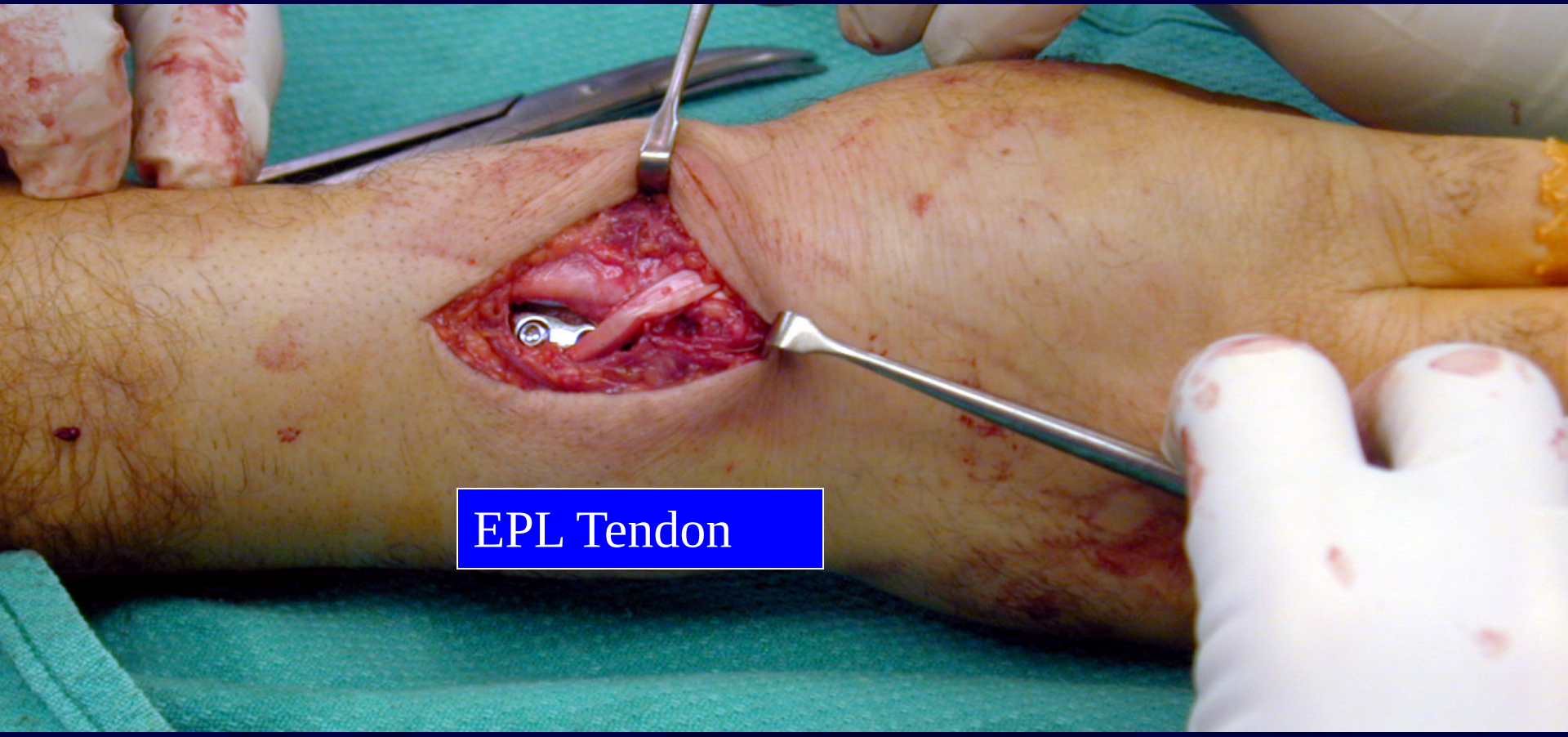
Radial shortening, comminution

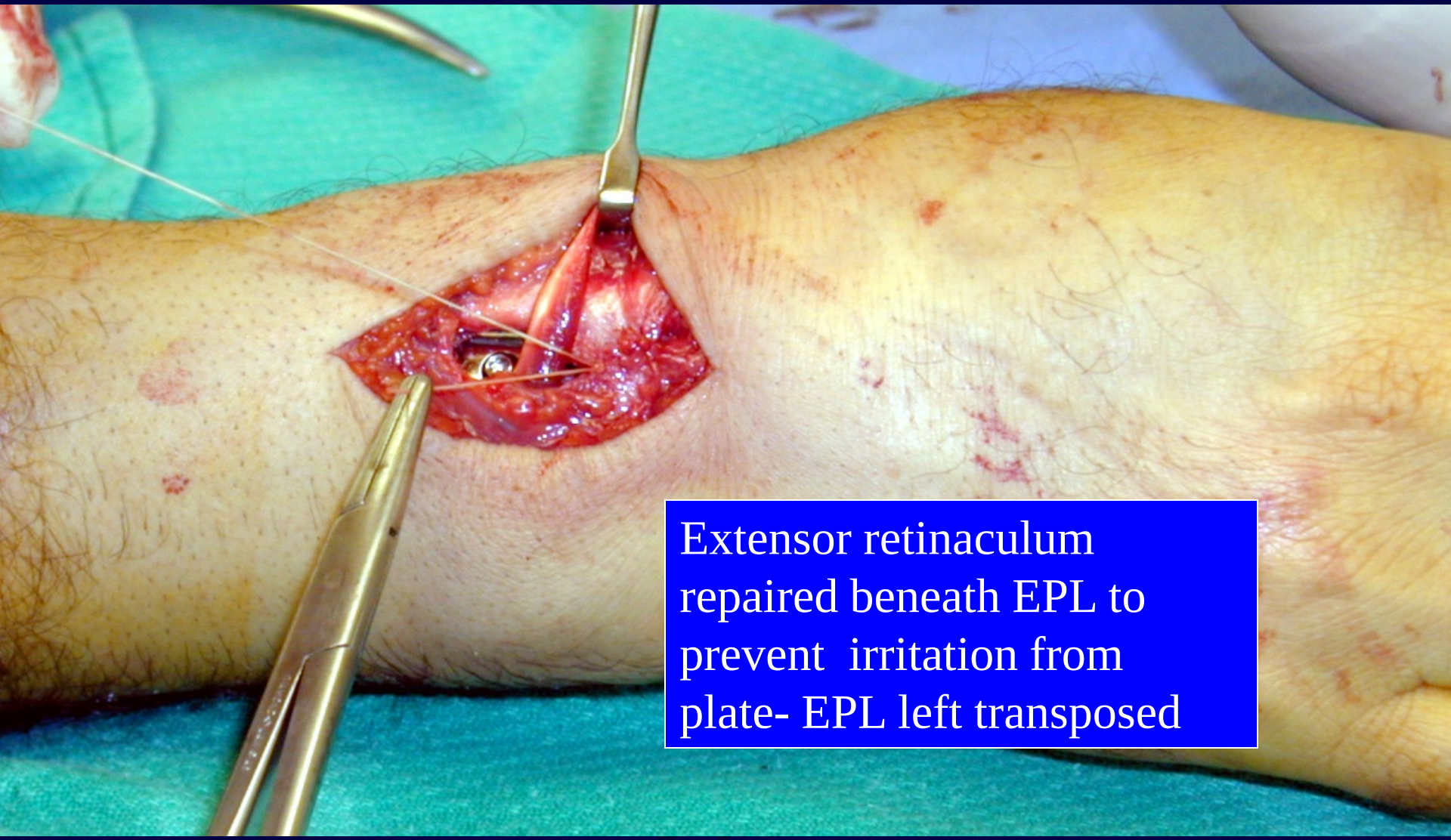
Dorsal angulation

Possible Indication for Volar and Dorsal Plating


Volar approach, application buttress plate


Finger-Trap Traction Intra-Op
Dorsal approach, application of 2 “L” buttress plates


EPL Tendon

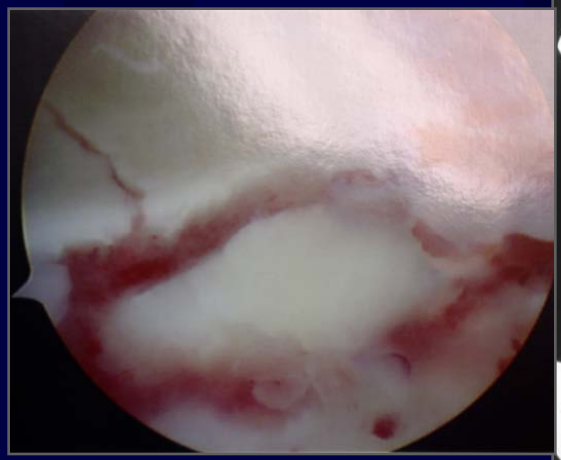

Extensor retinaculum repaired beneath EPL to prevent irritation from plate- EPL left transposed

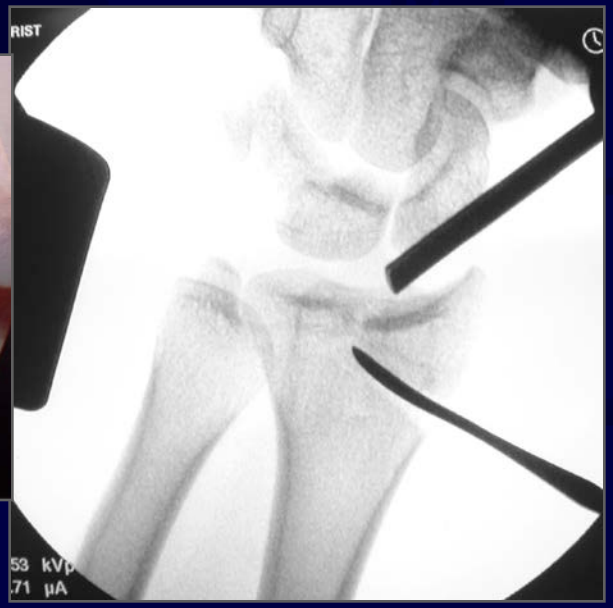
Advanced Techniques
Arthroscopic-Assisted

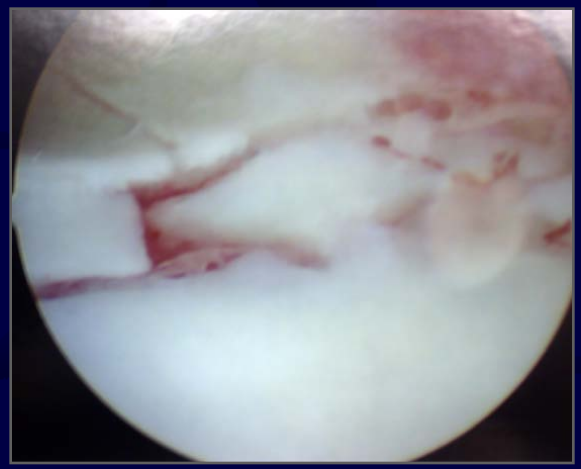
reduce articular incongruities

also diagnose associated soft tissue lesions

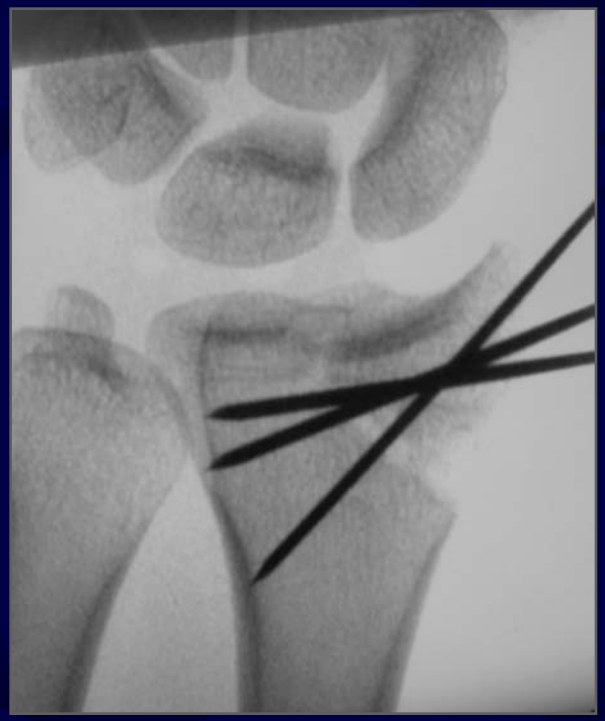
minimally invasive







Arthroscopic-Assisted



Culp and Osterman, OCNA 26(4) 1995

Malunion of Distal Radius Fractures

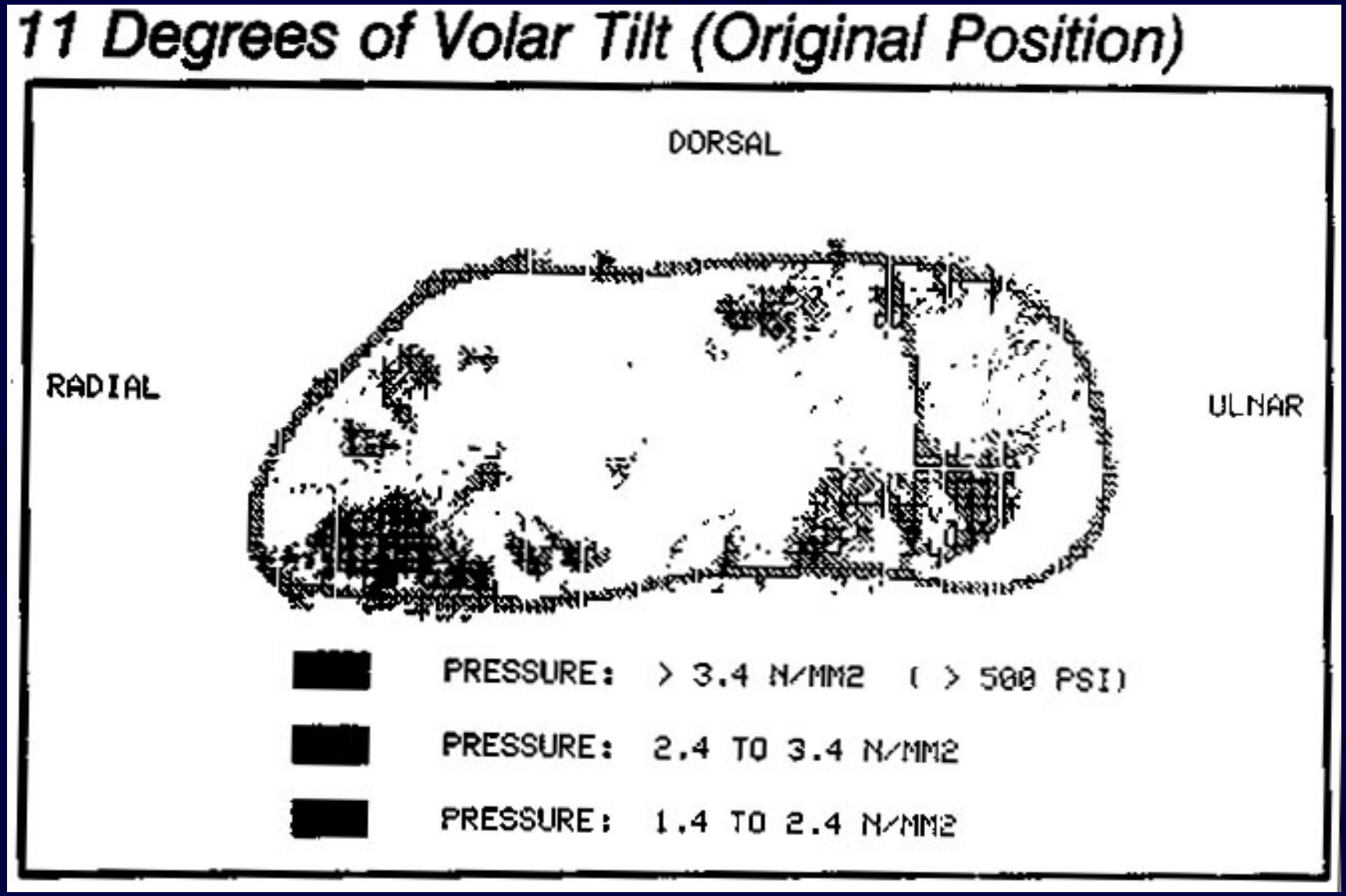
Changes load-bearing patterns on the distal radius and load sharing between the radius and ulna.

Can lead to arthrosis.

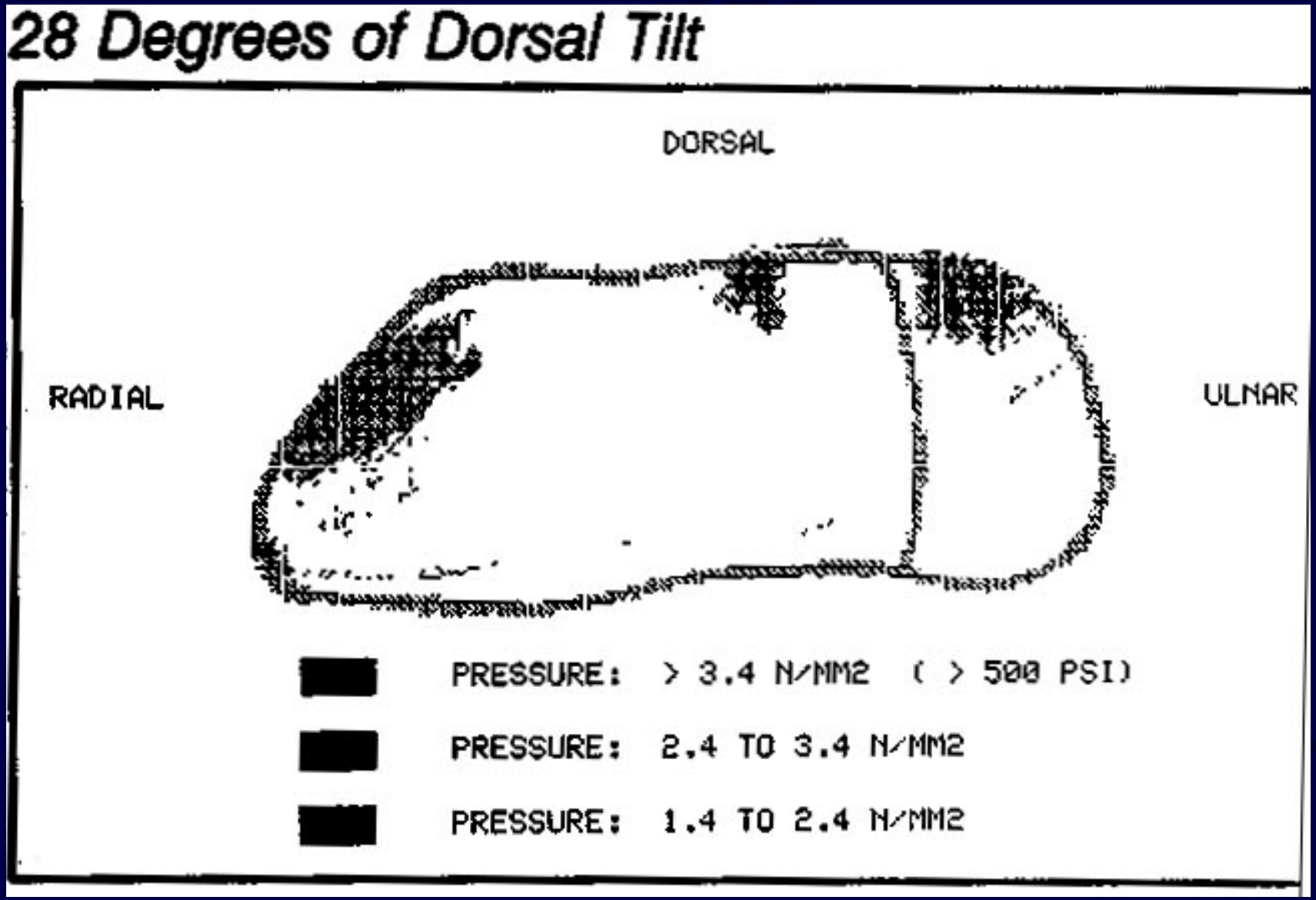

Injury X-Ray


X-ray 4 months later
shows malunion

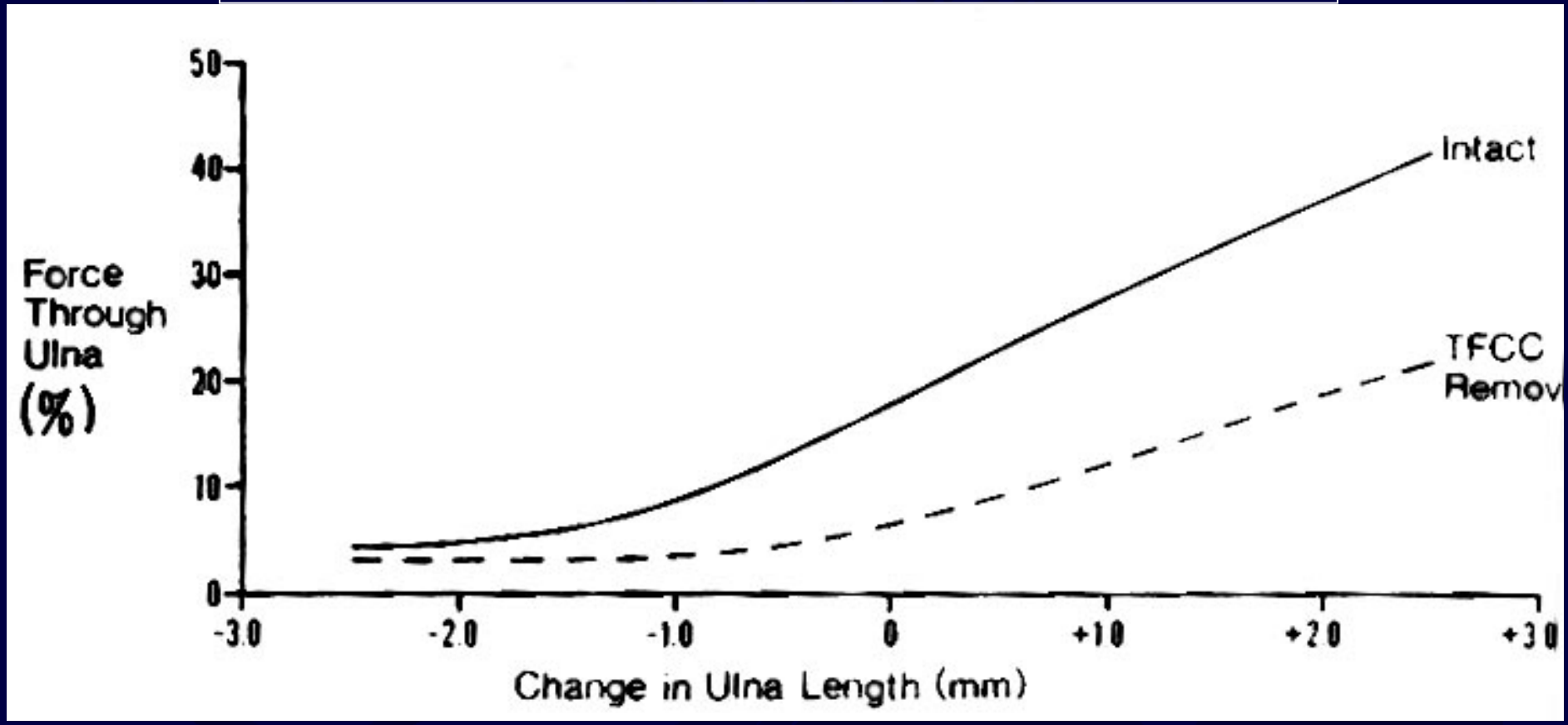
Normal loading patterns



Malunion: loading patterns



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)

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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

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