Forearm fractures need understanding of principles for diaphyseal and articular fractures

Andreas Panagopoulos, MD, PhD

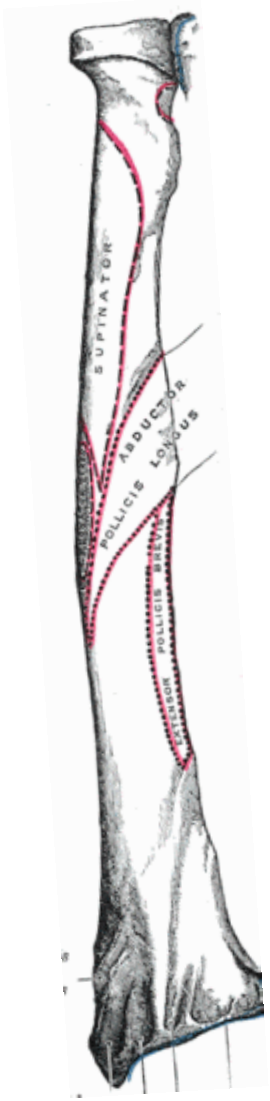
Assistant Professor, Patras University Hospital

Learning outcomes

- Review the concept of the forearm as a “joint”
- Describe the assessment, problems and treatment options of forearm fractures
- Review the options for surgical approaches
- Discussion complications and outcomes

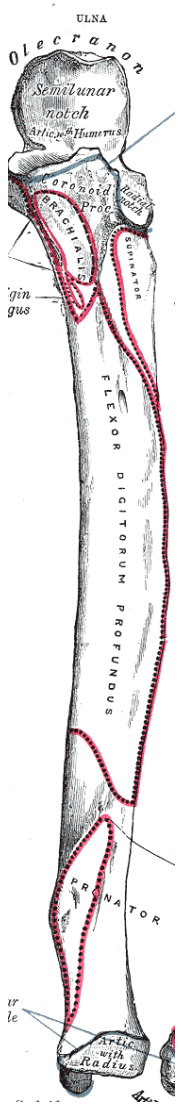
Understand why it is not “just another shaft fracture”

Introduction



- Work as functional unit
- Never injured in isolation
- Never injury one without affecting the other

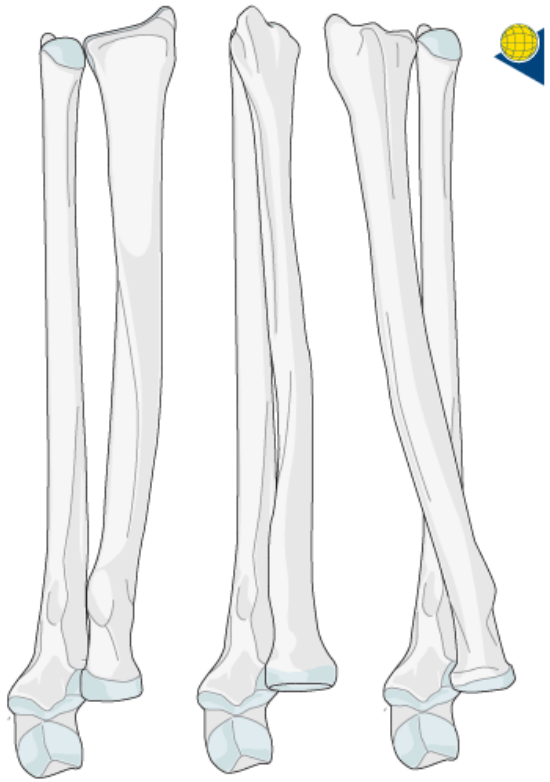
Must always be treated together



Functional unit

- The radial bow and the relations between the proximal and distal radio-ulnar joints comprise a complex **3-dimensional** functional unit.

- Even small deformities caused by fracture malunion can result in significant functional impairment



Function: position hand in space

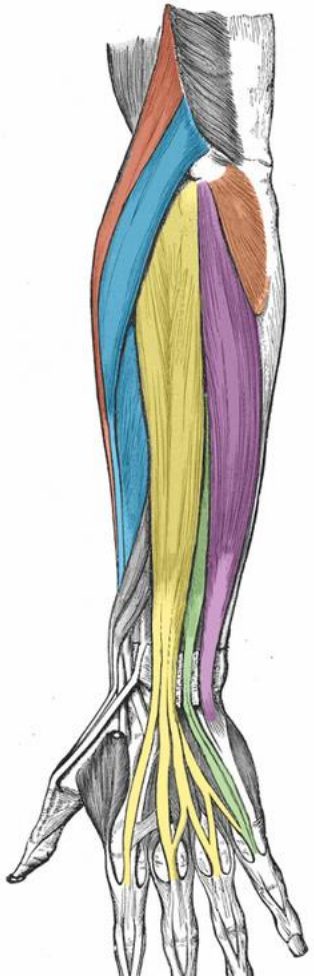
Requires:

Mobility

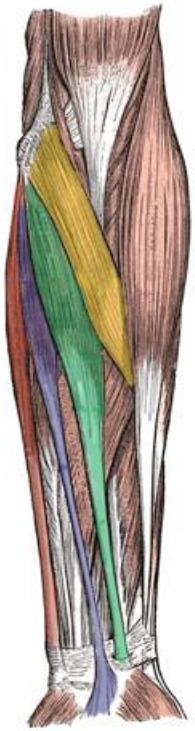
Stability

Alignment

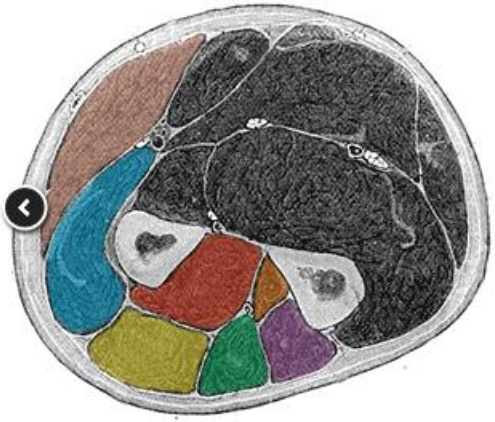
Anatomy



- Brachioradialis
- Extensor carpi radialis longus and brevis
- Extensor digitorum
- Extensor digit minimi
- Extensor carpi ulnaris
- Aconeus

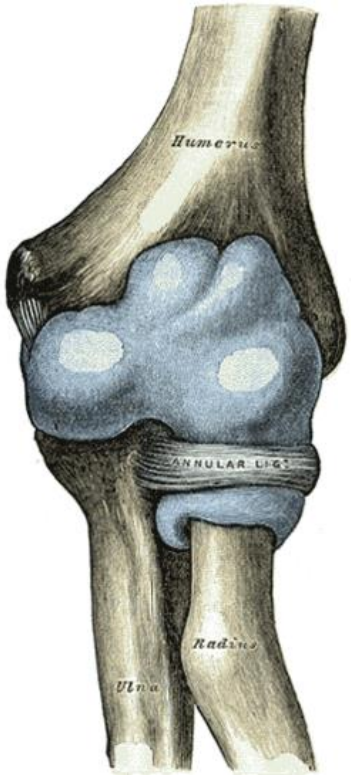


- Flexor carpi ulnaris
- Palmaris longus
- Flexor carpi radialis
- Pronator teres

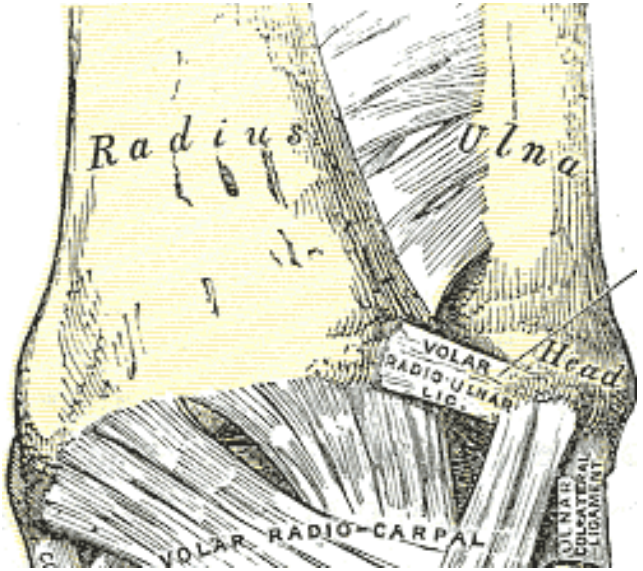


- Brachioradialis
- Extensor carpi radialis longus and brevis
- Extensor digitorum
- Extensor digiti minimi
- Extensor carpi ulnaris
- Abductor pollicis longus
- Extensor pollicis longus

Articulations



Ulno-humeral
Radio-capitellar
Proximal radio-ulnar



Distal radio-ulnar
Radio-carpal
Interosseous membrane

Extrinsic stabilizers

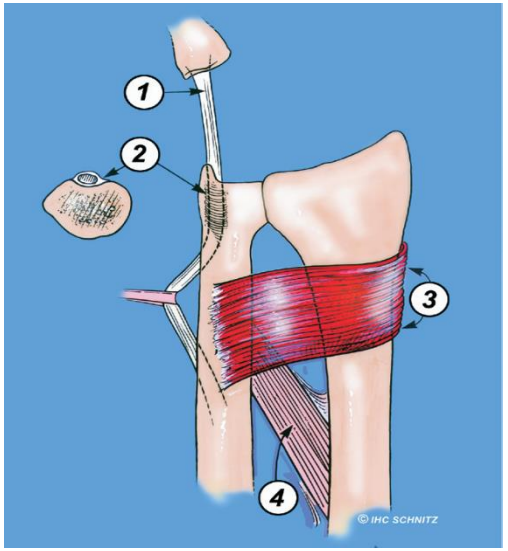
DRUJ

(1) dynamic tensioning of the ECU

(2) semirigid sixth dorsal compartment

(3) pronator quadratus,

(4) interosseous ligament

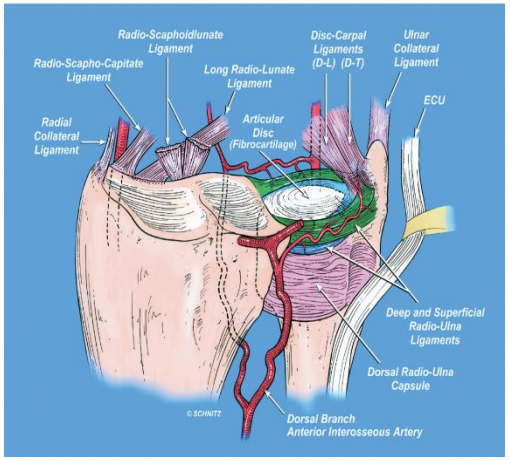


Intrinsic stabilizers

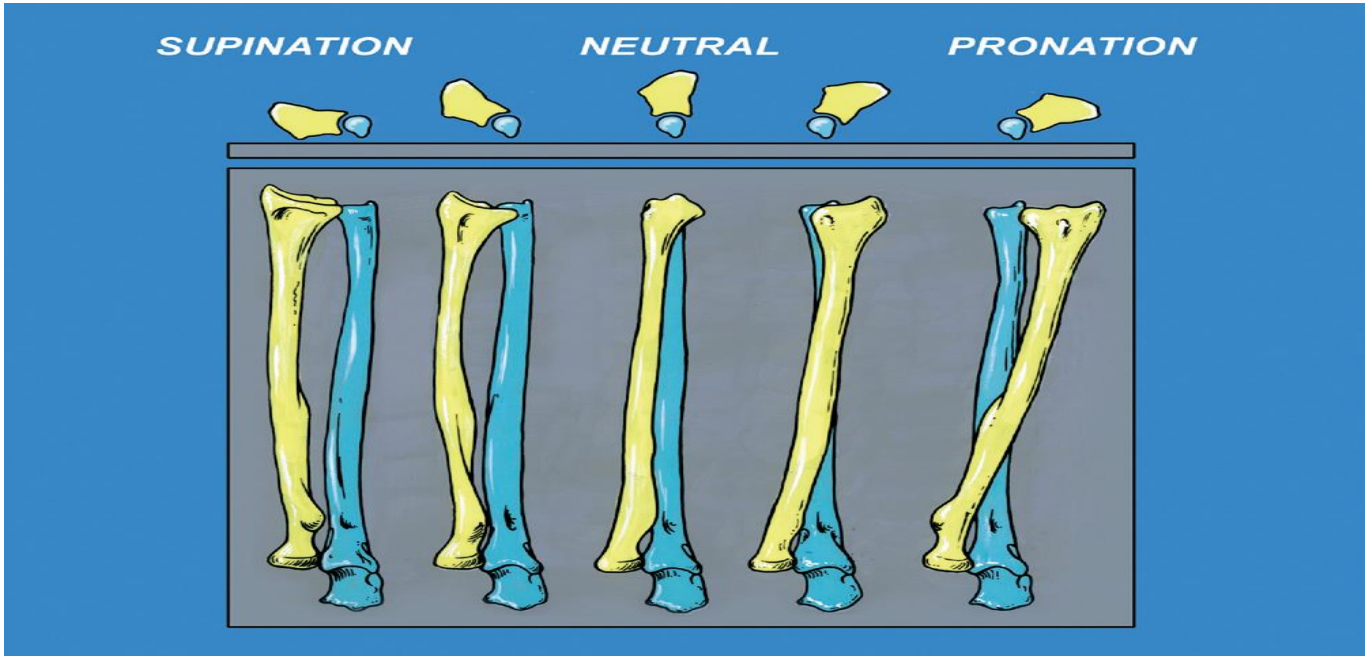
(1) superficial (green) & deep (blue) radioulna fibers

(2) 2 disc-carpal ligaments (lunate and triquetral)

(3) central articular disc (white).



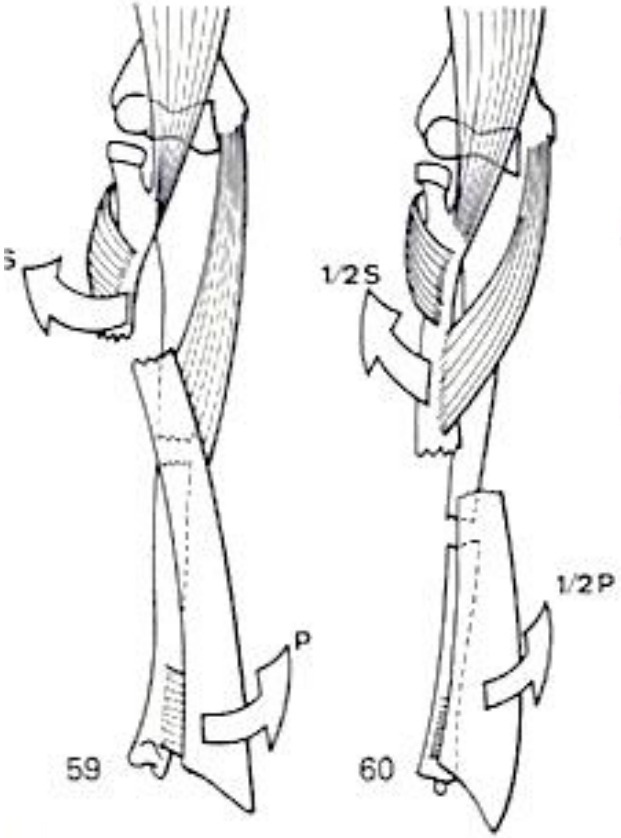
Motion

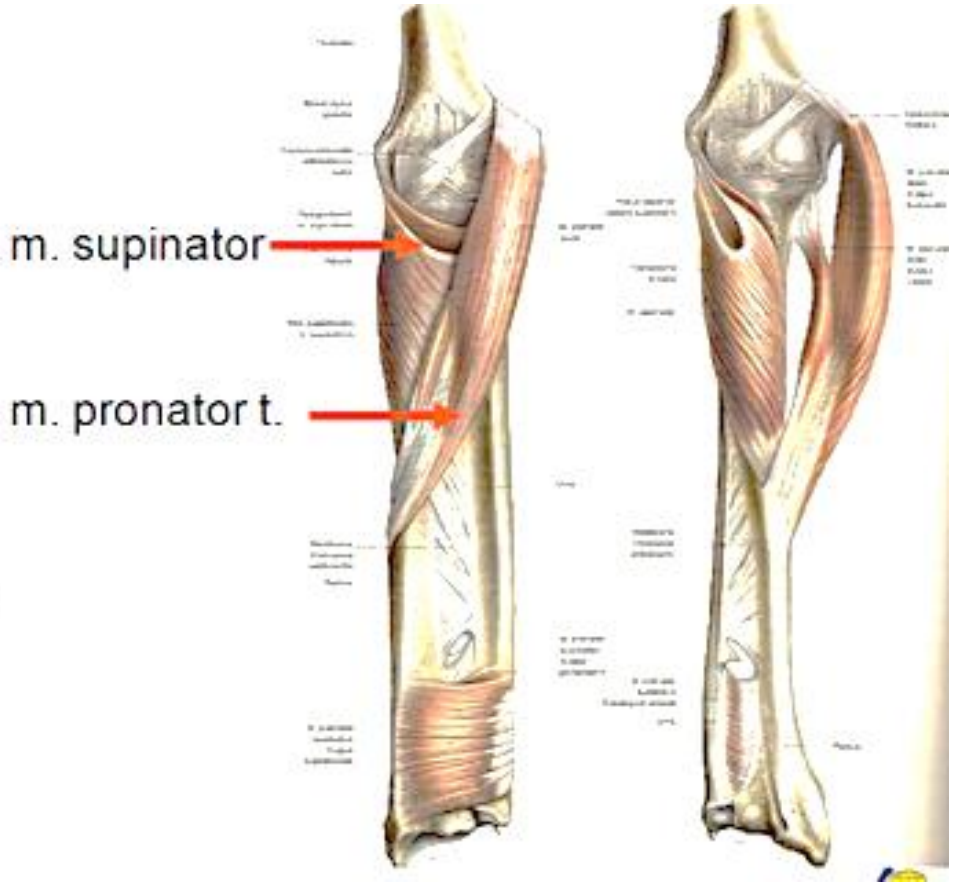


90° of forearm **supination**, at which point the two forearm bones are essentially parallel and the interosseous space widest

90° of **pronation**, at which point the radius has rotated across the anterior surface of the fixed ulna

Muscle forces





Consequences of injury

- Shortening
- Angulation
- Radial bow loss
- Loss of aligment
- Loss of relationship
- Dysfunction of unit
- **Disability**

Fracture mechanisms

- Axial compression
- Bending
- Rotation
- Direct trauma

Determines

- Fracture configuration
- Displacement
- Soft tissue injury
- **Associated injuries**


pa
lat


ap
lat

Clinical evaluation

Soft tissue
- Wounds
- Swelling
- Blisters

Neurological
- Careful exam
- Document

Vascular
- Pulses
- **Compartment syndrome**

Radiographic evaluation

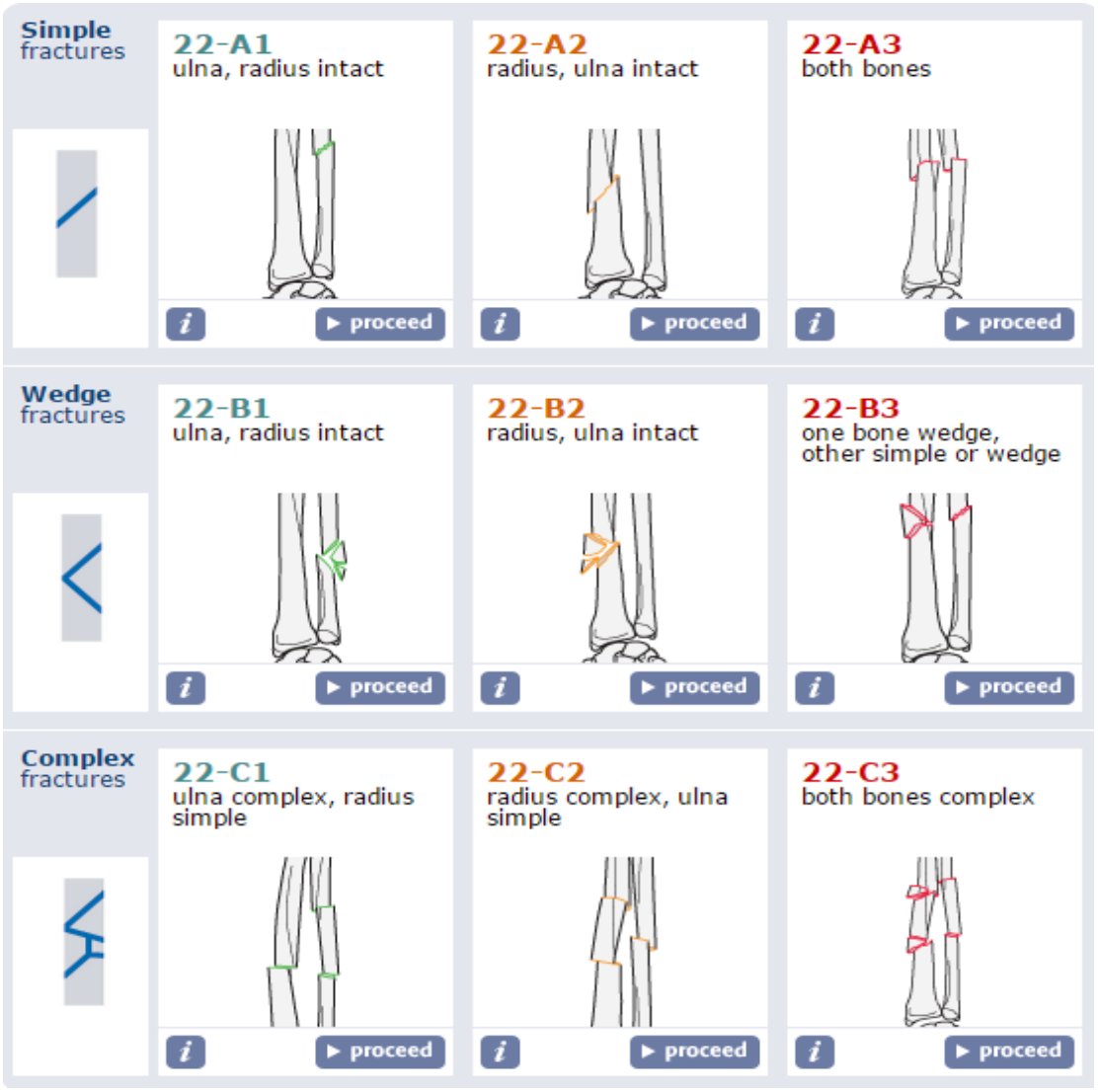
Full length AP & lateral
- elbow
- wrist

Ct scan
- selected articular fractures

MRI
- ligament injury

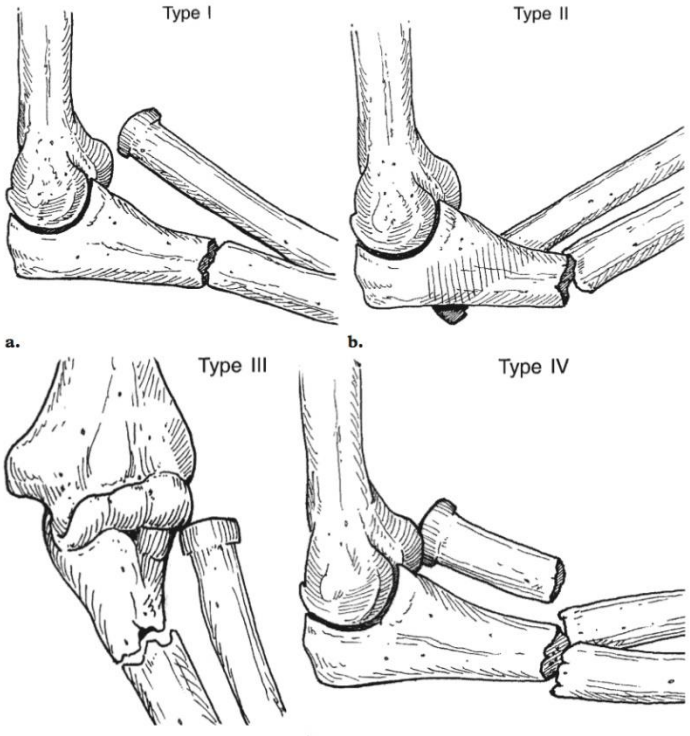
Angiography

Classification



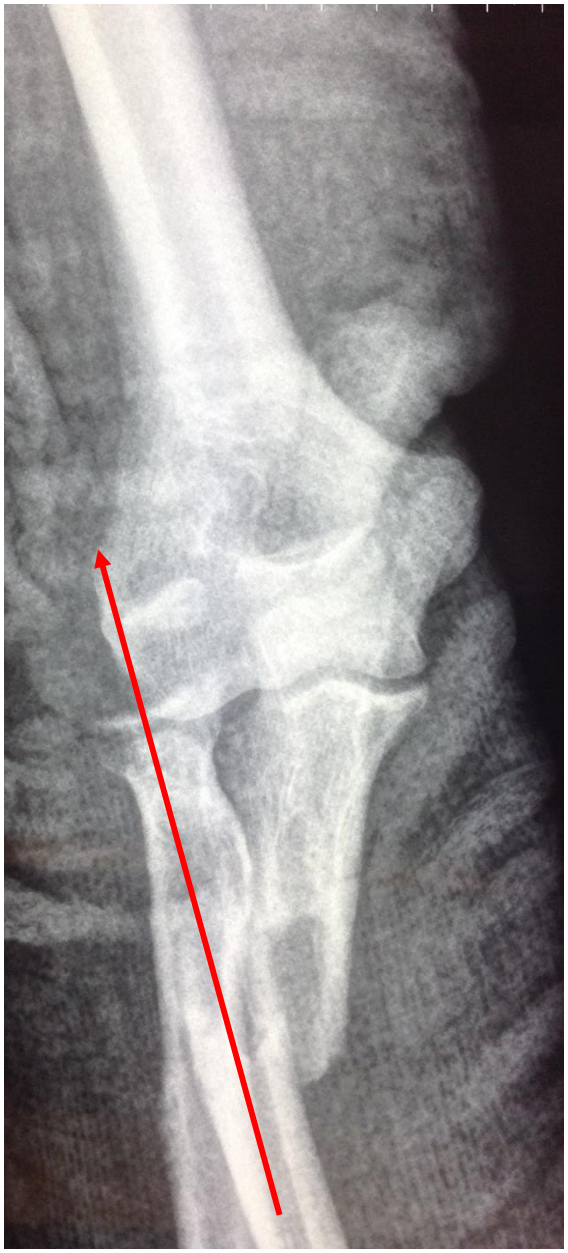
Monteggia type

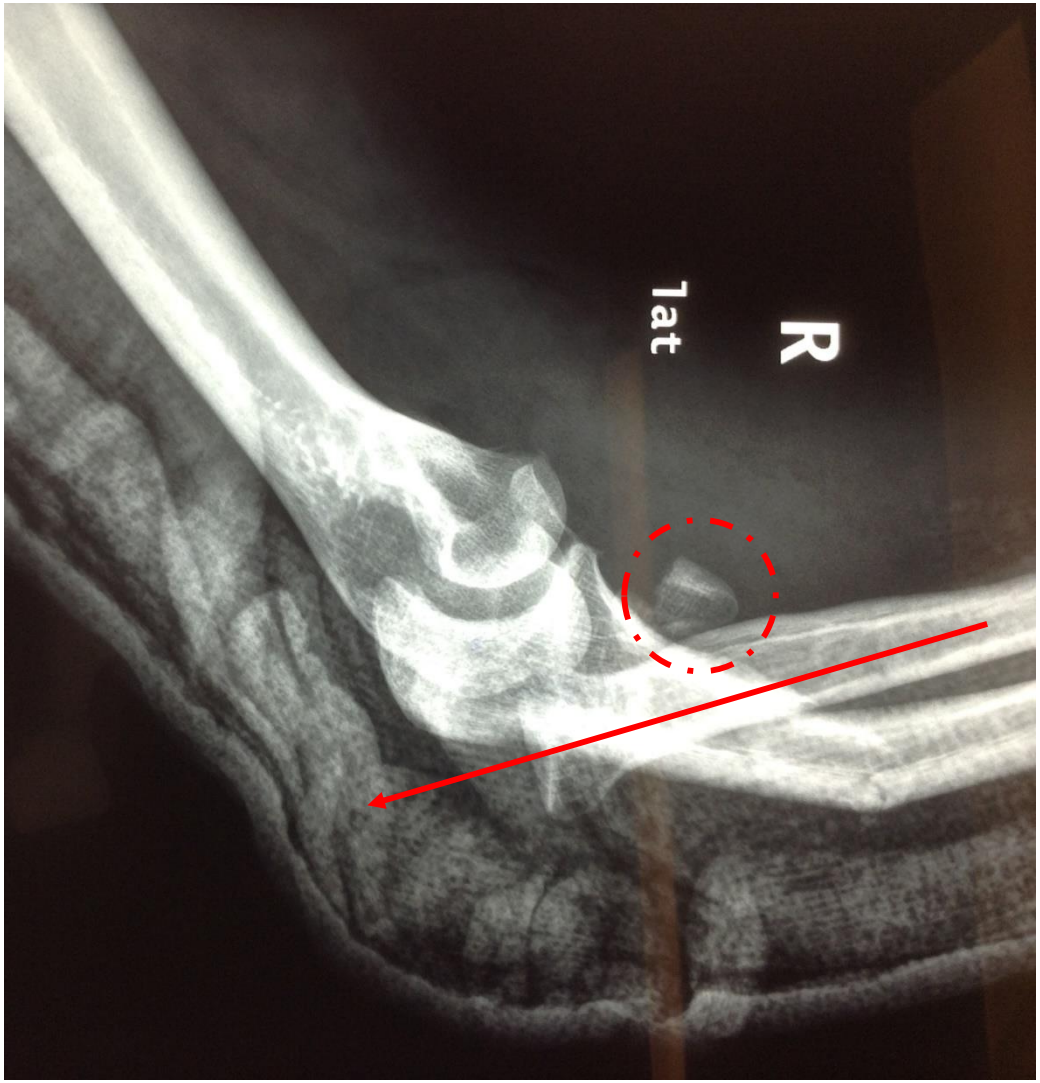
- Ulnar shaft fracture with dislocated radial head
- Types I-IV depending on direction of radial head dislocation fracture

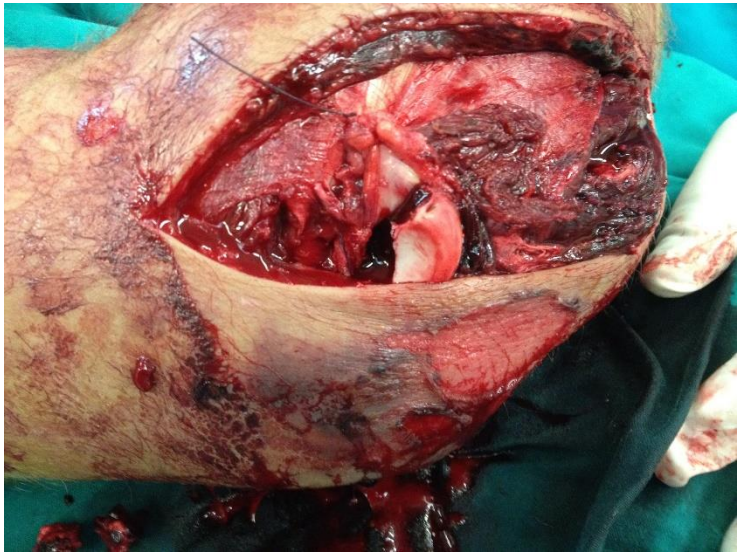


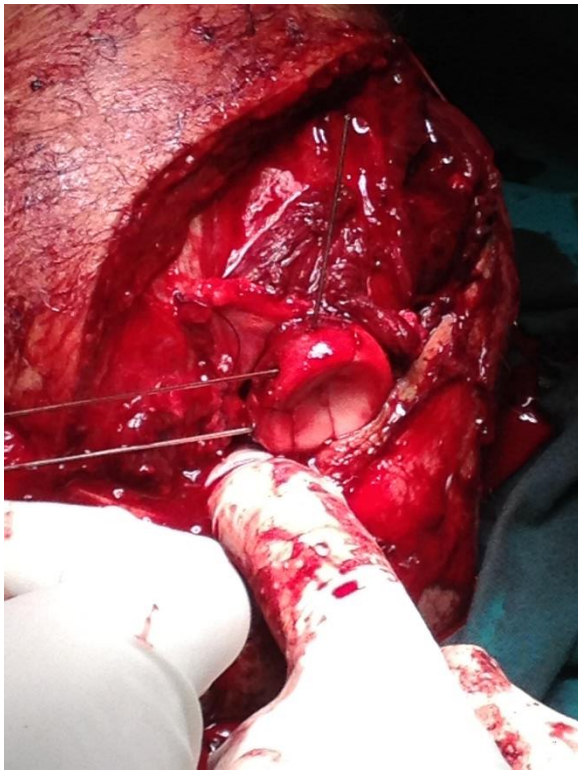
Monteggia type

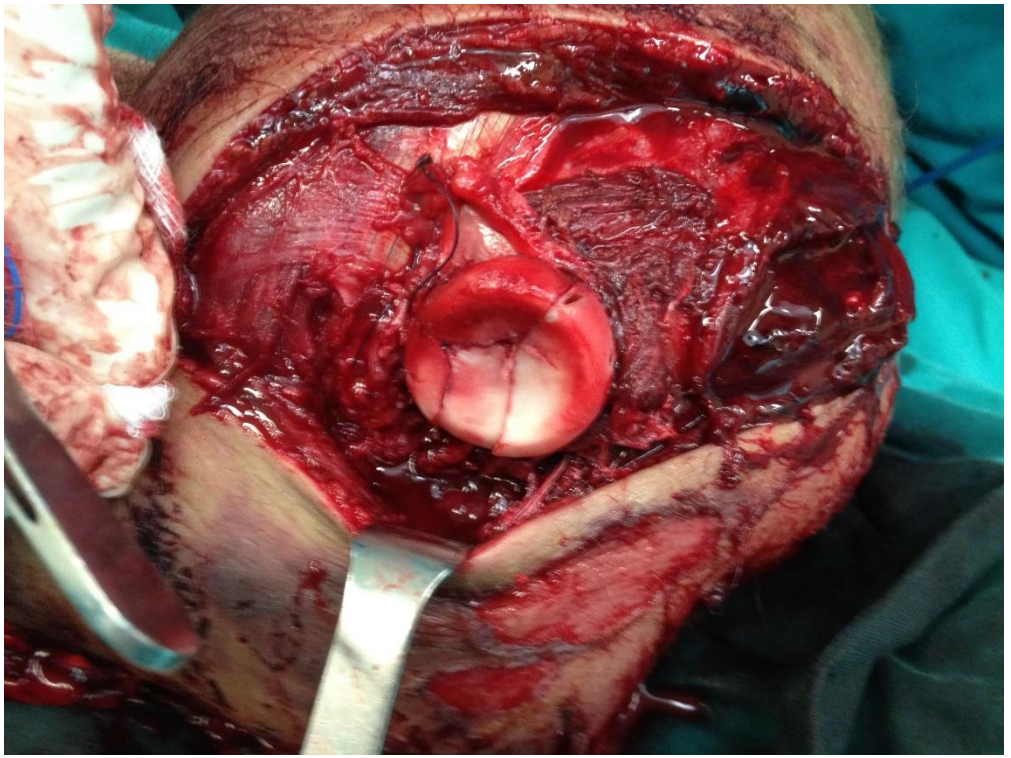
- Line drawn through radial head and shaft should line up with capitellum in all views




R
lat







Galleazzi type

- Radial shaft fracture with dislocated distal ulna
- Multiple variant in location of radius fracture
- Can be very subtle

Signs of DRJU Injury

- ulnar styloid fx
- widening of joint on AP view
- dorsal or volar displacement (lateral view)
- radial shortening (≥5mm)

if radial fracture is **<7.5 cm** from articular surface unstable in **55%**

if radial fracture is >7.5 cm from articular surface unstable in 6%

Personality of fracture

- Soft tissue damage
- Fracture displacement
- Osteoporosis
- Comminution
- Joint involvement
- Neuro/vascular injury

Goals of treatment

- Restore
  - relative length
  - rotation
  - radial bow
- Reduce joints
  - stabilize if needed
- Repair soft tissues
- Stabilize the fracture
  - absolute or relative
- **Early functional movement**

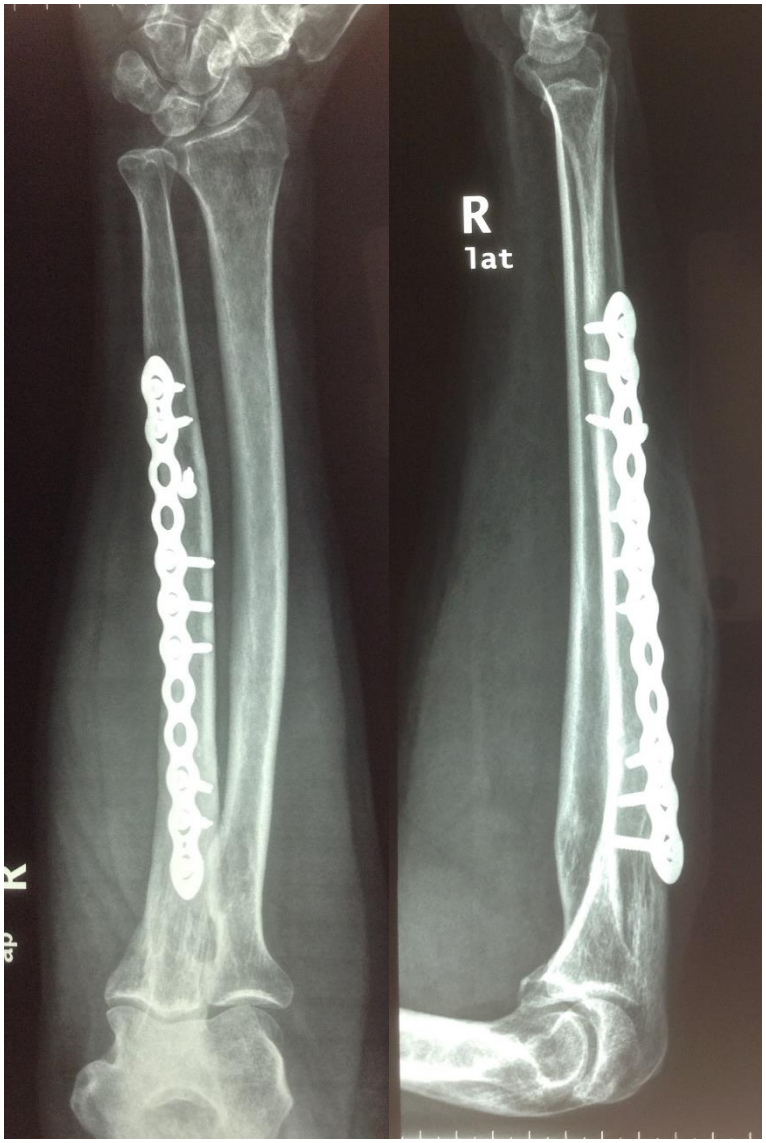
Conservative treatment?

3 weeks

12 weeks

Surgical indications

- All unstable bone fractures
- Displaced isolated fractures
  - 10 degrees of angulation
  - 50% of displacement
- Monteggia and Galeazzi
- Every open fracture



Preoperative decisions

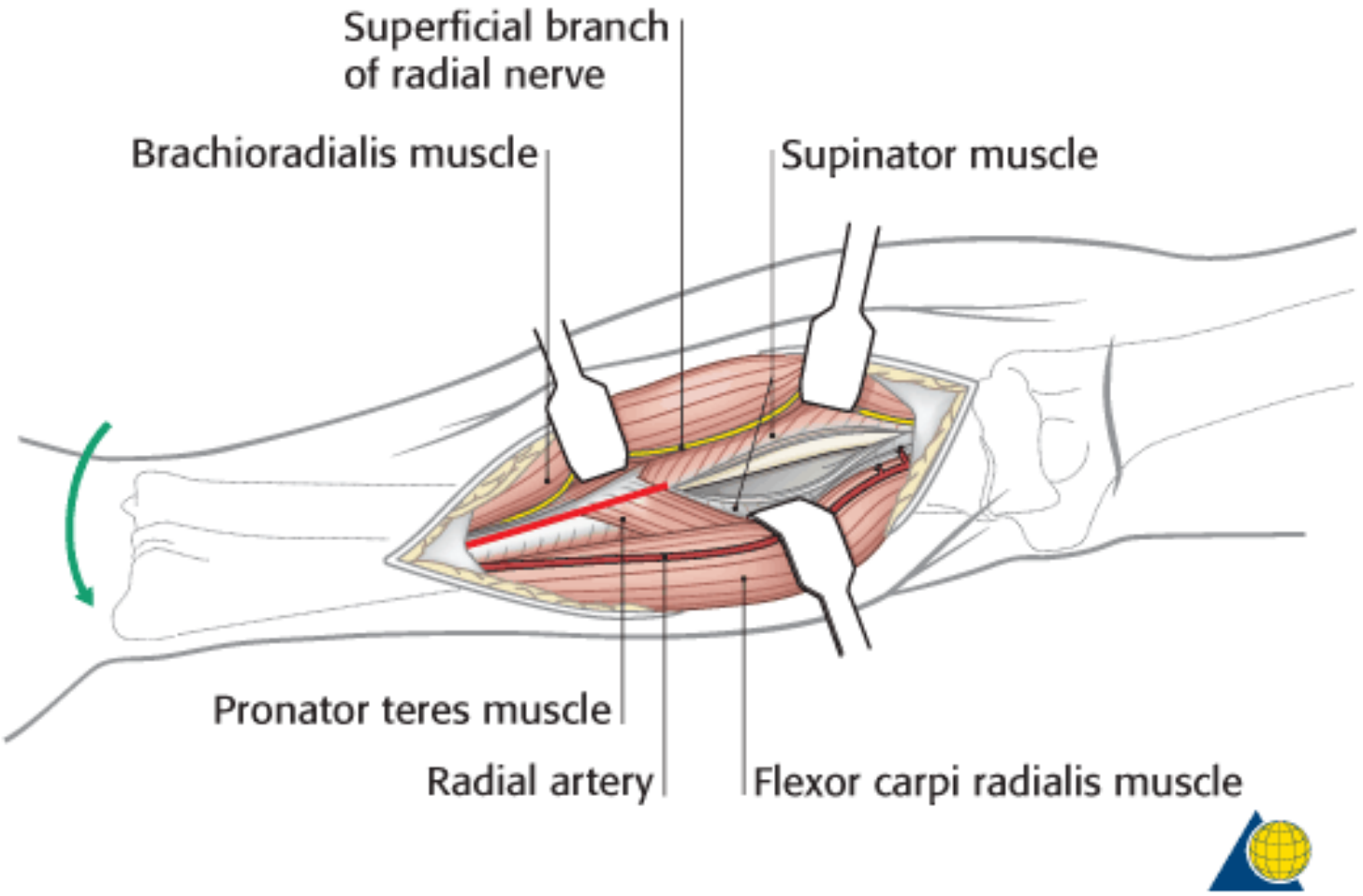
- Timing of surgery?
- Surgical approach
  - Henry (palmar)
  - Thompson (dorsolateral)
  - Boyd (proximal ulna)
- Ulna/radius first?
- Type of reduction
- Type of fixation
- Bone graft?

Timing of surgery

- Splint and elective surgery for simple closed displaced fractures
  - Reasonable alignment
  - Joints reduced
- Immediate fixation for:
  - open fractures
  - impending open fractures
  - compartment syndrome
  - unreducible dislocations

Approaches

Henry



Characteristics

Articular

- Anatomic reduction
  - open
- Interfragmentary compression
- Stable fixation

Diaphyseal

- Realigment
  - length & rotation
- Bridge plating
- Relative stability

Reduction/fixation

Surgical tactics

- Reduced “simpler” fracture
- Provisional fixation:
  - clamps
  - plate with few screws
- Reduce more complex fracture
  - provisional fixation
- Confirm alignment/rotation
- Definite fixation

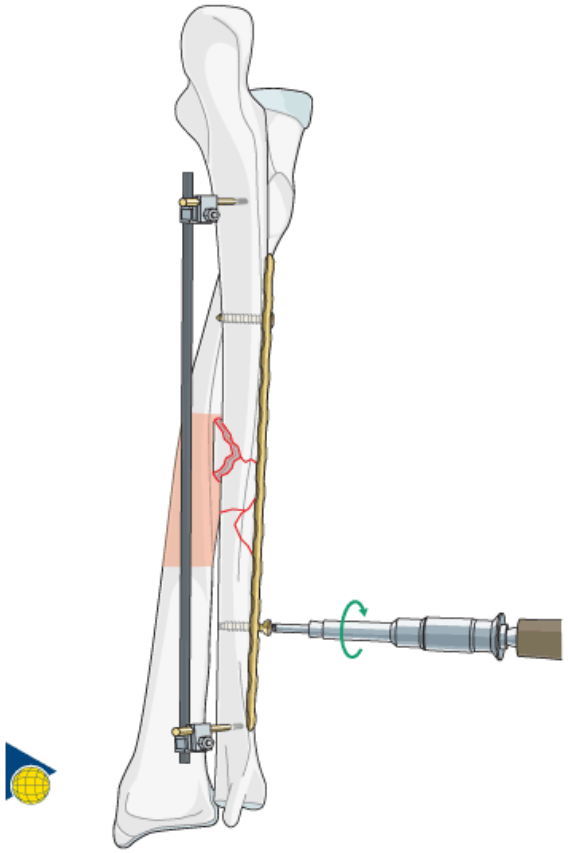
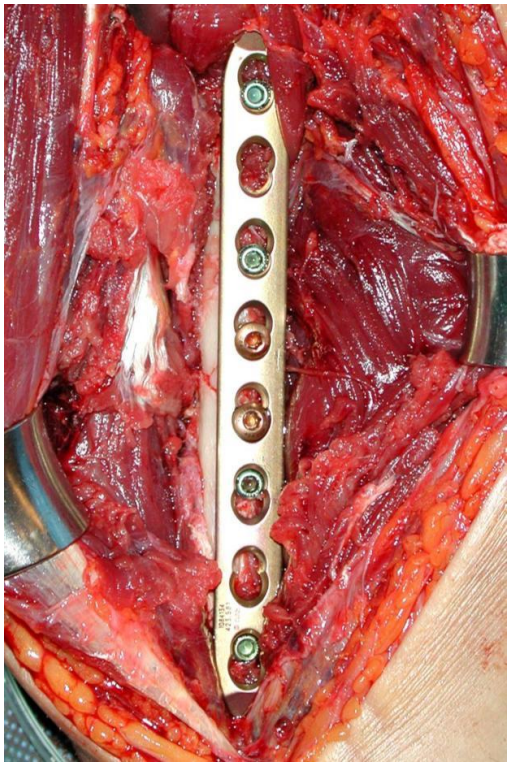
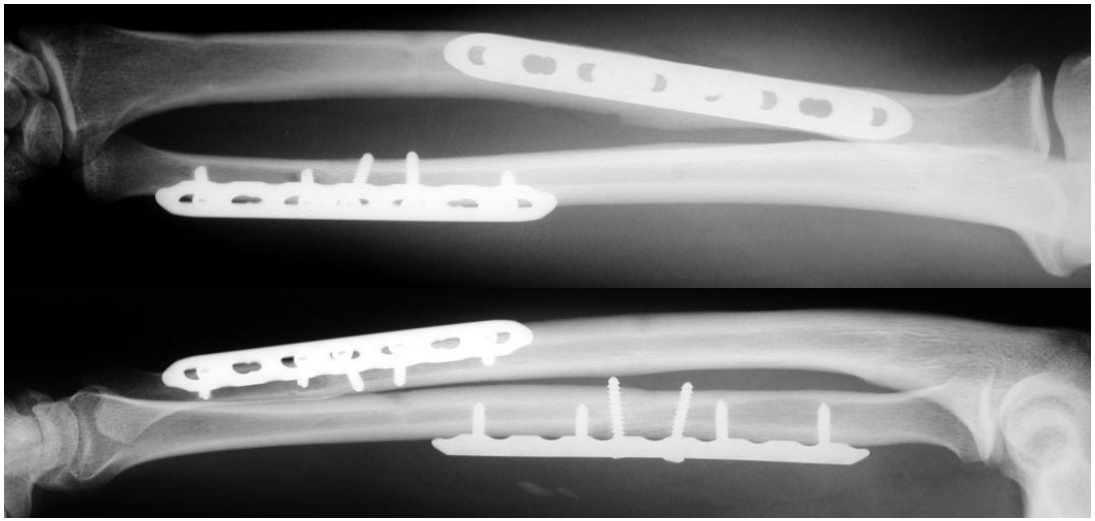
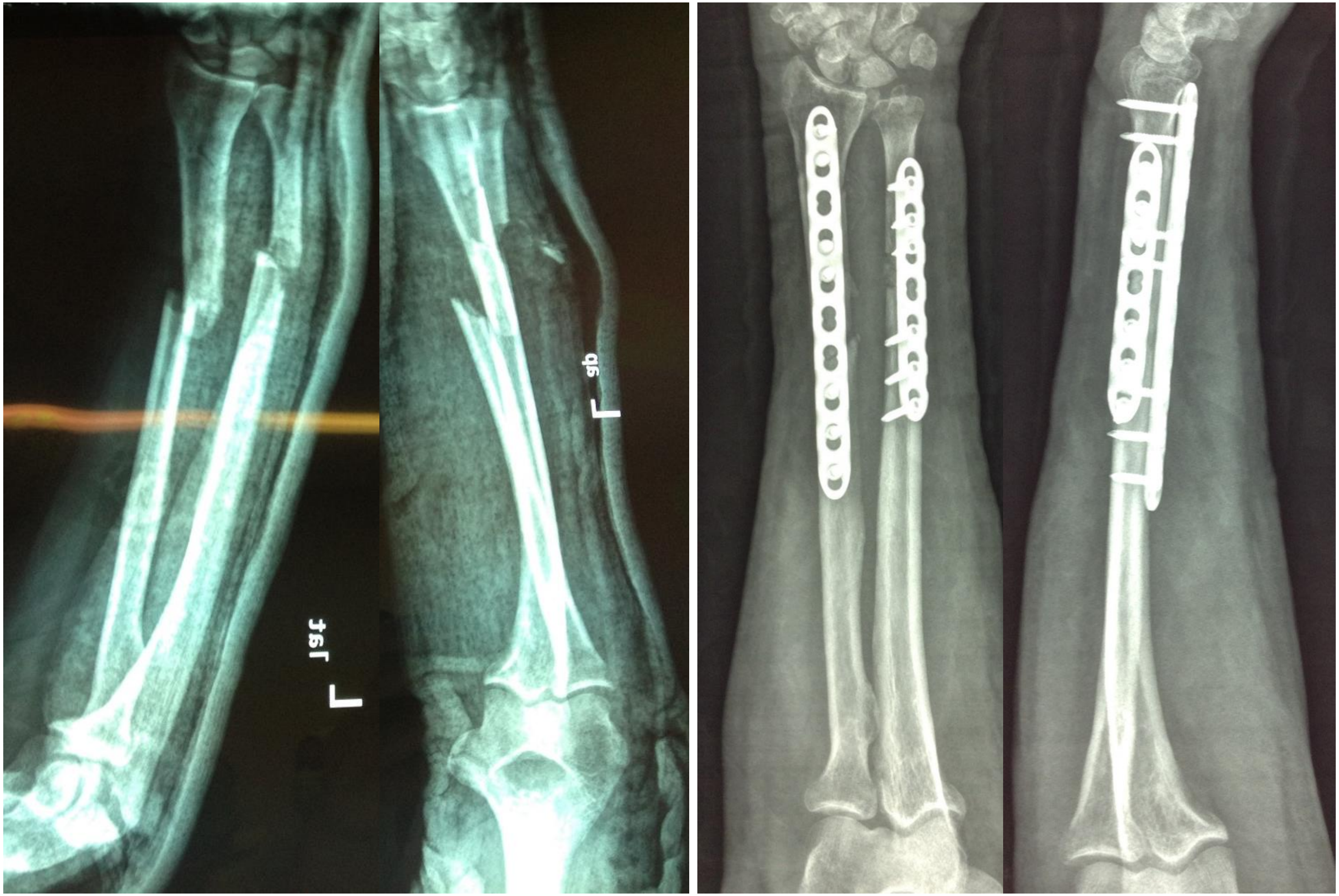


Plate fixation

- The gold standard treatment for more diaphyseal forearm fractures
- Stable, strong anatomical fixation
- Union rates more than 95%







Postoperative care

- Temporary splinting
- Avid prolonged immobilization

  - if you fix internally, do not fix it externally

- Immobilize the minimum time needed to protect soft tissues

  - Dislocations or instability may require more time of immoblzation

Complications

- nonunion 2-4%
- Infection 1-2%
- Hardware irritation
- Synostosis
- Malunion
- Compartment syndrome
- Refracture

Intramedullary fixation

- Relative indications
- Children
- Single fractures
- Bad soft tissues
- Pathologic fracture

Take-home messages

- Complete understanding of injury
- Understand functional unit
- Both bony and soft injuries must be addresses
- Combination of articular & diaphyseal principles
- ORIF with plates is standard