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SOA Elbow Symposium

Elbow Trauma & Instability

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Format

- Brief didactic outline of principle
- Case based discussion – participants involvement
- Panel input/feedback

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Elbow instability

- Pattern of injuries (bone & soft tissue)
- Predict mechanism/vector of loading forces
- Form strategies for treatment
- Surgical approaches
- Adjuncts
- Post-operative strategies

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2 common mechanisms

- 3D rotatory fracture/dislocation –
  - radius rotation (coronal plane)
  - ulna pathological rotation (axial plane)
  - relative humerus and forearm movement (sagittal plane)
- Direct axial compression -
  - humerus plunge into greater sigmoid notch +/- posterior displacement of forearm
  - Posterior dislocation of elbow – radial head provide buttress, normally in near full extension, collateral ligament and capsular incompetency +/- coronoid body fracture

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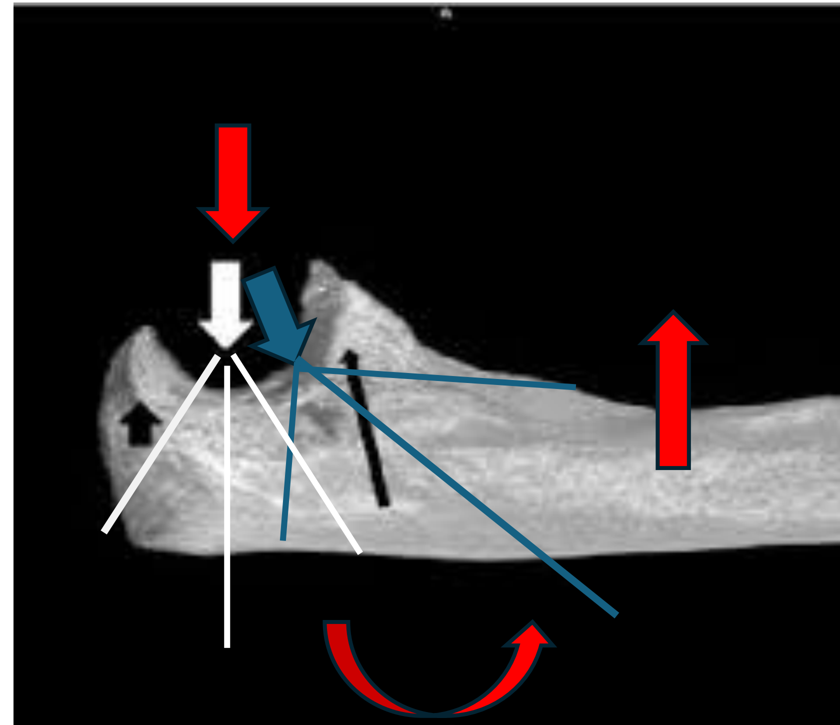
Direct axial compression – high energy/comminuted- coronoid involvement

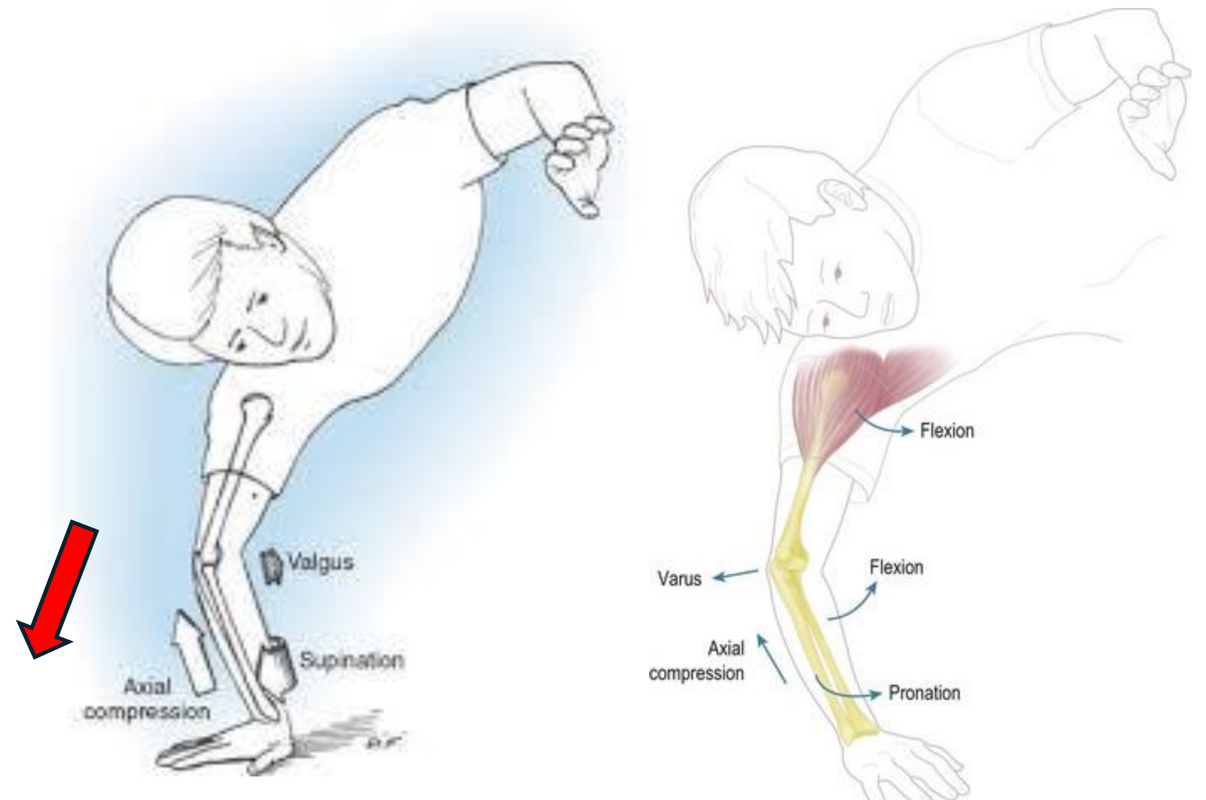
What is the coronoid attached to?	Classification
Ulnar Metaphysis	Trans-olecranon
Olecranon	Monteggia Variant
Neither	Trans-ulnar basal coronoid



- Flexed elbow, distal humerus driven throughmid metaphysis, comminuted, coronoid attached to distal metaphysis
- Less flexed elbow, distal humerus driven through distal metaphyseal area, coronoid separated
- Elbow flexed, distal humerus locked into sigmoid fossa acting as lever; bending torque from diaphysis, coronoid attached to the olecranon(Montaggia variant)

Rotatory injury pattern

- Axial load to the forearm by humerus
- Forearm static/locked, humerus driving through
  - Valgus “posterolateral”
  - Varus “posteromedial”
- Humerus static – forearm axial load – Essex-Lopresti
- Anatomy of distal humerus and ulna and position of forearm dictate fracture pattern



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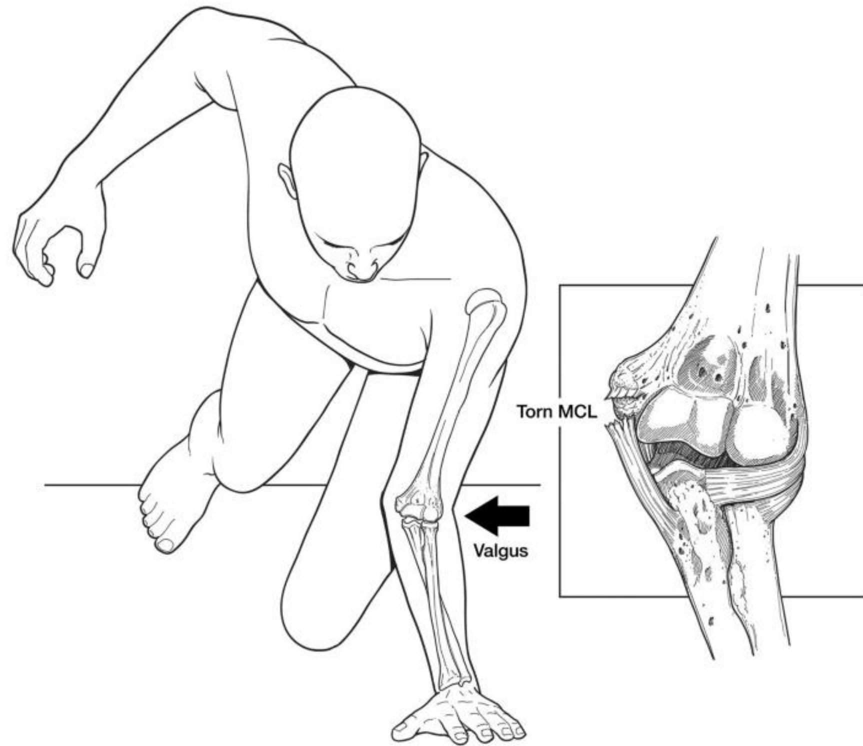
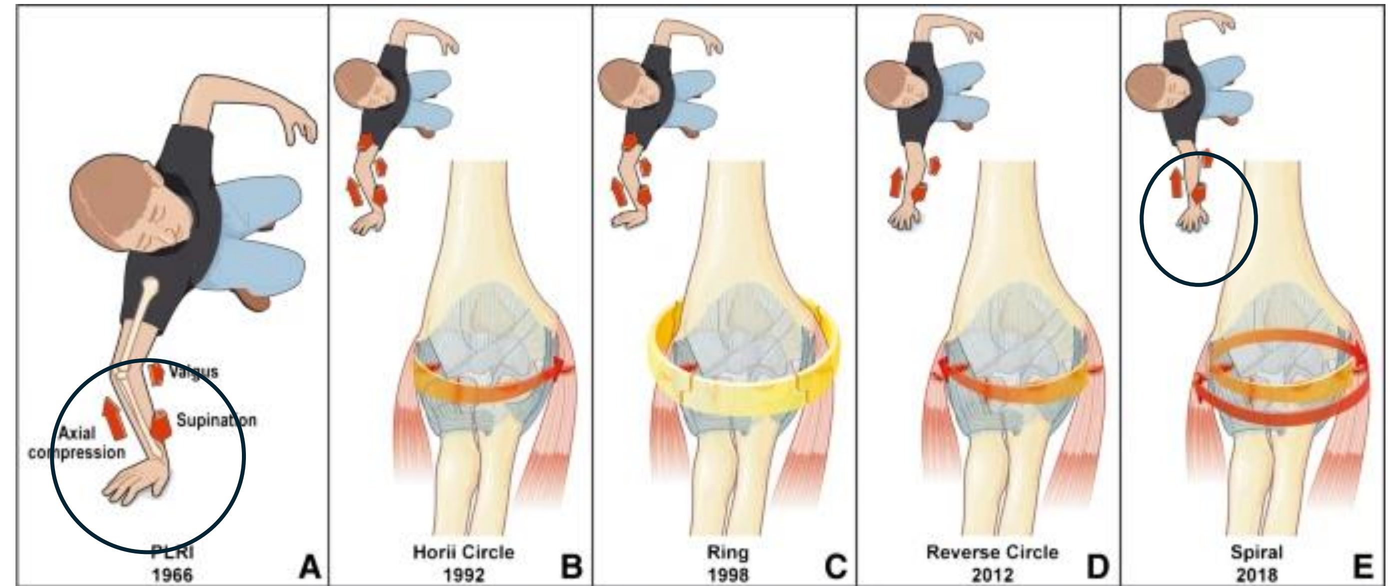


FIGURE 4: Arm position and deforming force of typical elbow dislocation mechanism. Valgus and axial forces are apparent at the elbow joint with the elbow extended and forearm pronated. Resultant damage to the medial collateral ligament is visible.

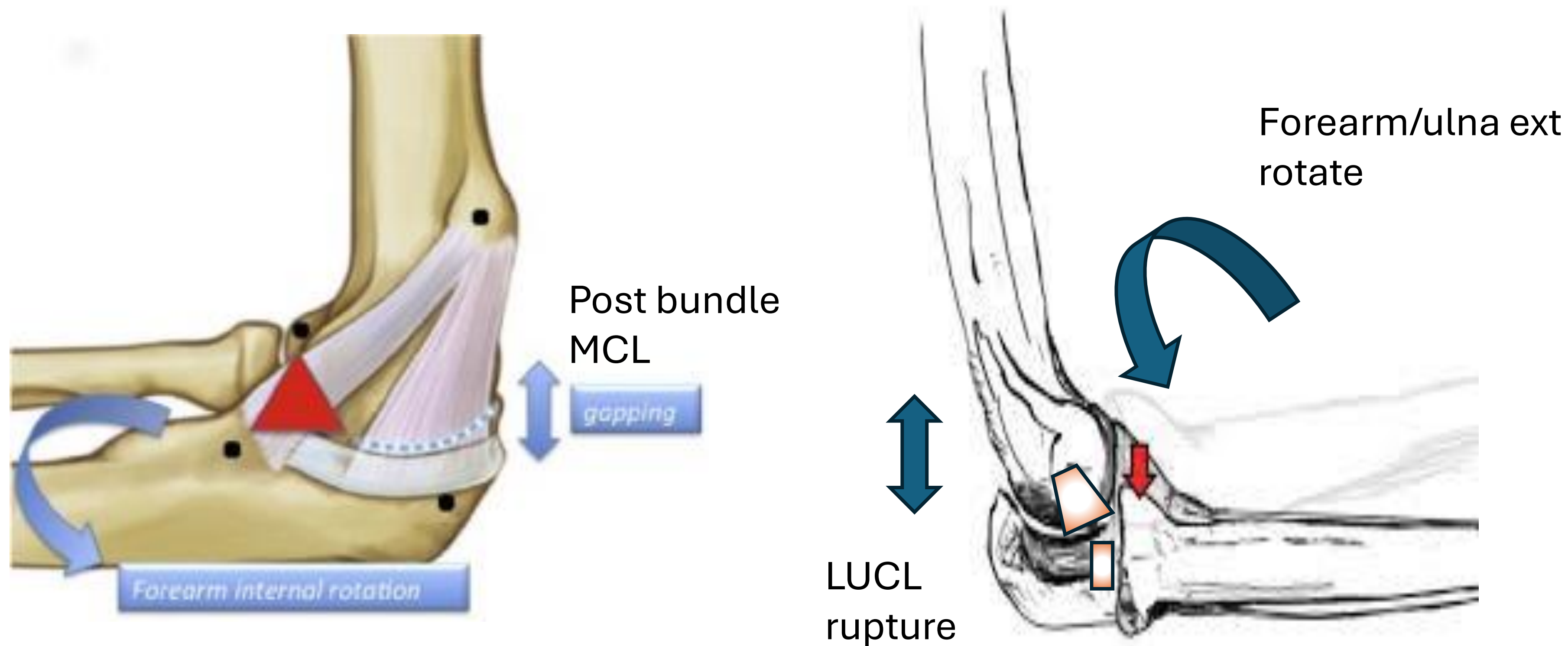
An Online Video Investigation Into the Mechanism of Elbow Dislocation

Joseph J. Schreiber, MD, Russell F. Warren, MD, Robert N. Hotchkiss, MD, Aaron Daluiski, MD



Bozon, O., Chrosciany, S., Loisel, M. *et al.* Terrible triad injury of the elbow: a historical perspective. *International Orthopaedics (SICOT)* **46**, 2265–2272 (2022). https://doi.org/10.1007/s00264-022-05472-4

Radial prono-supination versus pathological int/ext rotation of ulna



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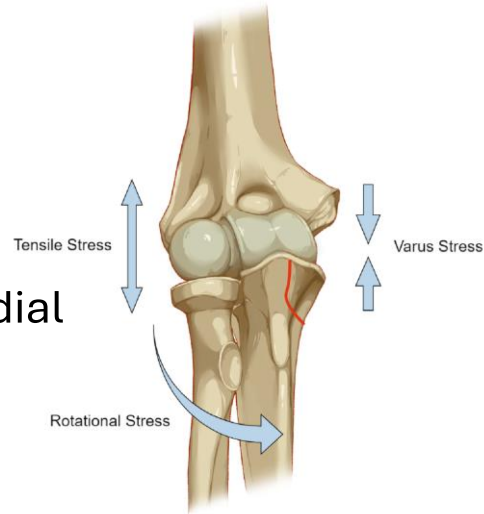
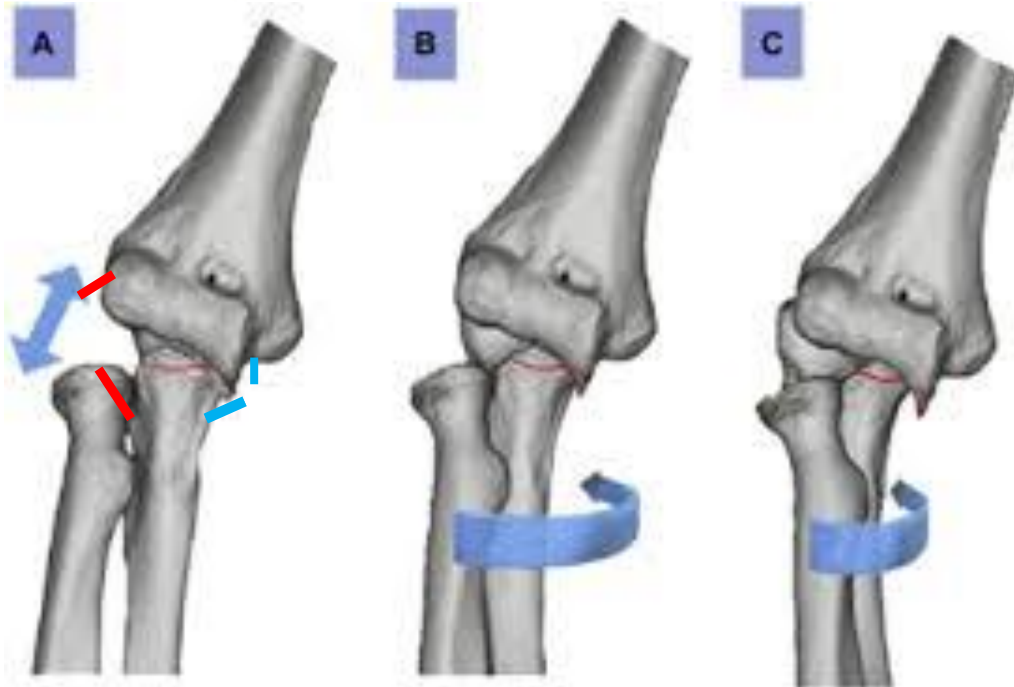
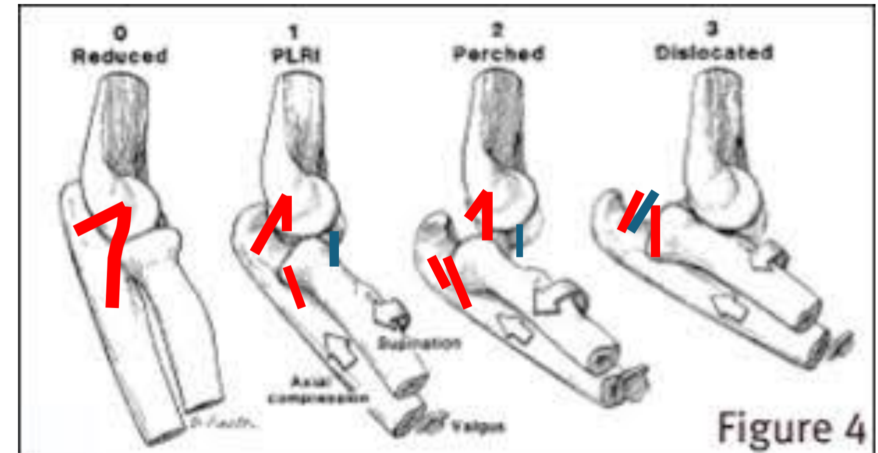
Mechanism

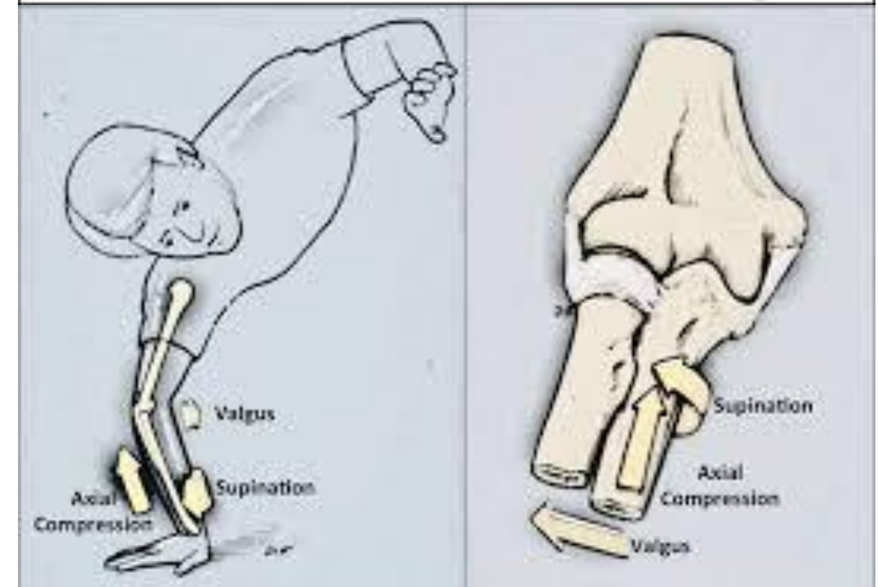
Varus
posteromedial





Valgus
posterolateral





Coronoid fracture is determined by amount ulna internal (posteromedial dislocation) external (posterolateral dislocation) due to ligament injury – hence amount of contact with trochlear

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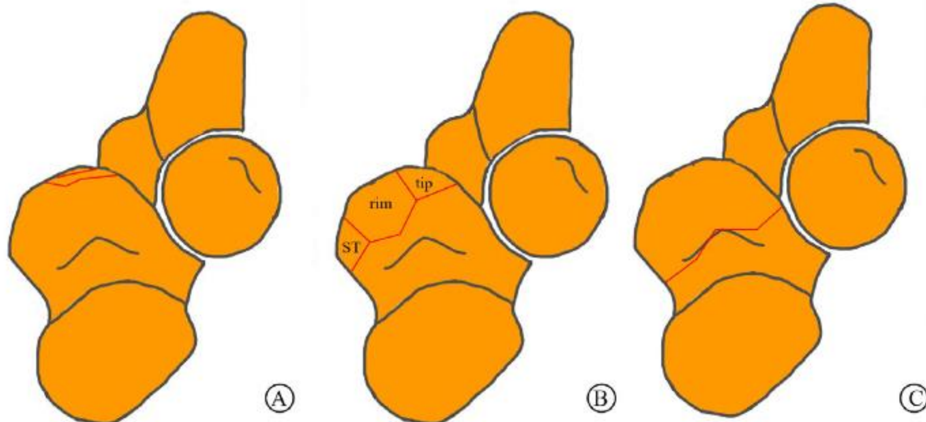


FIGURE 3 | O'Driscoll classification for coronoid fractures. (A) Type I: Tip fractures; (B) Type II: Anteromedial facet fractures (ST, sublime tubercle); (C) Type III: Body and basal fractures.

Radial head supinate, ulna ext rot

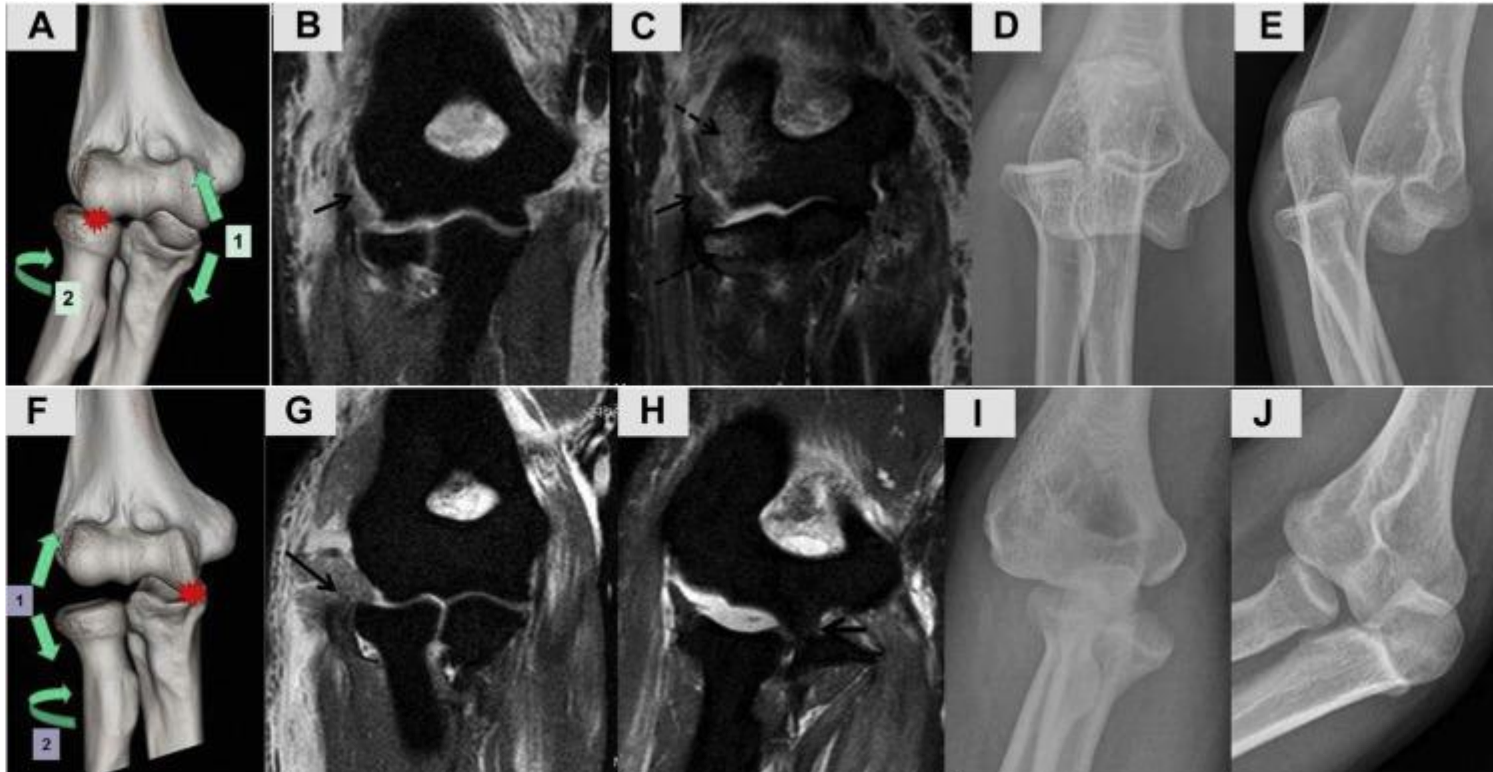
Simple dislocation or tip

Classic posterolateral terrible triad

Varus posteromedial

Radial head varus and ulna int rot

Horii circle? Medial start first? Position of forearm – during fall



- Normally muscle/tendon less injured than ligament (lower young modulus, less parallel collagen fibre; muscle as shock absorber)
- Ligament rupture – avulsion, avulsion fracture or mid substance
- A-E – simple or posterolateral varus
- F-J posteromedial

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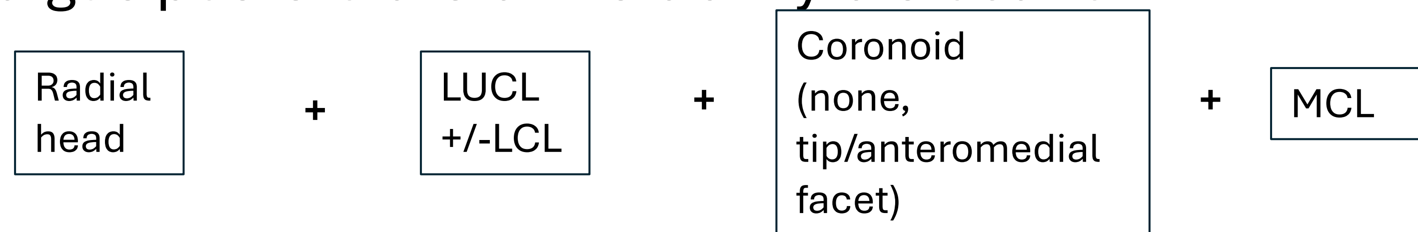
Summary

- Varus posteromedial instability/dislocation:

  - Radial head moving away from humerus and often spared
  - Medial collateral ligament complex – anterior (semi-extension) and posterior bundle –(flexion)
  - Coronoid often low body/base fracture – can be tip if both ant &post bundle MCL ruptured
  - Lateral collateral ligament complex – LCL rupture +/- LUCL

- Valgus posterolateral instability/dislocation:

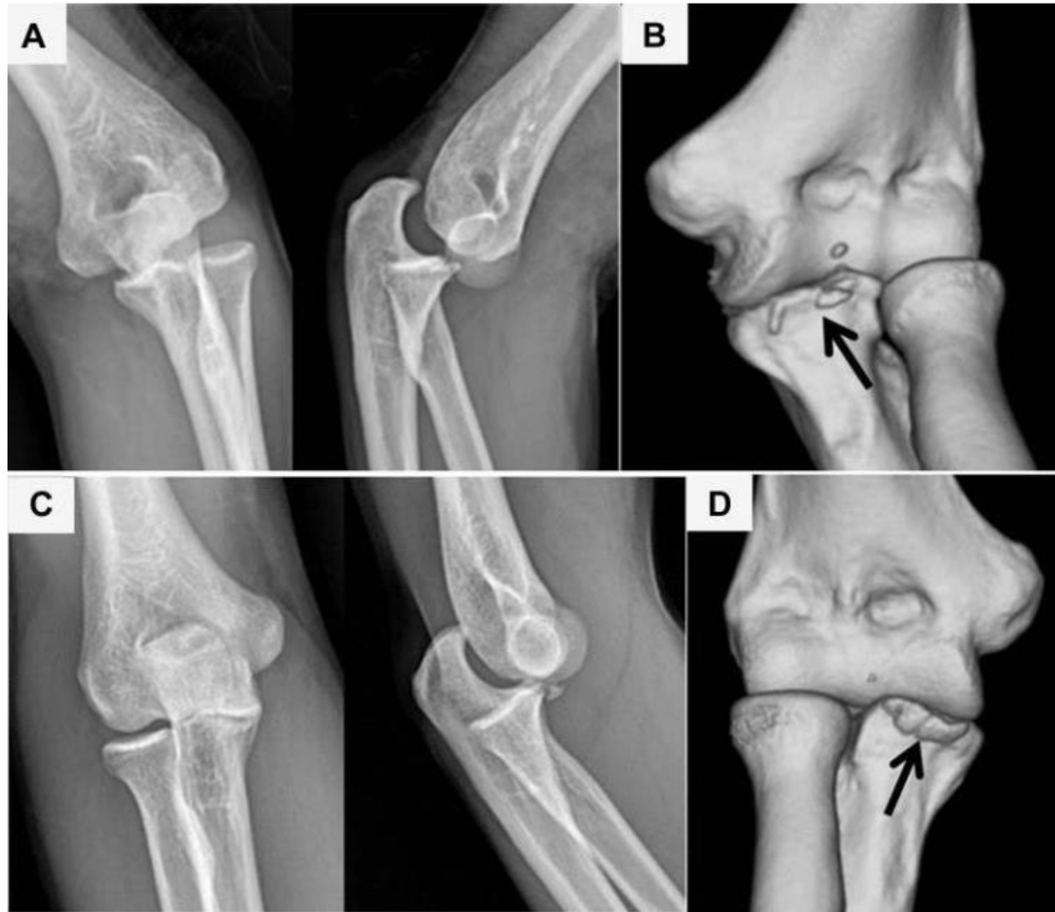


  - LUCL + radial head (often superomedial quadrant)
  - Coronoid – spared in simple dislocation, tip or anteromedial facet for terrible triad
  - MCL often involved

Treatment algorithm

- Plan surgical approach according to fracture and ruptured ligament
- Plan B.... and C
- Options:
  - Surgical or EUA/plaster immobilisation – conservative treatment is a form of treatment!
  - Surgical – repair, reconstruct, fix or replace ...... plan B ex-fix or internal ex-fix

Recap?



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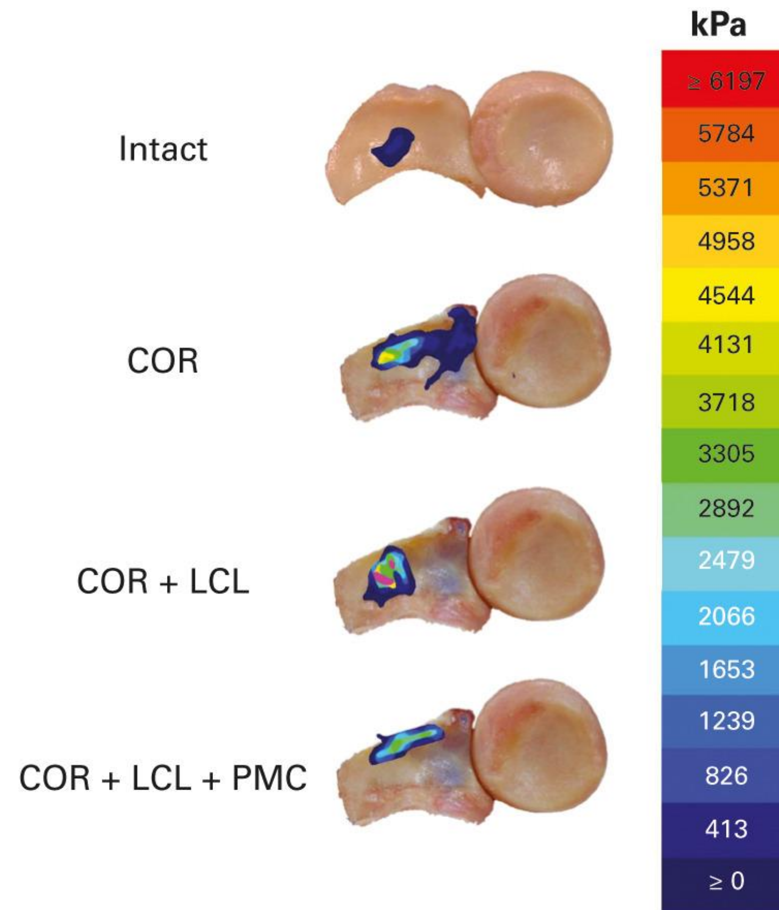

In the presence of an anteromedial fracture and disruption of the LCL, the posterior bundle of the MCL has to be disrupted for gross subluxation of the elbow to occur. However, elevated joint contact pressures are seen after an anteromedial fracture and LCL disruption even in the absence of such subluxation.

Bellato; JSES: 2017 role of PBMCL in PMRI of elbow

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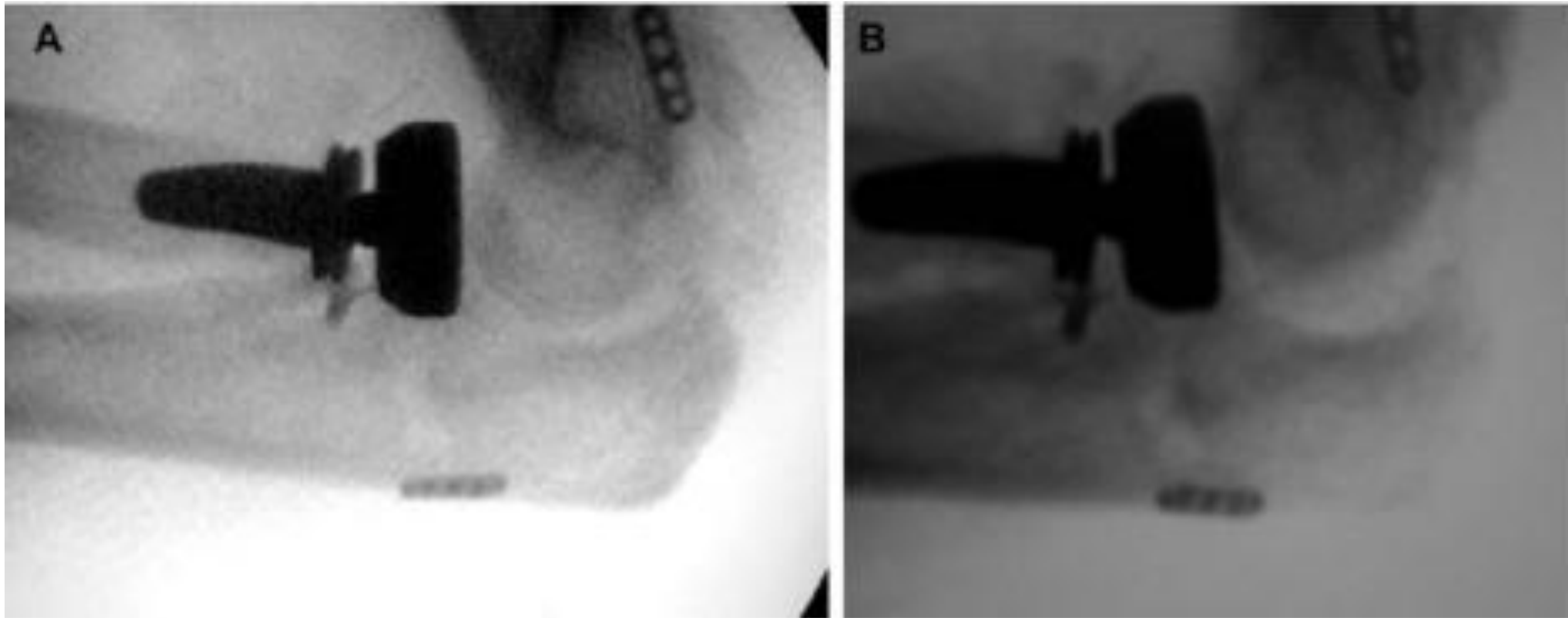
Posterior bundle MCL – drop sign of ulna in flexion



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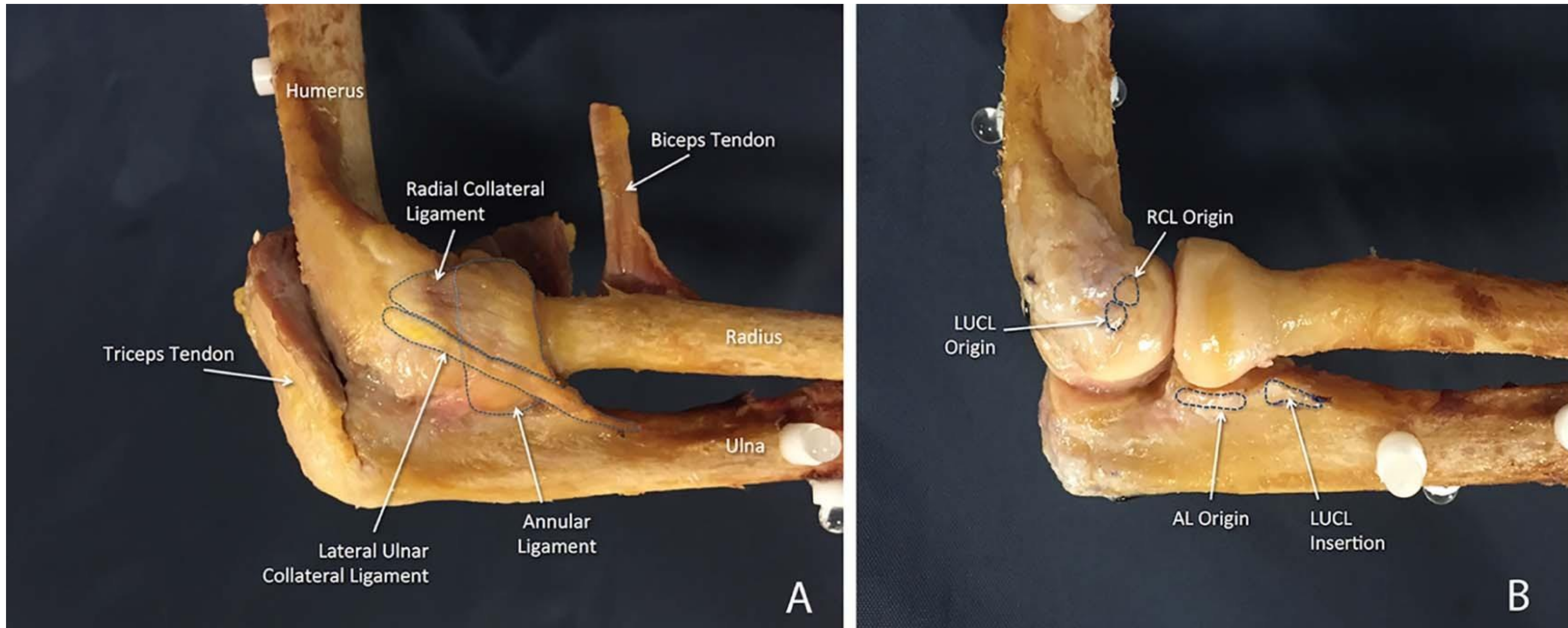
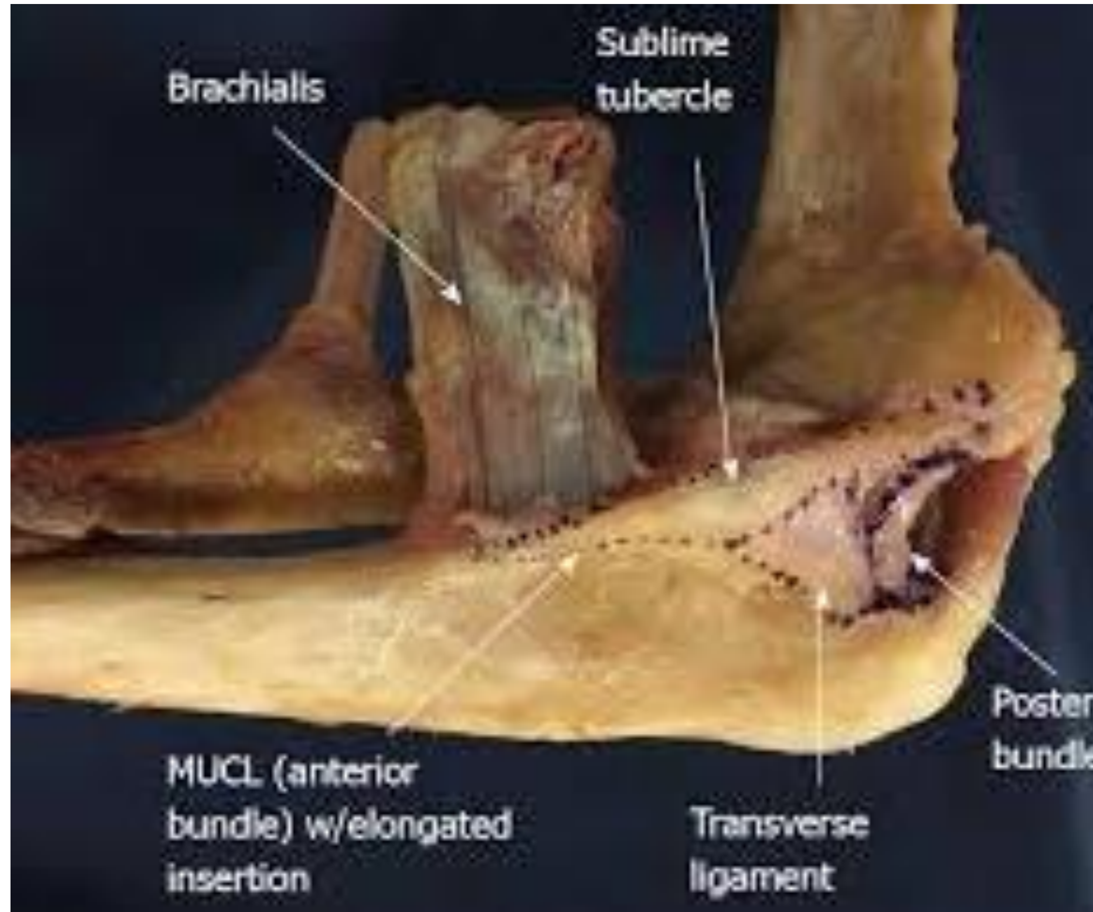
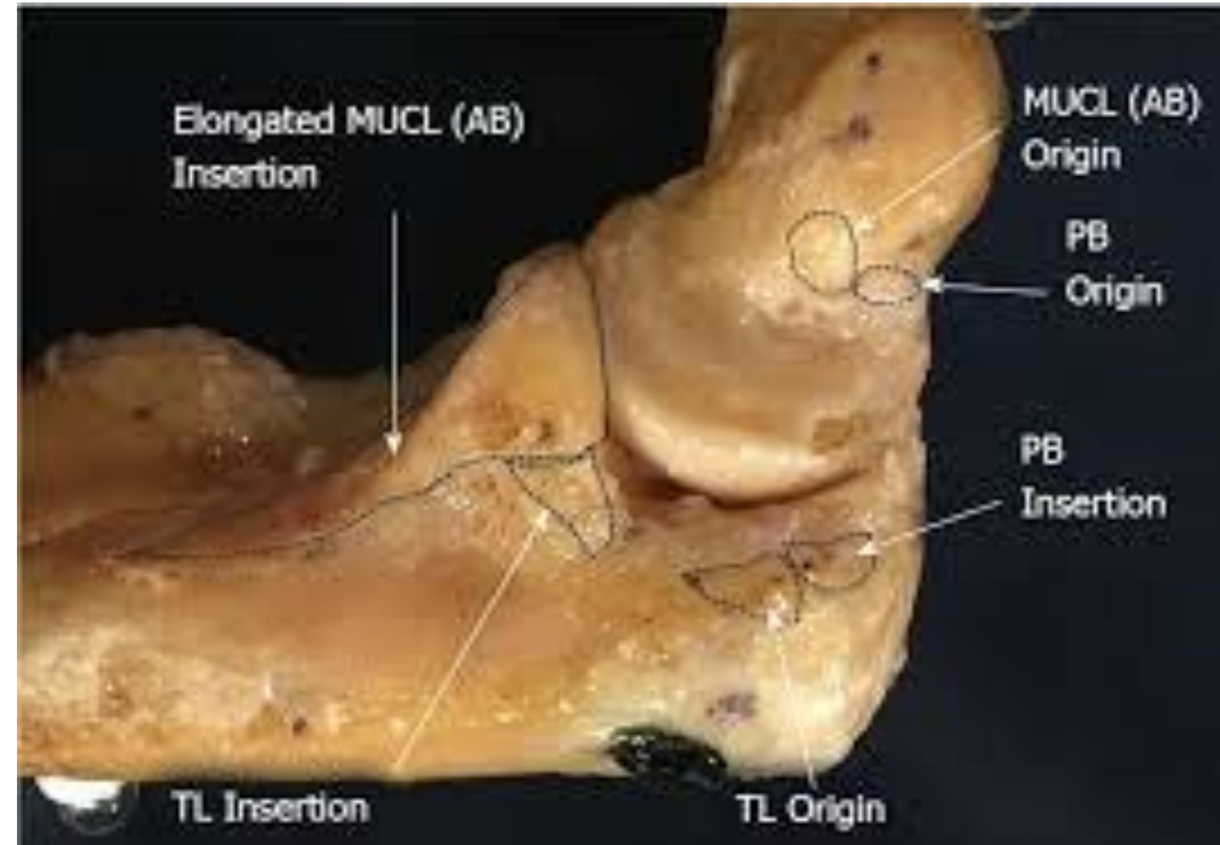
LCLC



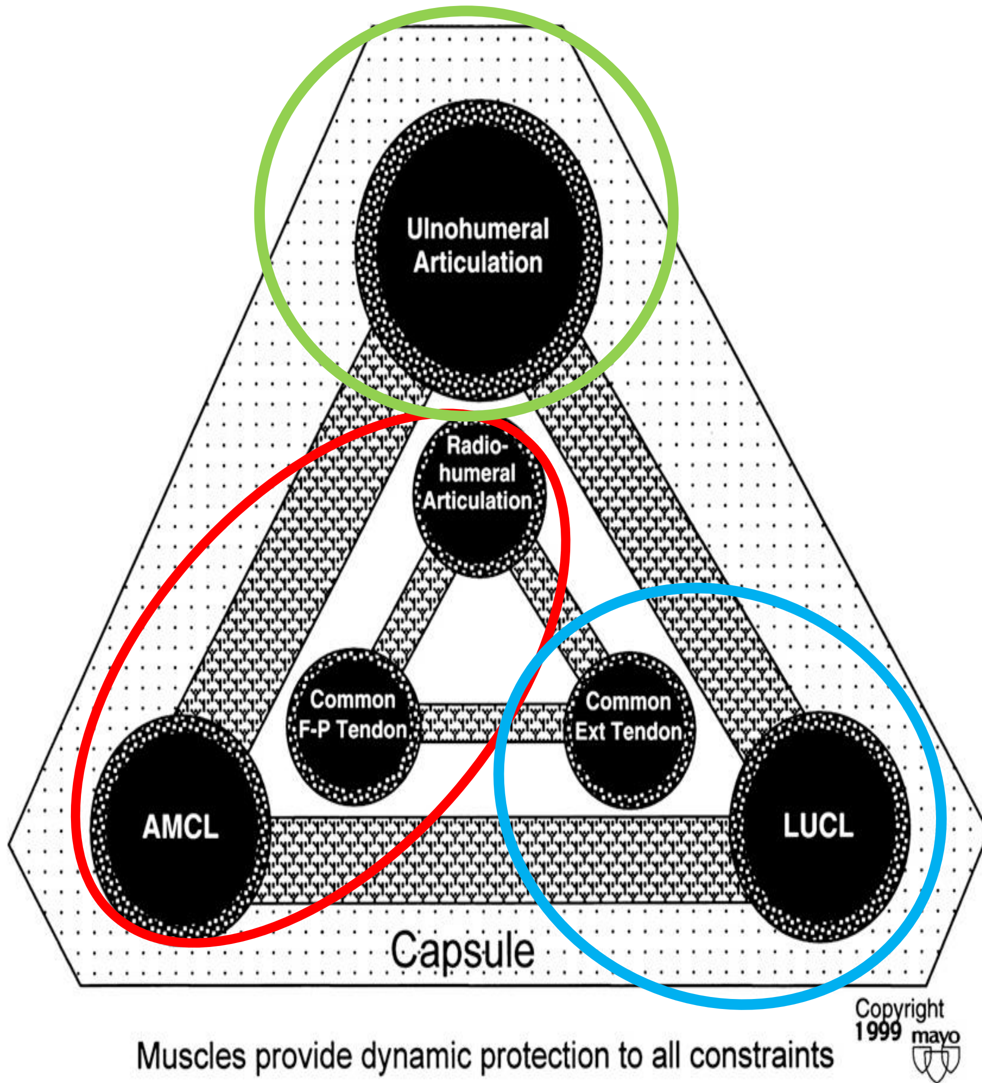
The lateral collateral ligament complex of the elbow: quantitative anatomic analysis of the lateral ulnar collateral, radial collateral, and annular ligaments. JSES 2019 Camp

MCL complex





Understanding the medial ulnar collateral ligament of the elbow: Review of native ligament anatomy and function. Labott . World J Orthop 2018; 9(6): 78-84



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Elbow stabilisers

- **Sagittal plane**
  - Ulnohumeral articulation: Coronoid and olecranon
- **Coronal and axial planes**
  - **Posteromedial instability –**
    - Radial side: LCLC
    - Ulnar side: MCLC + coronoid
    - Likely to need to tackle both sides
  - **Posterolateral instability -**
    - Radial side: Radial head + LUCL
    - Ulnar side: anteromedial facet +/- MCL
    - Ulnar side may not be necessary if fragment is small and radial head + LCL restoration provide buttress to anterior bundle MCL
    - If drop sign persist – posterior bundle MCL needs restoration

Bony buttress – primary stabiliser

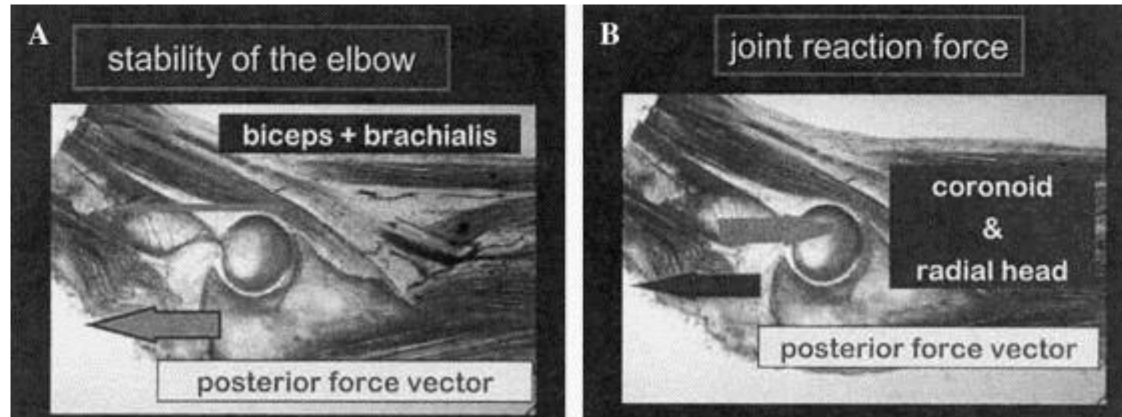

Figure 1. (A) Tension in the biceps and brachialis muscles creates a posterior vector force. (B) The posterior force vector is counteracted by the coronoid and radial head, creating a joint reaction force. (Reprinted with permission; from diagram of Robert N. Hotchkiss).

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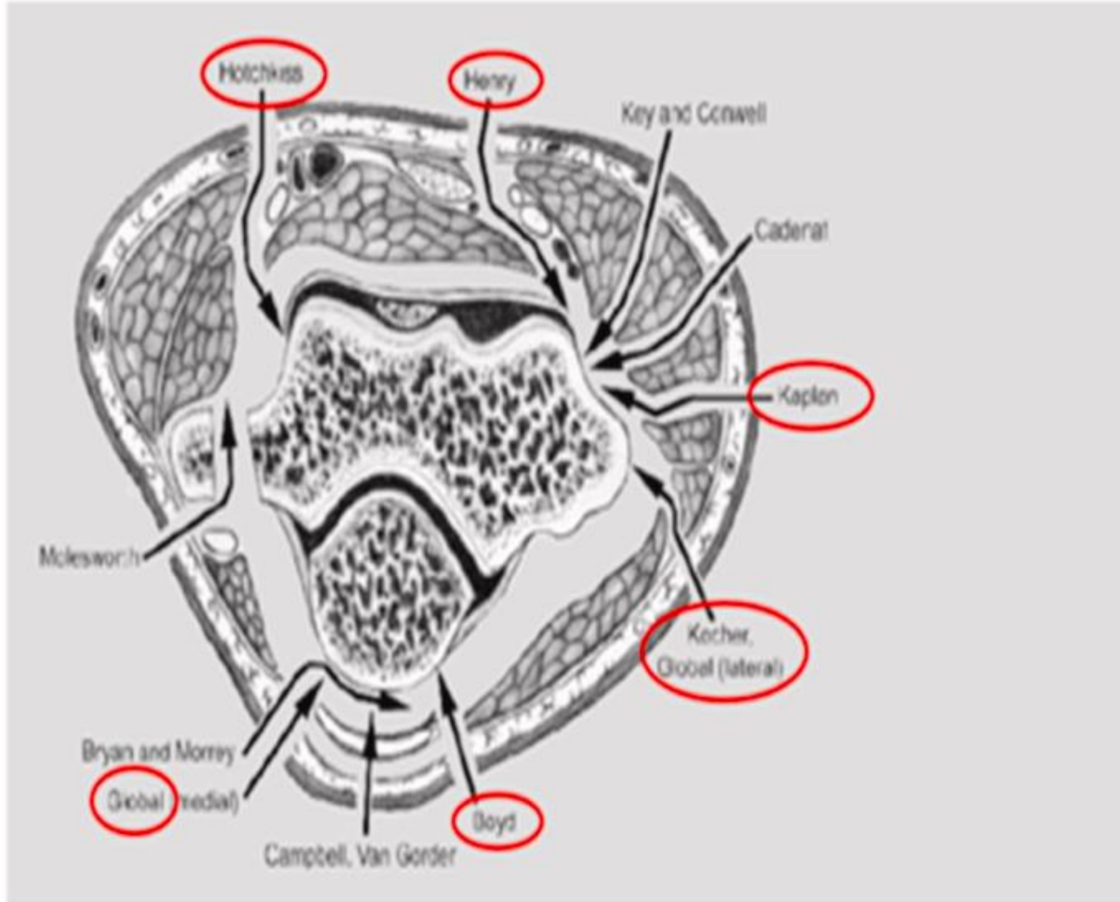
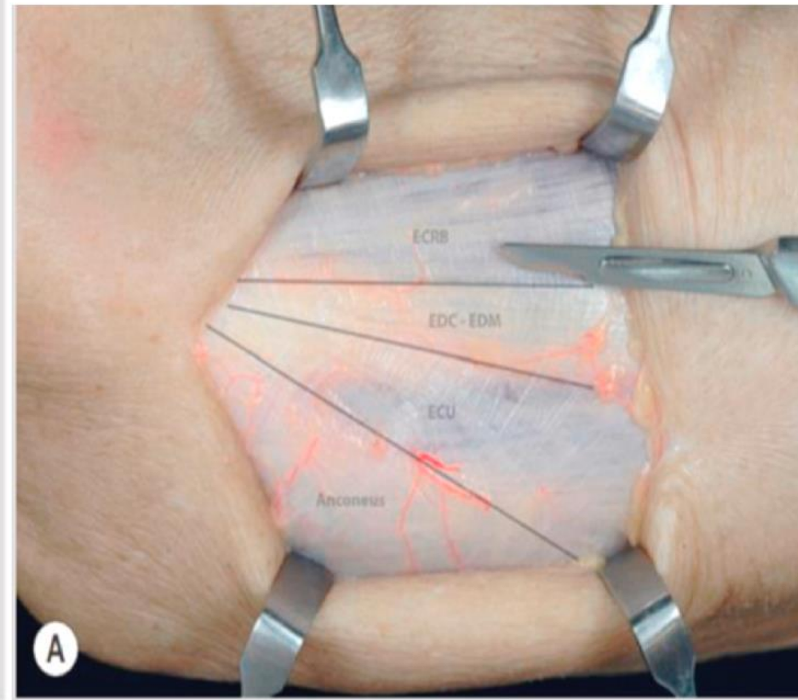
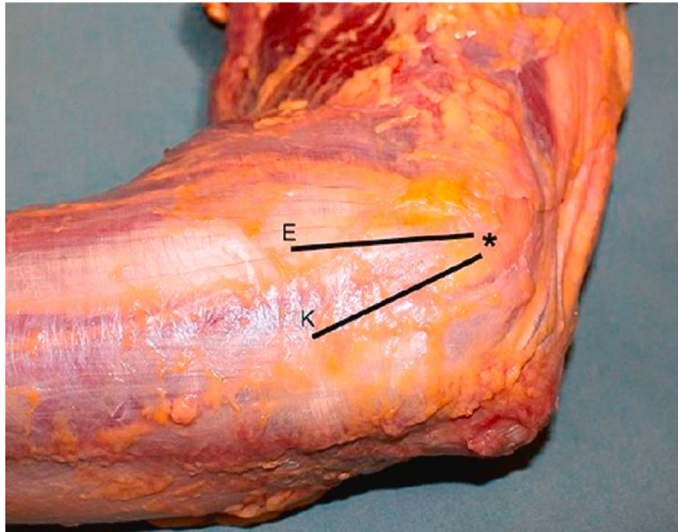
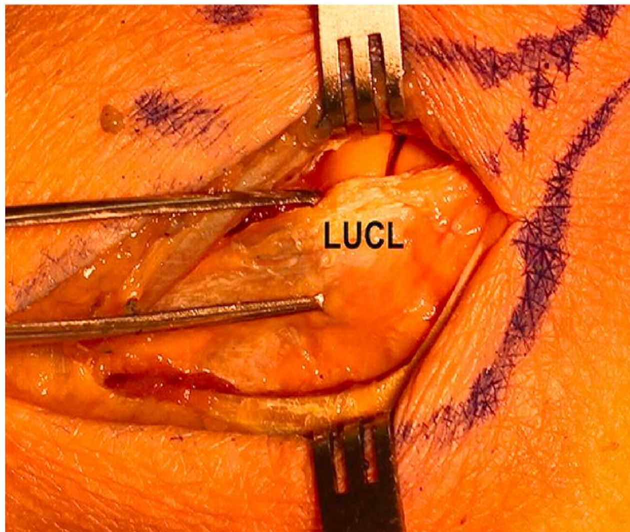
Surgical approaches



Aggarwal S, Paknikar K, Sinha J, Compson J, Reichert I. Comprehensive review of surgical approaches to the elbow. J Clin Orthop Trauma. 2021 Jun 21;20:101482.



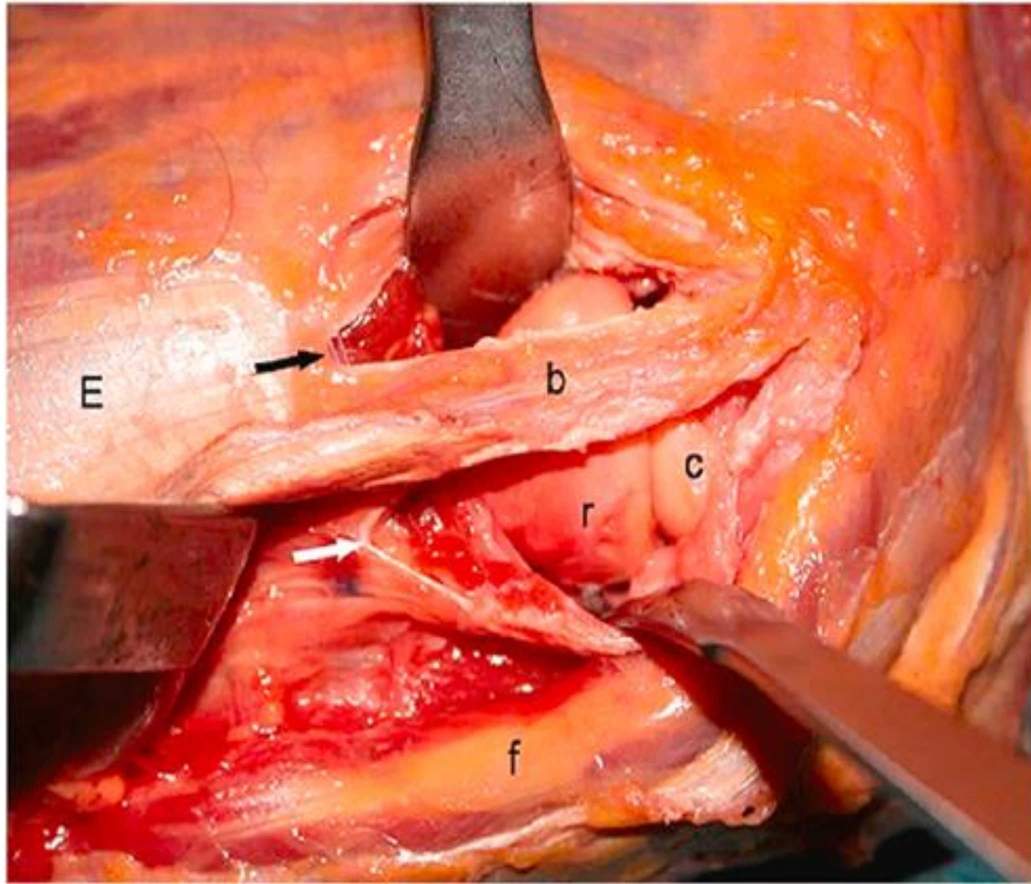




- **Kocher approach between anconeus and ECU**
  - Directly over LUCL
  - easy access for repair
  - difficult to get to anterior radial head fragment
  - Cautious with distal extension – PIN exit pt's 3 finger breadth distal to radial head – release humeral head of supinator and retract distal and volarly with nerve

- **EDC approach - between ECU and EDC or mid EDC**
  - PIN anterior, elevate the capsule and brachioradialis from lateral condylar ridge and move nerve medially
  - Difficult to reach the supinator crest if reconstruction is required – normally avulsed from humerus

- **Two windows approach**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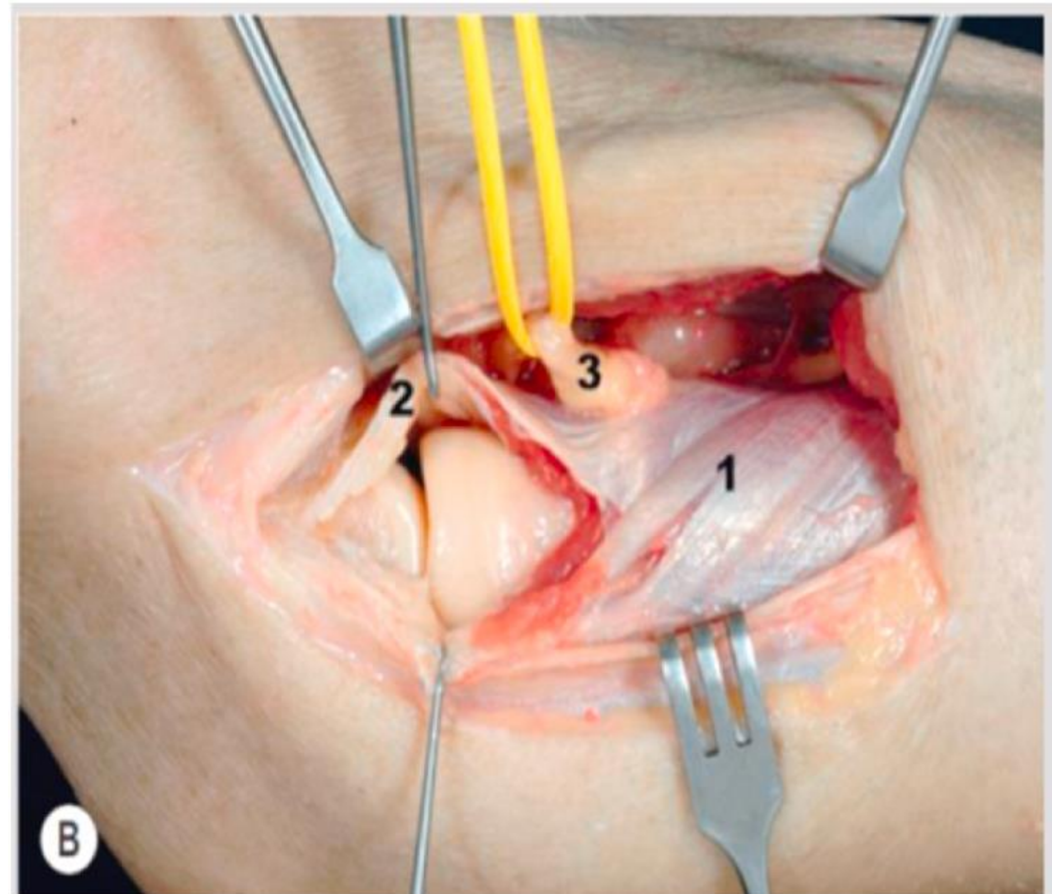
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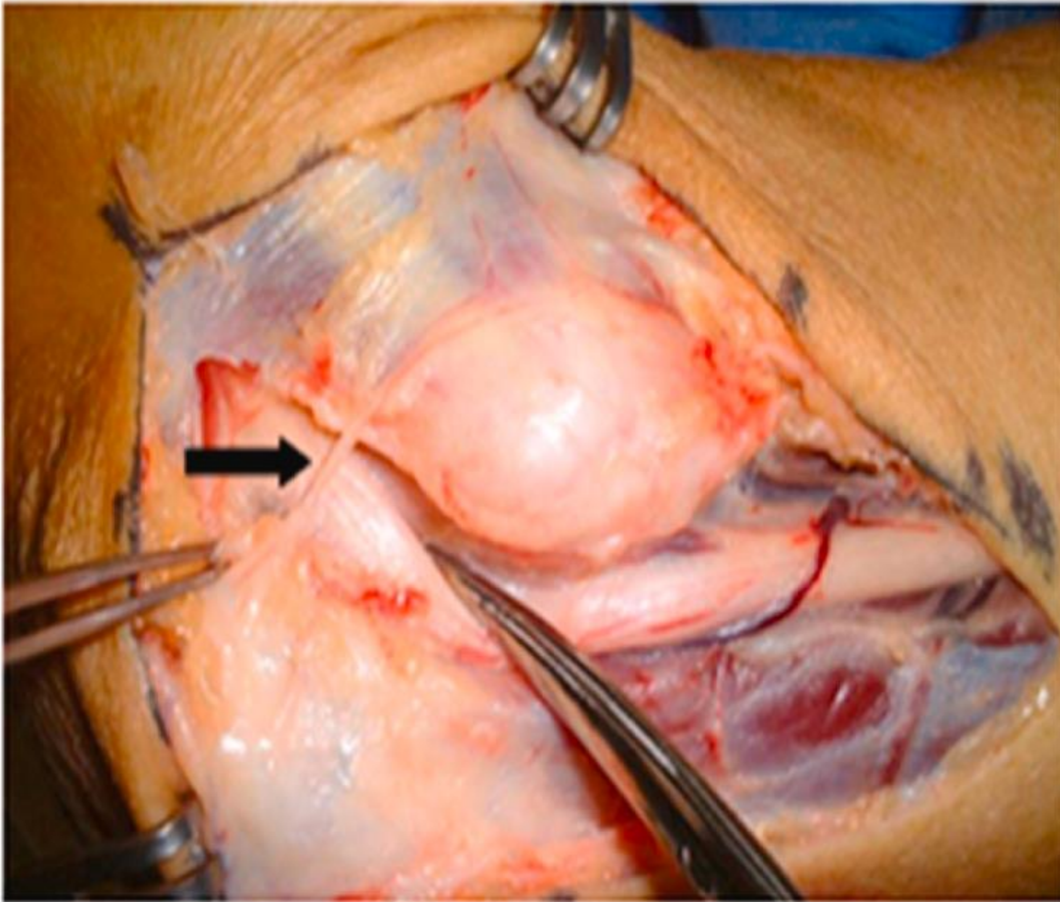
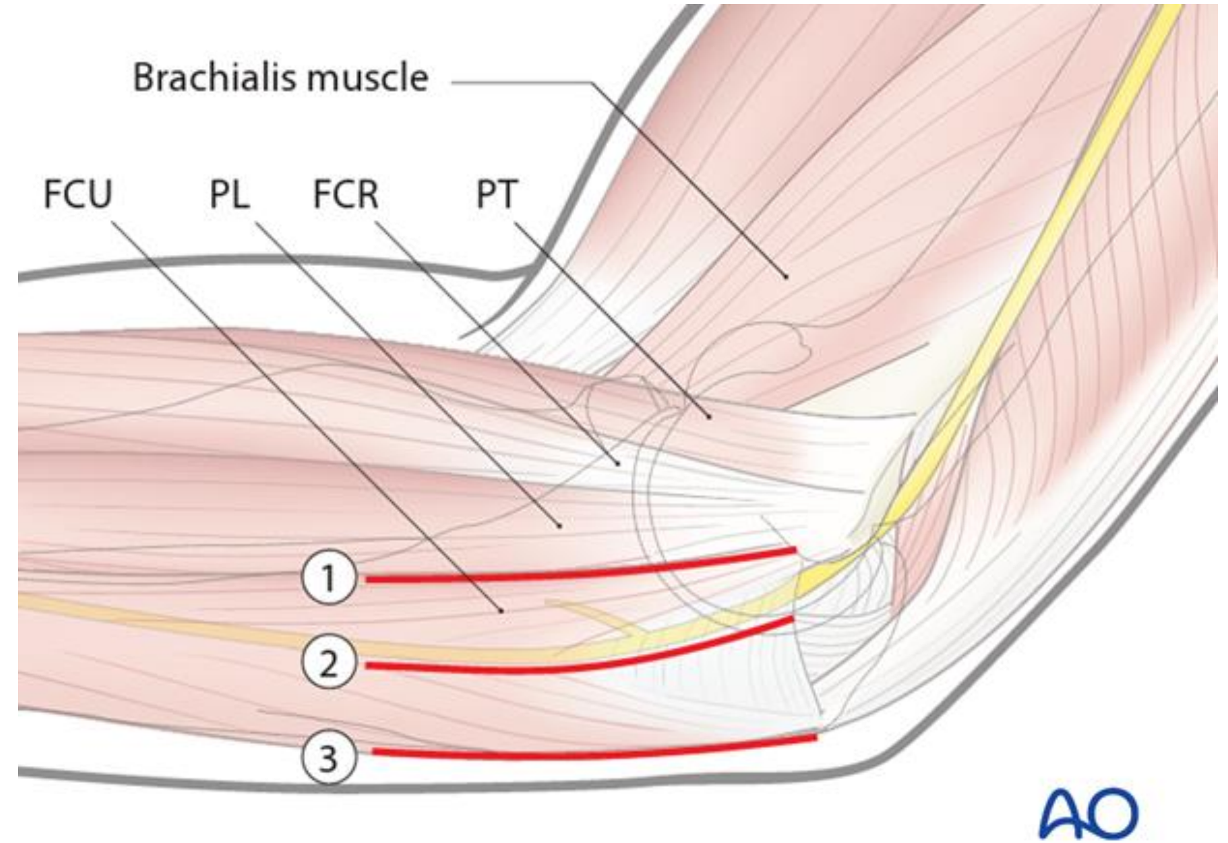
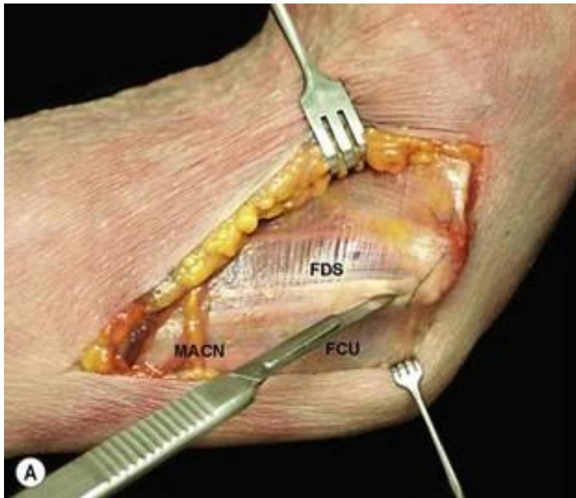
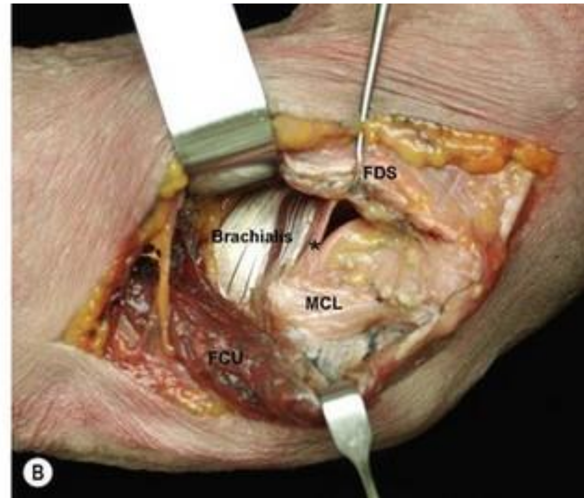
Medial side





Hotchkiss /Taylor Shyam approaches

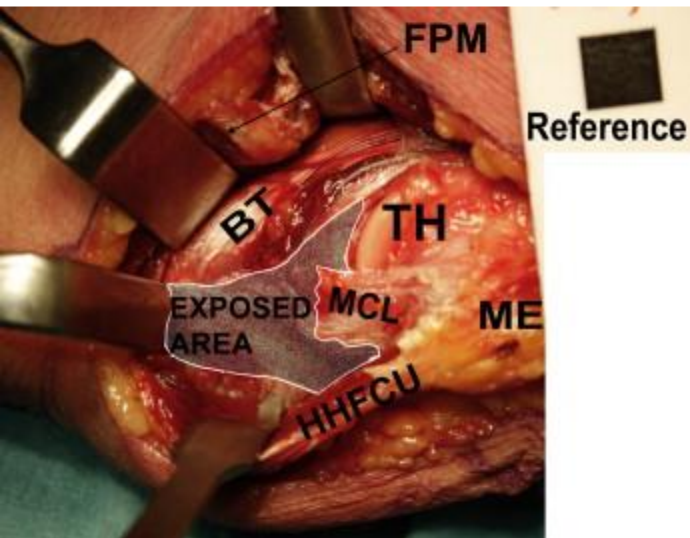


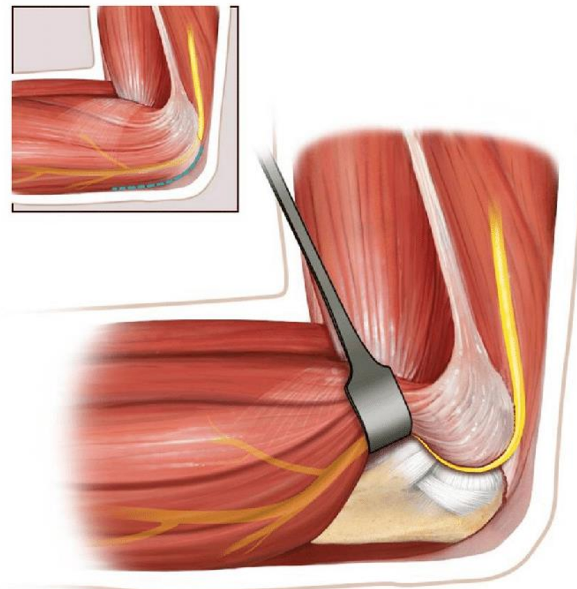


Hotchkiss – over the top - can reach sublime tubercle between palmaris/pronator
Need to release FDS from medial ridge

FCU split – reaching the base for coronoid body fixation/buttress; may need to sacrifice 1st motor branch to FCU

Taylor Shyam – elevate the FCU and ulnar nerve ; low coronoid fracture





Sales JM, Llusá M, Forcada P, et al. Orozco. Atlas de osteosíntesis. 2nd edn. Fracturas de los huesos largos. Vías de acceso quirúrgico. Barcelona: Elsevier-Masson; 2009.24
Jjost 2015 JSES. The extended medial elbow approach—a cadaveric study,

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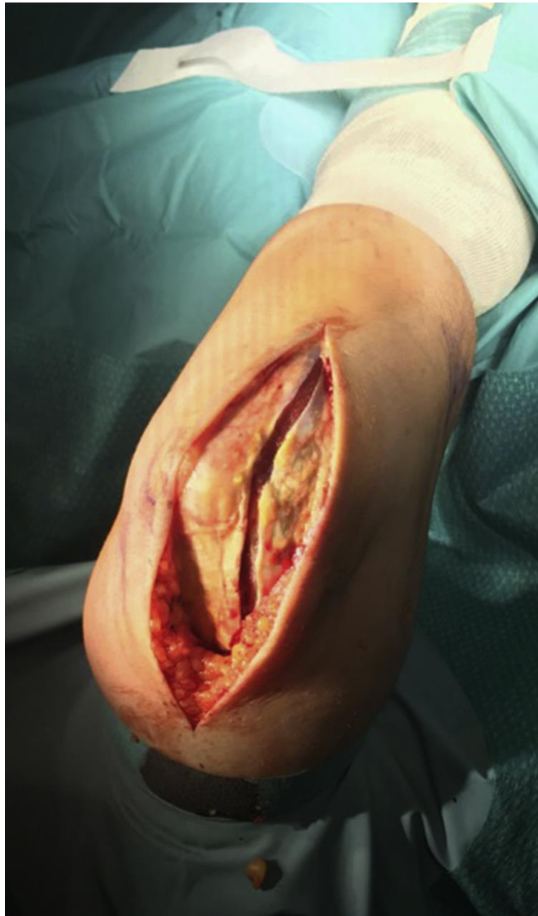
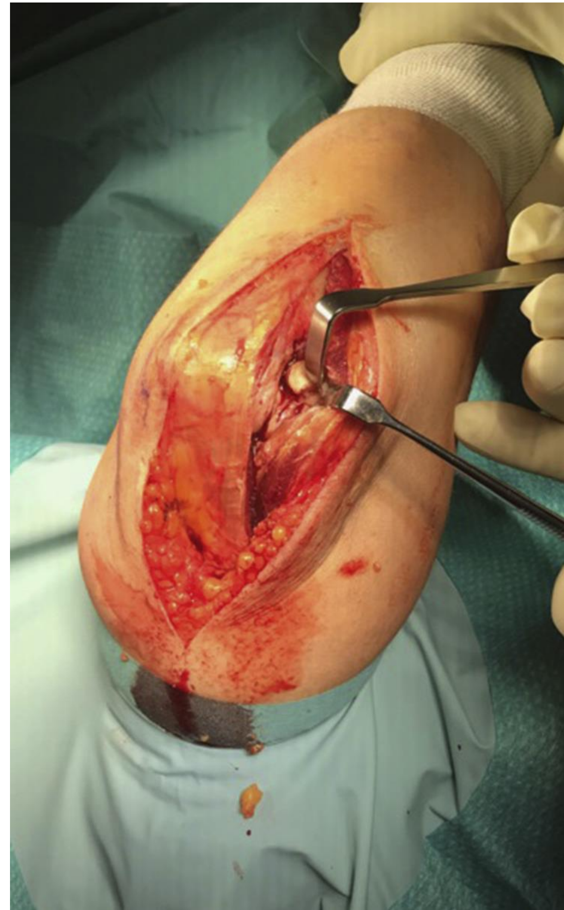
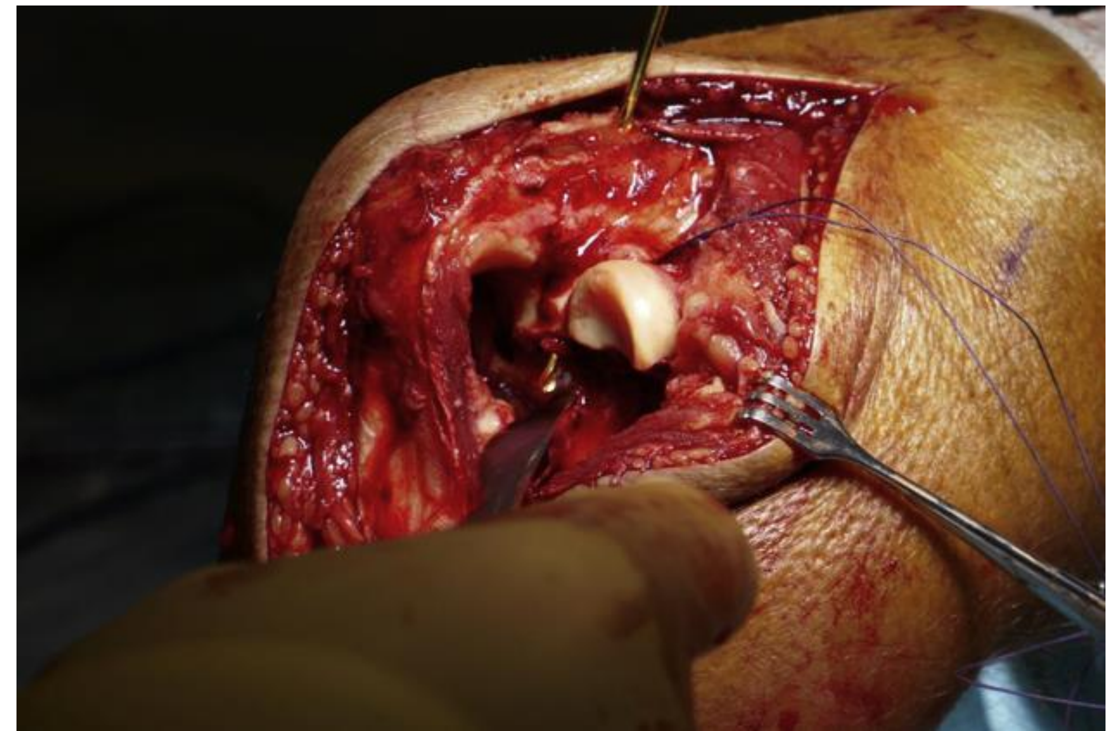
Posterior utility approach (Boyd)







- Release LUCL from supinator crest or retract the normally torn from humeral origin
- Subluxate joint to see coronoid
- Repair with anchor at the end
- Develop skin flap on medial side if medial approach needed

Carroll PJ, Morrissey DI. Posterior (Boyd) approach to terrible triad injuries. JSES Int. 2021

Useful resources

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Lee Van Rensburg

Post op rehab

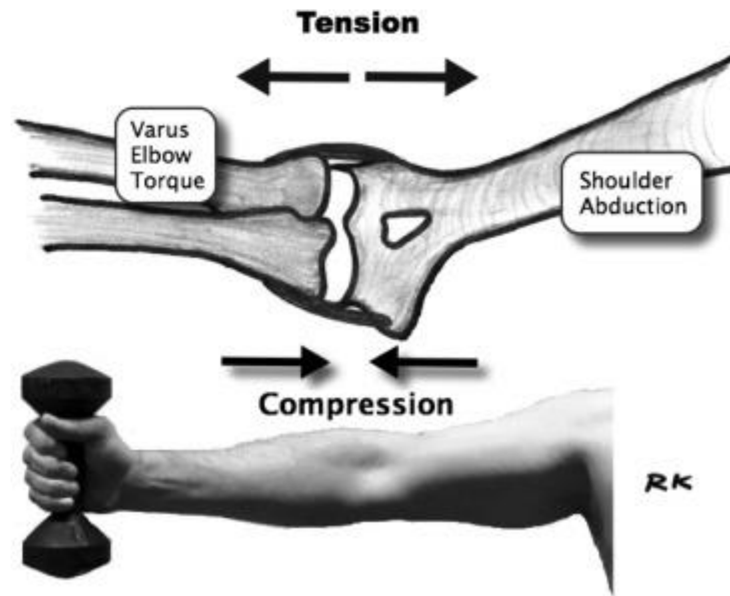
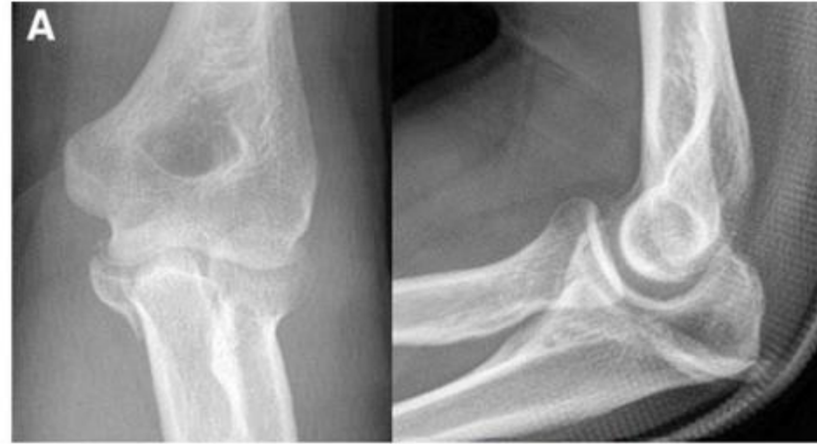


Figure 1. Shoulder abduction causes a substantial varus torque resulting in a lateral tensile force and medial compressive force. The forces on the elbow vary considerably depending on arm position.

Elbow Biomechanics: Soft Tissue Stabilizers; Kaufmann JHShttps://doi.org/10.1016/j.jhsa.2019.10.034

- Avoid varus stress – shoulder abduction
- Overhead antigravity passive/active assisted ROM
- Isometric bicep contraction
- Avoid plaster immobilisation >3 to 4 weeks, ideally none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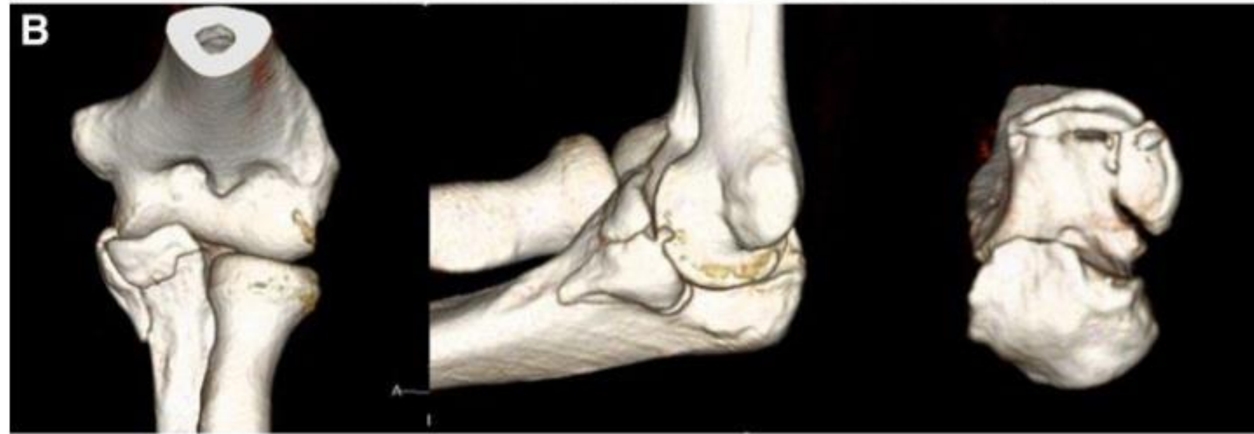
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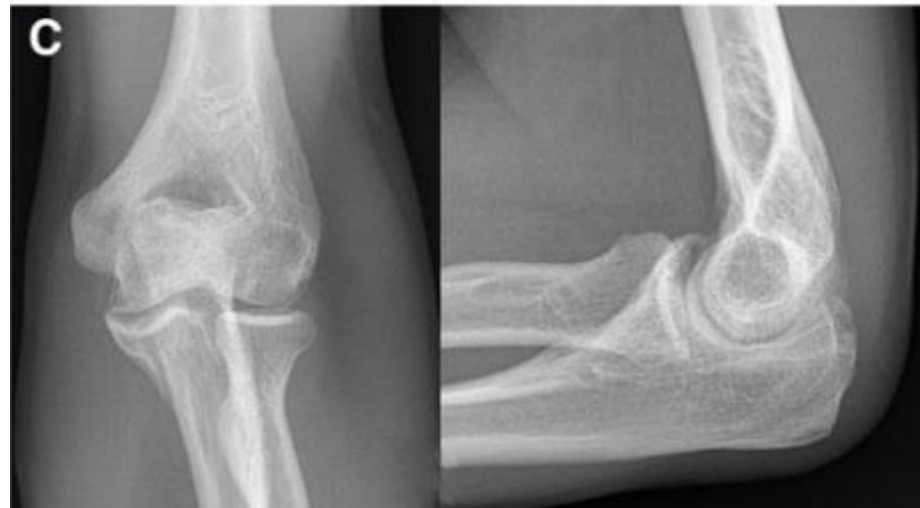
Non surgically managed anteromedial coronoid fractures in posteromedial rotatory instability: three cases with 2 years follow-up

Jun-Gyu Moon · Nitin Bither · Young-Jin Jeon · Sung-Mok Oh



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Most coronoid fractures and fracture-dislocations with no radial head involvement can be treated nonsurgically with elbow immobilization

Antonio M. Foruria, MD, PhD[a,*], Begoña Gutiérrez, MD, PhD[b], Jesús Cobos, MD[a], David L. Haeni, MD[a], Maria Valencia, MD, PhD[a], Emilio Calvo, MD, PhD, MBA[a]

J Shoulder Elbow Surg (2019) 28, 1395–1405