Elbow Instability

Ashley Burt

2/20/2019

Elbow Instability

- Introduction
- Anatomy
- Patterns of instability
    - PLRI
    - Valgus
    - PMRI
- Summary

Objectives

- Review elbow anatomy with emphasis on functional anatomy
- Identify common mechanisms of injury to the elbow
- Correlate typical injury patterns with imaging findings
  - What does the surgeon want to know?
  - Newly discussed associations (PMRI)
- Explore current and emerging treatment options

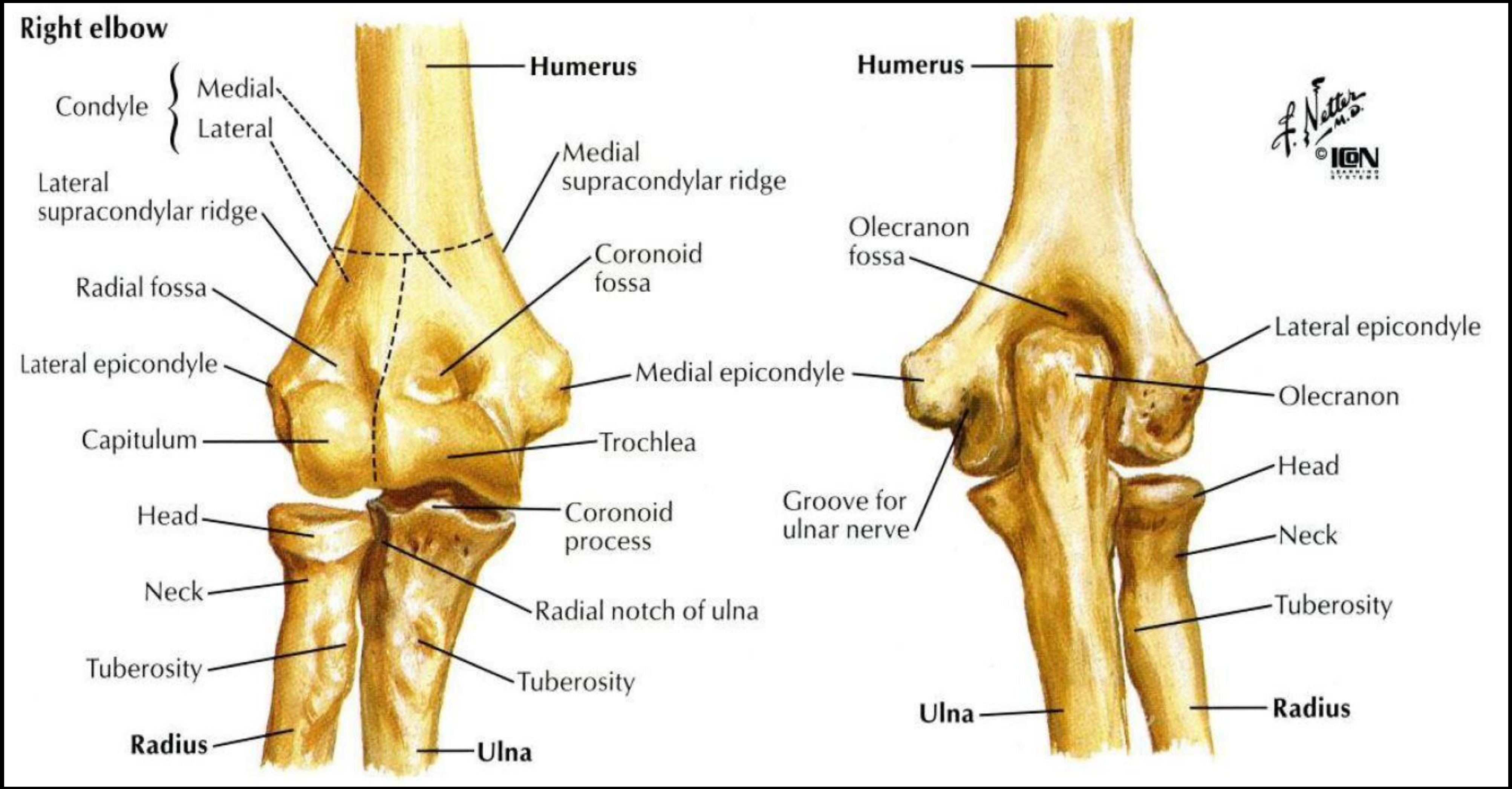
Elbow Instability History

- 1881 - First described by Albert E Lehrbuh
- 1940's – Attempt to restore elbow stability with coronoid augmentation by Reichenheim and Wainwright (separately)
- 1960's – Osborn and Cotterill recognized contribution of ligamentous insufficiency
- 1991 – Posterolateral rotatory instability first described by O'Driscoll … helped clarify biomechanics of elbow instability
- 2000's – Exponential growth in instability research

Elbow Basics

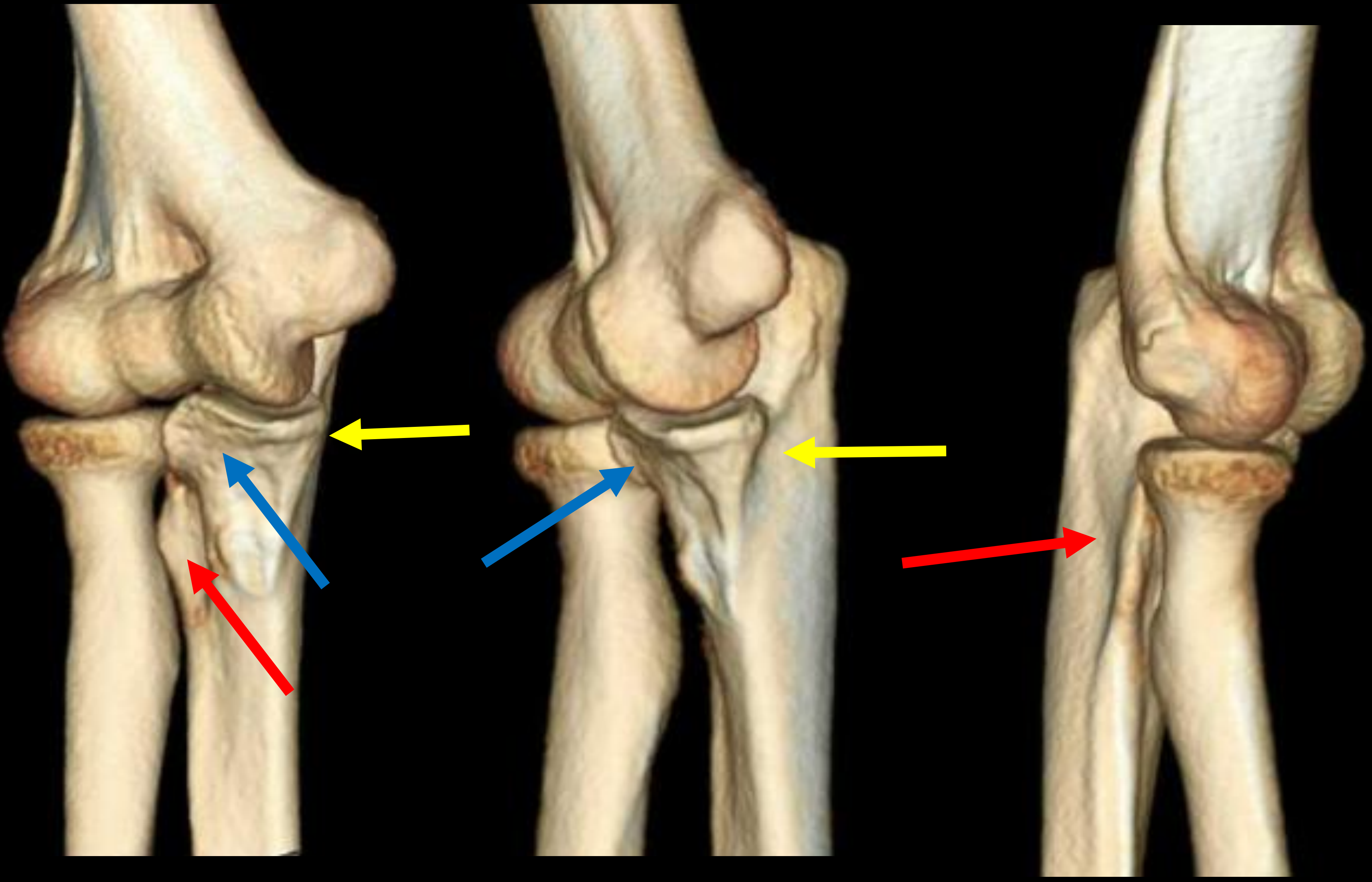
- Trochoginglymoid joint = hinge + pivot
  - 30° to 130 ° flexion/extension
  - 50° supination/pronation
- Normal valgus carrying angle
  - 5-10 ° for males
  - 10-15 ° for females
- In extension
  - 40% axial load transmitted through ulnohumeral joint
  - 60% axial load transmitted through radiocapitellar joint

Elbow Osseous Anatomy



Elbow Osseous Anatomy - Capitellum

Elbow Osseous Anatomy – Ulna



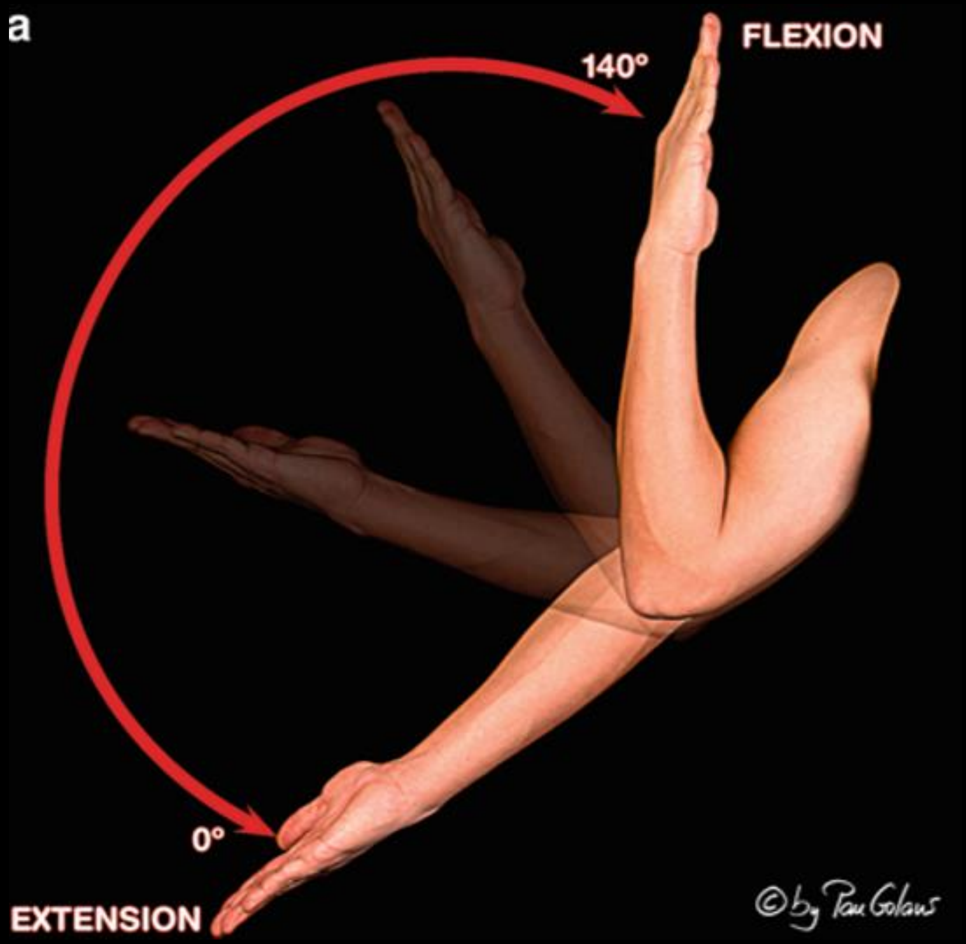
Coronoid Process
Sublime Tubercle
Supinator Crest

Radiocapitellar Joint

- Capitellum – radial head
- Allows hinge and pivot motion
- Congruency of radial head within capitellum key
  - Radial head 2nd most important restraint against valgus stress
  - Normal radius length maintains tension on LCL

Ulnohumeral Joint

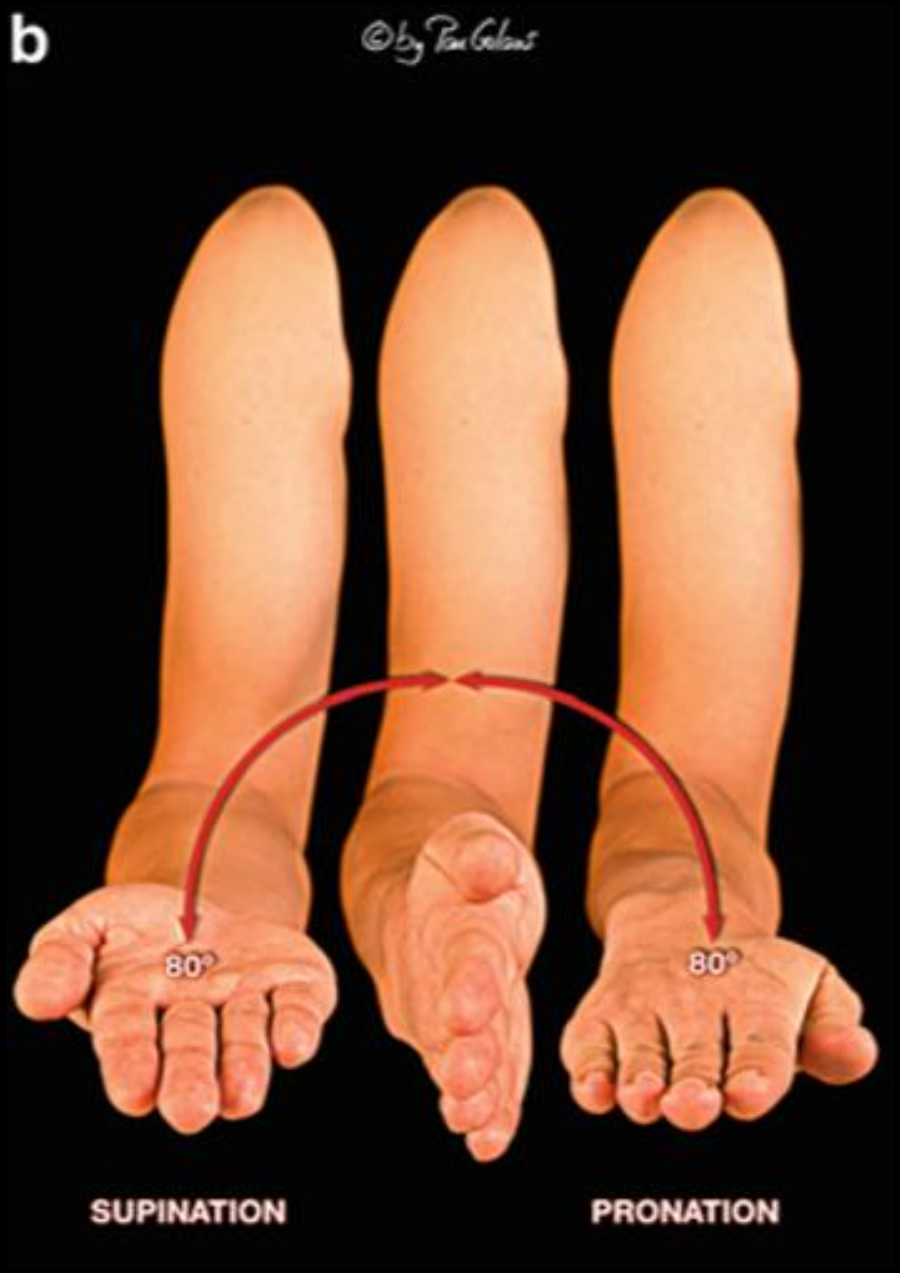
- Trochlea of humerus – trochlear notch of ulna
- Hinge Joint
- Provides medial-lateral stability between 0° - 30° flexion



Elbow Anatomy. In Sports Injuries (2014).

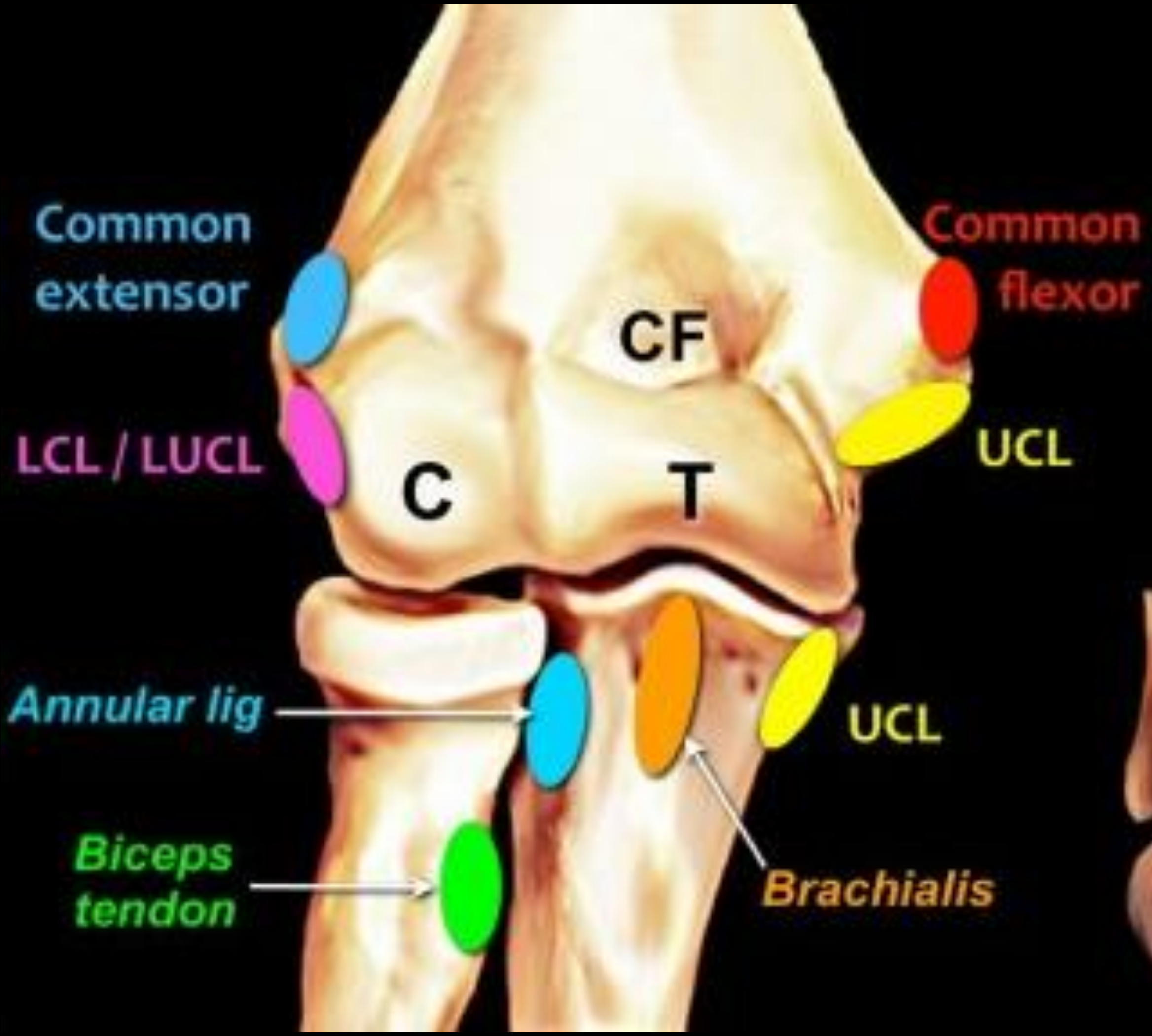
Proximal Radioulnar Joint

- Radial head – lesser sigmoid notch of ulna
- Pivot joint



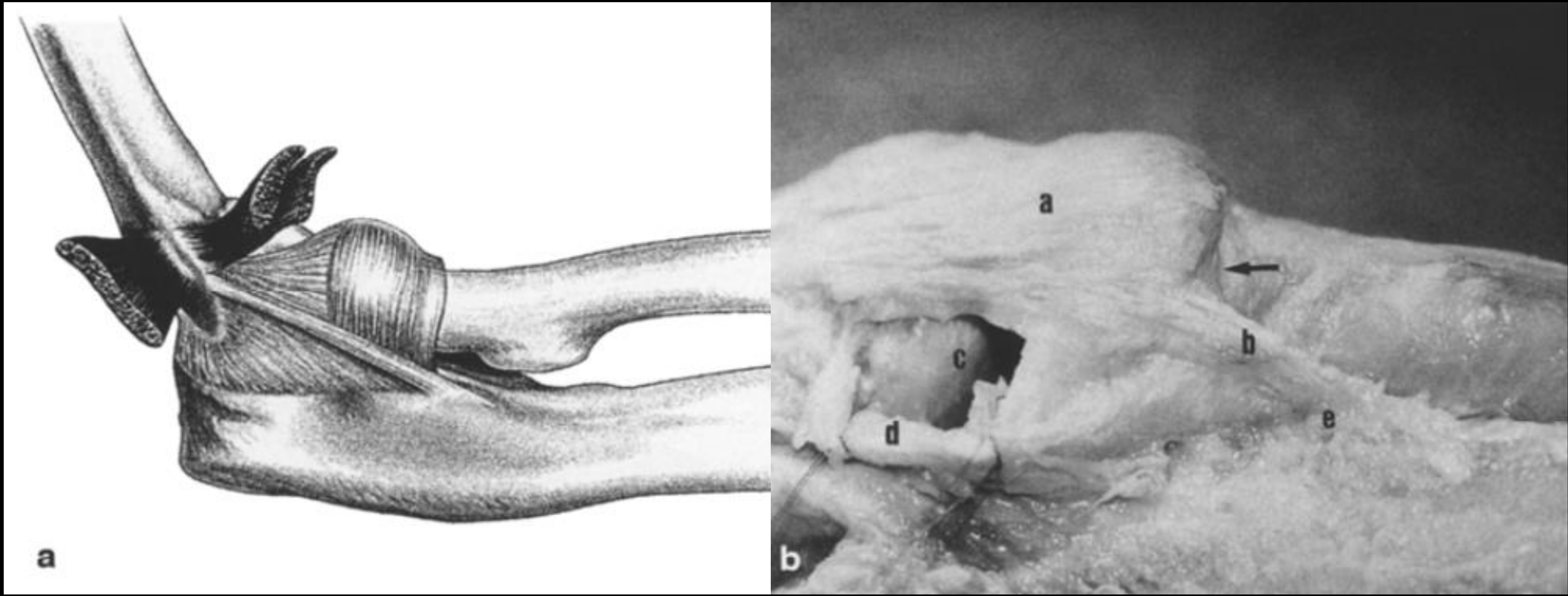
Elbow Anatomy. In Sports Injuries (2014).

Capsuloligamentous anatomy



The Radiology Assistant

Lateral Collateral Ligament Complex



Surgical and Radiologic Anatomy 21:3 187-191, 1999.

Lateral Ulnar Collateral Ligament

- Common origin with RCL from humerus
  - Deep and distal to common extensor tendon
- Blends indistinguishably with RCL proximal to annular ligament
  - RCL runs slightly anterior
- Passes posterolateral to radial head -> supinator crest insertion

RadiologyKey.com

Lateral Ulnar Collateral Ligament

Origin: Lateral humeral epicondyle

Insertion: Supinator crest of the ulna

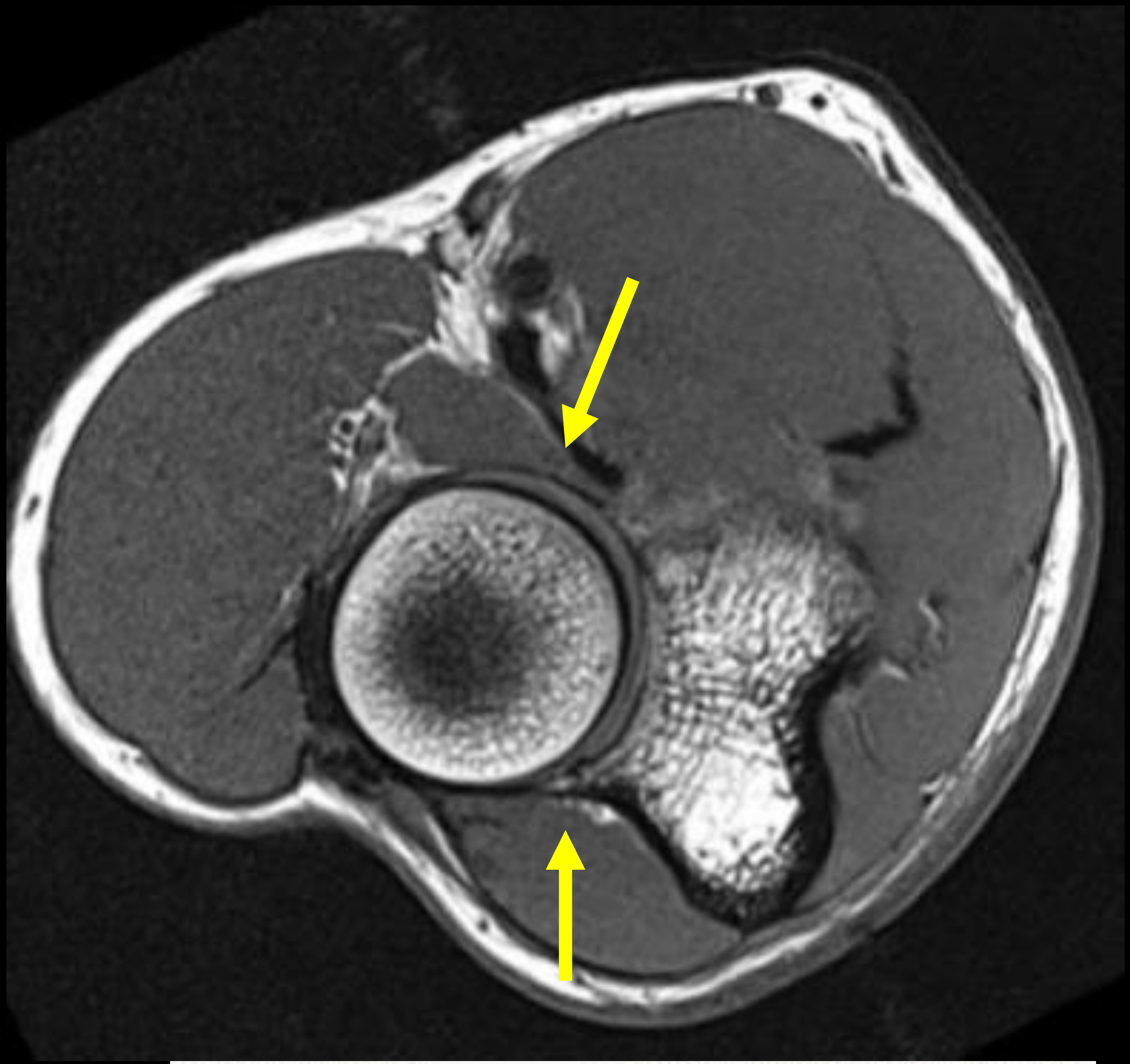
Am J Sports Med. 1999 Nov-Dec;27(6):796-800 c

Radial Collateral Ligament

- Common origin with LUCL from humerus
- Blends indistinguishably with LUCL proximal to annular ligament
- Fans out distally to inset on annular ligament and supinator muscle

Annular Ligament

- Attaches to the anterior and posterior margins of the lesser sigmoid notch of the ulna
- Stabilizes the radial head



Annular Ligament

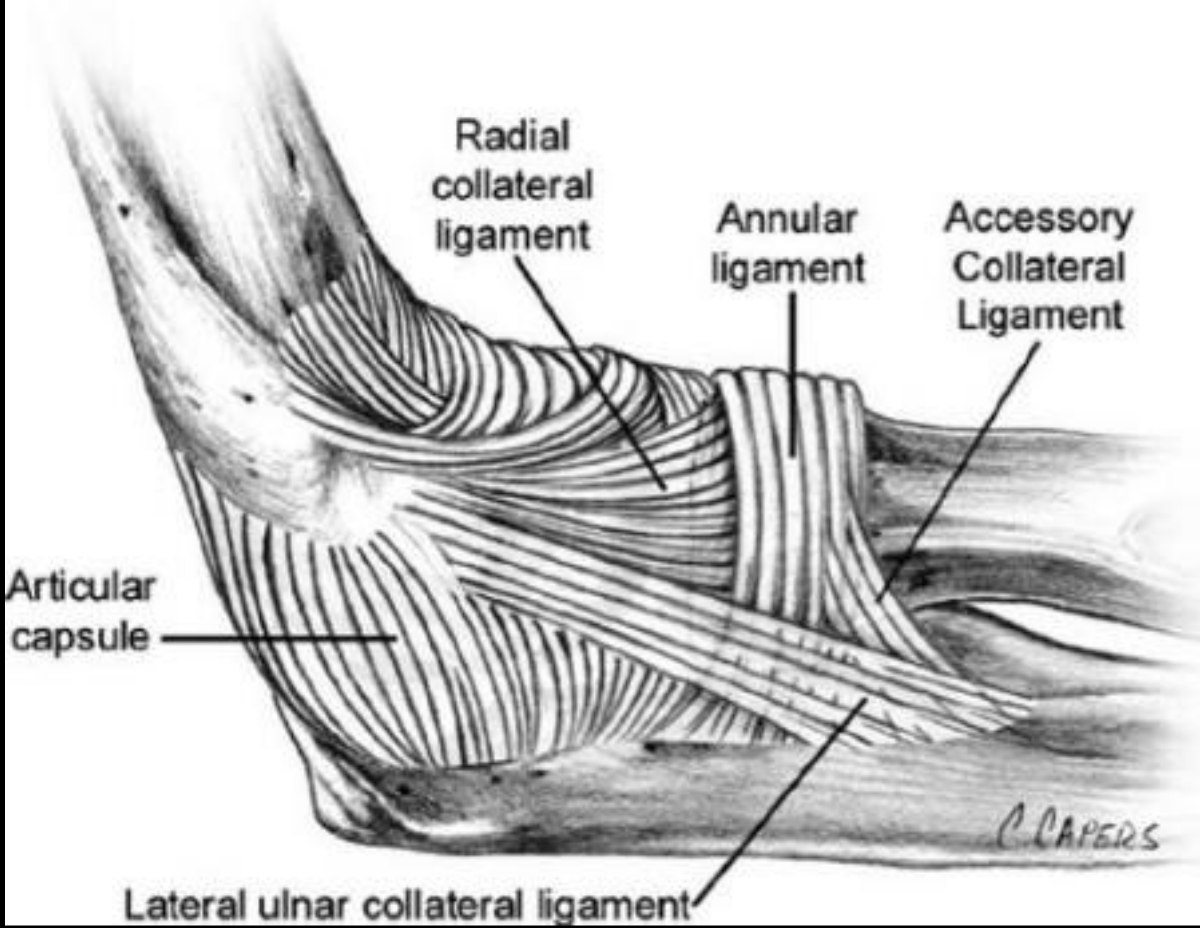
Origin/insertion: Anterior and posterior margins ulnar lesser sigmoid notch

Stabilizes: Proximal radioulnar joint

Am J Sports Med. 1999 Nov-Dec;27(6):796-800

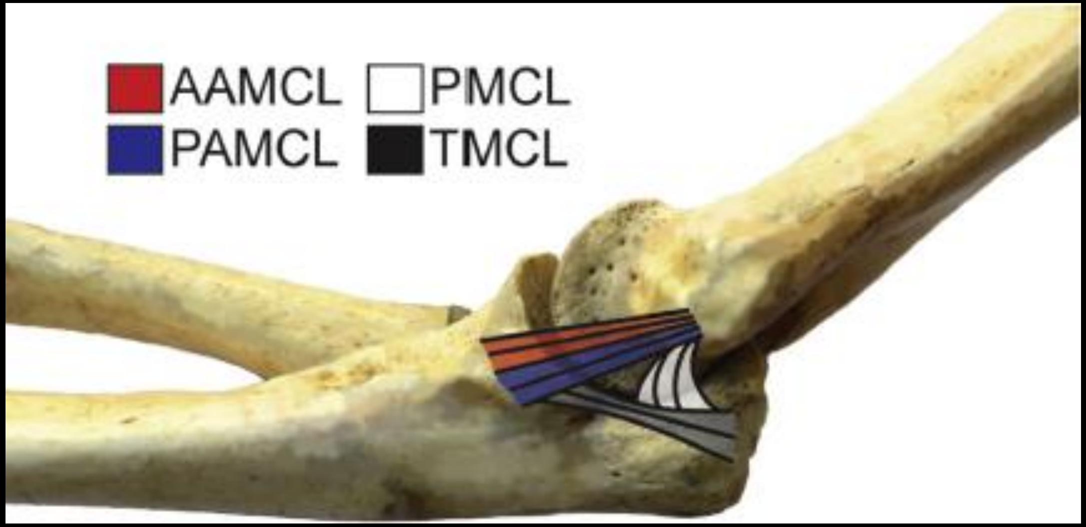
Accessory Lateral Collateral Ligament

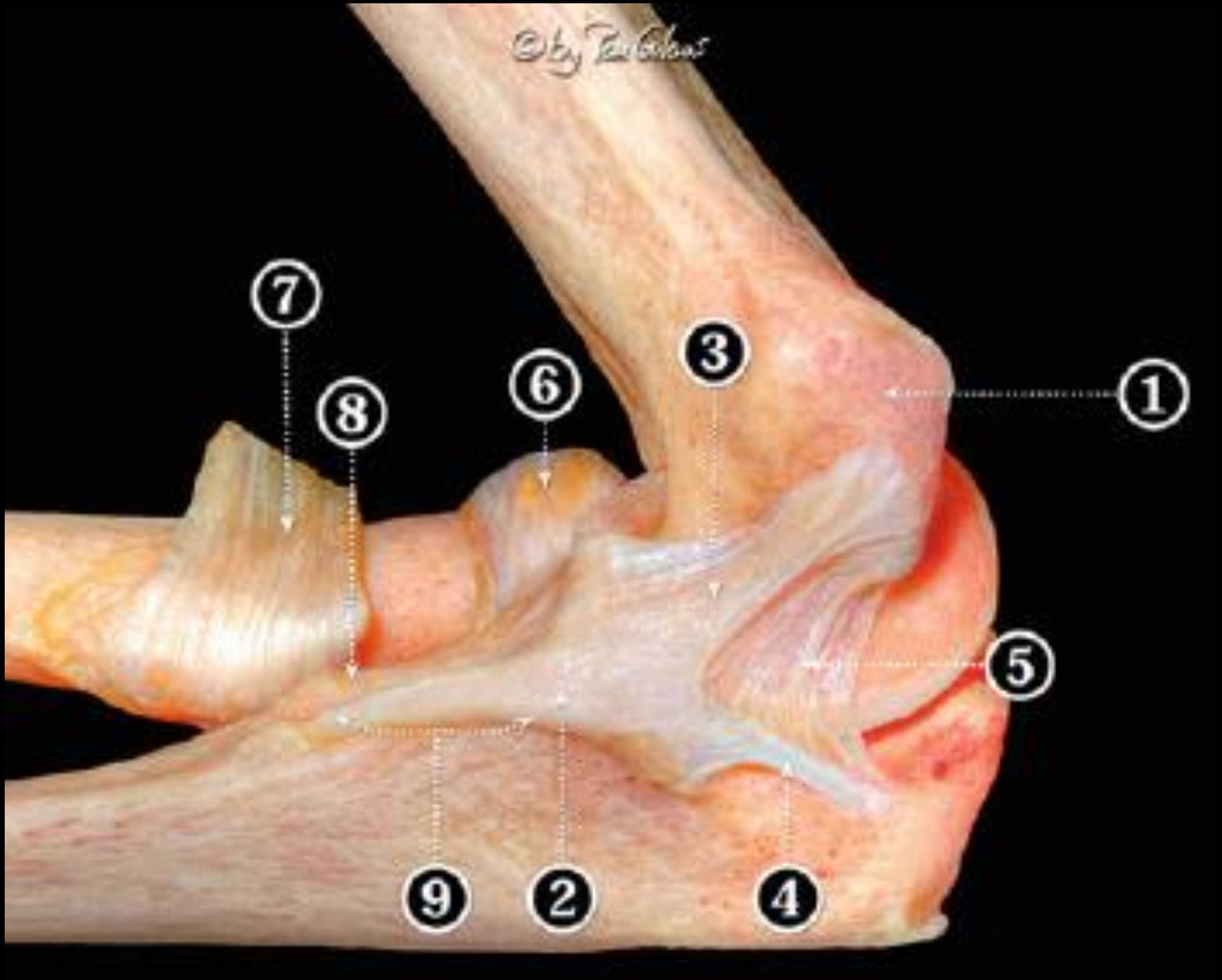
- Originates from annular ligament
- Inserts on supinator crest
- Stabilizes the annular ligament during varus stress



Medial Collateral Ligament

- 3 – anterior bundle
  - Anterior and posterior bands
- 5 – posterior bundle
- 4 – transverse bundle





J Hand Surg Am. 2014 Feb;39:199-205

Anterior Bundle MCL

- Primary restraint in valgus stress
- Inferior medial epicondyle to sublime tubercle
- Anterior band
  - Taut 0-60 degrees
  - Resistance to varus and valgus stress in extension
  - Role diminishes at 90 degrees flexion
- Posterior band
  - Taut 90-120 degrees
  - Questionable increasing role in stability

J Hand Surg Am. 2014 Feb;39:199-205

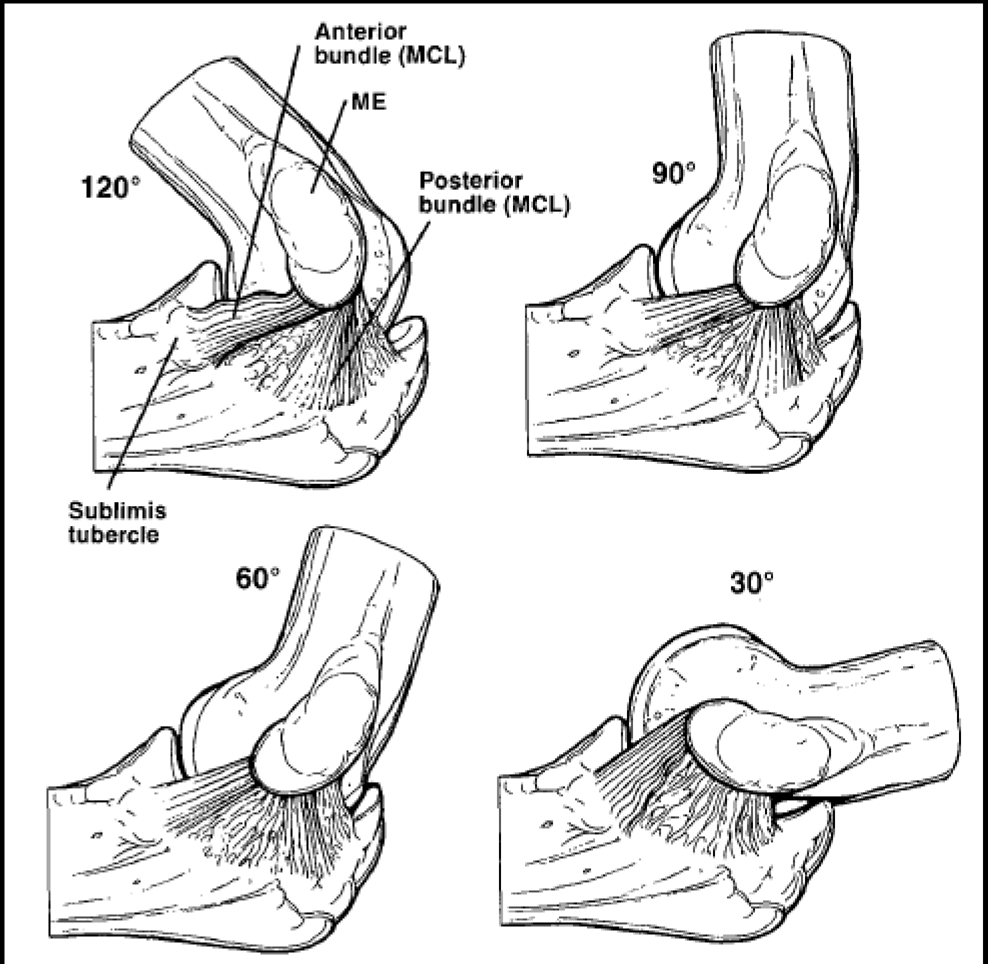
Biomechanical Evaluation of the Medial Collateral Ligament of the Elbow*

BY G. H. CALLAWAY, M.D.†, L. D. FIELD, M.D.‡, X.-H. DENG, M.D.§, P. A. TORZILLI, PH.D.§, S. J. O'BRIEN, M.D.§, D. W. ALTCHEK, M.D.§, AND R. F. WARREN, M.D.§, NEW YORK, N.Y.

Investigation performed at The Hospital for Special Surgery, Affiliated with The New York Hospital—Cornell University Medical College, New York City

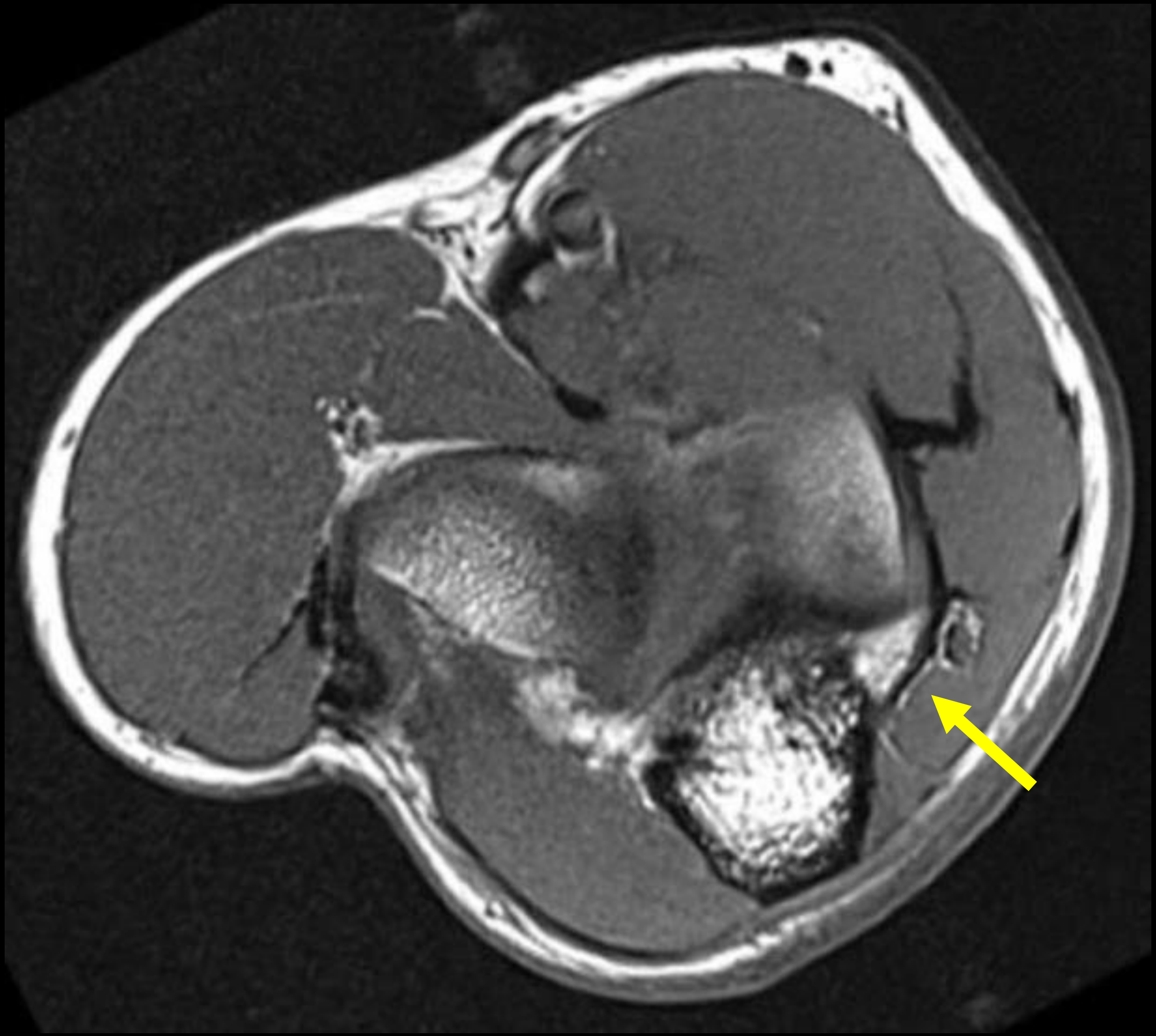
BAND ≠ BUNDLE

- Reciprocal bands
- Bands may injured separately
- Injury will depend on degree of flexion – anterior band more vulnerable in extension
- Injury to posterior *bundle* unlikely in absence of complete anterior *bundle* injury



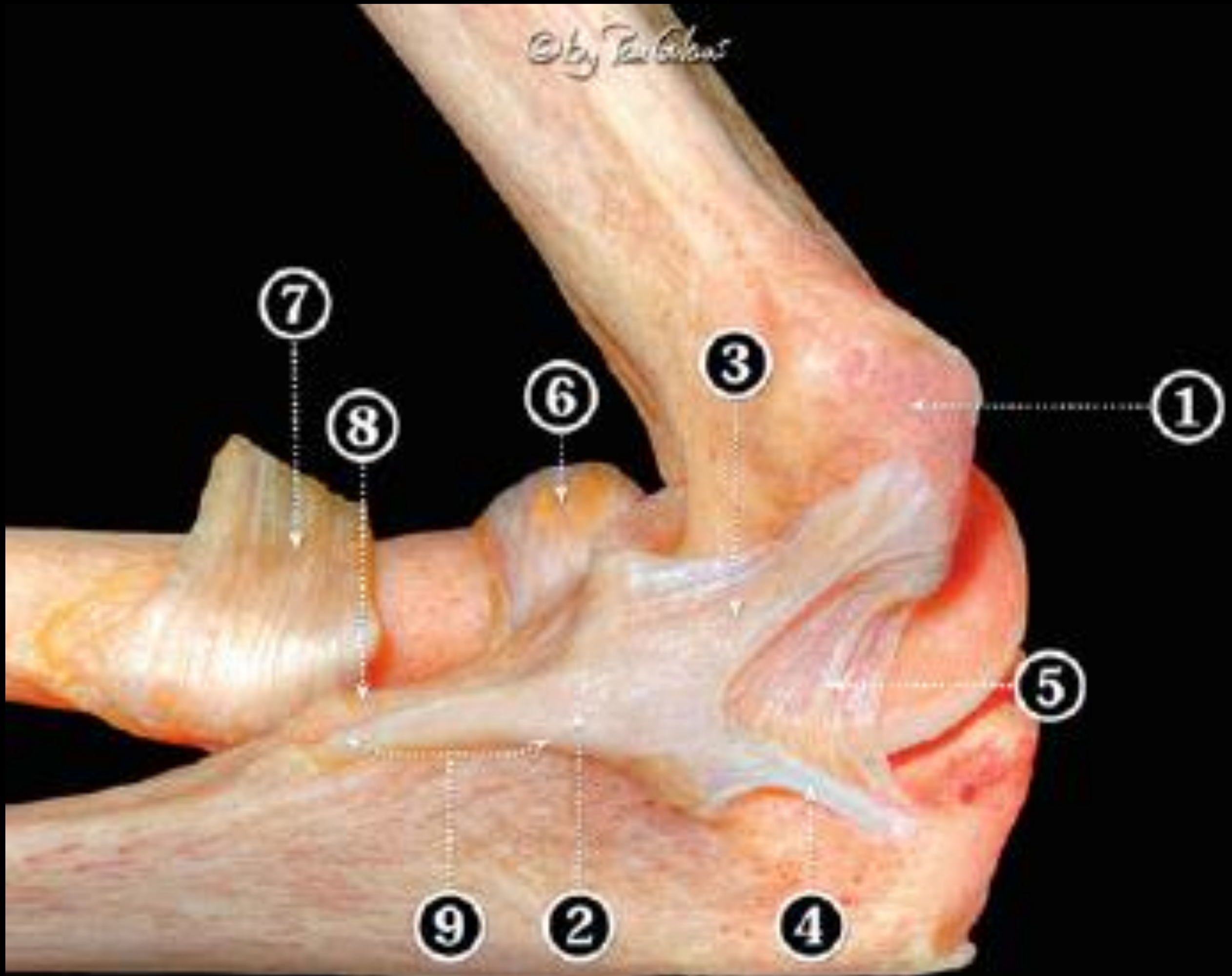
Posterior Bundle MCL

- Primary restraint to valgus stress in *maximal elbow flexion*
- Increasingly recognized role in stability
- Posterior aspect medial epicondyle to medial olecranon
- Forms floor of cubital tunnel



Transverse Bundle MCL

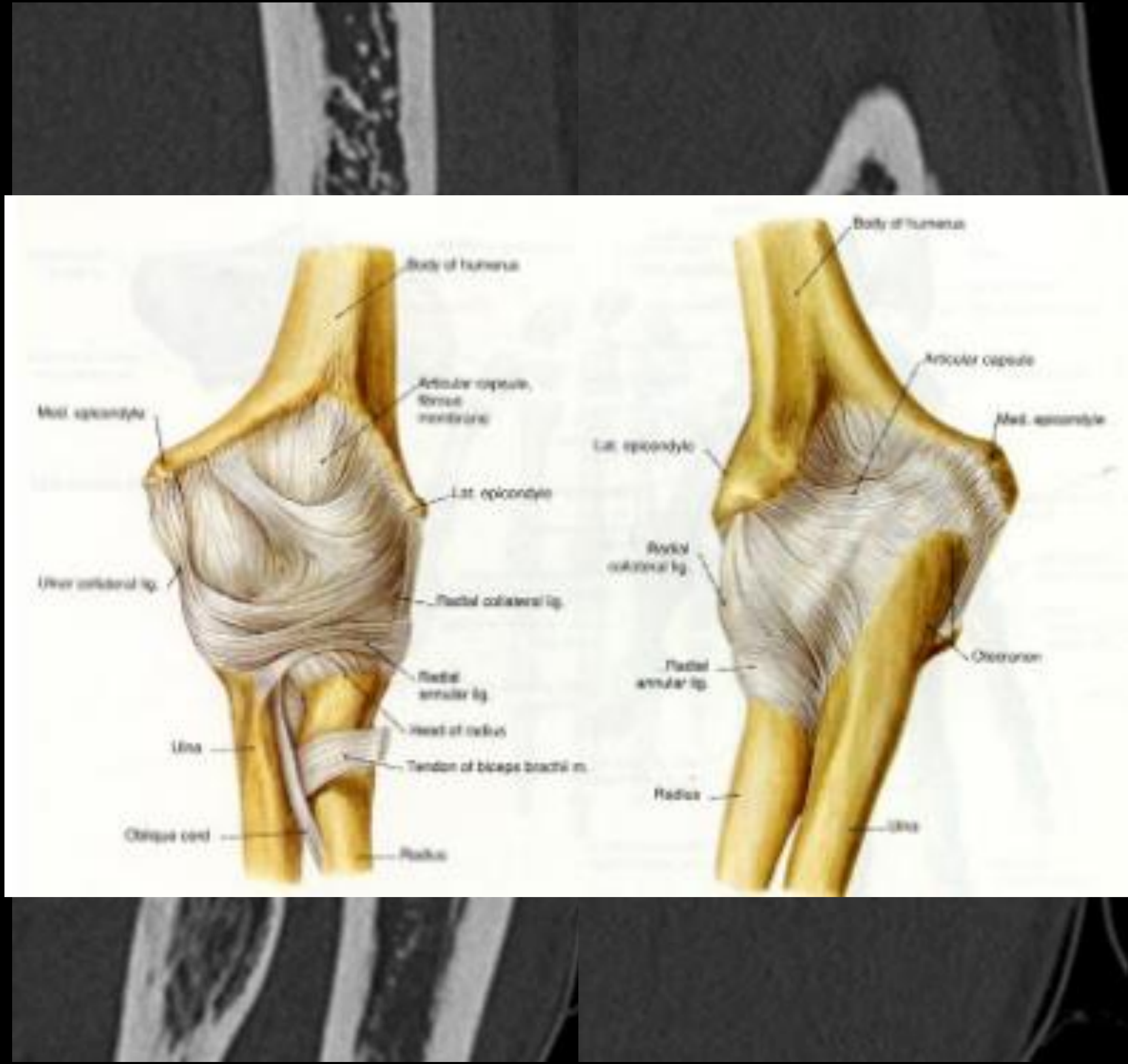
- No known direct contribution to stability
- Olecranon to coronoid process
- Horizontally spans the ulnar insertions of the anterior and posterior bundles
- Incompletely present



J Hand Surg Am. 2014 Feb;39:199-205

Joint Capsule

- Completely encases all 3 joints
- Posterior attachments
  - Humerus
  - Olecranon process
- Anterior attachments
  - Humerus
  - Coronoid process
  - Annular ligament



Muscular/Tendon anatomy

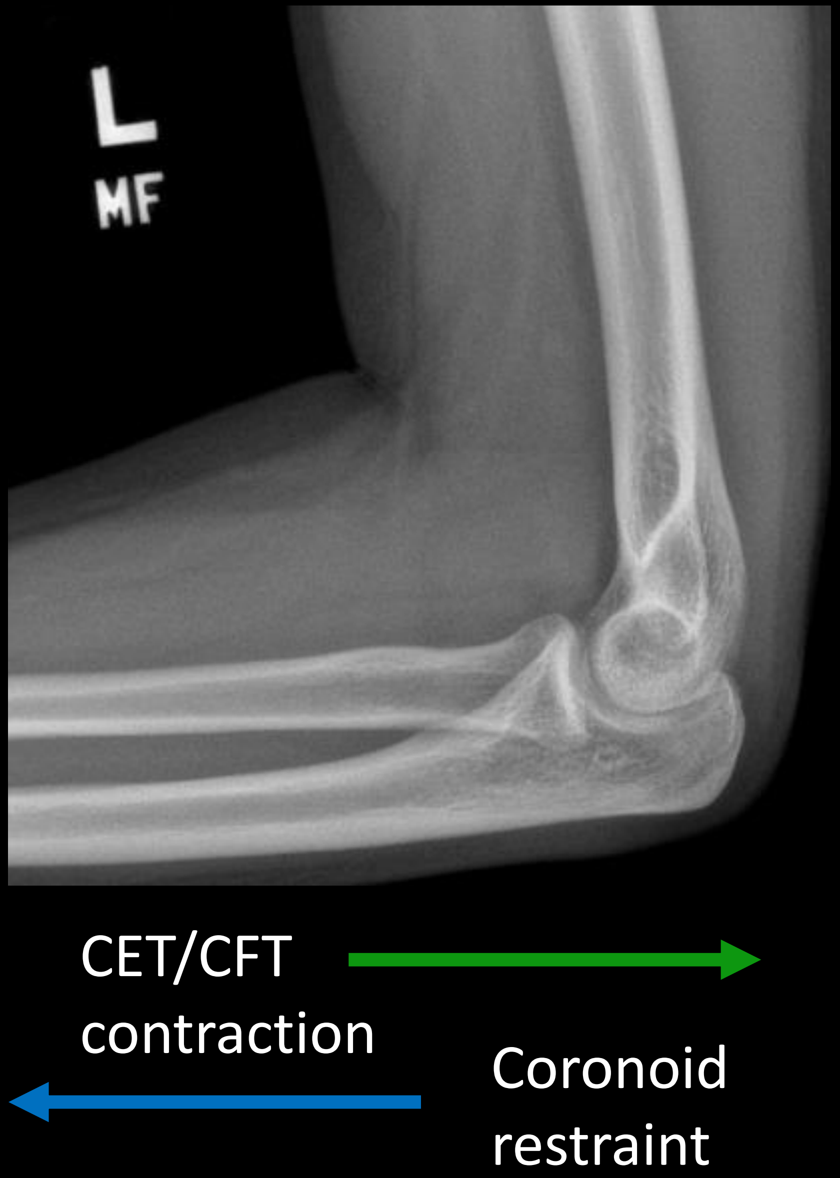
- Medial
  - Pronator teres
  - Palmaris
  - Common flexor tendon
    - Flexor carpi ulnaris
    - Flexor carpi radialis
    - Flexor digitorum superficialis
- Anterior
  - Biceps
  - Coracobrachialis
  - Brachialis
- Lateral
  - Common extensor tendon
    - Extensor carpi radialis brevis
    - Extensor digitorum
    - Extensor digiti minimi
    - Extensor carpi ulnaris
  - Supinator
  - Brachioradialis
  - Extensor carpi radialis longus
- Posterior
  - Triceps
  - Anconeus

Elbow stabilizers

- Static
  - Primary
  - Secondary
- Dynamic

Primary Static Stabilizers

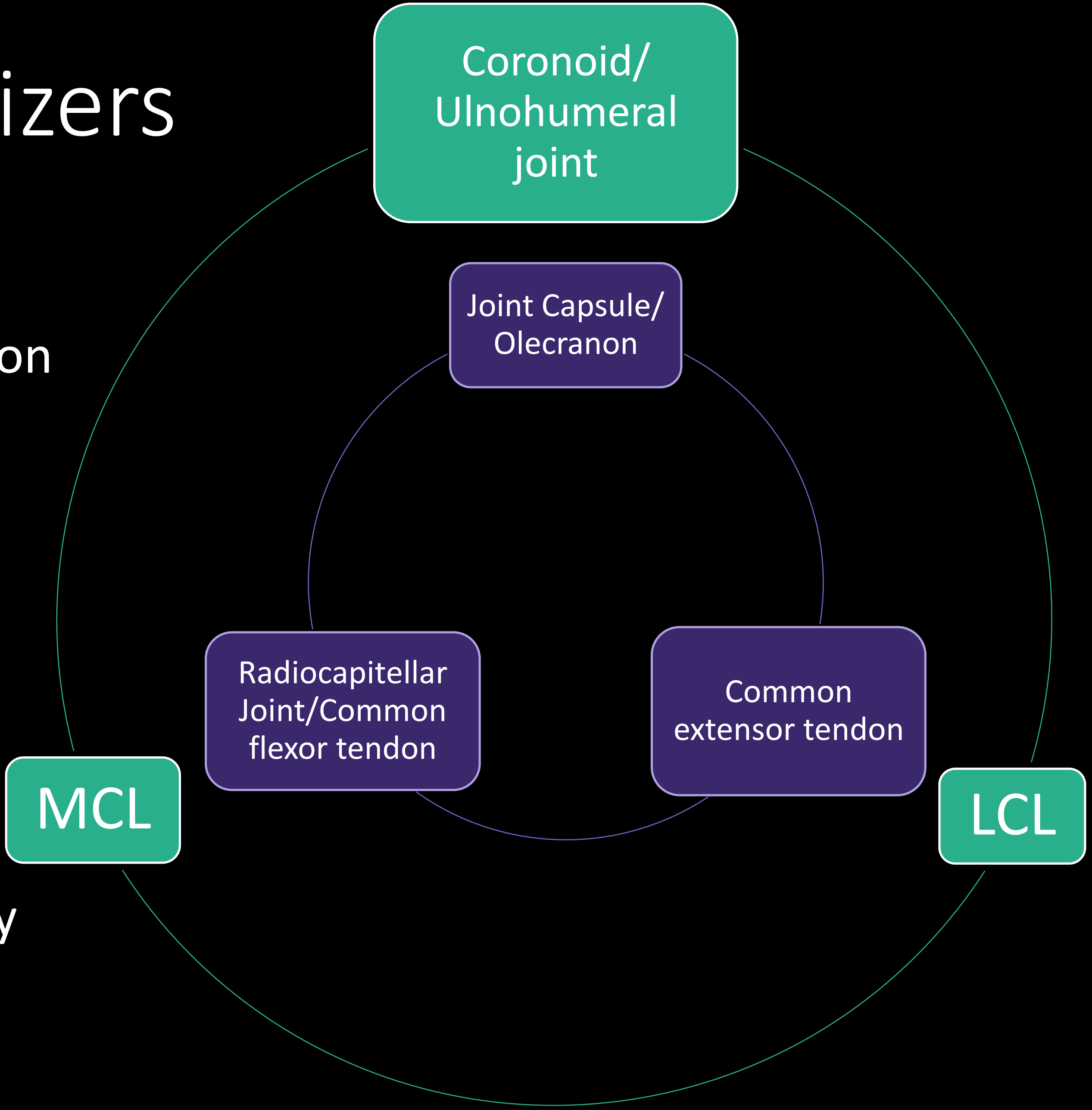
- Anterior bundle of the MCL
  - Valgus restraint
- LCL complex
  - Varus restraint
- Coronoid process of ulna
  - Primary stabilizer of ulnohumeral joint
  - >50% loss = significant instability
  - Anteromedial aspect of coronoid process most important



J Bone Joint Surg Am. 2006 Oct;88(10):2216-24.

Secondary Static Stabilizers

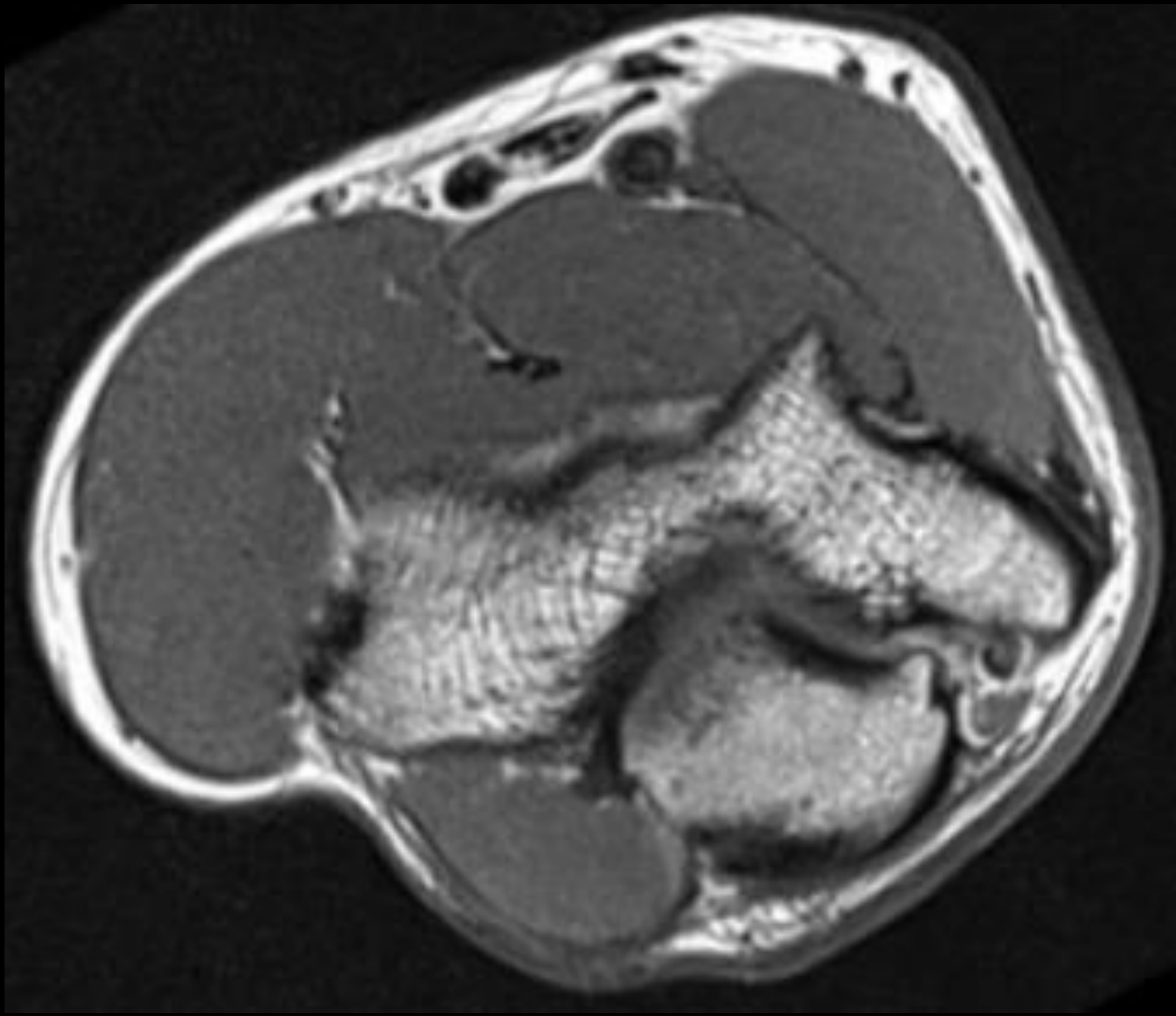
- Anterior joint capsule
  - Greatest contribution in elbow extension
- Radiocapitellar joint
  - Secondary valgus restraint
  - Greatest with 0-30 º flexion/pronation
- CET and CFT
- Olecranon
  - Linear relationship absence:instability
  - Beyond 87.5% absent = gross instability



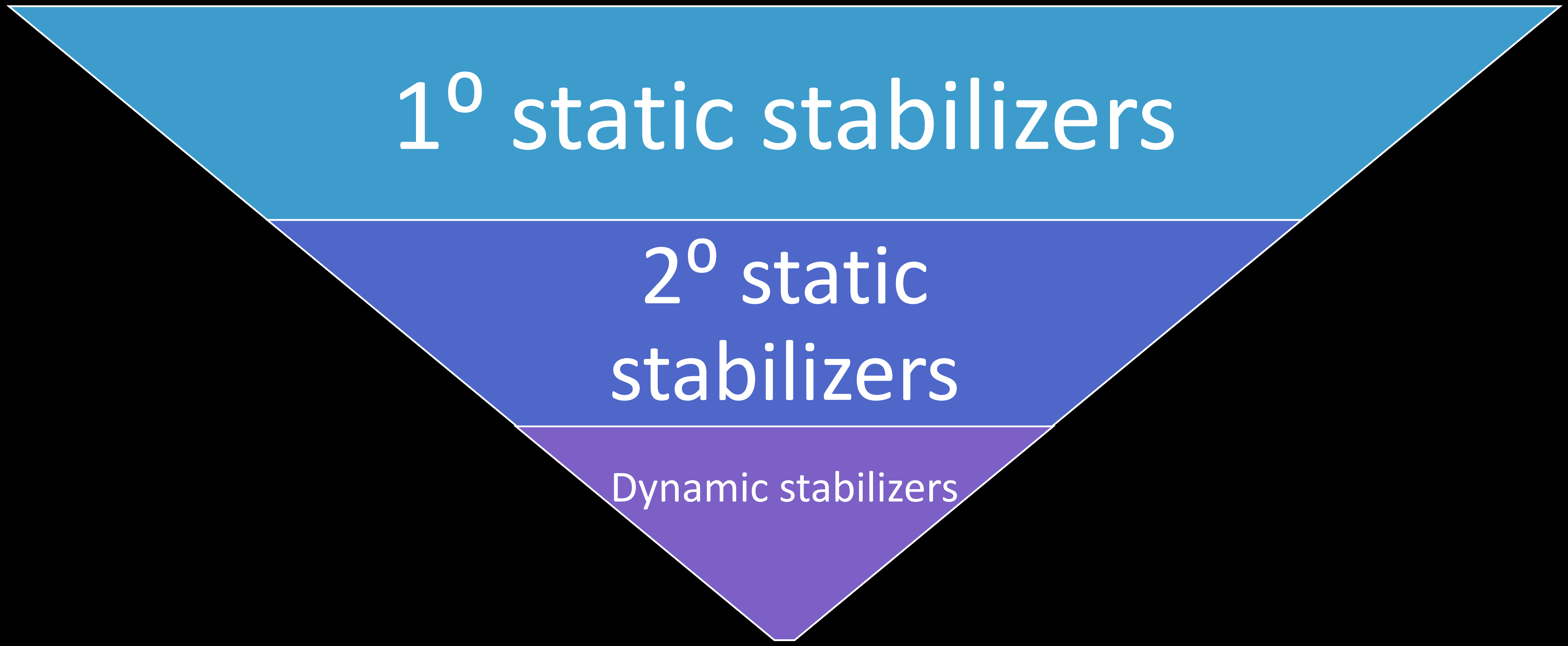
Am J Sports Med 1983;11:315-9.

Dynamic Stabilizers

- Compressive or active stability
- Muscles that cross the joint and tighten the capsule, especially:
  - Anconeus
  - Brachialis
  - Triceps
  - Biceps
- Valgus stress: flexor-pronators



Elbow stabilizers



Types of Instability

- Posterolateral Rotary Instability (PLRI)
- Valgus Instability
- Posteromedial Rotary Instability (PMRI)

Posterolateral Rotary Instability

Most common type of elbow instability

Rotatory subluxation of the ulna relative to trochlea

+

Posterolateral dislocation of radial head relative to capitellum

+

Stability of proximal radioulnar joint

Posterolateral Rotary Instability

- First described by O'Driscoll in 1991
- Classically associated by LUCL injury
- Increasing emphasis on role of entire LCL complex

Isolated LUCL transection → Minor joint laxity

LUCL + RCL transection → Posterolateral subluxation of ulnohumeral joint

Posterolateral Rotary Instability

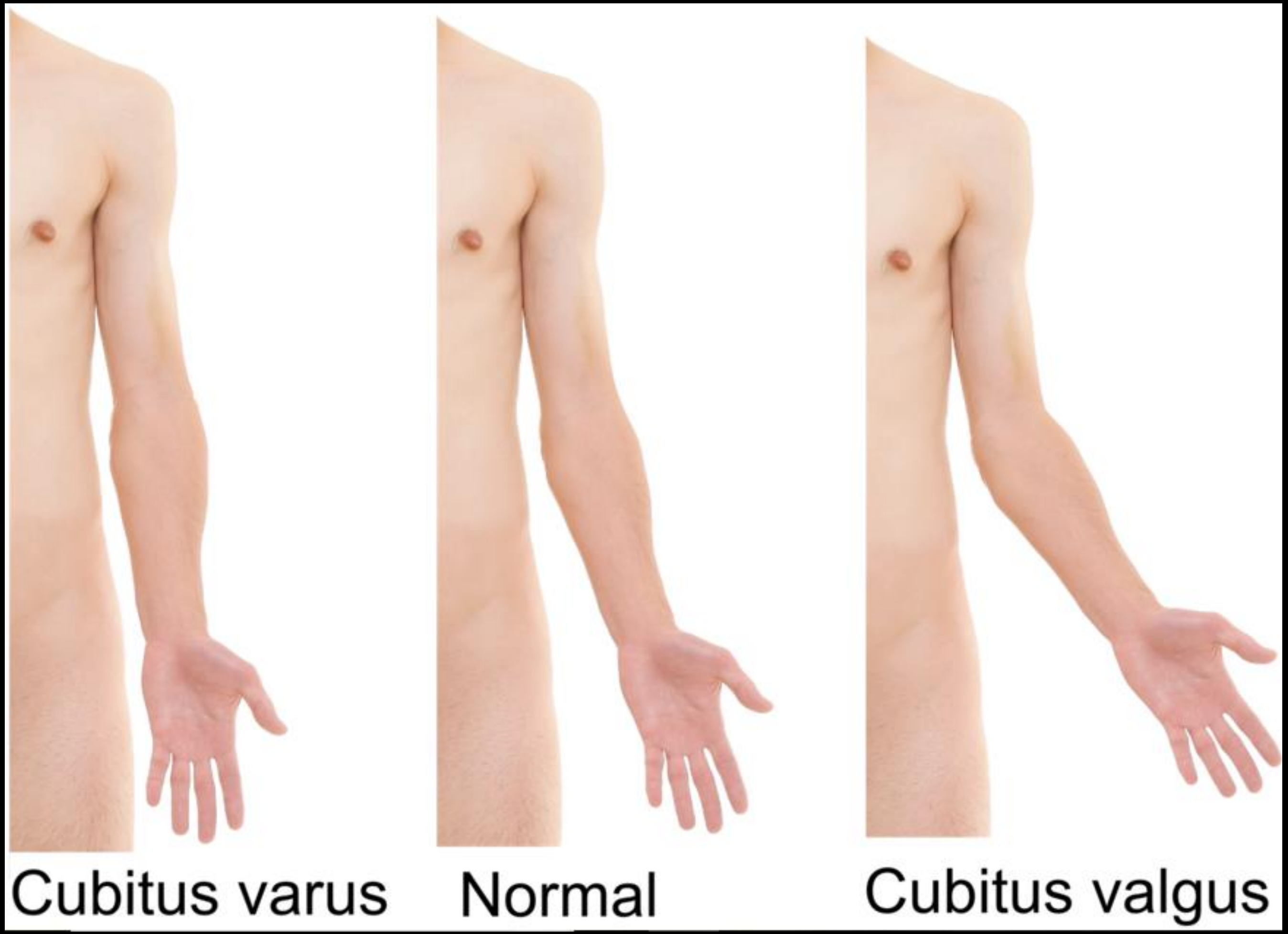
Degree of internal-external rotation and maximal varus-valgus laxity

Isolated LUCL = Isolated RCL

Transect LUCL + Transect RCL = internal-external rotation and varus-valgus laxity

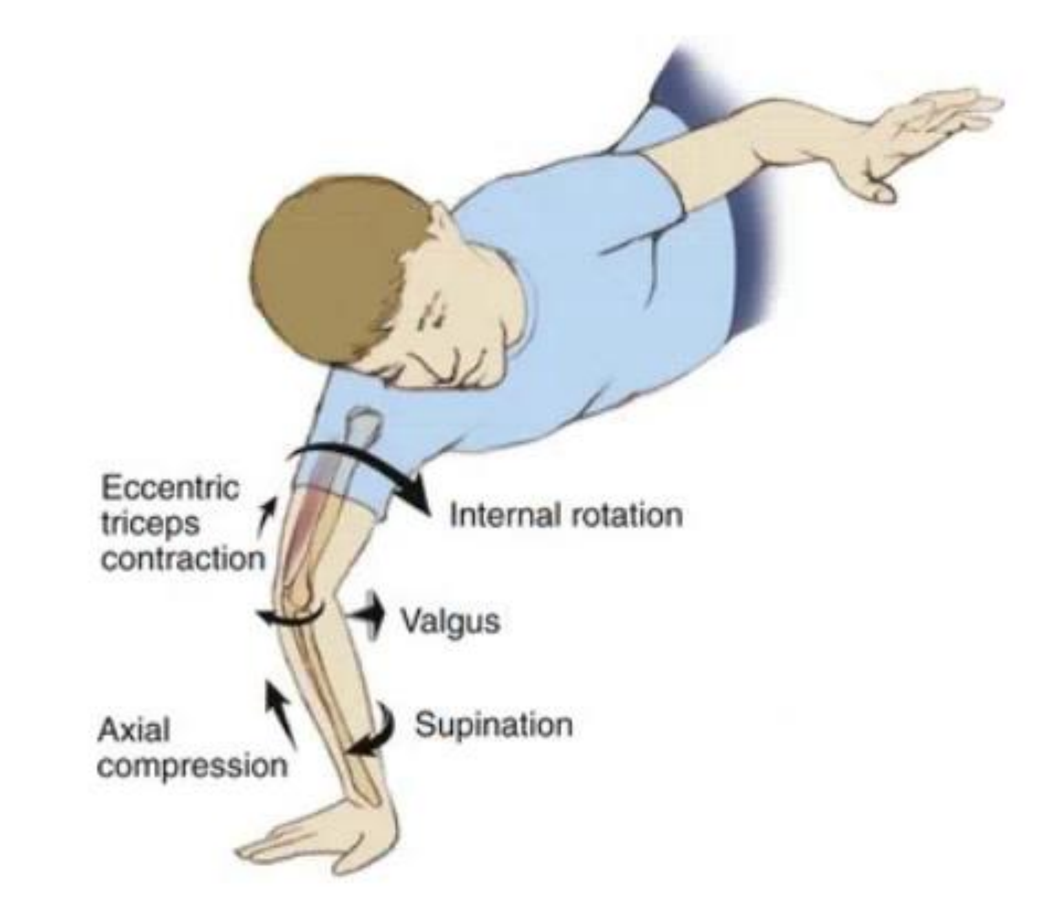
Mechanism of Injury

- Traumatic dislocation
  - Most common
- Iatrogenic injury
  - Lateral arthroscopic approach or open procedures
- Chronic repetitive injury
- Recurrent steroid injections
- Chronic cubits varus deformity



Wikipedia

Mechanism of Injury - dislocation

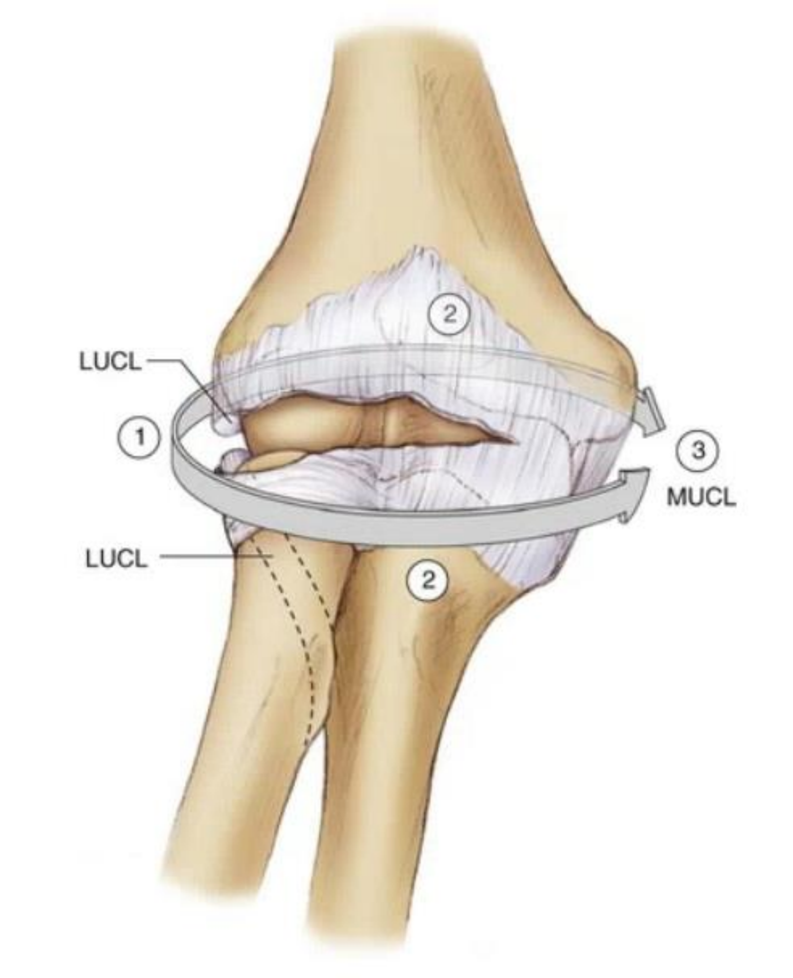


Ulna rotates on long axis → Distraction of radial aspect of ulnohumeral joint → Force transmitted through proximal RUJ to radius → Radius posteriorly displaces relative to capitellum

Surgical Treatment of Posterolateral Instability of the Elbow. Musculoskeletal Key.

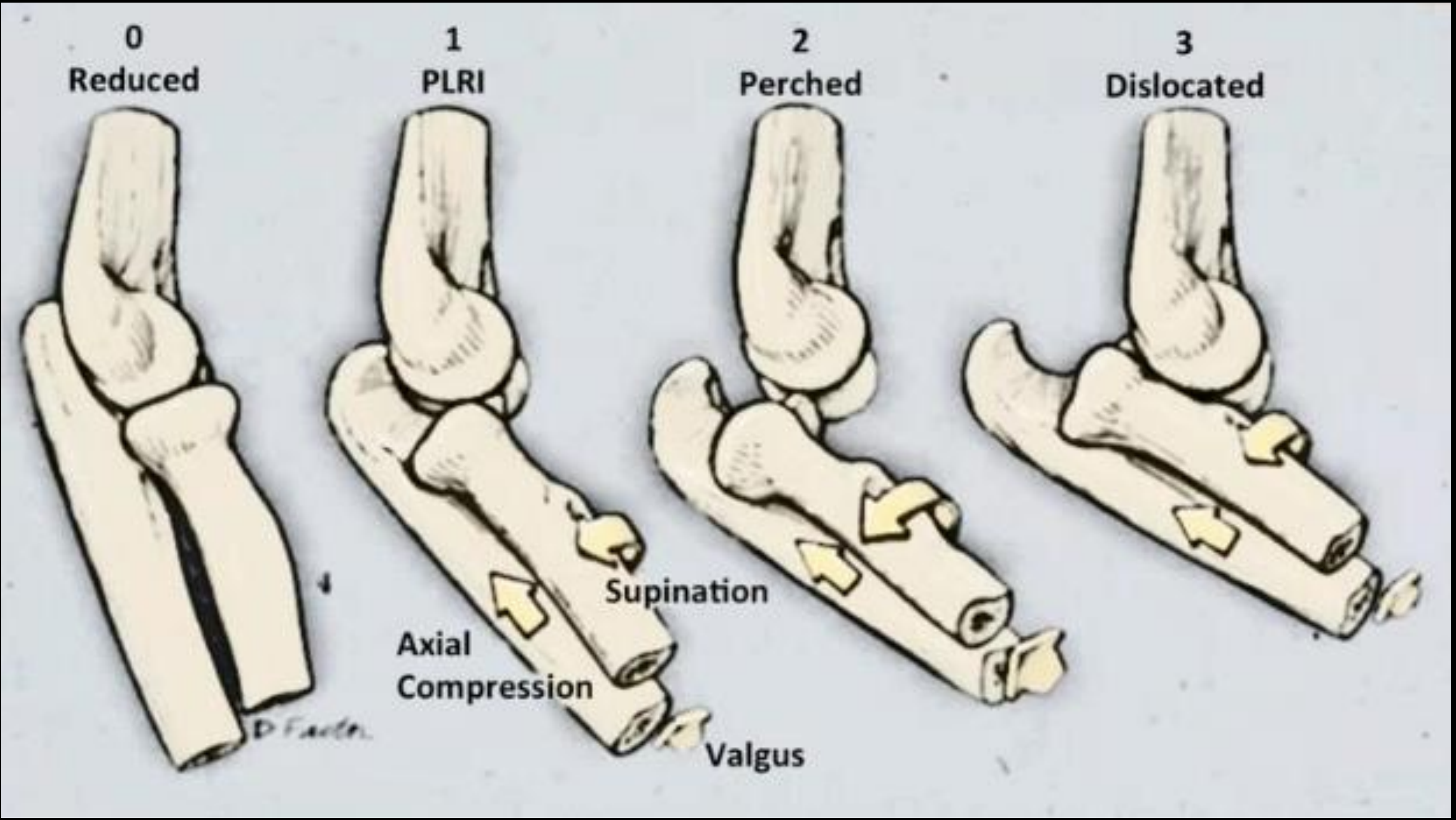
Mechanism of Injury – Horii circle

- Stage I: LCL complex disrupted
- Stage II: Involvement of anterior and posterior capsule
  - Perched elbow
- Stage III: MCL disrupted
  - Frank dislocation



Surgical Treatment of Posterolateral Instability of the Elbow. Musculoskeletal Key.

Biomechanics of elbow dislocation – O'Driscoll



Arthrosc Tech. 2017 Apr 3;6(2):e401-e405.

PLRI – original classification

Staging of Posterolateral Rotatory Instability

Stage	Degrees of Capsuloligamentous Disruption[a]
1	Subluxation of the elbow in a posterolateral direction
2	Subluxation of the elbow joint with the coronoid perched underneath the trochlea
3	Complete dislocation with the coronoid resting behind the trochlea
3A	Includes the posterior band of the medial collateral ligament tear
3B	Includes the anterior and posterior bands of the medial collateral ligament tear

Clin Orthop Relat Res. 2000;370:34-43

Alternative Theory

- Disruption begins medially
- Review of elbow dislocation youtube videos since Sept 2, 2011
  - 873 potential videos -> 77 high quality -> 62 deemed adequate
    - 97% shoulder abduction
    - 63% shoulder forward flexion
    - 92% elbow full extension
    - 68% forearm in pronation
    - 89% valgus stress
    - 90% axial compression
    - 94% body internal rotation
  - 4 distinct patterns
  - Most common pattern consistent with PLRI as described BUT
  - *Gross valgus deformity noted immediately after loading*
    - AMCL most important restraint to valgus instability

TABLE 2. Patterns of Elbow Dislocation Mechanism

Pattern	Shoulder Position	Elbow Position	Deforming Force	No. (%)
I	Flexion-abduction	Pronation-extension	Axial/valgus	33 (53)
II	Extension-abduction	Supination-extension	Axial/valgus	16 (25)
III	Hyperflexion-abduction	Pronation-extension	Axial/valgus	3 (5)
IV	Flexion-abduction	Flexion	Varus (extrinsic)	4 (6)

J Hand Surg 2013;38A:488–494.

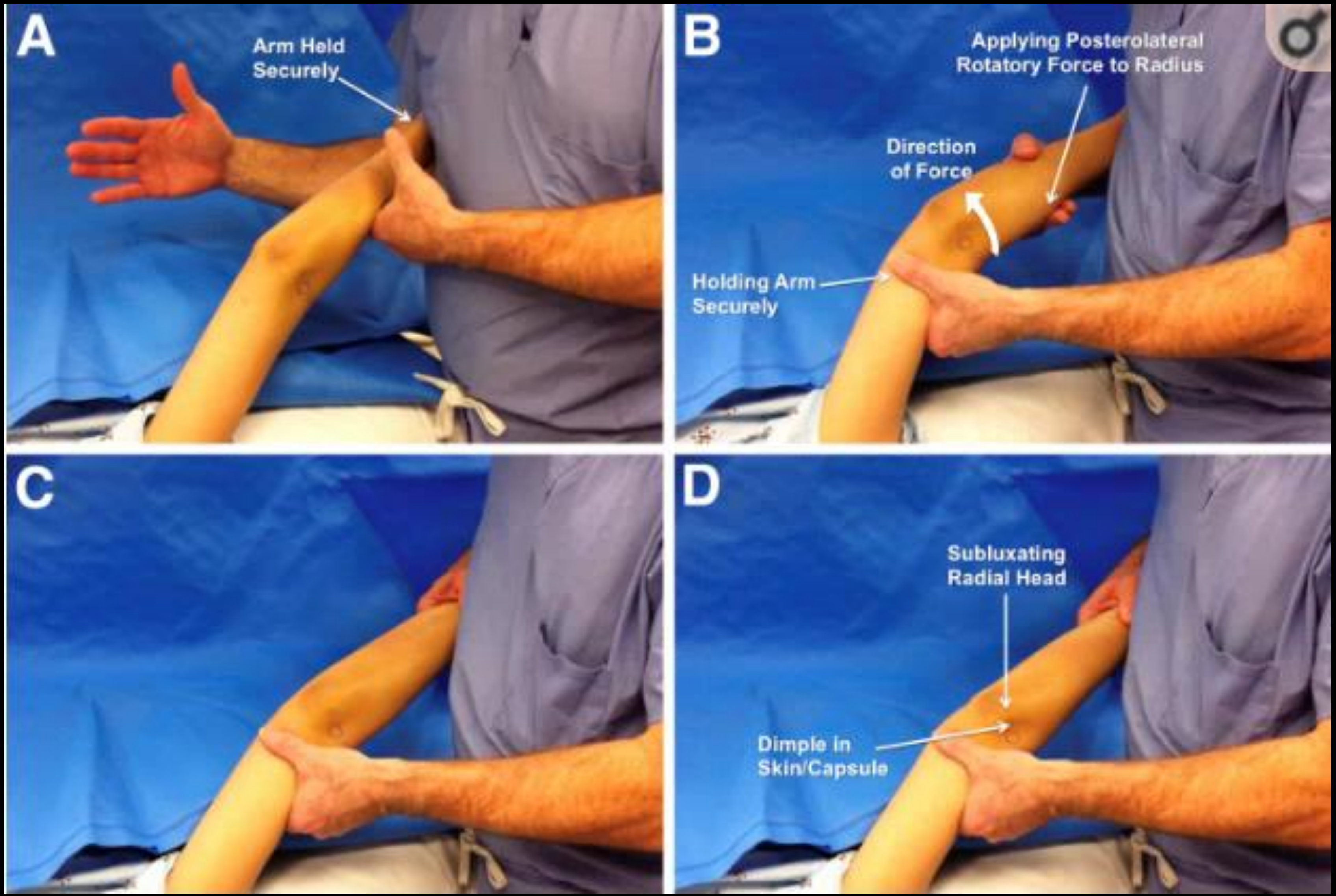
Alternative Theory

- Sojbjerg, Helmig and Kjaersgaard-Andersen in 1989
  - Cadaveric dislocation study showed AMCL tear (80%) > LUCL tear (20%)
- Josefsson, Johnell, Wendeberg in 1987
  - 31 pts examined under anesthesia after acute elbow dislocation
  - All patients unstable to valgus stress
  - Only 26% unstable to varus stress
  - No specific PLRI evaluation
- Rhyou IH, Kim YS in 2012
  - MRI study evaluating ligamentous injury & osseous contusion after dislocation
  - Medial-sided origin of instability for simple dislocation

Clinical Presentation

- Pain
- Clicking, snapping, clunking
- Catching with elbow extension (pushing off from chair)
- Symptoms occur in extension arc in supination

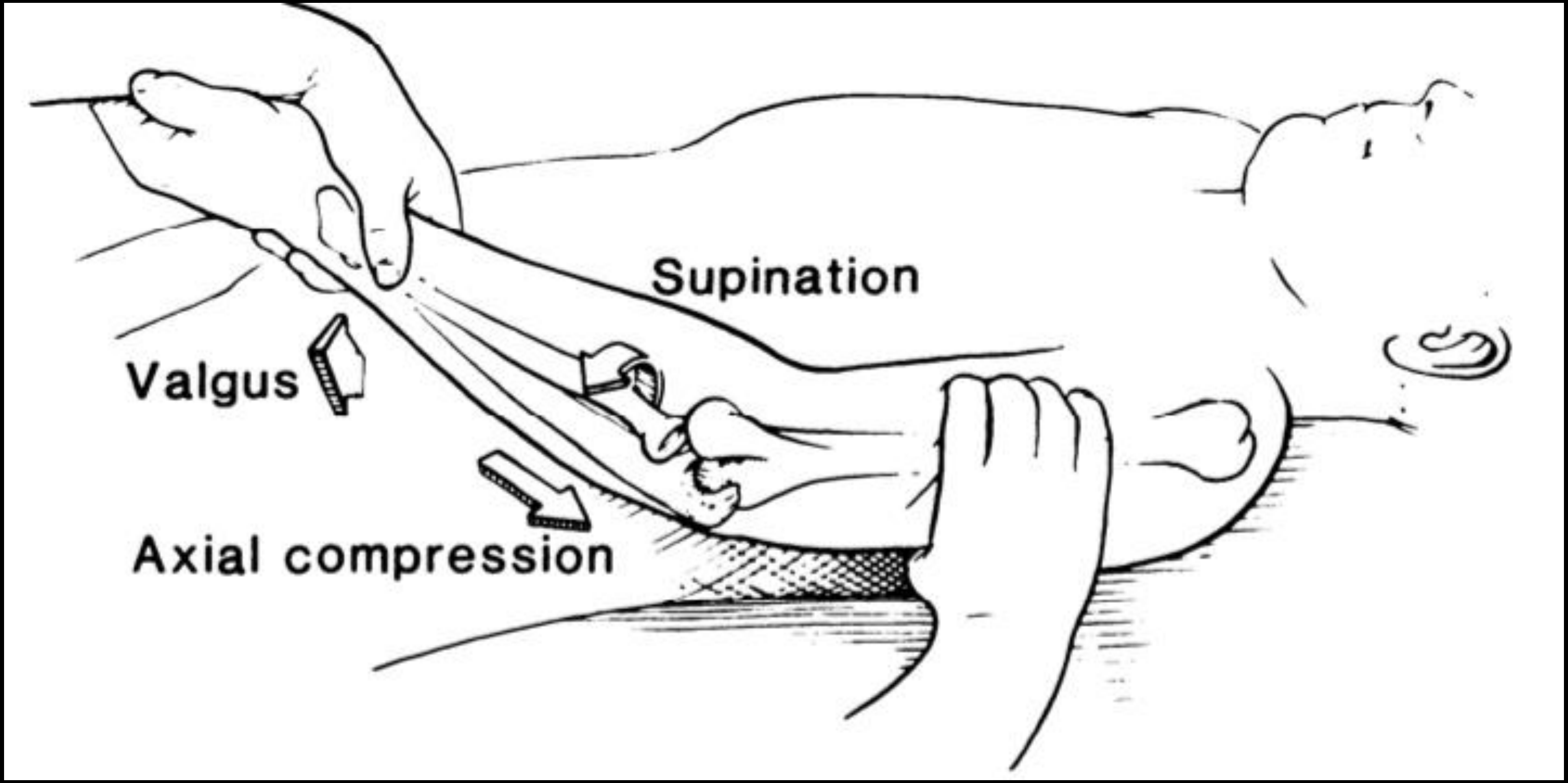
Posterolateral Rotatory Drawer Test



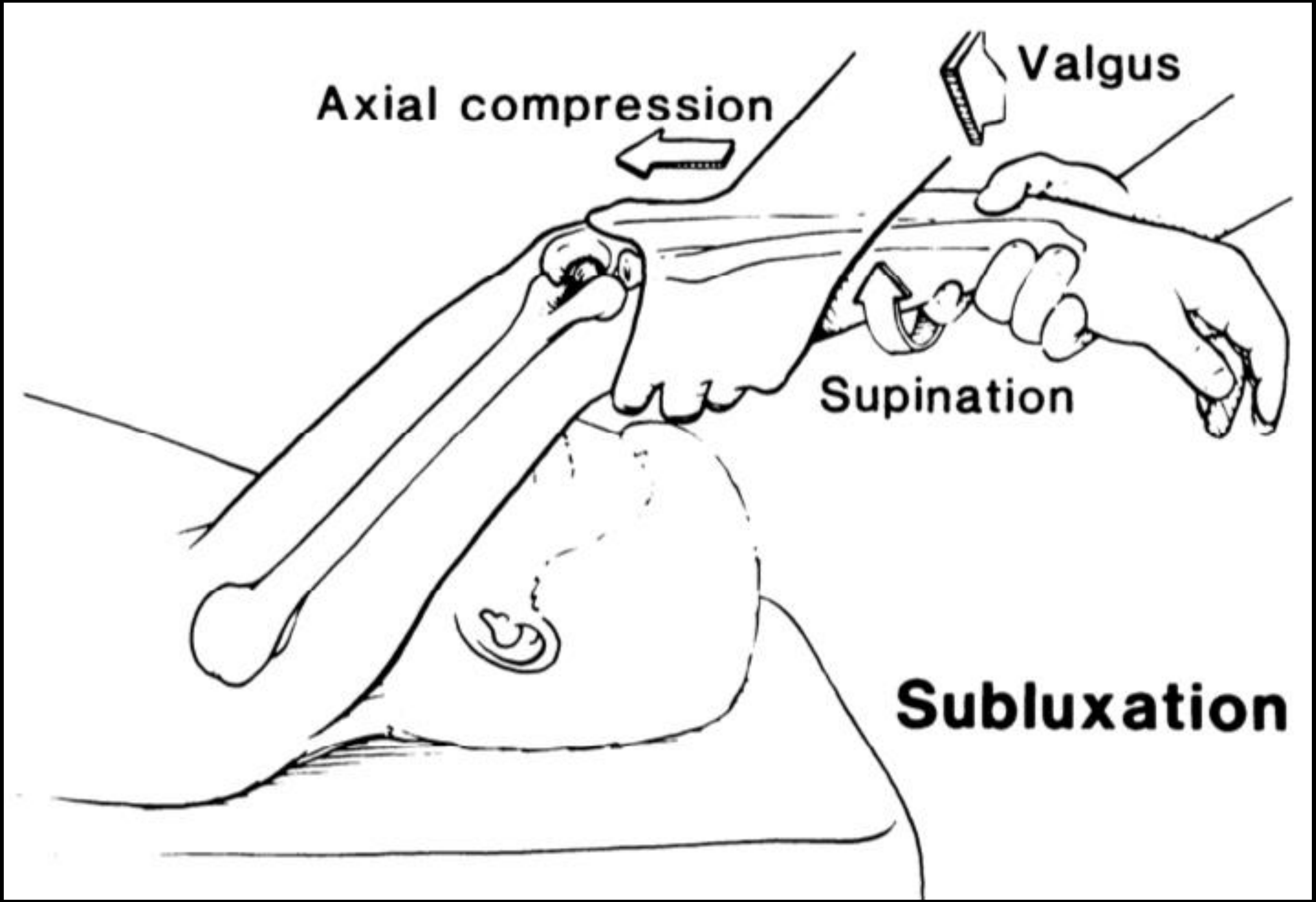
Most reliable of the clinical tests

Arthrosc Tech. 2017 Apr 3;6(2):e401-e405.

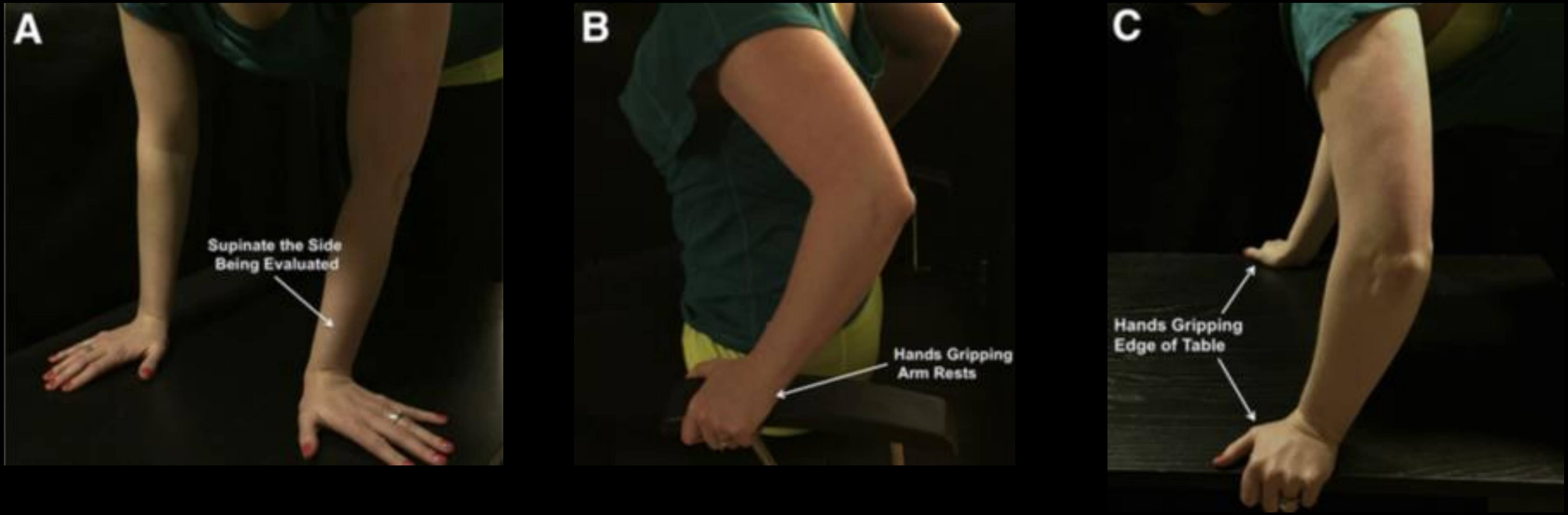
Lateral pivot shift



Lateral pivot shift



PLRI testing – Push up tests



Arthrosc Tech. 2017 Apr 3;6(2):e407-e411.

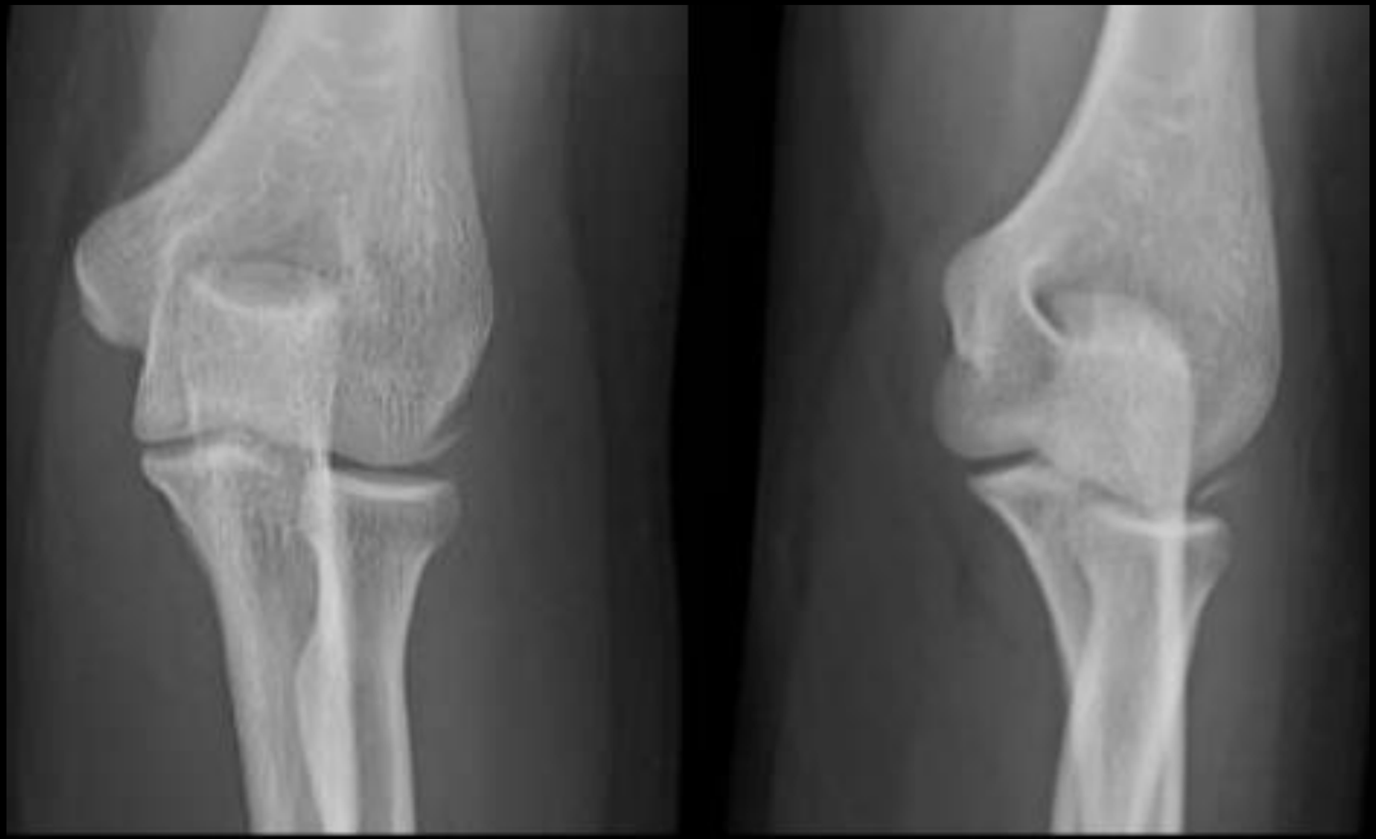
PLRI testing

	Advantages	Limitations
Posterolateral rotatory drawer test	Most sensitive examination maneuver Allows assessment of degree of instability Can be performed in the awake and anesthetized patient Does not cause pain or discomfort for the patient	Not always performed or described accurately
Lateral pivot-shift test	Highly specific test Dramatic phenomenon when positive	May cause discomfort in some patients Can be difficult to perform in the awake patient if not able to relax
Push-up tests	Allows the patient to control the speed and force of the examination	Can only be performed in the awake and cooperative patient Does not assess the degree of instability
Radiograph	Evaluates bony structure and alignment	Generally unrevealing
Computed tomography scan	Shows articular dysplasia, malunion and nonunion of fractures, impaction fractures	Additional radiation
Magnetic resonance imaging	Allows assessment of the lateral collateral ligament complex Allows assessment of articular surfaces	Can miss lateral collateral ligament injuries Does not permit dynamic assessment
Dynamic fluoroscopy	Allows assessment of the degree of instability Can be performed in the awake and anesthetized patient	Radiation exposure for the patient and provider
Dynamic ultrasound	Allows assessment of the degree of instability Can be performed in the awake and anesthetized patient No radiation exposure	Emerging technology in need of additional validation

Arthrosc Tech. 2017 Apr 3;6(2):e407-e411.

Radiographs

- Avulsion fracture of the LCL complex
- Varus malalignment of elbow
- Widening of radiocapetellar joint (LCL disruption)
- Stress radiographs = ulnohumeral widening and radial head subluxation



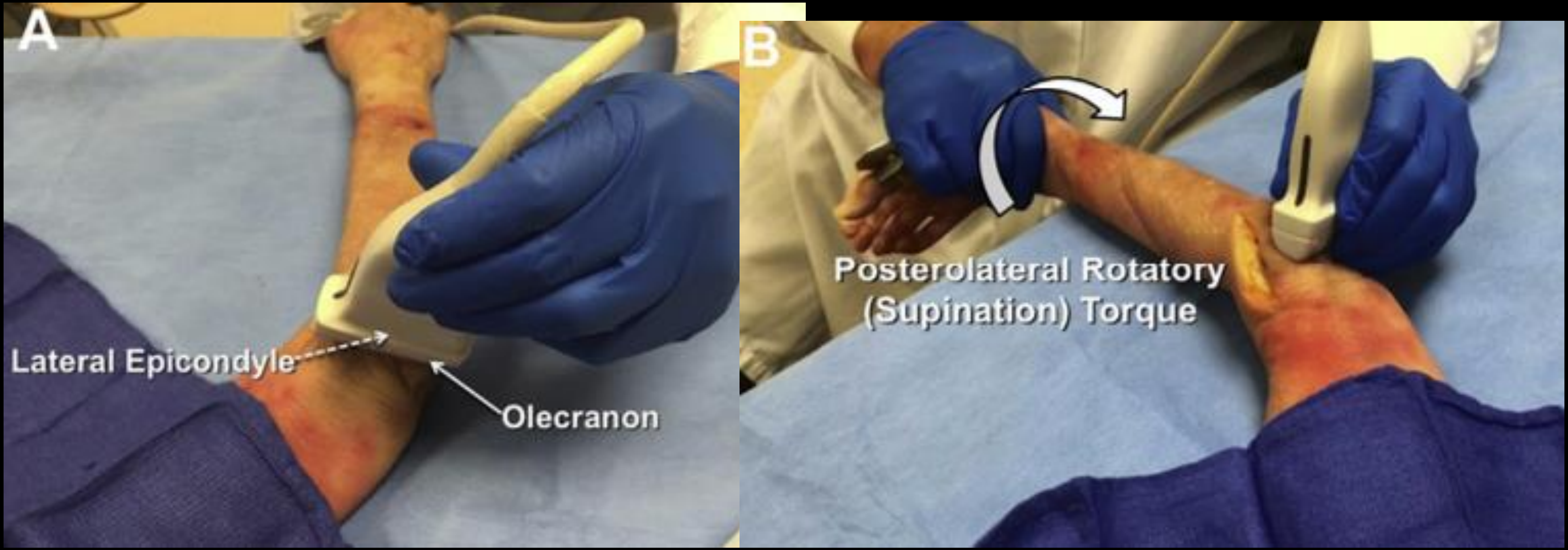
Radiographs

Drop sign = ulnohumeral distance > 4mm on lateral unstressed radiograph

J Shoulder Elbow Surg 2005; 14:312-17.

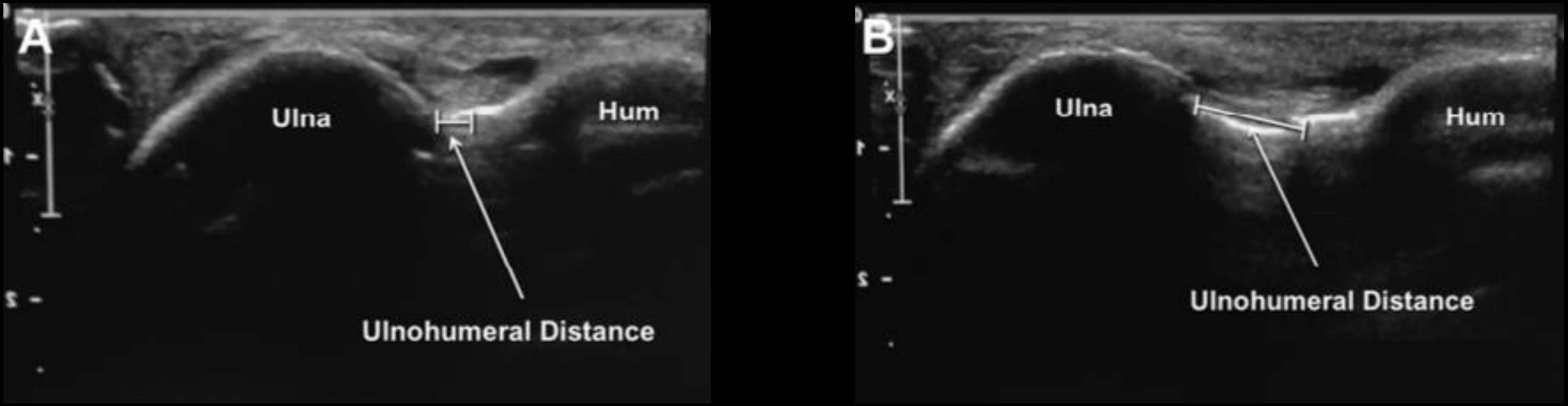
Sonographic PLRI Stress Test

Assess for widening of the posterolateral ulnohumeral joint



PM R. 2017 Mar;9(3):275-282

Sonographic PLRI Stress Test



- A = at rest
- B = with stress
- Laxity = distance with stress – distance at rest

PM R. 2017 Mar;9(3):275-282

Sonographic PLRI Stress Test

- Group 1: Intact elbow
- Group 2: ECRB release
- Group 3: LCL release, + posterolateral drawer test
- Group 4: LCLC release with capsule release, + lateral pivot shift test

	Mean Values for All Sages				
	1	2	3	4	*P* Value*
Rest, mm	3	3	3	3	.58
Stress, mm	4	6	8	13	< .001
Laxity, mm	1	3	6	10	< .001

PM R. 2017 Mar;9(3):275-282

Computed Tomography

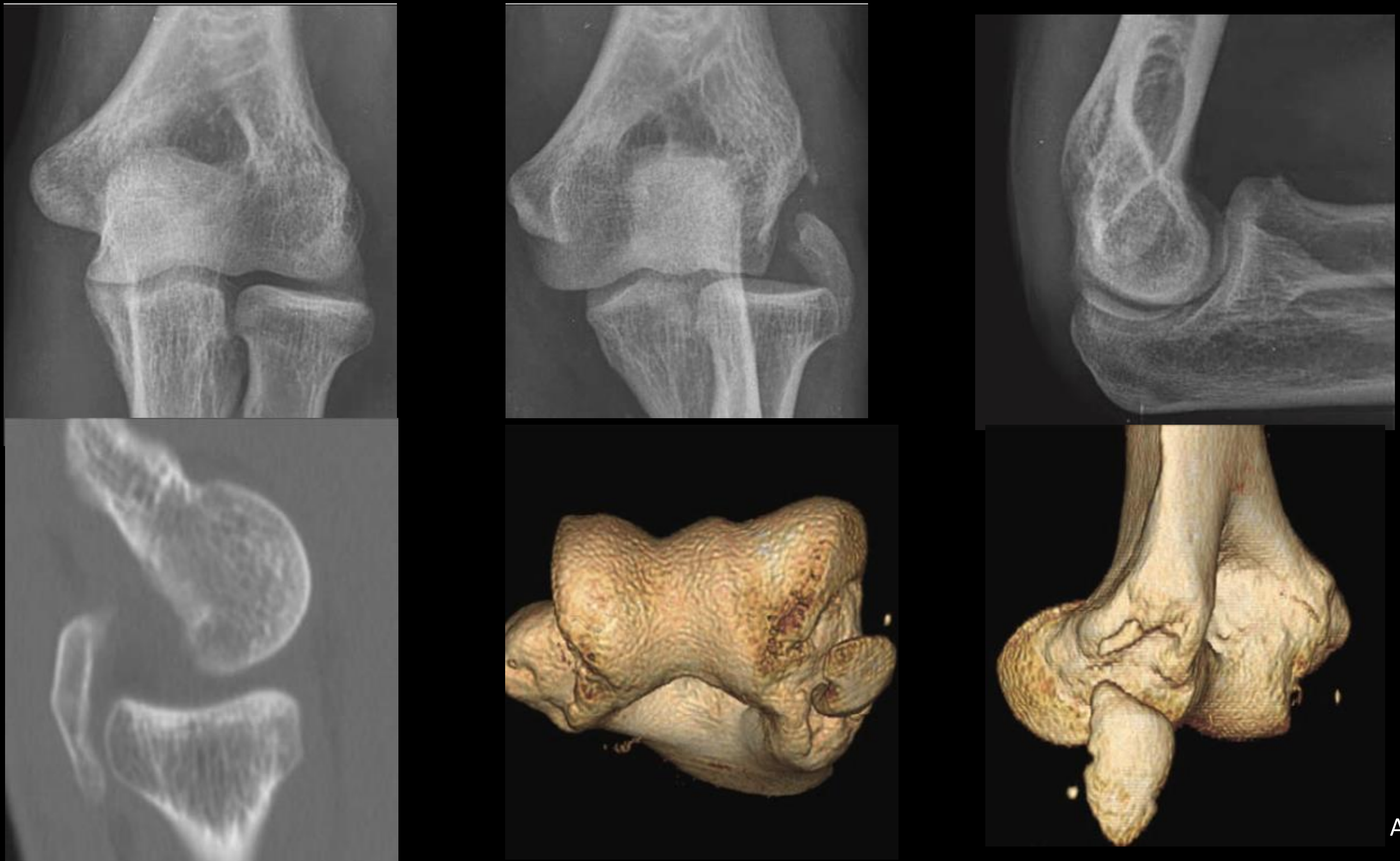
- Often acquired in the acute setting to better assess for fractures
- Less of a role in chronic injury
- CT arthrogram can be helpful if MRI cannot be obtained

Quick Aside: Osborne-Cotterill Lesion

- 1966: “an osteochondral fracture of the posterolateral margin of the capitellum with or without a crater or shovel-like defect in the radial head”
- Bankart/Hill-Sachs equivalents
- 2008: Jeon et al deems this an “Osborne-Cotterill lesion”
  - Indicative of PLRI
  - Shear/depression fracture of capitellum and lateral condyle

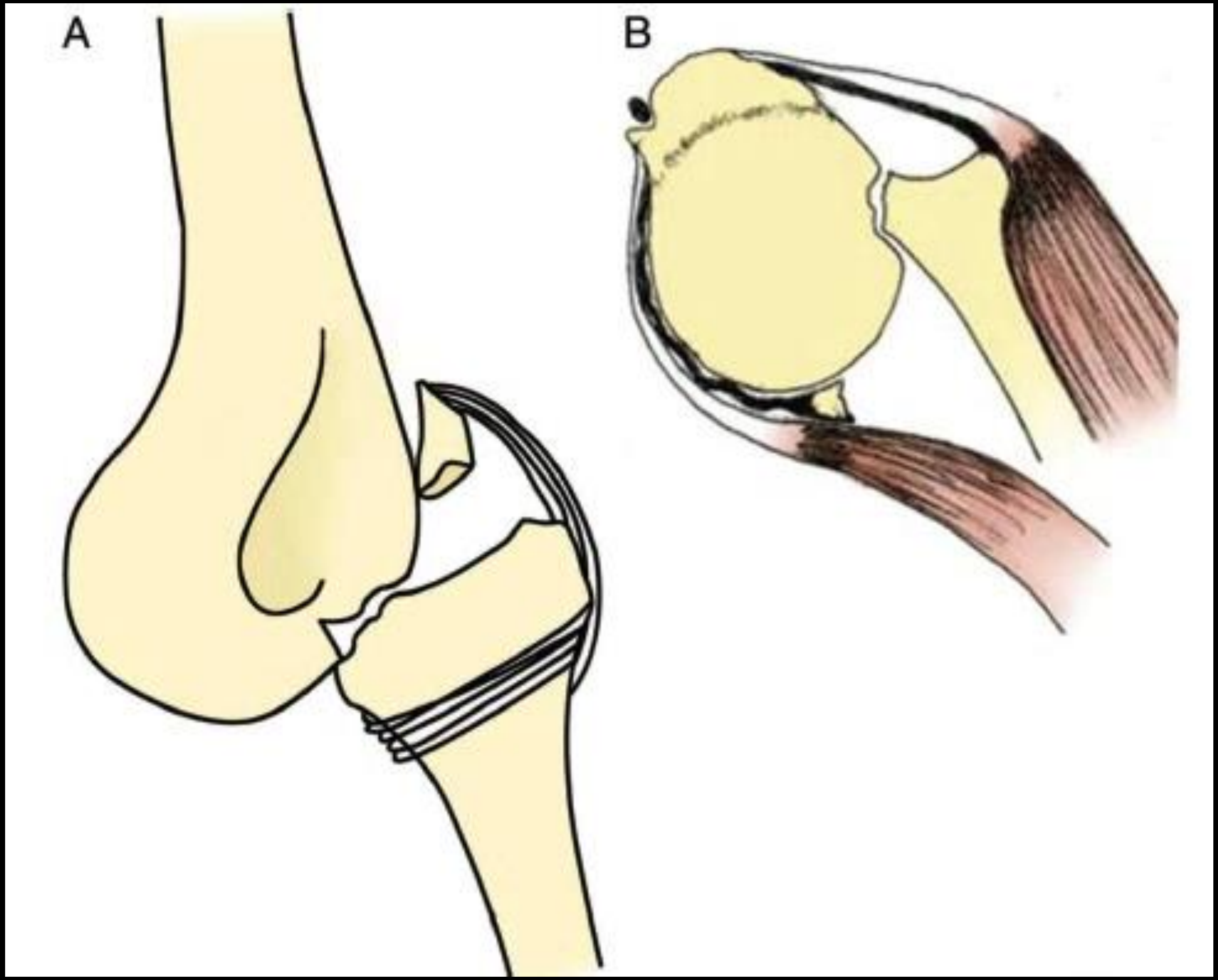
AJR. 2008;191: 727-729

Osborne-Cotterill Lesion



AJR. 2008;191: 727-729

Osborne Cotterill Lesion

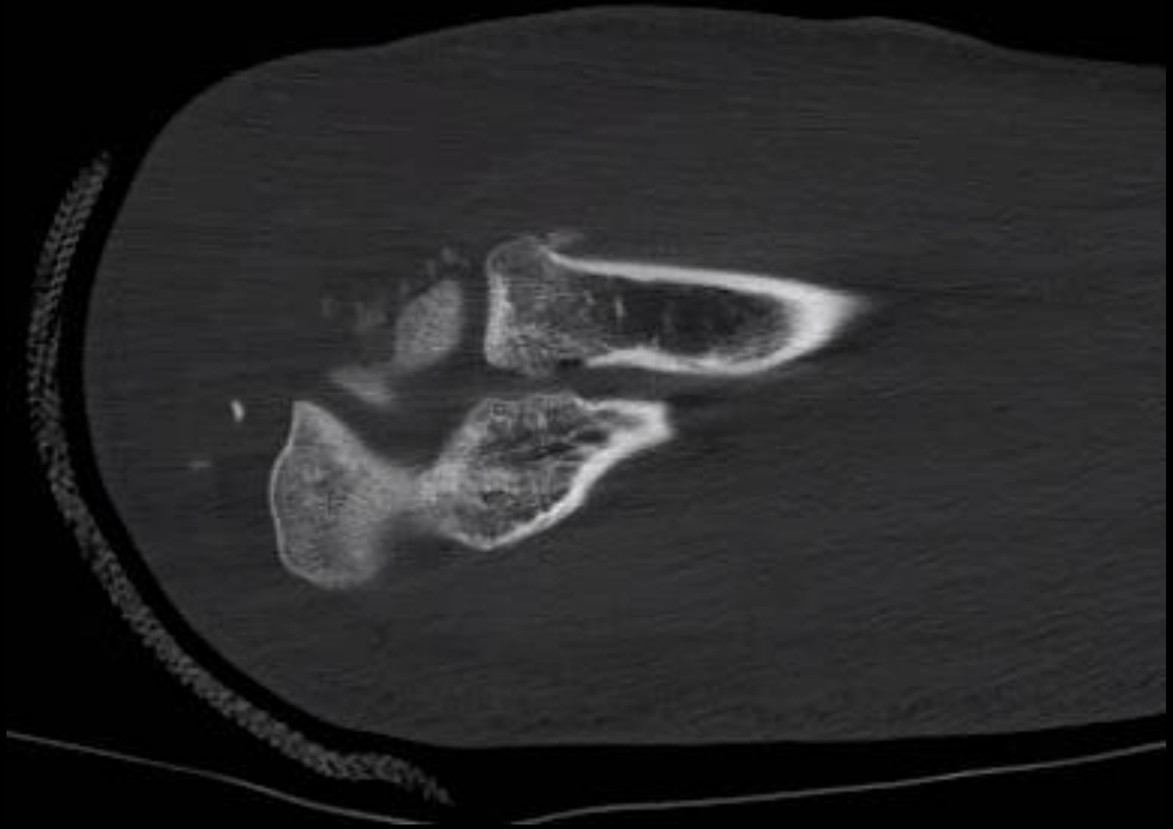


Capitellar defect ~ osseous Bankart lesion

Radial head fracture ~ Hill-Sachs deformity

J Trauma. 2011 Sep;71(3):E45-9

Osborne-Cotterill Lesion



J Shoulder Elbow Surg. 2018 Jul;27(7):1178-1184. doi: 10.1016/j.jse.2018.02.045. Epub 2018 Apr 22.

The contribution of the posterolateral capsule to elbow joint stability: a cadaveric biomechanical investigation.

Edwards DS[1], Arshad MS[2], Luokkala T[2], Kedgley AE[3], Watts AC[2].

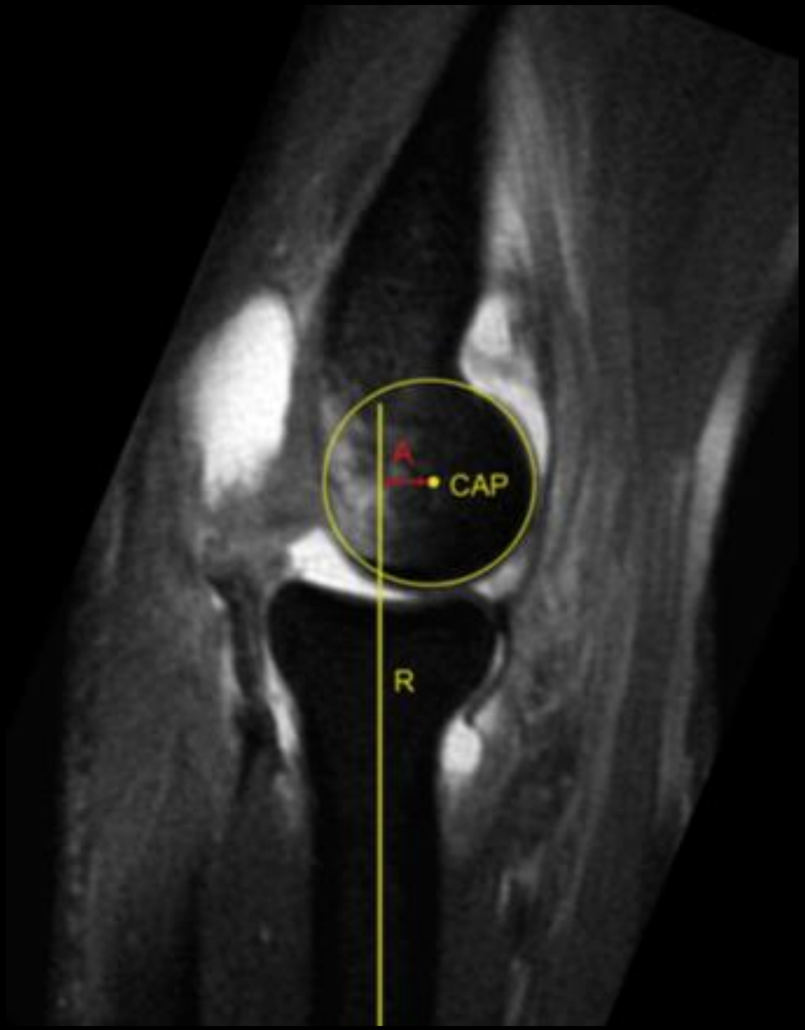
- 30-60˚ flexion: greater radial head displacement with OCL
- < 30 ˚ or > 60 ˚: no difference OCL vs intact capsule
- OCL + LCL injury → markedly greater radial head displacement than OCL alone
- Conclusion = capsular attachment at site of OCL contributes to instability
- “Osborne-Cotterill ligament”
- Pitfalls of study

MRI findings

- LUCL usually avulses from the distal humerus
- +/- fracture/bone bruises
  - Radial head
  - Posterior capitellum
- Posterior subluxation of the radius in relation to capitellum

- Static evaluation = major disadvantage
- No consensus on sensitivity/specificity of MRI for PLRI

Radiocapitellar Incongruity



Technique:

- Sagittal view center radial head
- Rotational center of capitulum (CAP)
- Longitudinal axis of radius (R)
- Distance between CAP and R

If > 1.2 mm,

- Sensitivity: 67%
- Specificity: 70%

Positive predictive value of 100% if >3.4 mm

J Hand Surg Am. 2015;40(7):1428e1433.

Sagittal Ulnohumeral Incongruity

Technique:

- Sagittal view coronoid process tip
- Best fit circle trochlea (TR) and olecranon (OL)
- B1 = TR center to olecranon tip
- B2 = TR center to middle point
- B3 = TR center to coronoid tip
- Greatest difference between B1, B2 and B3

No statistically significant difference between PLRI and stable elbows

J Hand Surg Am. 2015;40(7):1428e1433.

Coronal Ulnohumeral Incongruity

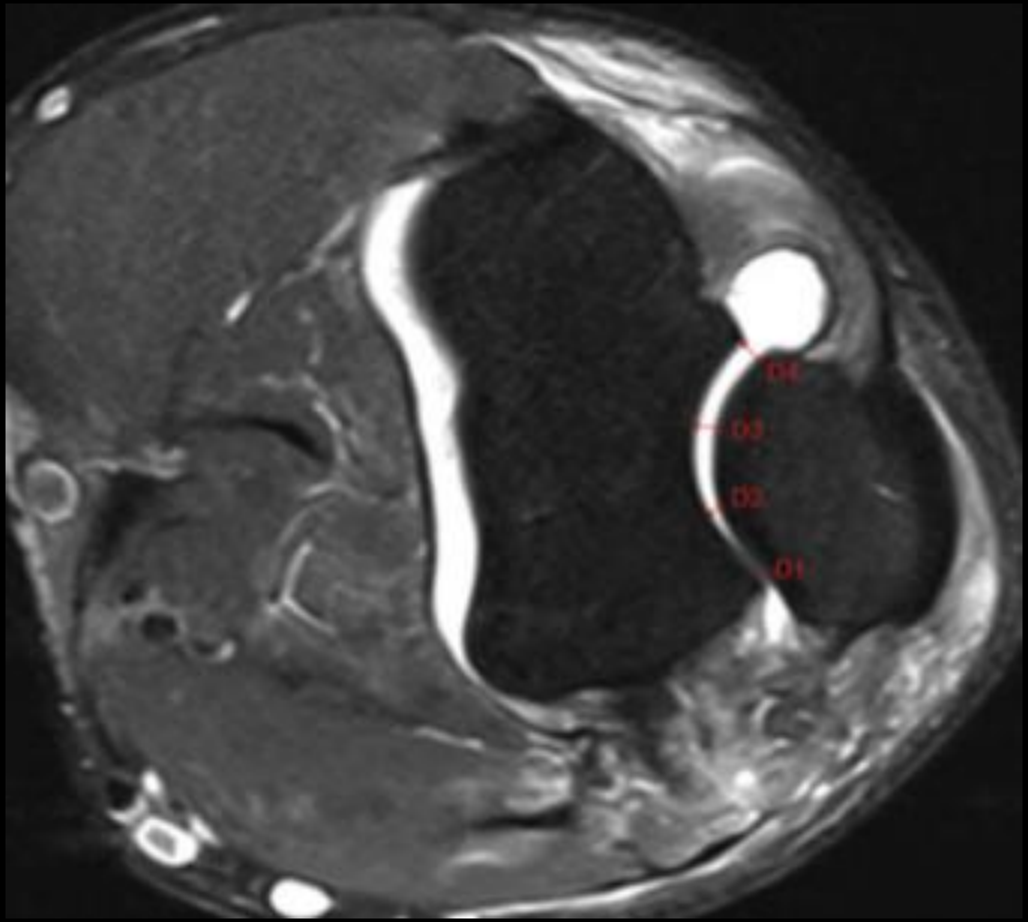
Technique:

- Rotational center distal humerus
- Distance between trochlea and olecranon measured at ulnar edge (C1), radial edge (C4) and two points in between (C2, C3)
- Greatest difference between C1, C2, C3 and C4

No statistically significant difference between PLRI and stable elbows

J Hand Surg Am. 2015;40(7):1428e1433.

Axial Ulnohumeral Incongruity



Technique:

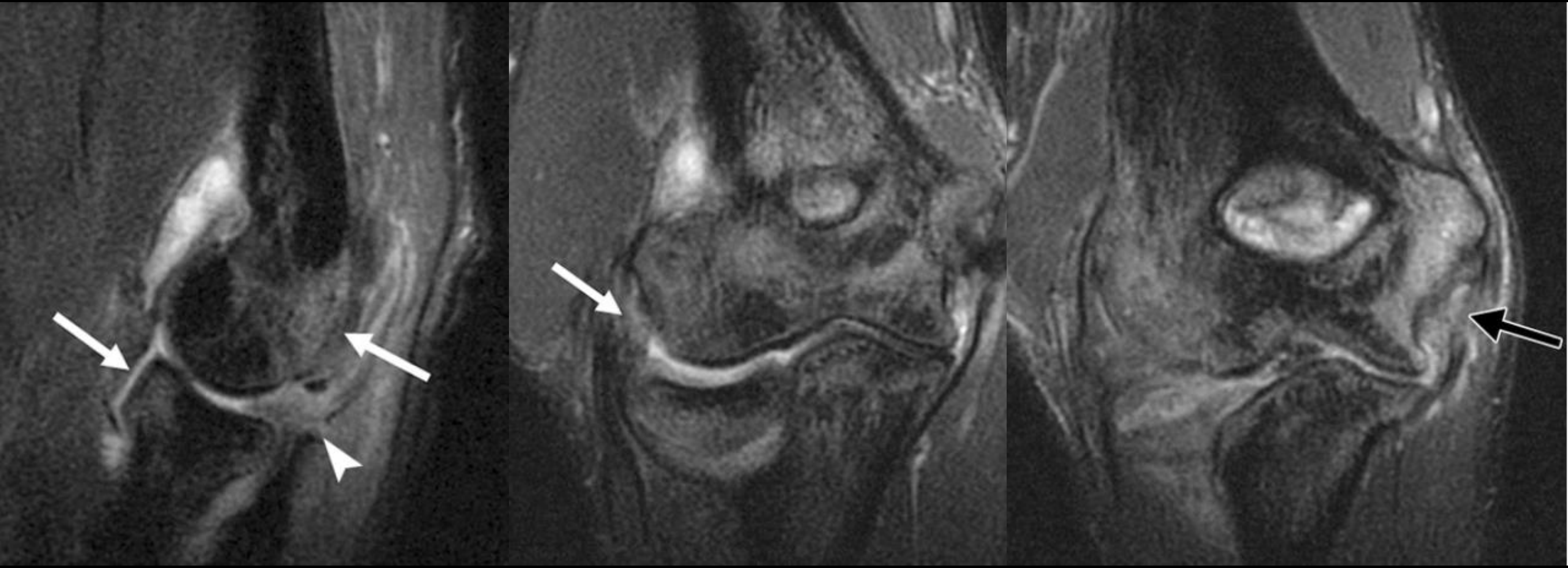
- Motion axis of distal humerus
- Distance between trochlea and olecranon measured at ulnar edge (D1), radial edge (D4) and two points in between (D2, D3)
- Greatest difference between D1, D2, D3 and D4

If > 0.7 mm,

- Sensitivity: 63%
- Specificity: 70%

J Hand Surg Am. 2015;40(7):1428e1433.

PLRI Case #1



Radiology. 2016 Jul;280(1):328.

PLRI Case #2

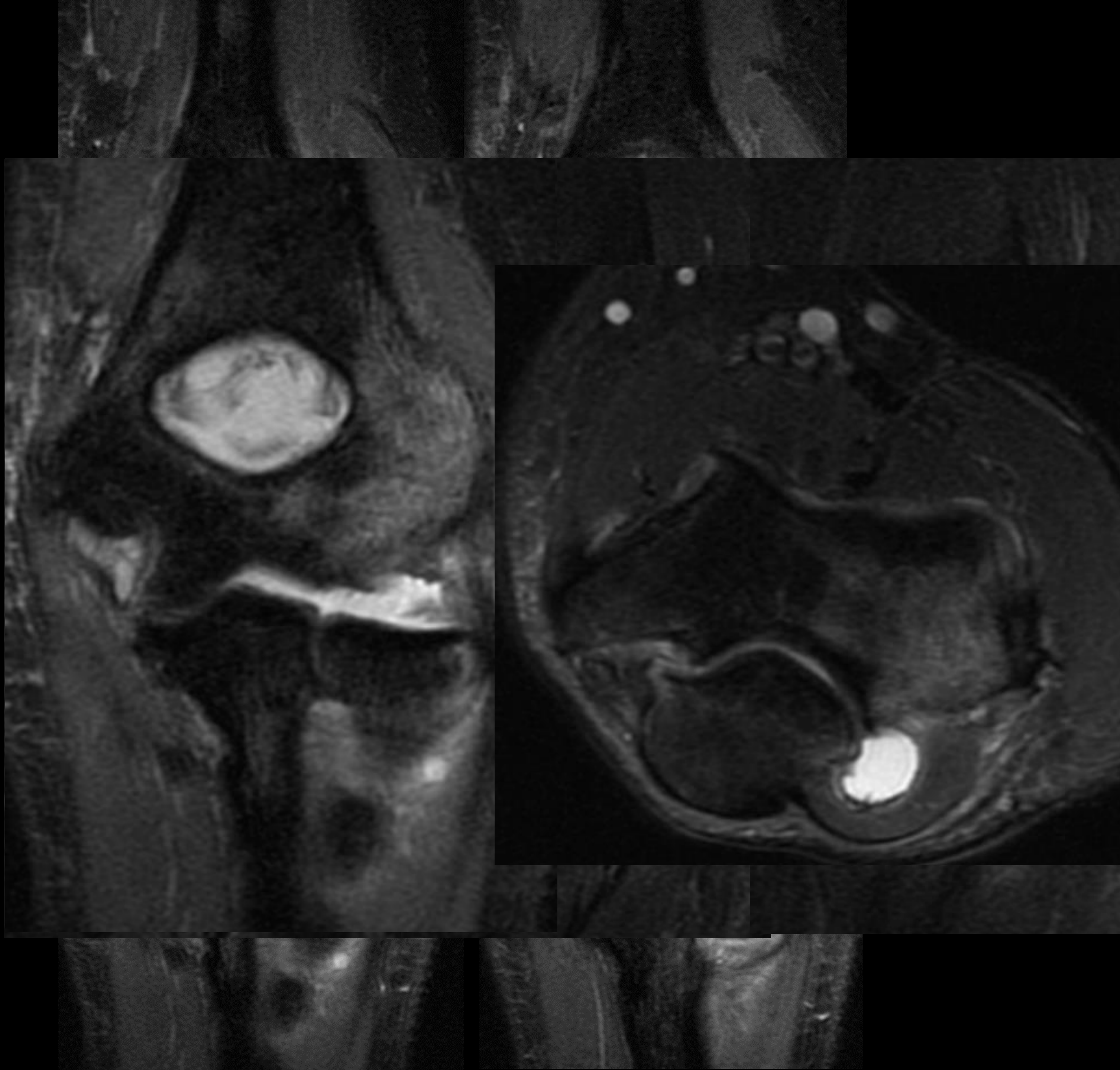
- 7/27/2018
- 64 yo F post fall

PLRI Case #2

- 2/7/2019
- Persistent pain, instability and decreased ROM
- Green arrow: anterior bundle MCL stripping with edema
- Yellow arrow: thickening/irregularity of RCL and LUCL at humeral attachment
- Radiocapitellar subluxation

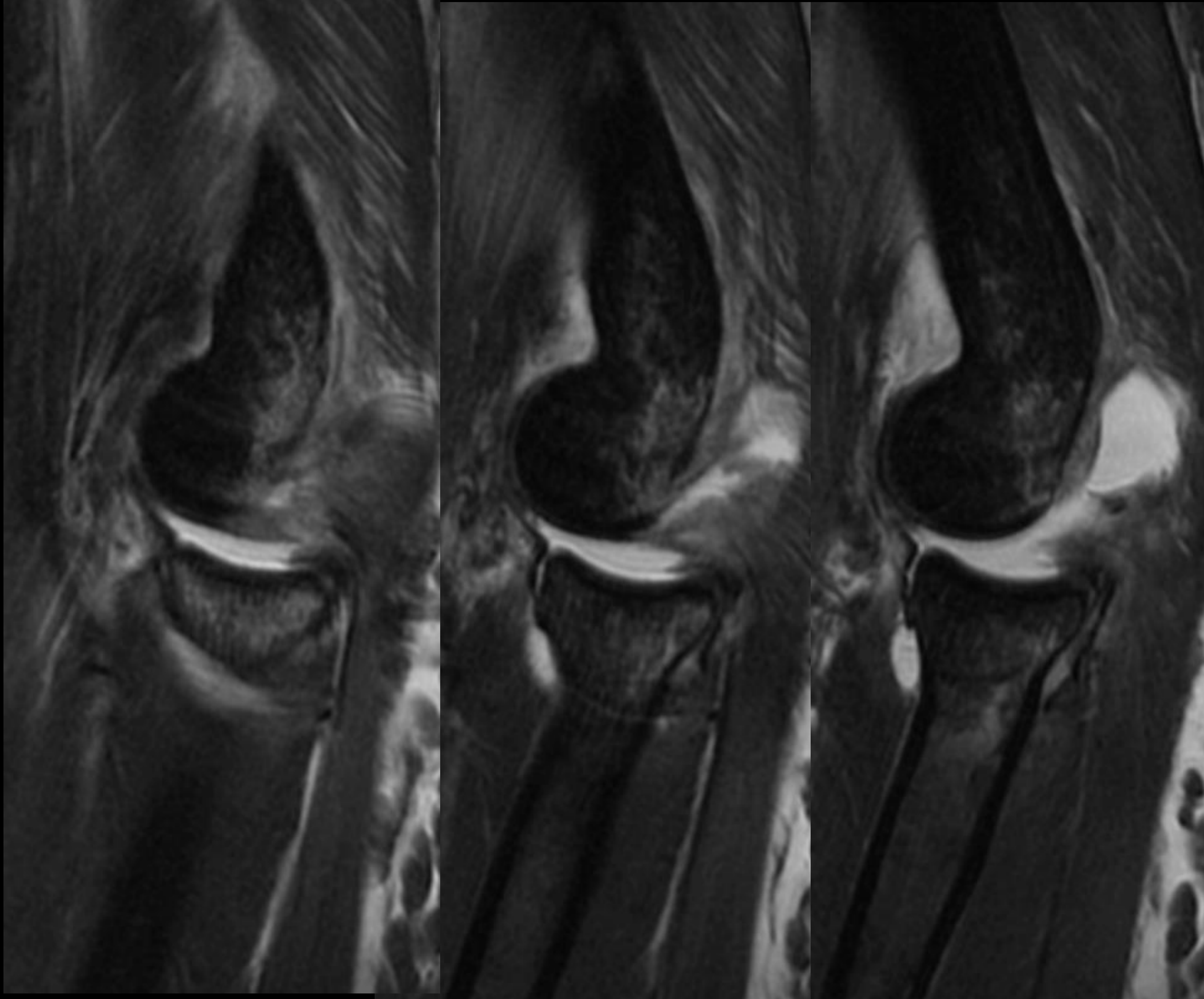
PLRI Case #3

- 41 yo F with decreased ROM and pain after bike injury 4 months prior
- Complete RCL and LUCL tears at humeral attachment
- Widening and subluxation of radiocapitellar joint
- Anterior and posterior MCL bundle tear
- Osborne-Cotterill lesion



PLRI Case #4

- 28 yo F with recent fall and pain
- Complete RCL, LUCL & CET tear
- Complete AB/PB MCL & CFT tear
- Osborne-Cotterill lesion
- Radiocapitellar subluxation



Non-operative Treatment

- Only for acute injuries/dislocations
- Immobilize in 90° flexion for 1 week
  - LCL disrupted but MCL intact -> pronate
  - LCL and MCL disrupted -> neutral
- Early active ROM after splint removal

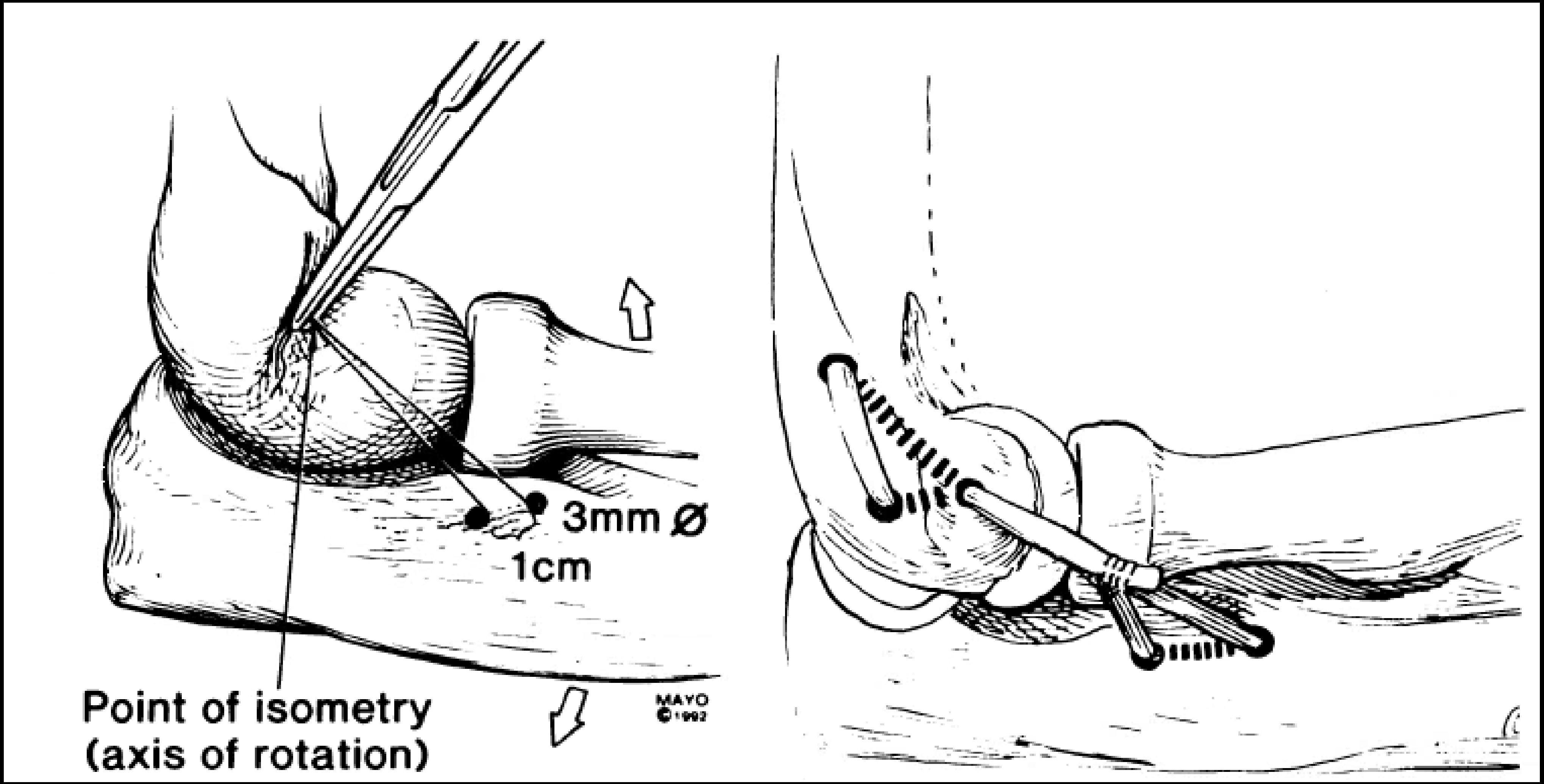
Surgical Treatment Indications

- Complex dislocation
  - Fixation of LCL if coronoid fragment > 2.5 mm
  - Increasing incidence of coronoid fracture fixation
  - Sublime tubercle injury -> must fix
- Osteochondral fragment
- Soft tissue entrapment
- Chronic PLRI

Surgical Treatment Technique

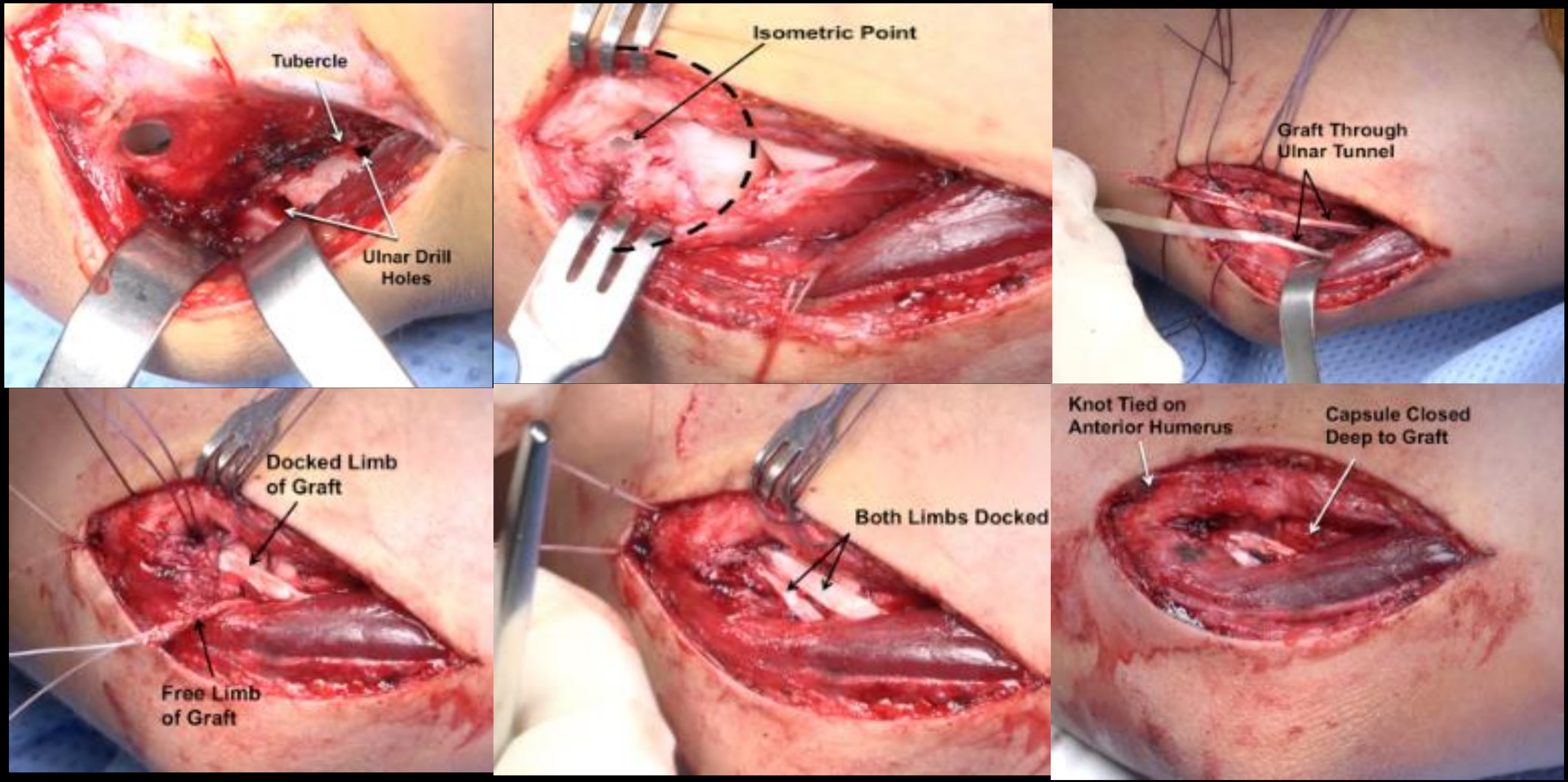
- Mainstay of treatment = restore LCL complex function
- Graft with palmaris longus, gracilis or triceps fascia
  - Docking technique currently most utilized
- Graft covers > 25% radial head to create sling
- Coronoid fractures
  - Fix large fragments
  - Remove small fragments
- Recurrent instability in 3-8%

Graft Repair of LCL



J Bone Joint Surg Am. 1992 Sep;74(8):1235-41

Docking Technique



Arthrosc Tech. 2017 Aug; 6(4): e1101–e1105.

Docking Technique

- Advantages
  - Reduced bone removal
  - Creation of an isometric construct
  - Historically high rate of restoration of joint stability

- Disadvantages
  - Precise anatomic knowledge and technical precision is required

Arthrosc Tech. 2017 Aug; 6(4): e1101–e1105.

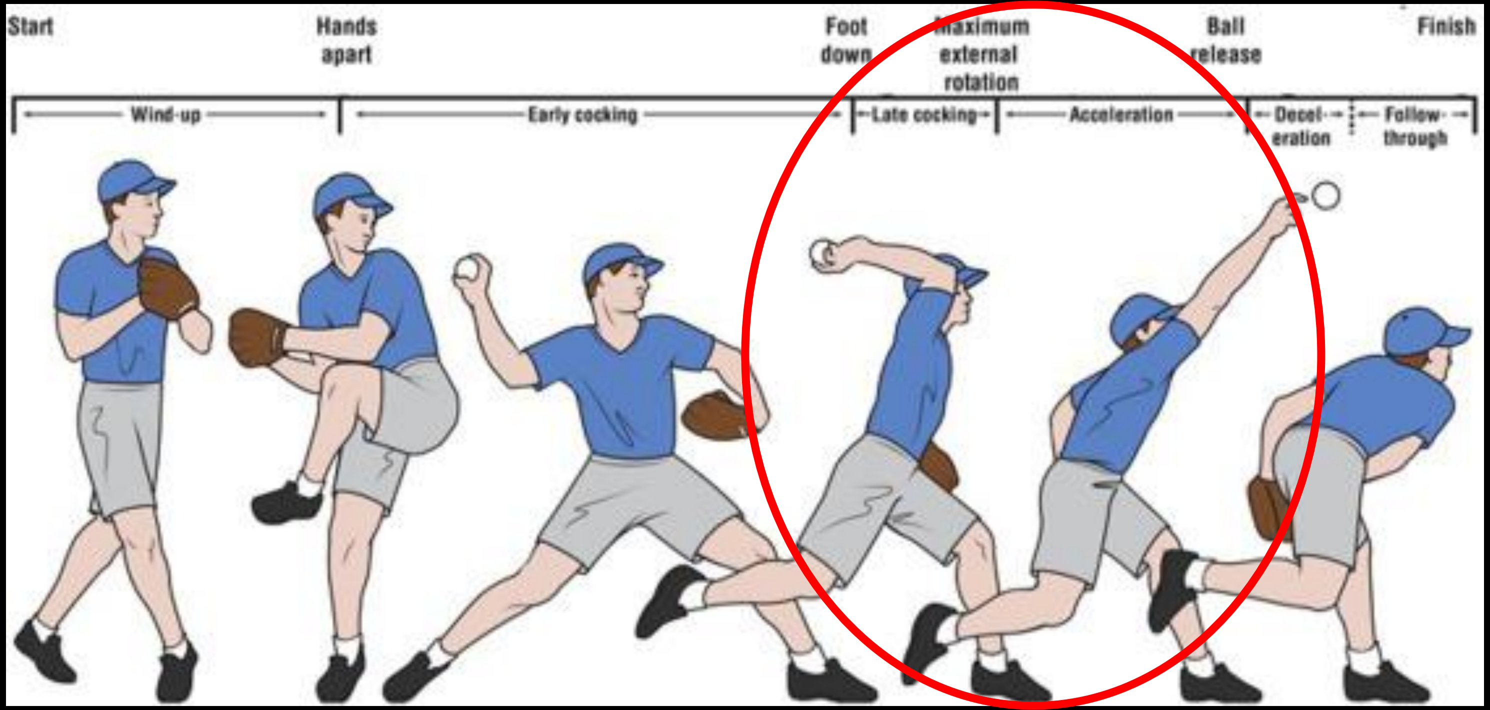

Take a
break!

Valgus Instability

- Second most common type of instability
- Injury or rupture to the medial collateral ligament
- Overhead athletes (pitchers)
- Uncommon in skeletally immature athletes
  - Medial epicondyle avulsions = little leaguers elbow

Mechanism of Action

- Dislocation
- Overuse
  - Repetitive valgus stress -> rupture anterior band MCL
  - Late cocking/early acceleration phase of throwing
  - Valgus load greatest in acceleration phase
- Iatrogenic
  - Excessive olecranon resection



Oper Tech Sports Med. 2016 Sept; 24(3): 156-161

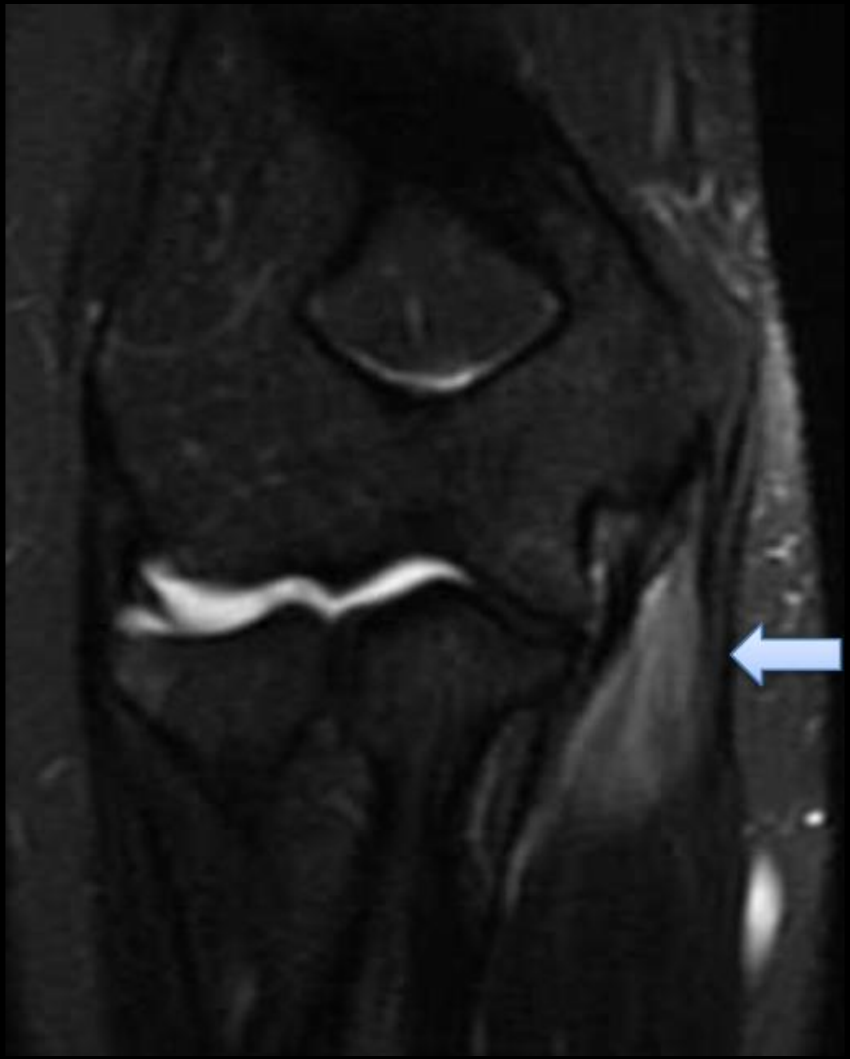
Spectrum of Acute Valgus Injury

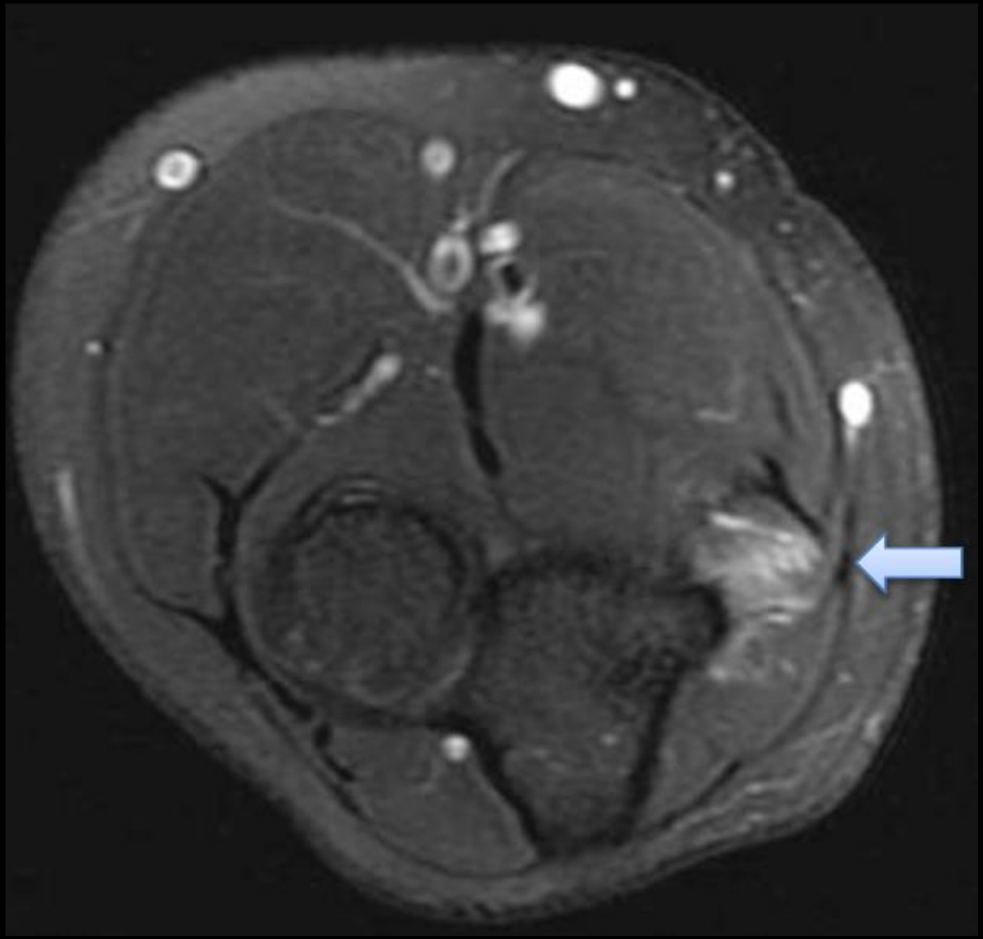
Flexor muscle strain → Common flexor tendon tear → MCL tear → Combined injury

Stable

Unstable

Spectrum - Flexor Muscle Strain

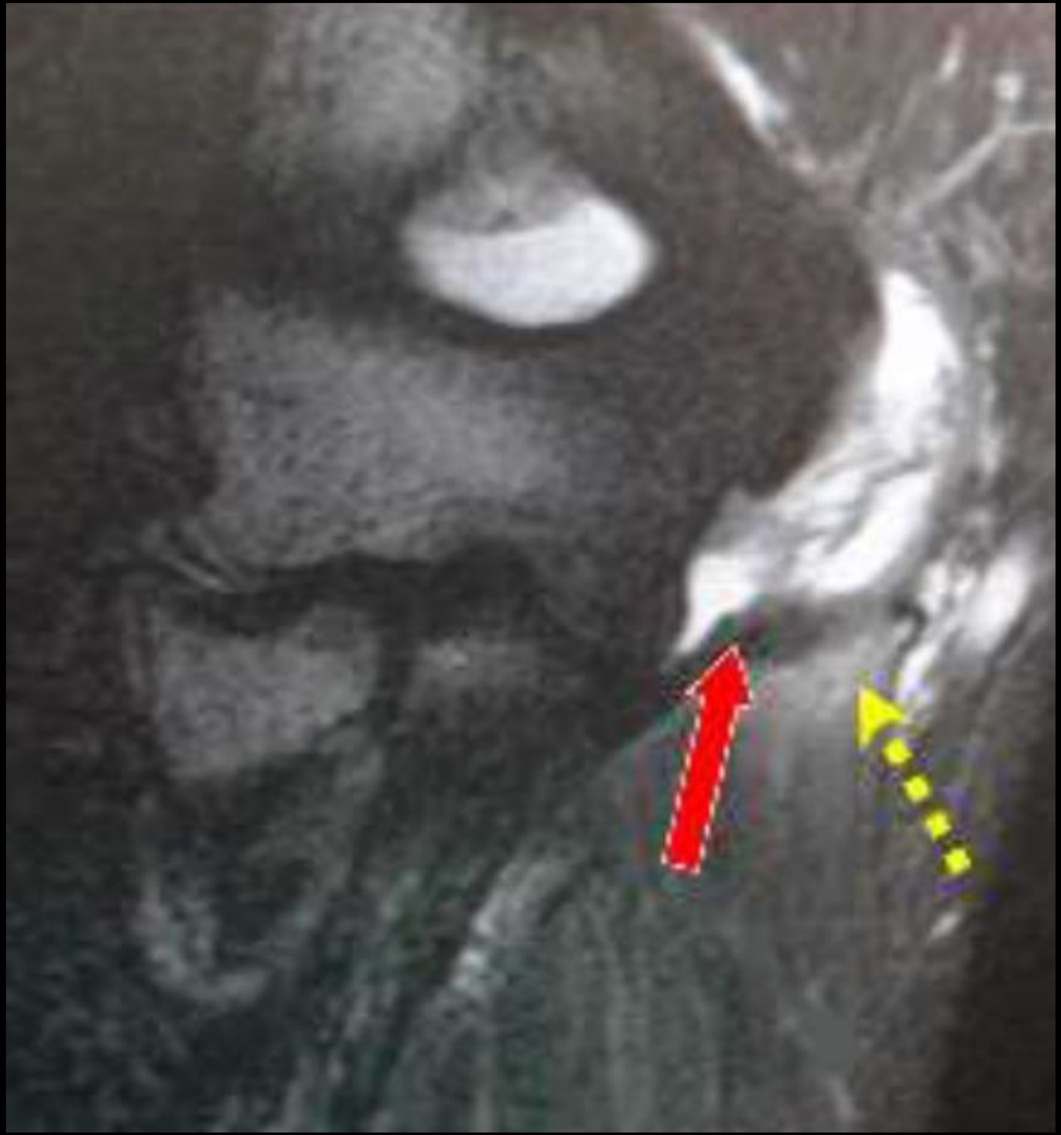




Spectrum – Common Flexor Tendon Tear

Spectrum – MCL Tear

Spectrum – Combined Tendon & Muscle Injury



Acute Presentation

- Acute injury may present as pain with “pop”
- Does NOT cause subluxation/dislocation
- Decreased throwing performance
  - Velocity
  - Accuracy
- Pain of MCL origin

Chronic Presentation

- MCL degeneration/thickening
- Valgus extension overload
- Ulnar neuritis
- Medial epicondylitis

Valgus Stress Test

- Flex elbow 20-30°
- Forearm is supinated
- Externally rotate humerus
- Apply valgus stress
- Positive = MCL pain
- 50% sensitive

J Hand Surg AM. 2017 Feb; 42(2): 118-126.

Milking maneuver

- Forearm supinated
- Elbow flexed at 90°
- Pull on patient’s thumb
- Positive = apprehension, instability or pain

J Hand Surg AM. 2017 Feb; 42(2): 118-126.

Modified milking maneuver

- Humerus adducted, externally rotated
- Valgus stress through thumb
- Flex elbow to 70°
- Positive = apprehension, instability or pain

J Hand Surg AM. 2017 Feb; 42(2): 118-126.

Moving Valgus Stress Test

- Abduct, externally rotate shoulder
- Extend elbow from full flexion to 30° flexion
- Apply valgus force throughout
- Positive = apprehension, instability or pain between 70-120°
- 100% sensitive, 75% specific

J Hand Surg AM. 2017 Feb; 42(2): 118-126.

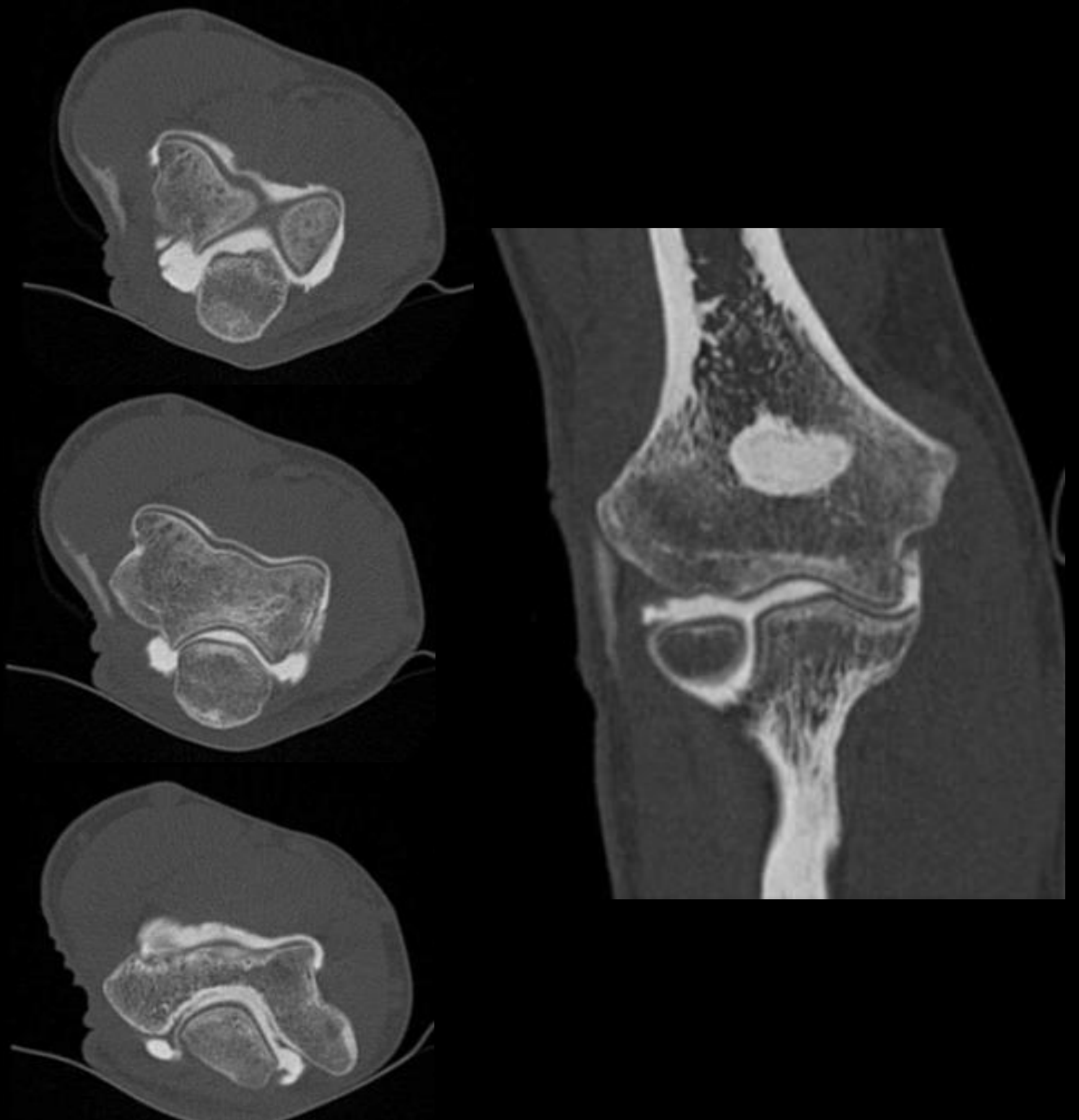
Radiographs

- Gravity or manual stress may show widening of medial joint line >3 mm
- Posteromedial osteophyte may suggest overuse

Orthobullets

CT arthrography

- Can better demonstrate partial thickness MCL tears
- 91% specific
- 71-86% sensitive



MRI

- Noncontrast
  - MCL injury – acute v chronic
  - 57-79% sensitive
  - 100% specific
- MR arthrogram
  - T-sign
  - 97% sensitive
  - 100% specific

The Radiology Assistant

Dynamic Ultrasound

Can evaluate laxity with valgus stress

Nonoperative Treatment

- First line
- 6 weeks rest from throwing
- Physical therapy for flexor-pronator strengthening
- 42% return to preinjury level in ~24 weeks

Surgical Treatment

- Indications
  - High-level throwers
  - Failed conservative treatment
- Tommy John Surgery
- Outcomes
  - 90% return to preinjury throwing

Surgical Techniques

- Reconstruction > direct repair
- Autograft > allograft
- Palmaris longus > gracilis

- Modified Jobe Technique
- Docking Technique
- Hybrid Interference-Screw Technique
- Cortical Suspensory Fixation

Modified Jobe Technique

- Figure of 8 reconstruction
- 2 tunnels in humerus
- Single tunnel in ulnar sublime tubercle

https://www.arthrex.com/elbow/modified-jobe-technique/

Docking Technique

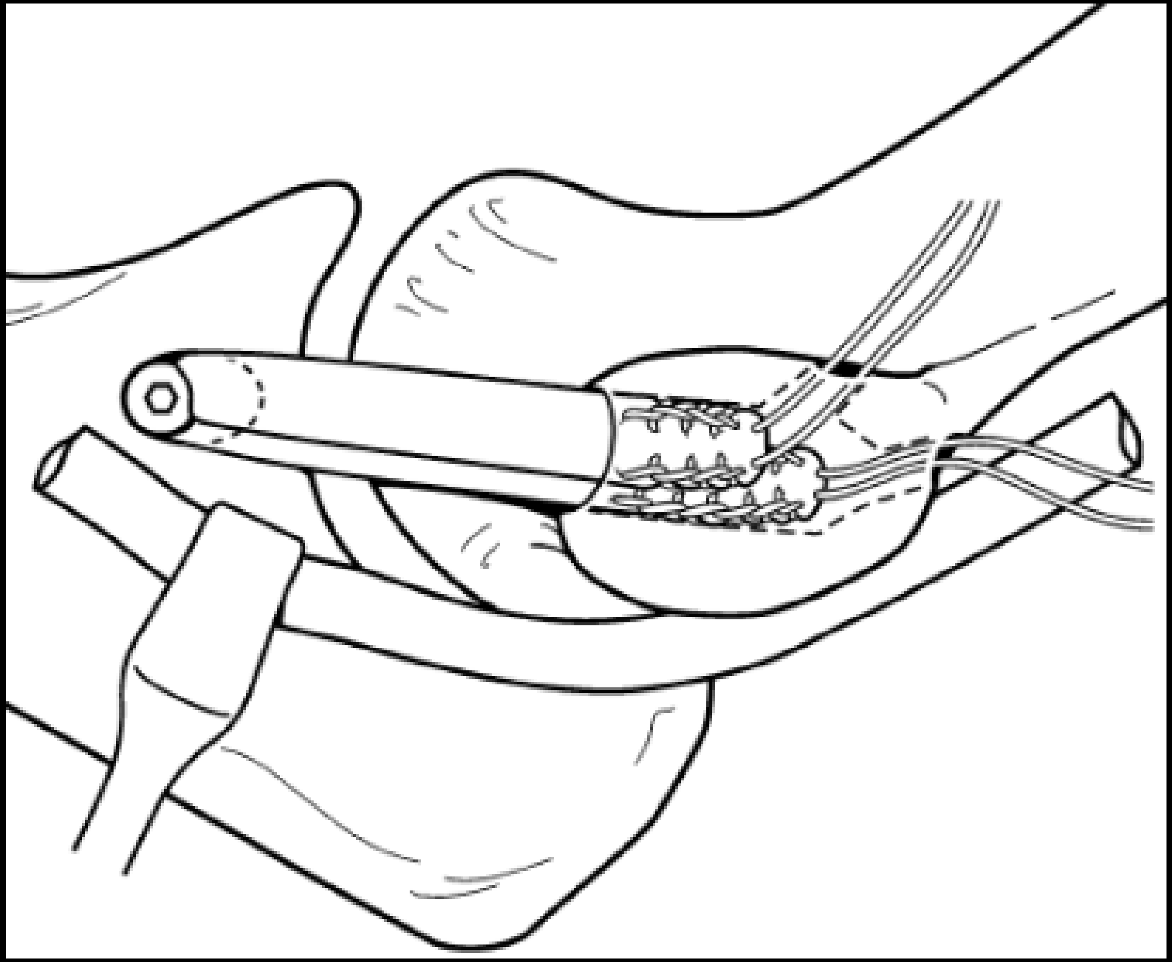
- Single humeral docking tunnel
- 2 punctures medial epicondyle

- Best outcomes and lowest complications

https://www.arthrex.com/elbow/docking-technique

Hybrid Interference-Screw Technique (DANE TJ)

- Docking fixation in humerus
- Interference screw in ulna

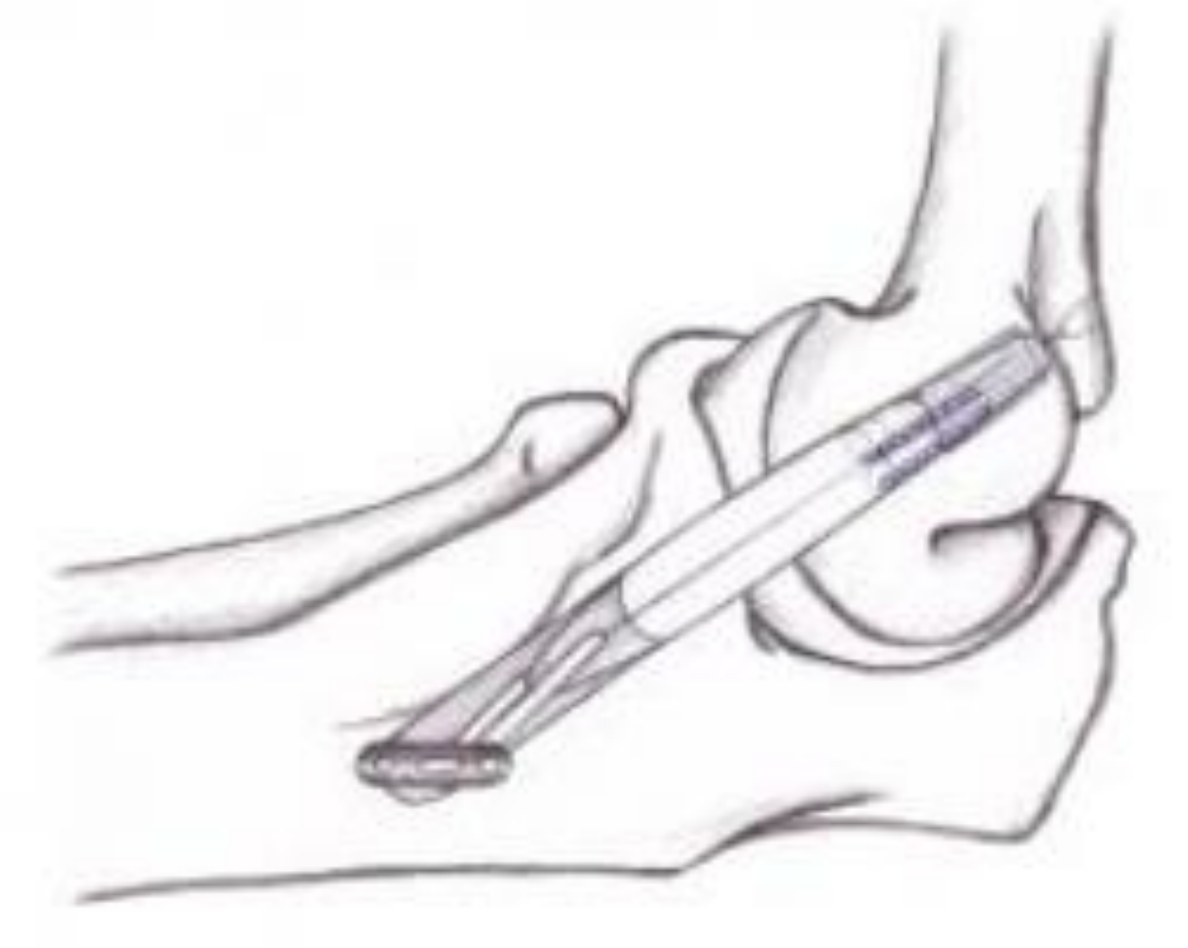


Tech Shoulder Elb Surg 2006; 7(1):36-43

Cortical Suspensory Fixation

- Docking in humerus
- Endobutton in ulna

- Strongest technique



https://emedicine.medscape.com/article/1230902-treatment#d10

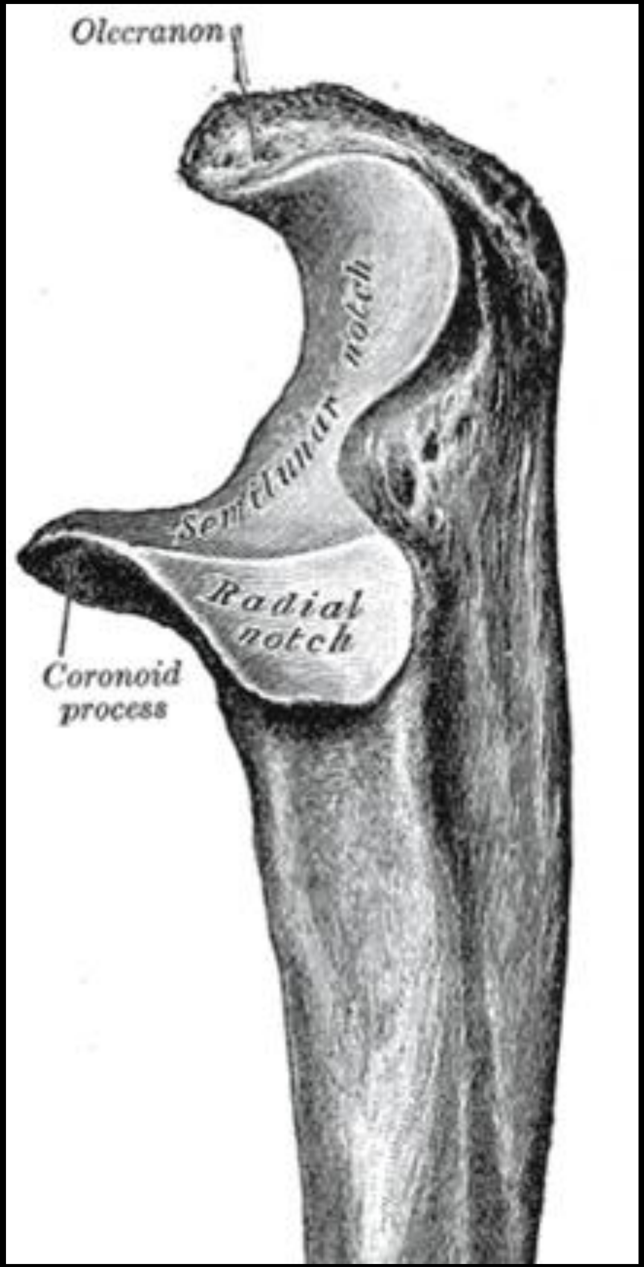

OUT OF
ORDER!

Posteromedial Rotatory Instability

- First described by O'Driscoll in 2003
- Characterized by:
  - Anteromedial fracture of coronoid
  - Disruption of the LCL
  - +/- injury to the MCL
- Varus elbow stabilizers
  - Osseous articulation
  - LCL
  - Capsule

Coronoid Process

- Anteromedial “facet”
- Region between coronoid tip and sublime tubercle
- 60% coronoid unsupported by ulnar metaphysis = prone to fracture
- Resists posterior ulnar subluxation and posteromedial/lateral rotatory forces



Accompanying Injuries

- LCL humeral avulsion – common
- Posterior bundle MCL
- +/- anterior bundle MCL
- Olecranon fracture
  - LCL may be preserved
- Coronoid base fracture
- Radial head fracture - rare

Mechanism of Injury

Pronation +
ad +
orce

Compression + internal rotation + varus force

NO CONSENSUS

onoid fx

Varus overload + LCL rupture + convex coronoid fx

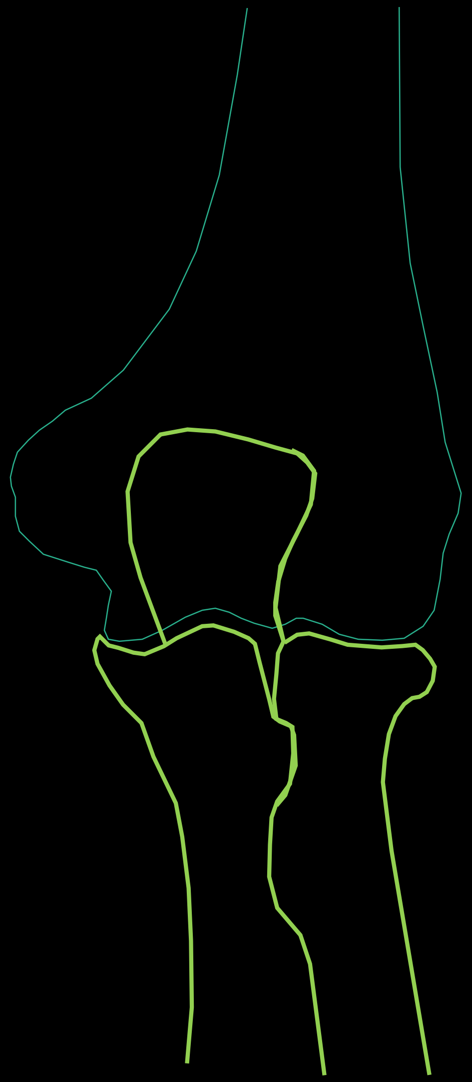
Pronation + varus + axial force

Varus Posteromedial Rotatory Instability

Fracture-subluxation or fracture-dislocation

Courtesy of Dr. Eric Chang

Varus Posteromedial Rotatory Instability



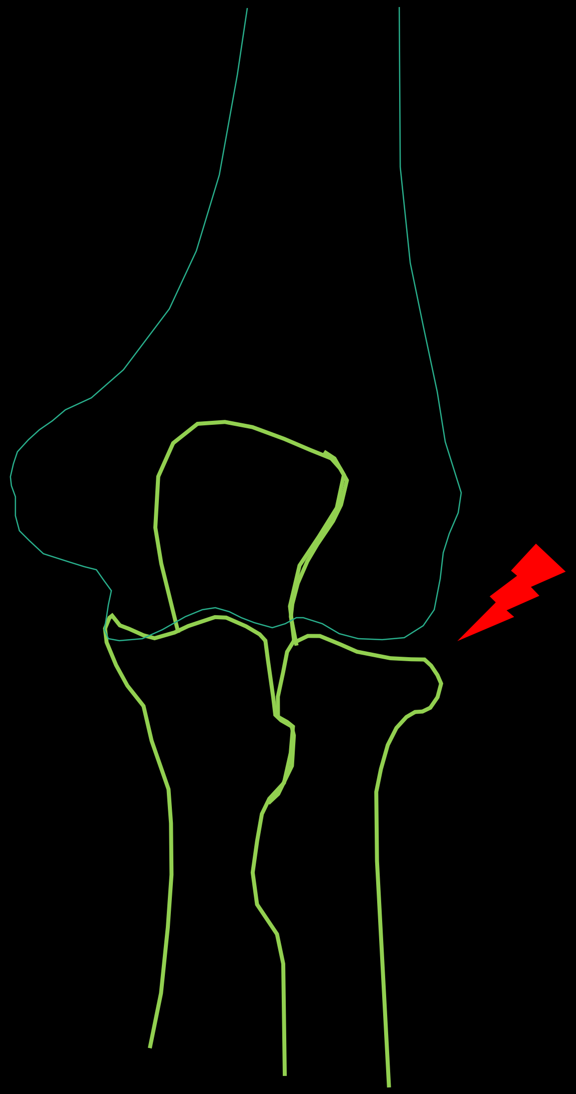
Fracture-subluxation or fracture-dislocation

- Axial loading

Courtesy of Dr. Eric Chang

Varus Posteromedial Rotatory Instability

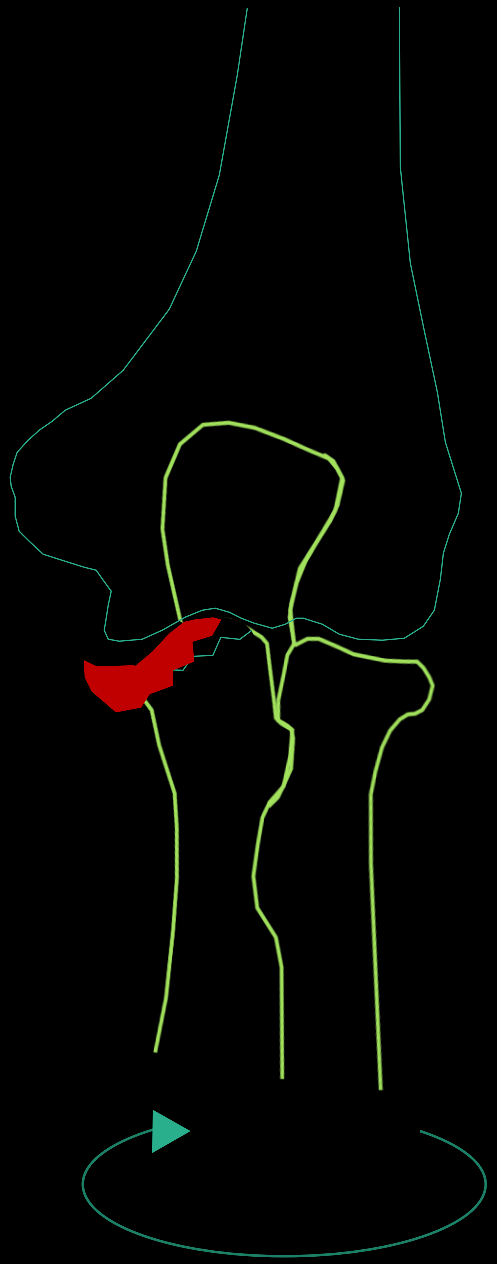
Fracture-subluxation or fracture-dislocation



- Axial loading
- Varus force

Courtesy of Dr. Eric Chang

Varus Posteromedial Rotatory Instability



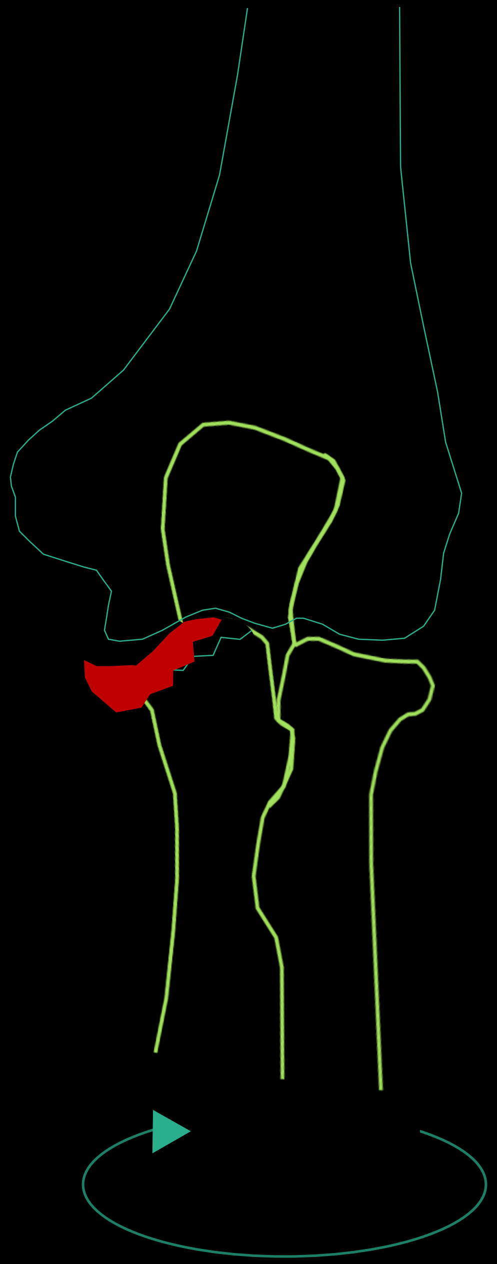
Fracture-subluxation or fracture-dislocation

- Axial loading
- Varus force
- Internal rotation of the forearm with shearing and fracture of the anteromedial facet of the coronoid process

Courtesy of Dr. Eric Chang

Varus Posteromedial Rotatory Instability

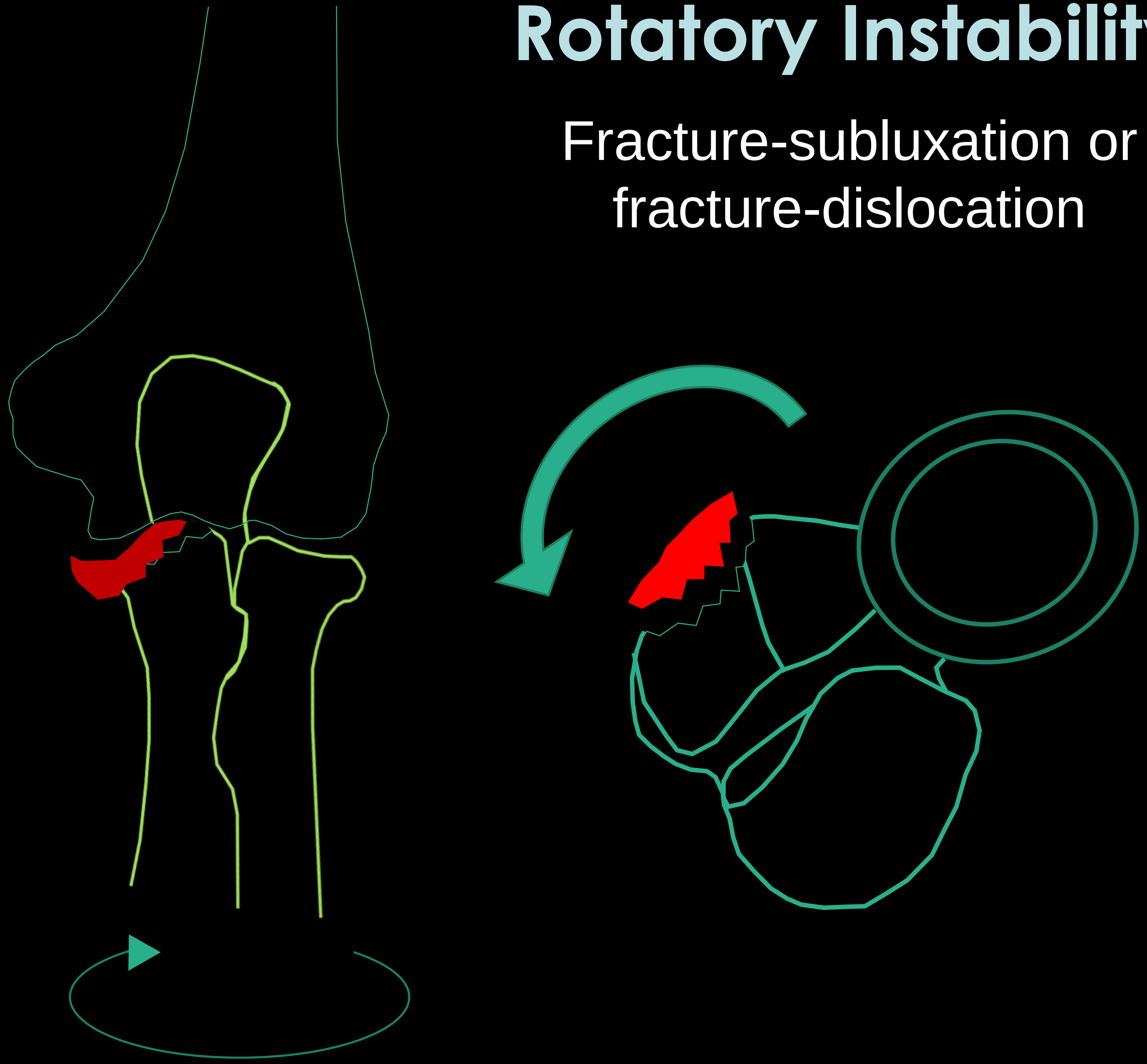
Fracture-subluxation or fracture-dislocation



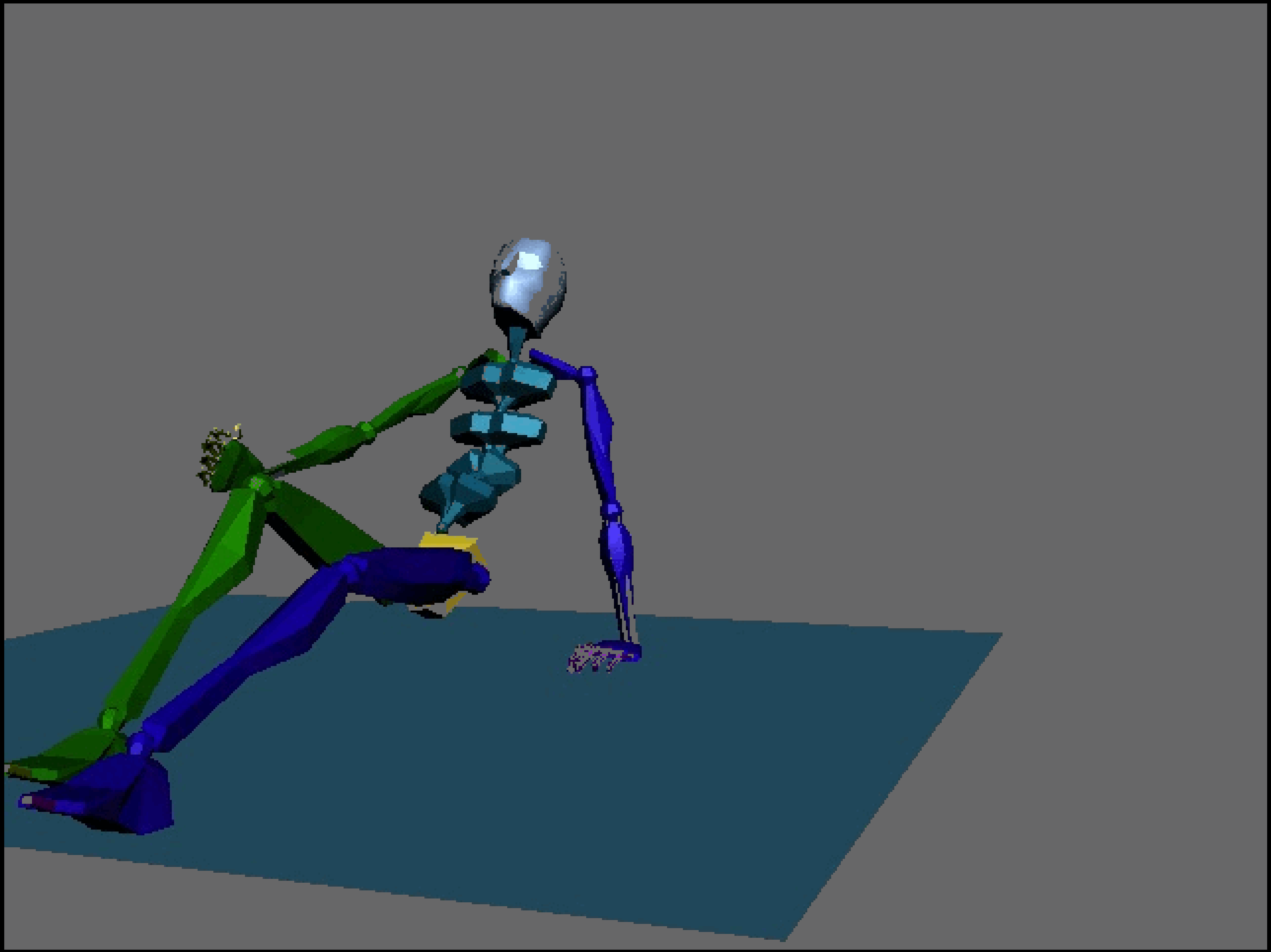
Courtesy of Dr. Eric Chang

Varus Posteromedial Rotatory Instability

Fracture-subluxation or fracture-dislocation



Courtesy of Dr. Eric Chang



Courtesy of Dr. Eric Chang

Coronoid Fractures – Regan and Morrey

- Original classification system

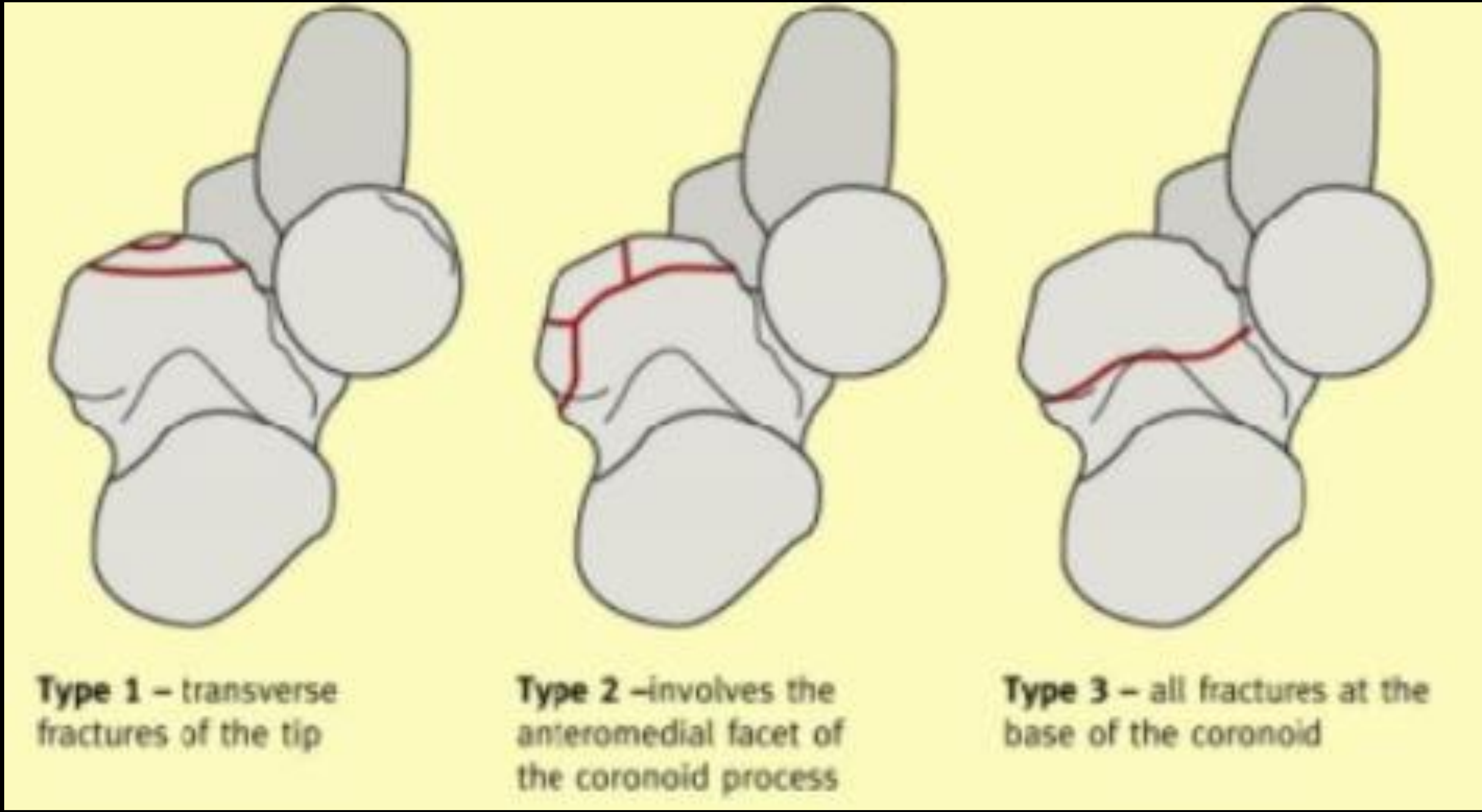
Type	Description
Type I	"Avulsion" of the coronoid tip
Type II	Single or comminuted fracture involving ≤50% coronoid
Type III	Single or comminuted fracture involving >50% coronoid

- Doesn't address location of fracture

Coronoid Fractures – O'Driscoll

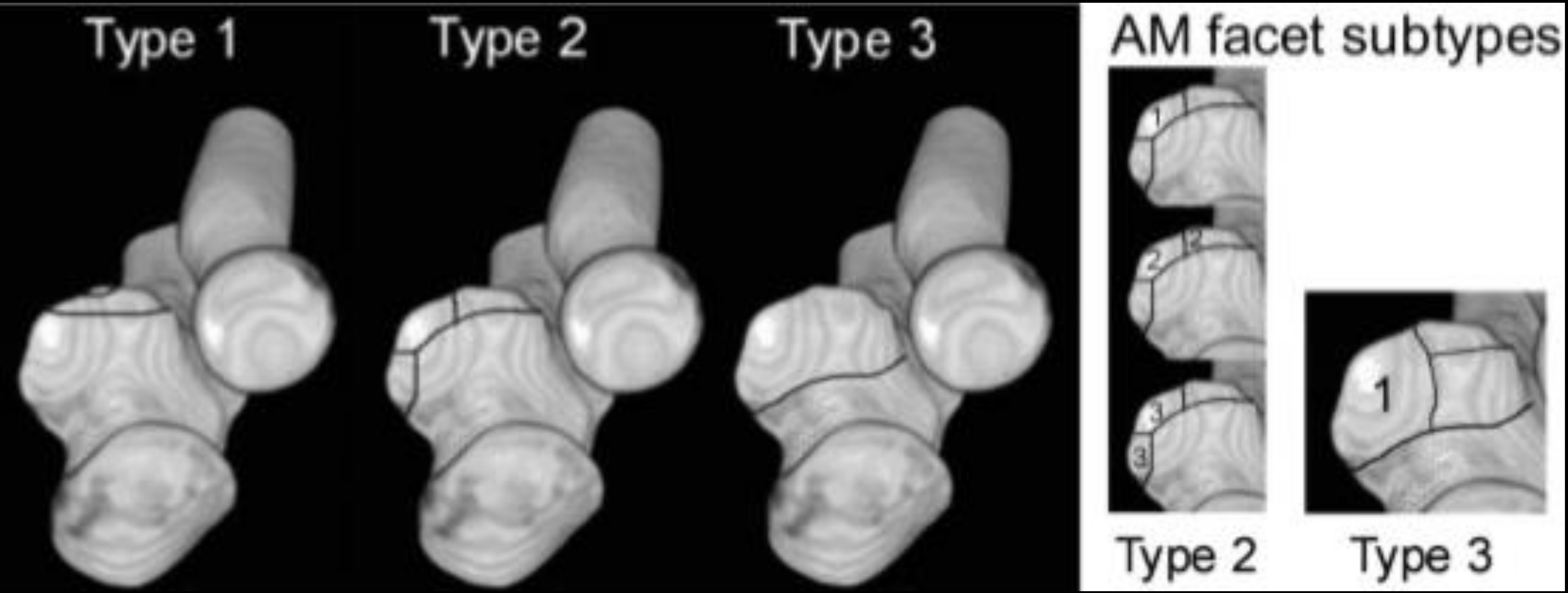
Type I Tip	Subtype I	≤2 mm coronoid height
	Subtype II	> 2 mm coronoid height
Type II Anteromedial	Subtype I	Anteromedial rim
	Subtype II	Anteromedial rim and tip
	Subtype III	Anteromedial rim and sublime tubercle
Type III Base	Subtype I	Coronoid body and base
	Subtype II	Trans-olecranon coronoid base

Coronoid Fractures – O’Driscoll



Instr Course Lect 2003; 52:113-134.

Coronoid Fractures – O'Driscoll



J Hand Surg Am. 2006;31(1):45–52.

Coronoid Fractures – Doornberg and Ring

Fracture Type	Injury Type
Large	Anterior (25%) dislocation Posterior (75%) dislocation
Small transverse	Terrible triad
Anteromedial ‘facet’	Posteromedial Rotatory Instability

Role of the Posterior Bundle of MCL

- Classically PMRI was attributed to the coronoid fracture and LCL
- Increasing evidence that posterior band MCL plays role in stability
- Persistent instability post coronoid fixation + LCL and anterior bundle MCL repair

pMCL = posterior *bundle* MCL and aMCL = anterior *bundle* MCL

Role of the pMCL – Pollock 2009

- First paper to recognize role of posterior bundle MCL
- Cadaveric study
- Isolated pMCL transection ->
  - Increased elbow rotation
  - Increased varus/valgus motion

Role of the pMCL – Morrey 2012

- Professional pitcher
- Persistent medial instability despite multiple traditional aMCL reconstructions
- Isolated pMCL reconstruction -> return to competition
- Olecranon deficient

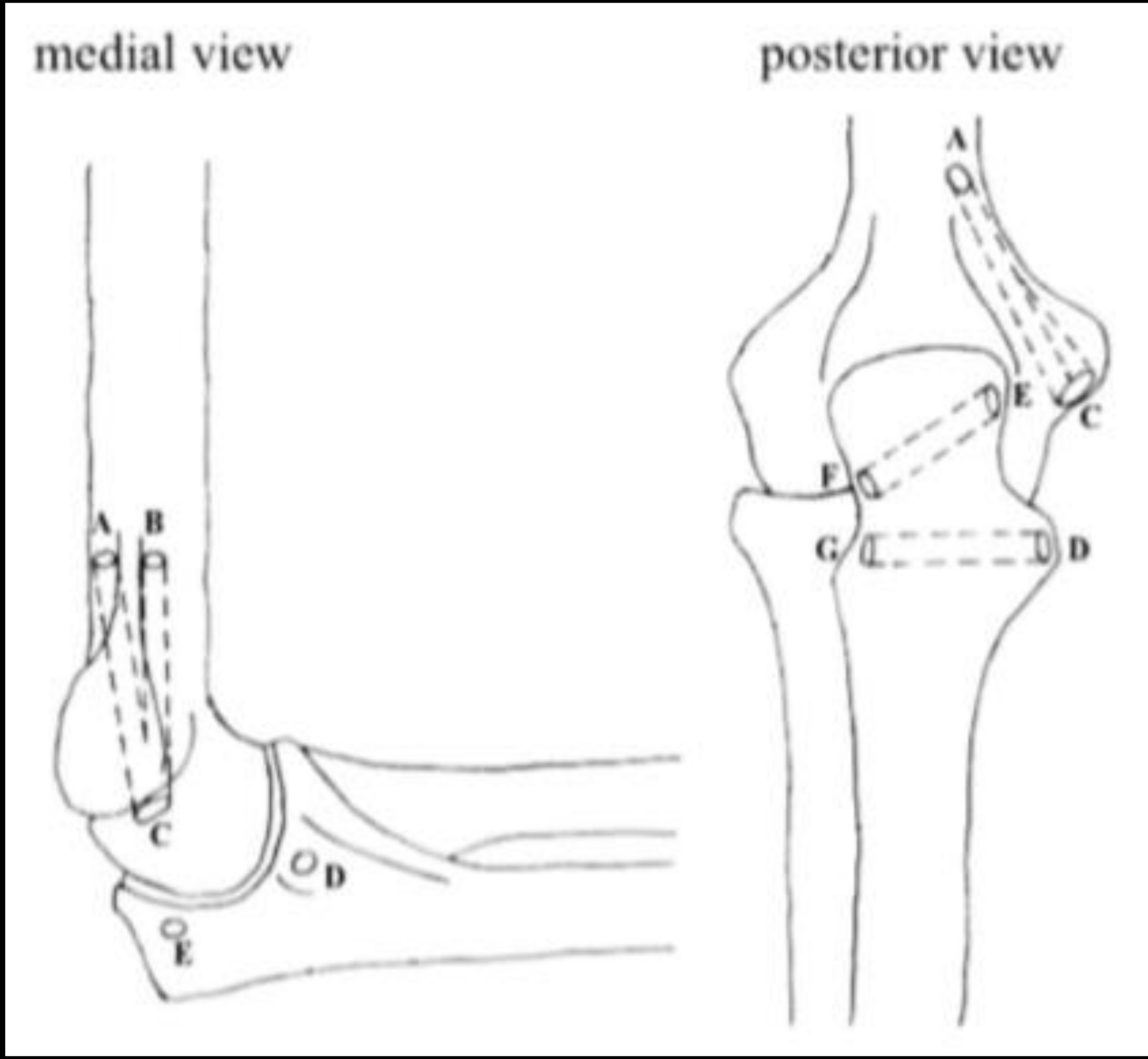
Role of the pMCL – Golan 2016

- Isolated sectioning of the pMCL
  - Increased gapping of the anterior aspect of the ulnohumeral joint
  - increased ulnohumeral torsion at 60° and 90°
  - Despite integrity of aMCL
- Greatest gaps occurred at 60° flexion
- Conclusion: isolated pMCL injury can cause instability in the absence of AMC fracture or aMCL injury….

Role of the pMCL – Sard 2017

- Cadaveric study – 16 elbows
  - Intact MCL
  - Transected aMCL
  - Transected aMCL + pMCL
- Dislocation only with transected aMCL + pMCL
- Reconstruction aMCL and pMCL
  - Complete recovery elbow stability
  - Re-establish elbow ROM

MCL repair - Sard



Musculoskelet Surg. 2017 Dec;101(Suppl 2):181-186.

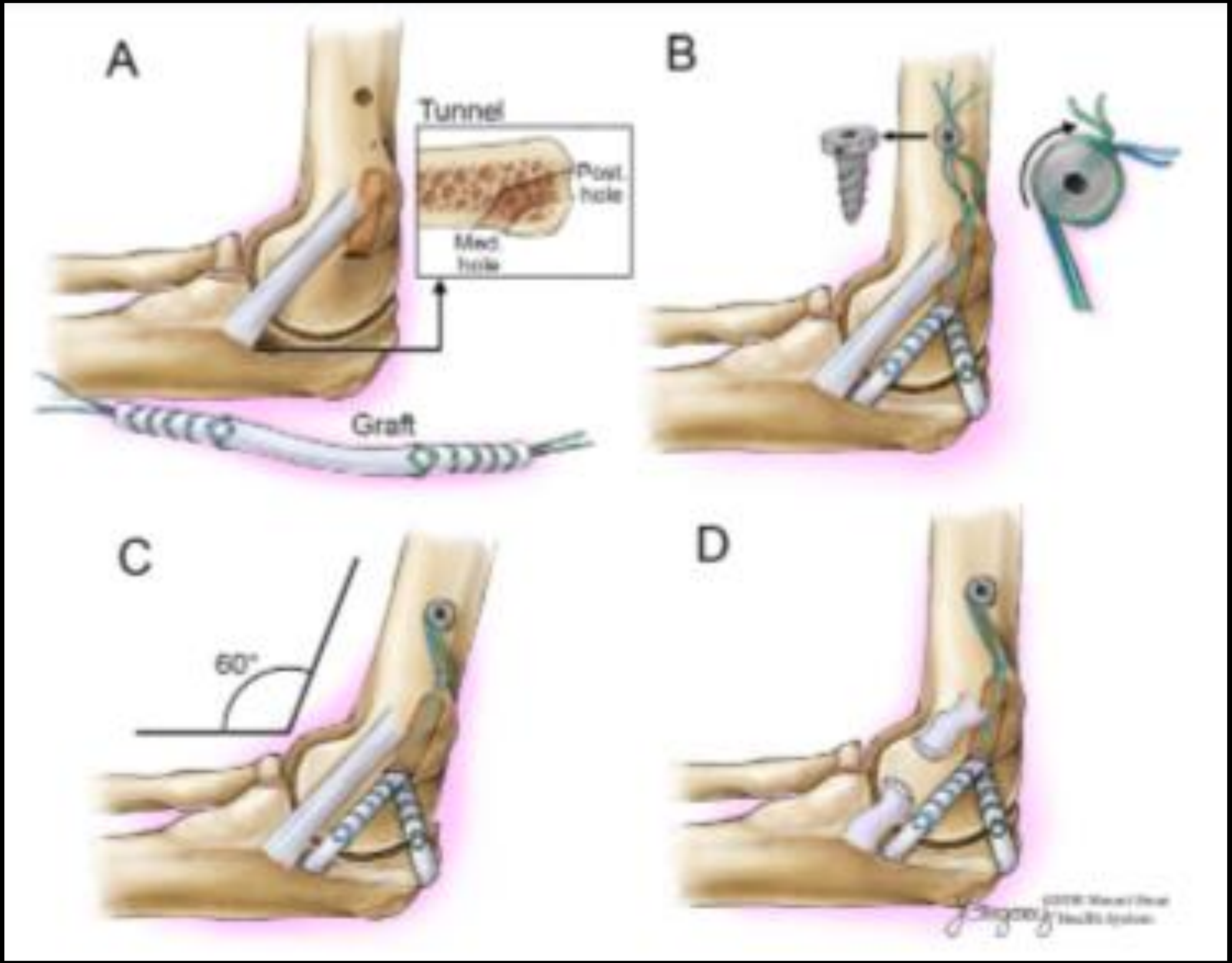
Role of the pMCL – Hwang 2018

- Supports Sard's findings, different conclusion
- pMCL necessary for subluxation to occur
- Increased ulnohumeral contact pressure can occur with intact pMCL
- Conclusion: post-traumatic arthritis can occur in absence of pMCL injury

Role of the pMCL – Gluck 2018

- pMCL greatest contribution to stability at 90° flexion
- Post pMCL repair
  - Joint gapping decreased at the higher degrees of flexion
- Isolated pMCL reconstruction
  - Stability can improve but not perfect
  - Recommend concurrent coronoid fracture fixation
- Conclusion: PMRI can occur with pMCL + coronoid fracture, in the absence of an LCL injury.

MCL repair - Gluck



J Shoulder Elbow Surg. 2018 Jul;27(7):1317-1325.

Clinical Presentation

- Elbow subluxation versus frank dislocation
- Clicking, popping, slipping
- Pain
- Nonspecific, subtle symptoms

- Paucity of clinical tests

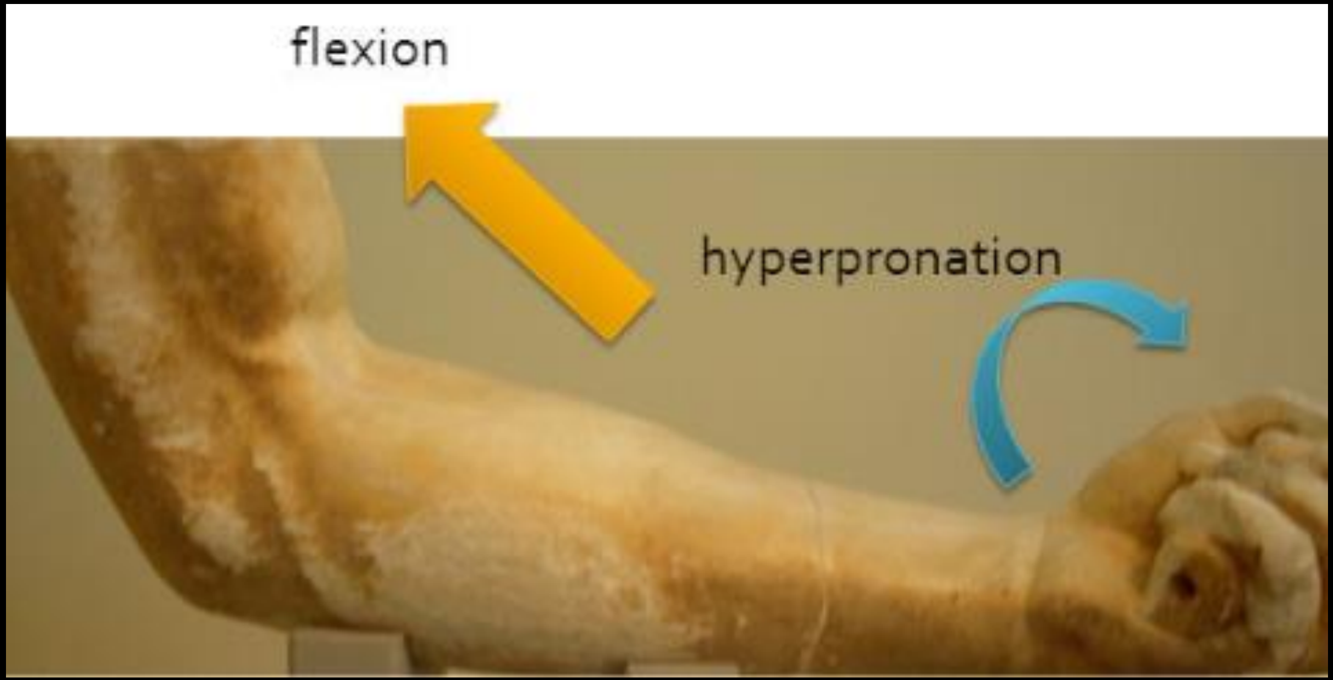
Gravity-assisted Varus Stress Test

- Shoulder abducted to 90°
- Forearm in neutral rotation
- Elbow moved from extension to flexion
- Positive = instability, pain, crepitation
- Most sensitive, specific

J Hand Surg AM. 2017 Feb; 42(2): 118-126.

Hyperpronation Test

- Elbow in 90° flexion
- Examiner passively hyperpronates patient’s forearm
- Examiner palpates for ulnohumeral subluxation



Radiographs

- Anteromedial coronoid fractures – may need obliques
- +/- lateral epicondyle avulsion fractures
- Subtle decrease medial ulnohumeral space
- +/- widened radiocapitellar joint if complete LCL disruption

J Hand Surg Am. 2006;31(1):45–52.

Radiographs – Double Crescent Sign

- Described by Sanchez-Sotelo
- Pathognomonic for anteromedial coronoid fractures
- Displaced anteromedial coronoid fragment
  - Double subchondral density
  - Loss of parallelism between medial coronoid and opposing distal humeral articular surface

Varus Posteromedial Rotatory Instability.
In: Tashjian RZ (ed), The Unstable Elbow.

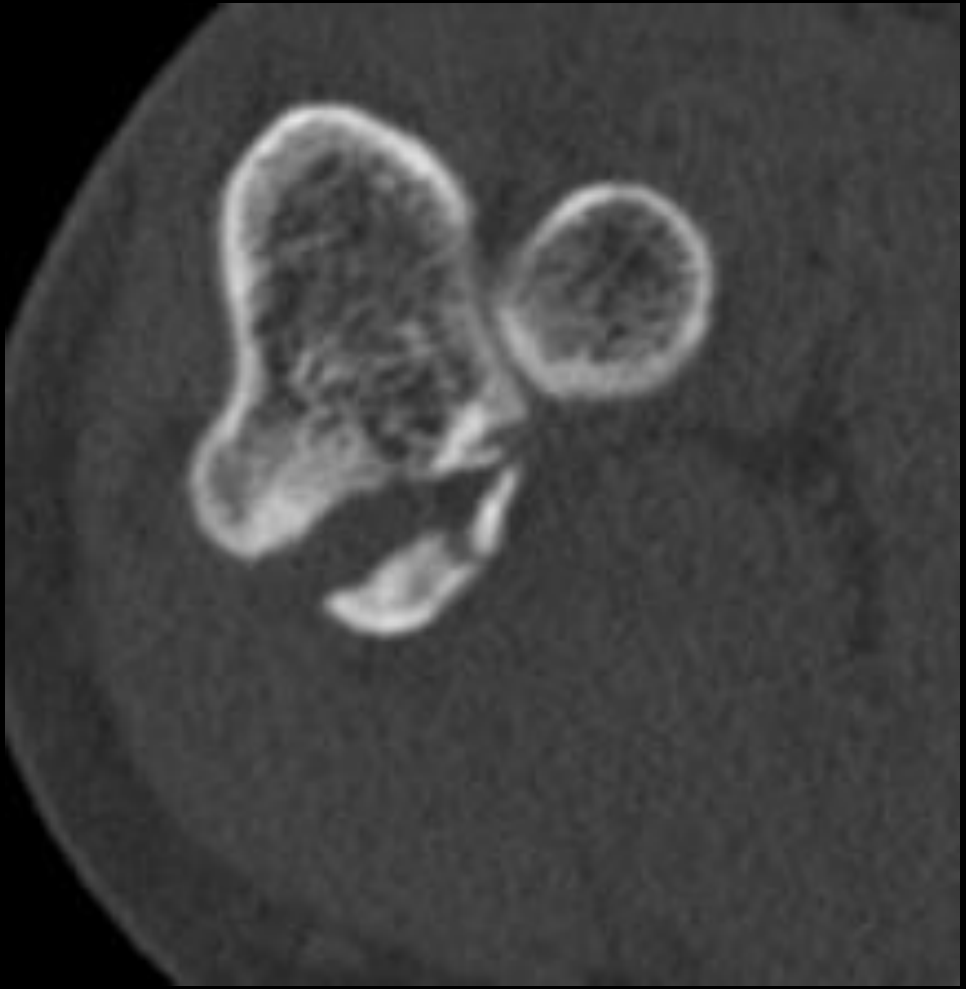
Radiographs – Stress Images

- Gold Standard
- Varus stress under anesthesia
- Widening of the radiocapitellar joint

Instr Course Lect 2003; 52:113-134.

Computed Tomography

- Always recommended in acute setting to better characterize the coronoid process fractures
- 3D reconstructions popular for surgical planning



Acute Elbow Trauma. Strategies in Fracture Treatments. Springer; 2019, Chapter 2.

MRI

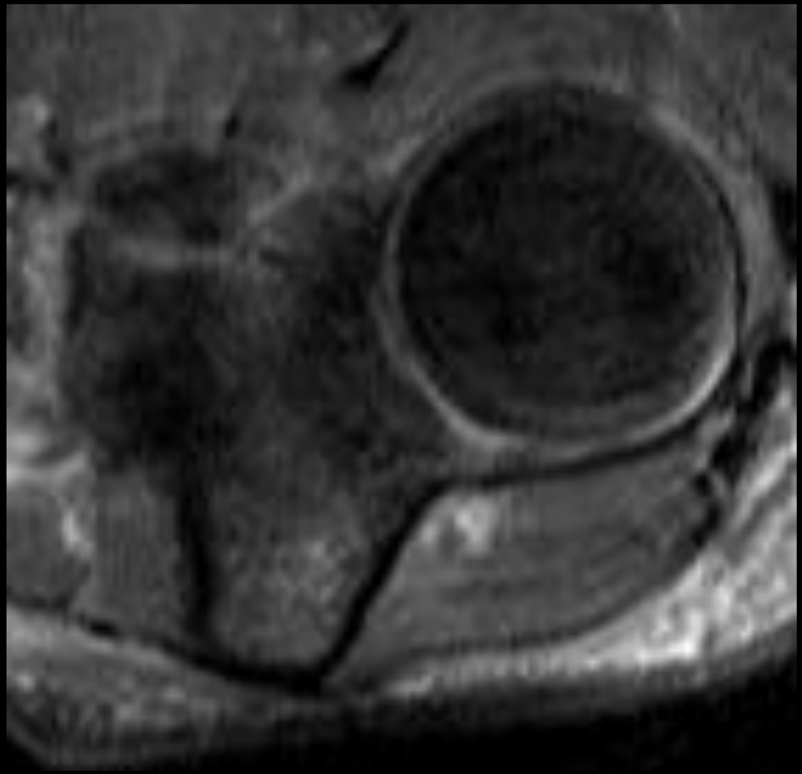
- Can demonstrate degree of LCL and MCL injury
- Increasingly important to determine degree of injury of pMCL

PRMI Case #1

- 30 yo M post fall
- Oblique radiograph best demonstrates fracture of the anteromedial coronoid facet.

Courtesy of Dr. Eric Chang

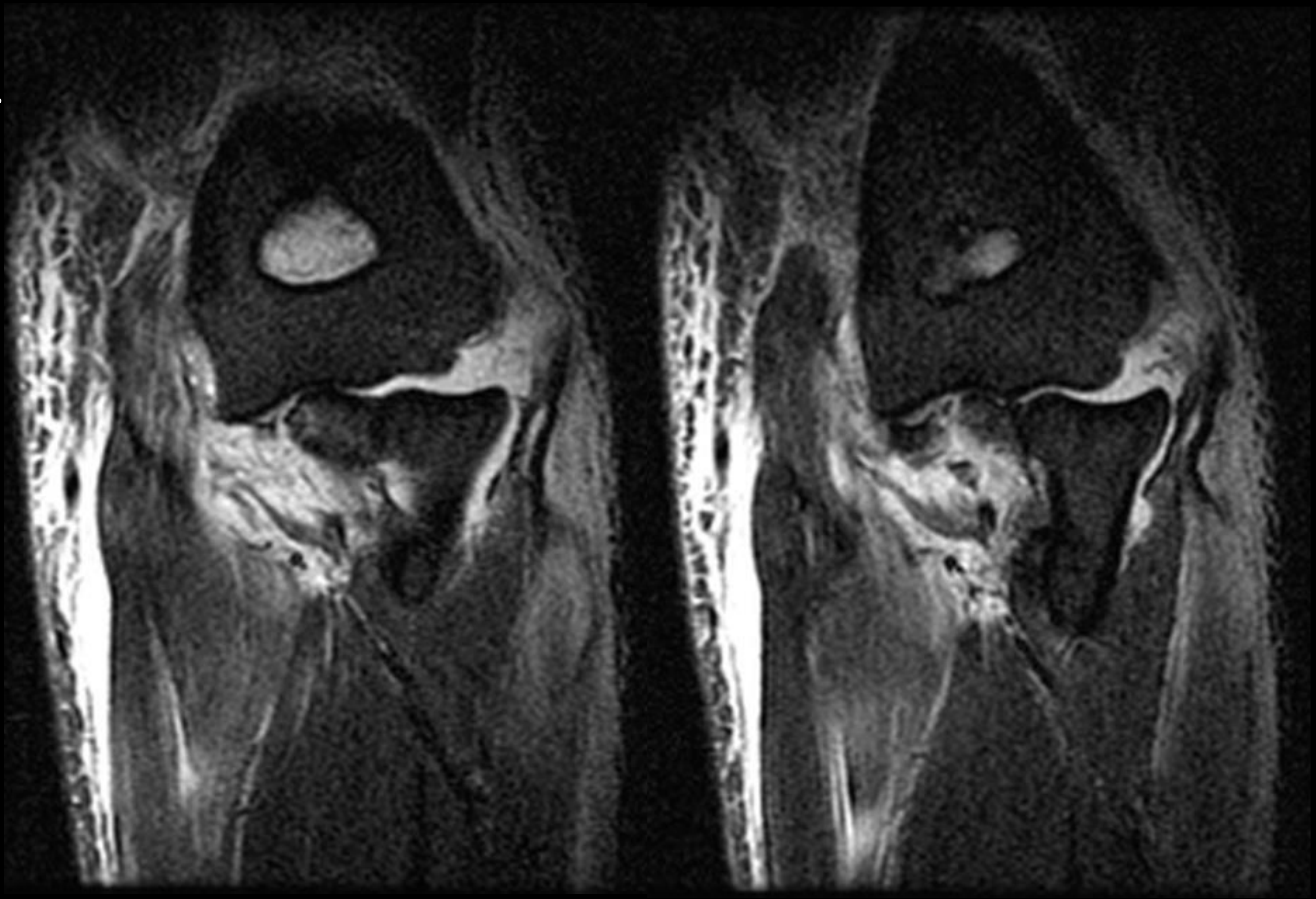
PRMI Case #1



Courtesy of Dr. Eric Chang

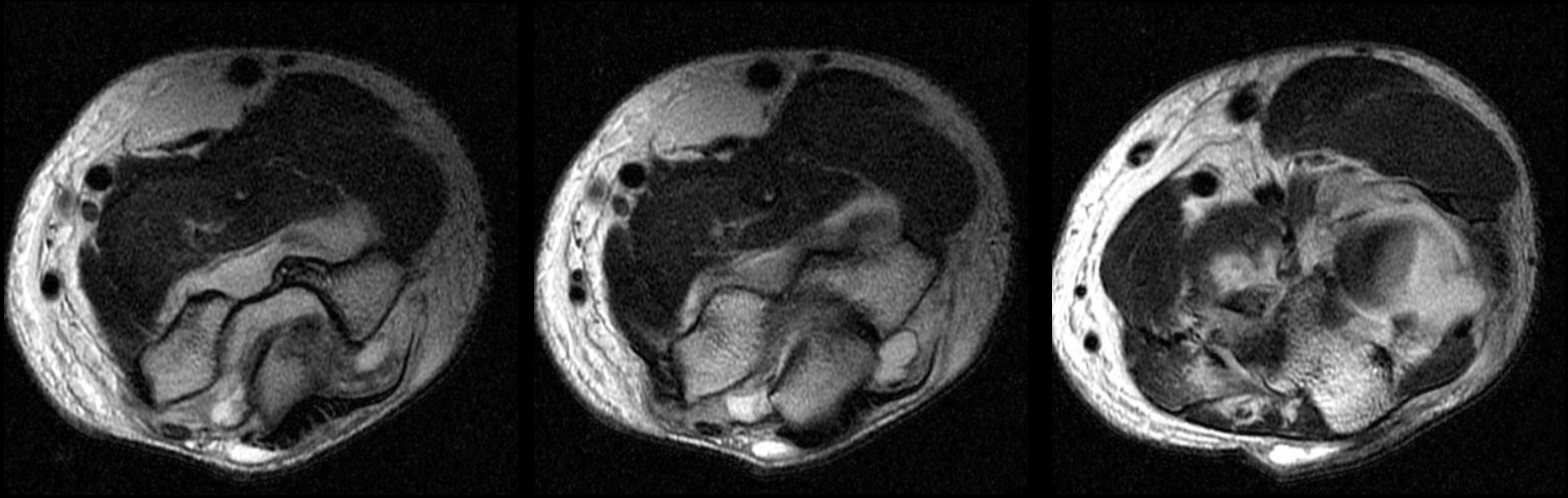
PRMI Case #2

- 46 yo M fall
- Varus angulation
- LUCL, RCL, CET tear
- Coronoid fx



Courtesy of Dr. Eric Chang

PRMI Case #2



Courtesy of Dr. Eric Chang

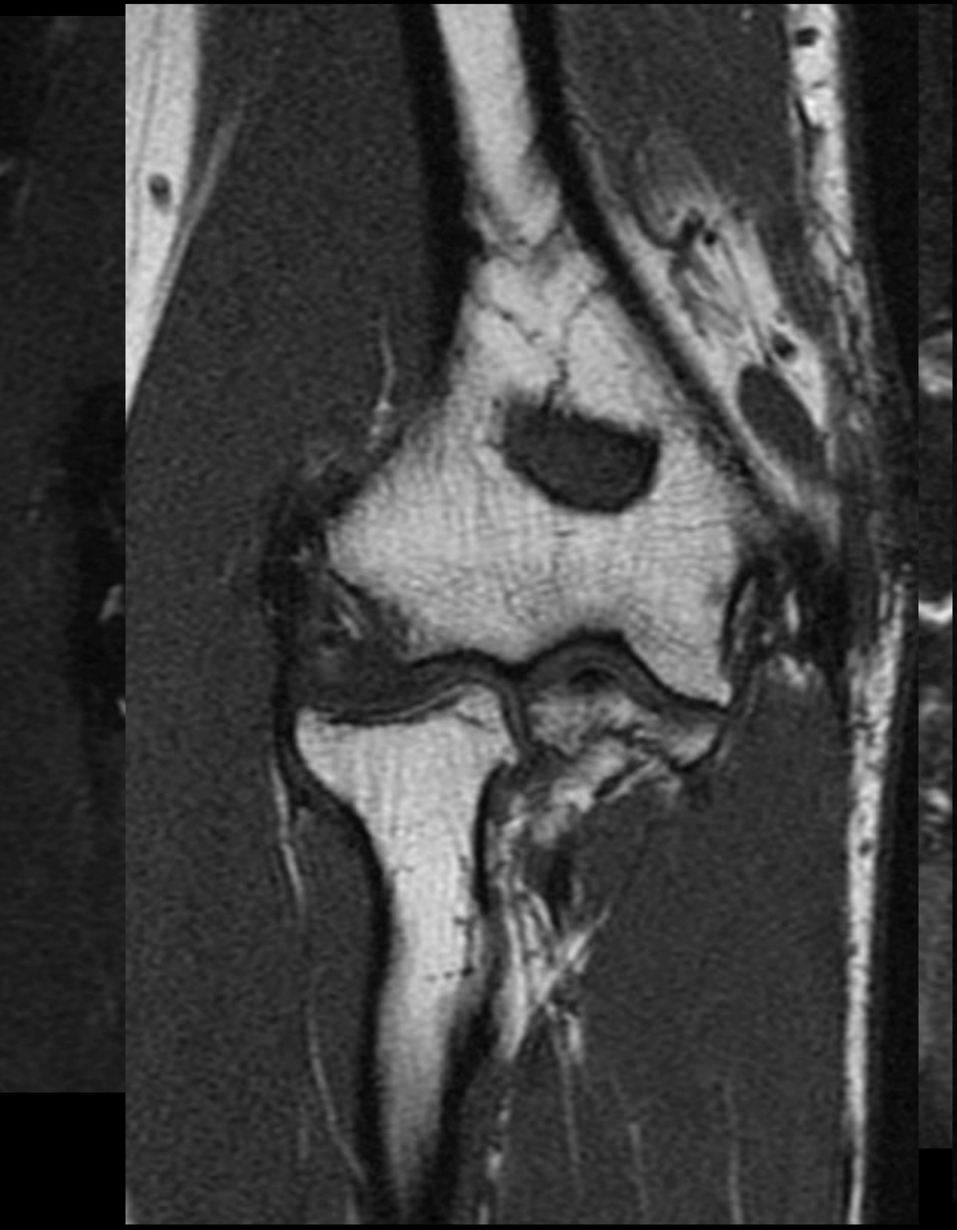
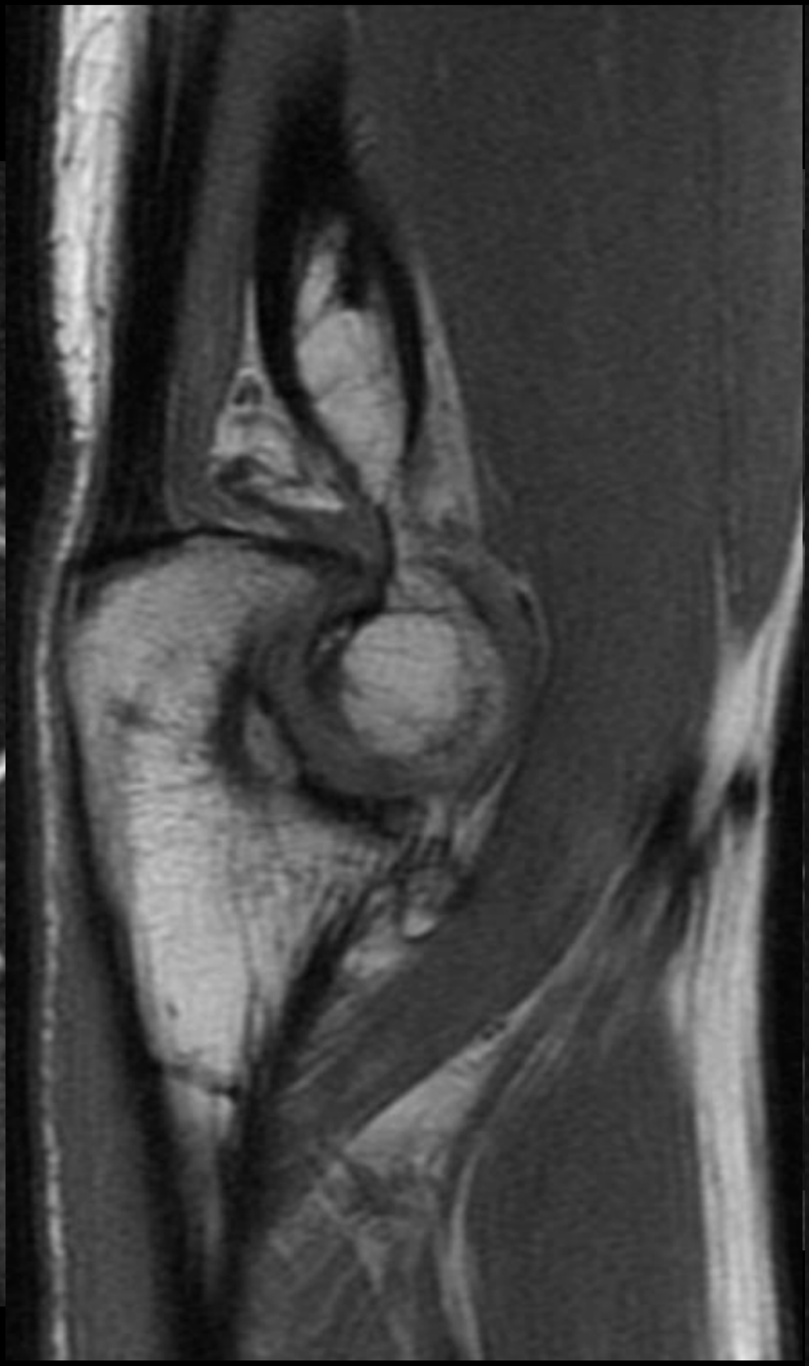
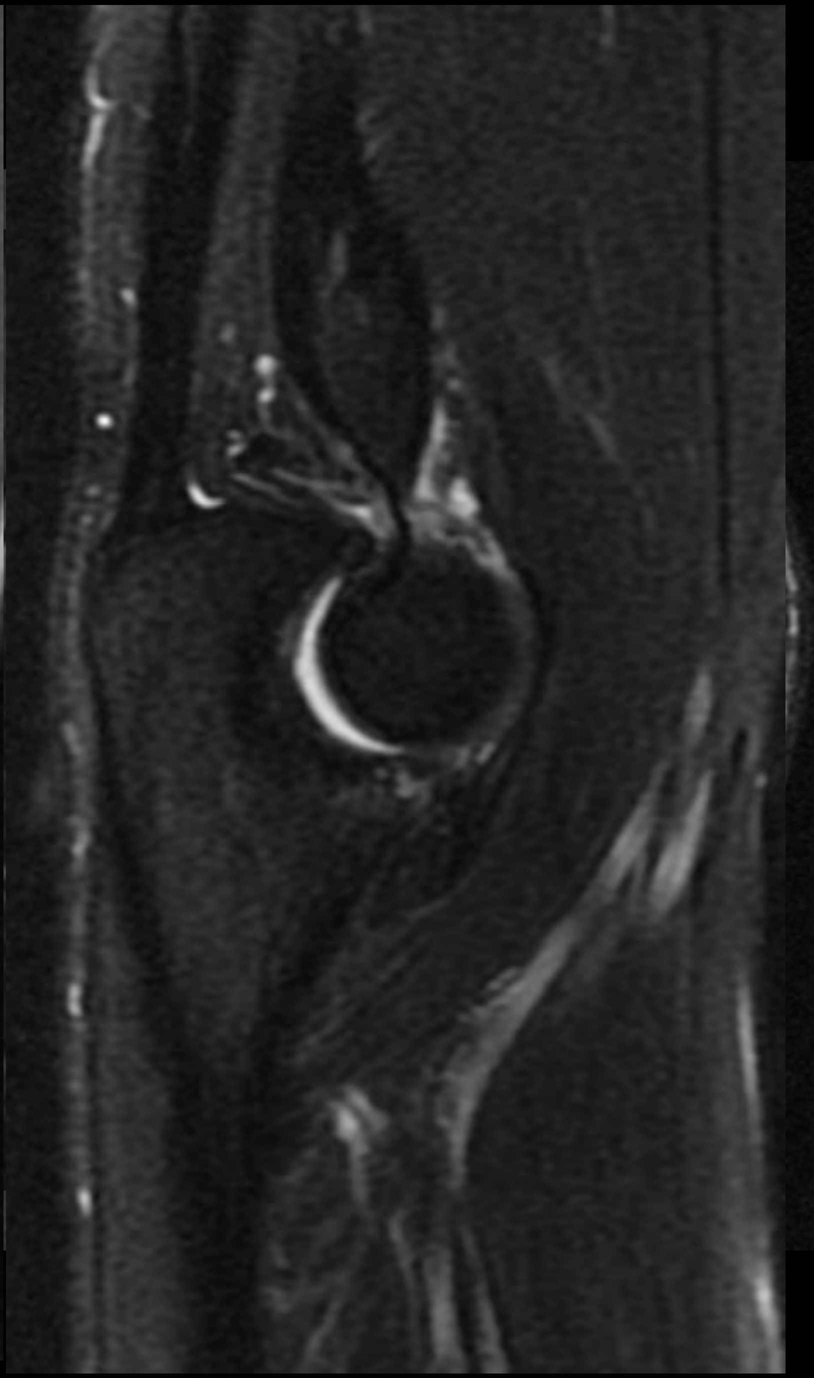
PRMI Case #3

- Young patient post elbow injury
- Elbow joint effusion
- Fracture difficult to appreciate by radiograph

PRMI Case #3

- Minimally displaced fracture of the coronoid process
- Increased signal and irregularity of proximal MCL

PRMI Case #4

Nonoperative treatment

- No clear guidelines
- Indications:
  - No recurrent subluxation/dislocation
  - Small coronoid fragment
  - Compliant patient
  - Absence of concurrent muscle injury
- Cast in 90° flexion with neutral rotation
- Avoid shoulder abduction (varus stress at elbow)
- Limited outcome studies

Surgical Treatment

- Indications
  - Nonconcentric elbow
  - Displaced anteromedial coronoid fracture
  - Trapped fracture fragment or soft tissue
  - “Larger” coronoid fragments
- Approach is controversial

Treatment Based on O'Driscoll Classification

Isolated tip fracture	Fix if fragment > 10% coronoid height Repair MCL if fracture < 10% height
Anteromedial 'facet' fracture	ORIF coronoid process fracture Bone graft reconstruction
Base fracture	Type I: ORIF with contoured plate Type II: Two plate technique

Alternative Treatment Recommendations

Pollock et al	Small subtype I with intact MCL: nonoperative LCL Large subtype I or subtype II/III: fixation and LCL recon
Rhyou et al	Fragment > 6 mm: ORIF Fragment ≤ 5 mm: LCL reconstruction alone
Park et al	Subtype I: LCL repair/reconstruction only Subtype II/III: ORIF + LCL +/- MCL
Chen et al	Non-comminuted fx: Fix fracture, rehab LCL Comminuted fx: LCL repair + external fixator
Rameriz et al	Buttressing/plate fixation preferred Severe comminution: anterior capsule reattachment

O’Driscoll Type II-II fixation

Acute Elbow Trauma. Strategies in Fracture Treatments. Springer; 2019, Chapter 2.

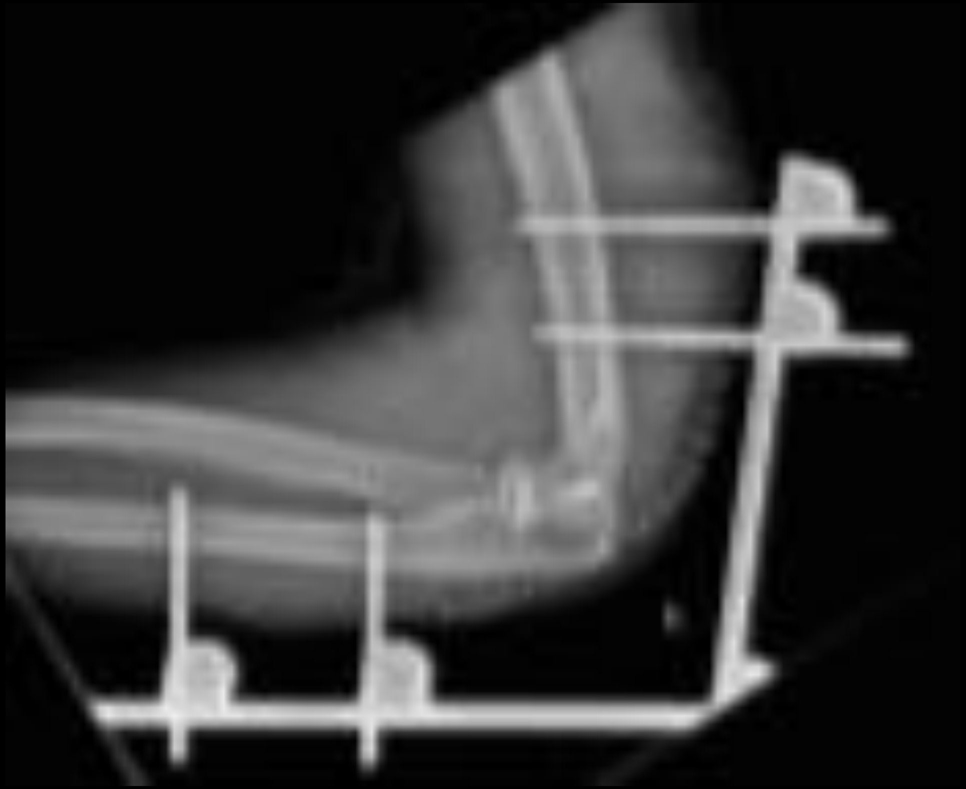
O'Driscoll Type II-III fixation

J Orthop Trauma. 2018 Dec;32(12):e469-e474.

Screw Fixation

Hand Clin 31 (2015) 557–563

Comminuted Coronoid Fracture



Varus Posteromedial Rotatory Instability. In: Tashjian RZ (ed), The Unstable Elbow. Springer, Switzerland.

Outcomes

- Primary concern = rapidly progressive OA
- Limited outcome studies
- Doornberg and Ring 2006 (18 pts)
  - 22% repeat surgery
  - 33% post-traumatic OA
- Park et al 2015 (11 pts)
  - 9% persistent joint incongruity
  - 18% ulnar neuropathy


The End

References

- Beingessner DM, Whitcomb Pollock J, King GJW. Introduction to posteromedial rotatory instability (PMRI) of the elbow 1304-Rockwood. 2014, Chapter 12.
- Berg EE, DeHoll D. The lateral elbow ligaments. A correlative radiographic study. Am J Sports Med. 1999 Nov-Dec;27(6):796-800.
- Bucknor MD, Stevens KJ, Steinbach LS. Elbow Imaging in Sport: Sports Imaging Series. Radiology. 2016 Jul;280(1):328. doi: 10.1148/radiol.2016164015. PubMed PMID: 27322984.
- Callaway GH, Field LD, Deng XH, Torzilli PA, O'Brien SJ, Altchek DW, Warren RF. Biomechanical evaluation of the medial collateral ligament of the elbow. J Bone Joint Surg Am. 1997 Aug;79(8):1223-31.
- Camp CL, O'Driscoll SW, Wempe MK, Smith J. The Sonographic Posterolateral Rotatory Stress Test for Elbow Instability: A Cadaveric Validation Study. PM R. 2017 Mar;9(3):275-282.
- Camp CL, Smith J, O'Driscoll SW. Posterolateral Rotatory Instability of the Elbow: Part I. Mechanism of Injury and the Posterolateral Rotatory Drawer Test. Arthrosc Tech. 2017 Apr 3;6(2):e401-e405.
- Camp CL, Smith J, O'Driscoll SW. Posterolateral Rotatory Instability of the Elbow: Part II. Supplementary Examination and Dynamic Imaging Techniques. Arthrosc Tech. 2017 Apr 3;6(2):e407-e411.
- Chan K, Athwal GS. (2017) Varus Posteromedial Rotatory Instability. In: Tashjian RZ (ed), The Unstable Elbow. Springer, Switzerland.
- Cheung E, Rightmire E, Safran M. *Surgical Treatment of Posterolateral Instability of the Elbow.* Musculoskeletal Key. https://musculoskeletalkey.com/surgical-treatment-of-posterolateral-instability-of-the-elbow/ Updated Jun 2016. Accessed Feb 3, 2019.
- Cohen MS, Hastings H 2nd. Rotatory instability of the elbow. The anatomy and role of the lateral stabilizers. *J Bone Joint Surg Am.* 1997;79:225-33.
- Conway JE. The DANE TJ procedure for elbow medial ulnar collateral ligament insufficiency. Tech Shoulder Elb Surg 2006; 7(1):36-43
- Coonrad RW, Roush TF, Major NM, Basamania CJ. The drop sign, a radiographic warning sign of elbow instability. J Shoulder Elbow Surg 2005; 14:312-17.

References

- Cotten A, Jacobson J, Brossmann Joachim, Pedowitz R, Haghighi P, Trudell D, Resnick D. Collateral Ligaments of the Elbow: Conventional MR Imaging and MR Arthrography with Coronal Oblique Plane and Elbow Flexion. Radiology 204:806-812, 1997.
- Doornberg JN, Ring D. Coronoid fracture patterns. J Hand Surg Am. 2006;31(1):45–52.
- Doornberg JN, Ring DC. Fracture of the anteromedial facet of the coronoid process. J Bone Joint Surg Am. 2006 Oct;88(10):2216-24.
- Dunning CE, Zarzour ZD, Patterson SD, Johnson JA, King GJ: Ligamentous stabilizers against posterolateral rotator instability of the elbow. J Bone Joint Surg (Am) 2001;83:1823-1828.
- Edwards DS, Arshad MS, Luokkala T, Kedgley AE, Watts AC. The contribution of the posterolateral capsule to elbow joint stability: a cadaveric biomechanical investigation. J Shoulder Elbow Surg. 2018 Jul;27(7):1178-1184. doi: 10.1016/j.jse.2018.02.045. Epub 2018 Apr 22.
- Erickson BJ, Thorsness RJ, Hamamoto BS, et al.The Biomechanics of Throwing. Oper Tech Sports Med. 2016 Sept; 24(3): 156-161
- Eygendaal D, Verdegaal SH, Obermann WR, van Vugt AB, Poll RG, Rozing PM. Posterolateral dislocation of the elbow joint: relationship to medial instability. J Bone Joint Surg Am. 2000;82(4):555e560.
- Feldman DR, Schabel SI, Friedman RJ, Young JW. Translational injuries in posterior elbow dislocation. Skeletal Radiol. 1997;26(2): 134e136.
- Gluck MJ, Beck CM, Golan EJ, Nasser P, Shukla DR, Hausman MR. Varus posteromedial rotatory instability: a biomechanical analysis of posterior bundle of the medial ulnar collateral ligament reconstruction. J Shoulder Elbow Surg. 2018 Jul;27(7):1317-1325.
- Golan EJ, Shukla DR, Nasser P, Hausman M. Isolated ligamentous injury can cause posteromedial elbow instability: a cadaveric study. J Shoulder Elbow Surg. 2016 Dec;25(12):2019-2024.
- Hackl M., Müller L.P. (2019) Terrible Triad Injuries. In: Biberthaler P., Siebenlist S., Waddell J. (eds) Acute Elbow Trauma. Strategies in Fracture Treatments. Springer, Cham.
- Hannouche D, Begue T. Functional anatomy of the lateral collateral ligament complex of the elbow. Surgical and Radiologic Anatomy 21:3 187-191, 1999.
- Hwang JT, Shields MN, Berglund LJ, Hooke AW, Fitzsimmons JS, O'Driscoll SW. The role of the posterior bundle of the medial collateral ligament in posteromedial rotatory instability of the elbow. Bone Joint J. 2018

References

- Imatani J, Ogura T, Morito Y, Hashizume H, Inoue H. Anatomic and histo- logic studies of the lateral collateral ligament complex of the elbow joint. *J Shoulder Elbow Surg.* 1999;8:625-7.
- Jeon I, Micic ID, Yamamoto N, Morrey BF. Osborne-Cotterill Lesion: An Osseous Defect of the Capitellum Associated with Instability of the Elbow. AJR 191:727-729, 2008.
- Jeon IH, Min WK, Micic ID, Cho HS, Kim PT. Surgical treatment and clinical implication for posterolateral rotatory instability of the elbow: Osborne-Cotterill lesion of the elbow. J Trauma. 2011 Sep;71(3):E45-9.
- Lenich A, Siebenlist S, Imhoff AB. Traumatic Rotatory Instability of Elbow: Posterolateral Rotatory Instability (PLRI) and Posteromedial Rotatory Instability (PMRI*).* Acute Elbow Trauma. Strategies in Fracture Treatments. Springer; 2019, Chapter 2.
- Malagelada, Francesc & Dalmau-Pastor, Miki & Vega, Jordi & Golano, Pau. (2014). Elbow Anatomy. 10.1007/978-3-642-36801-1_38-1.
- Matzon JL, Widmer BJ, Draganich LF, Mass DP, Phillips CS. Anatomy of the coronoid process. J Hand Surg Am. 2006 Oct;31(8):1272-8.
- McKee MD, Schemitsch EH, Sala MJ, O’Driscoll SW. The patho- anatomy of lateral ligamentous disruption in complex elbow insta- bility. J Shoulder Elbow Surg. 2003;12(4):391e396.
- McLean J, Kempston MP, Pike JM, Goetz TJ, Daneshvar P. Varus Posteromedial Rotatory Instability of the Elbow: Injury Pattern and Surgical Experience of 27 Acute Consecutive Surgical Patients. J Orthop Trauma. 2018 Dec;32(12):e469-e474.
- Morrey BF, An KN. Articular and ligamentous contributions to the stability of the elbow joint. Am J Sports Med 1983;11:315-9.
- Morrey BF. Reconstruction of the posterior bundle of the medial collateral ligament: a solution for posteromedial olecranon deficiency—a case report. J Shoulder Elbow Surg 2012;21:e16-9.
- Nestor BJ, O'Driscoll SW, Morrey BF. Ligamentous reconstruction for posterolateral rotatory instability of the elbow. J Bone Joint Surg Am. 1992 Sep;74(8):1235-41.
- O’Driscoll SW, Bell DF, Morrey BF. Posterolateral rotatory instability of the elbow. J Bone Joint Surg (Am) 73:440-446, 1991.
- O’Driscoll SW, Morrey BF, Korinek S, et al. Elbow subluxation and dislocation. A spectrum of instability. Clin Orthop. 1992;280:186–97.

References

- O'Driscoll SW, Jupiter JB, Cohen MS, Ring D, McKee MD. Difficult elbow fractures: pearls and pitfalls. Instr Course Lect. 2003;52:113-34. Review.
- Olsen BS, Vaesel MT, Helmig P, Sojbjerg JO, Sneppen O. Lateral collateral ligament of the elbow joint: anatomy and kinematics. *J Shoulder Elbow Surg.* 1996;5:103-12.
- Park SM, Lee JS, Jung JY, Kim JY, Song KS. How should anteromedial coronoid facet fracture be managed? A surgical strategy based on O'Driscoll classification and ligament injury. J Shoulder Elbow Surg. 2015 Jan;24(1):74-82.
- Pollock JW, Brownhill J, Ferreira L, McDonald CP, Johnson J, King G. The effect of anteromedial facet fractures of the coronoid and lateral collateral ligament injury on elbow stability and kinematics. J Bone Joint Surg Am. 2009 Jun;91(6):1448-58.

- Pollock JW, Brownhill J, Ferreira L, McDonald CP, Johnson J, King G. The effect of anteromedial facet fractures of the coronoid and lateral collateral ligament injury on elbow stability and kinematics. J Bone Joint Surg Am. 2009 Jun;91(6):1448-58.

- Pollock JW, Brownhill J, Ferreira LM, McDonald CP, Johnson JA ,King GJ. Effect of the posterior bundle of the medial collateral ligament on elbow stability. J Hand Surg Am 2009;34:116-23.
- Potter HG, Weiland AJ, Schatz JA, Paletta GA, Hotchkiss RN. Posterolateral rotatory instability of the elbow: usefulness of MR imaging in diagnosis. Radiology. 1997;204(1):185e189.
- Ramirez MA, Stein JA, Murthi AM. Varus Posteromedial Instability. Hand Clin. 2015 Nov;31(4):557-63. doi: 10.1016/j.hcl.2015.06.005. Epub 2015 Aug 7. Review.
- Ramirez MA, Stein JA, Murthi AM. Varus Posteromedial Instability. Hand Clin. 2015 Nov;31(4):557-63.
- Richard MJ, Aldridge JM III, Wiesler ER, Ruch DS. Traumatic valgus instability of the elbow: pathoanatomy and results of direct repair. J Bone Joint Surg Am. 2008;90(11):2416e2422.
- Sard A, Dutto E, Rotini R, Vanni S, Pastorelli S, Battiston B. The posterior bundle of the elbow medial collateral ligament: biomechanical study and proposal for a new reconstruction surgical technique. Musculoskelet Surg. 2017 Dec;101(Suppl 2):181-186.
- Schneeberger AG, Sadowski MM, Jacob HA. Coronoid process and radial head as posterolateral rotatory stabilizers of the elbow. J Bone Joint Surg Am. 2004 May;86-A(5):975-82.