Elbow Instability and related pathology

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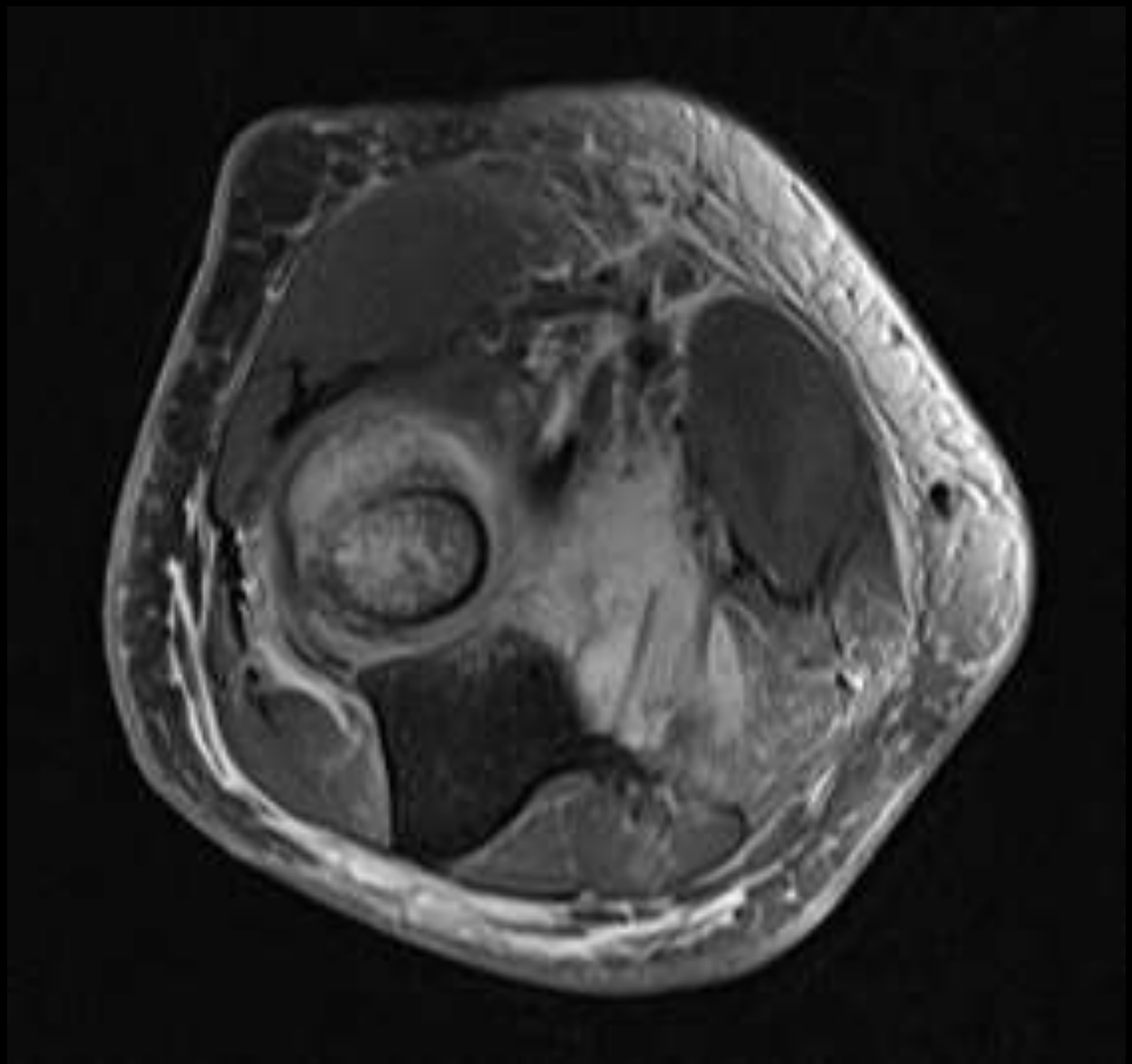
April 2010

Inspiration

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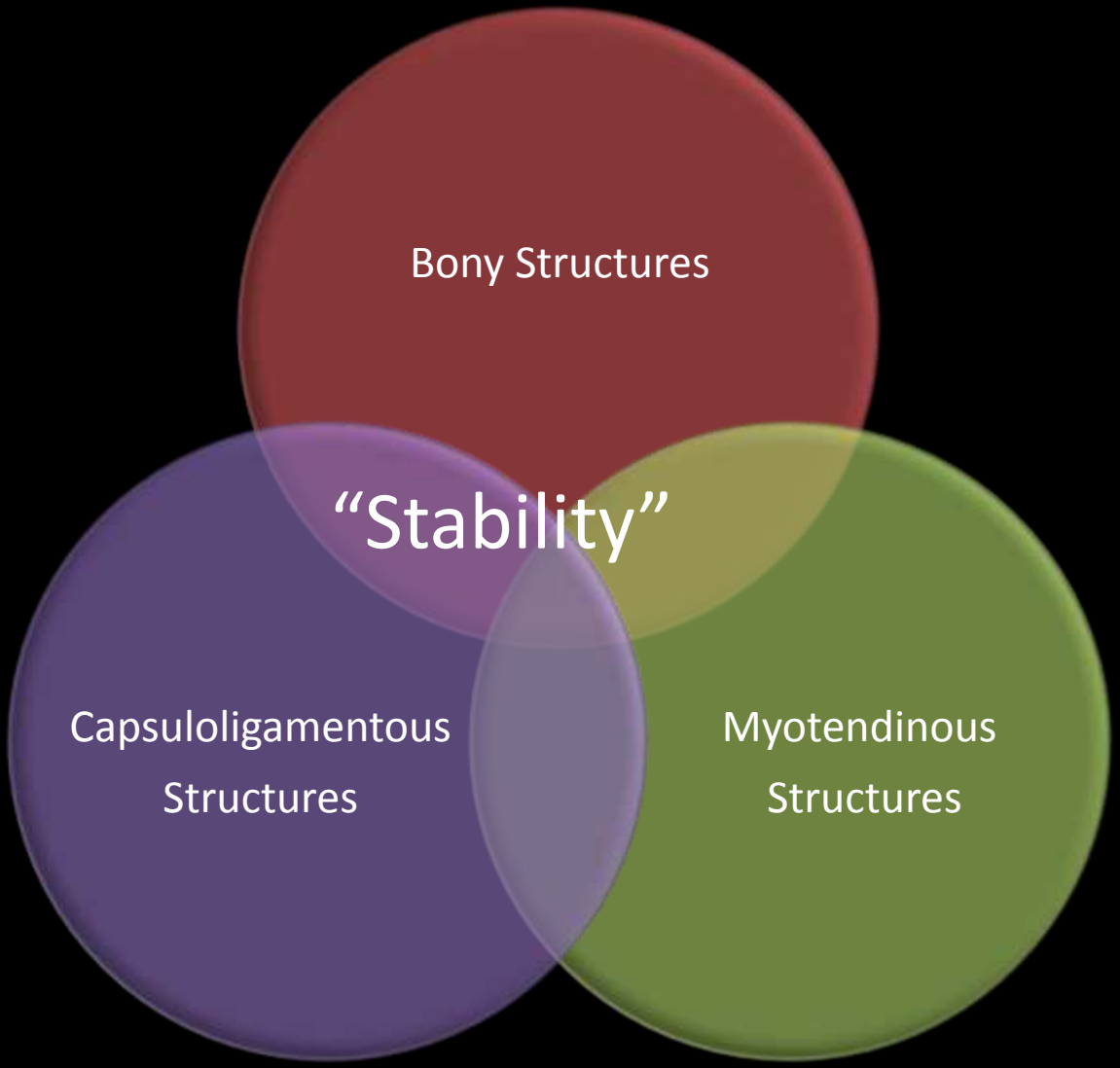
Introduction to Instability

- Elbow instability increasingly recognized and stressed in literature
  - Pubmed search “elbow instability” years 2000-2010 = 663 entries
- Elbow “instability” should not be considered a single entity
  - Distinct clinical entities
  - Acute and chronic pathology
  - Presentation, findings, and treatment are unique

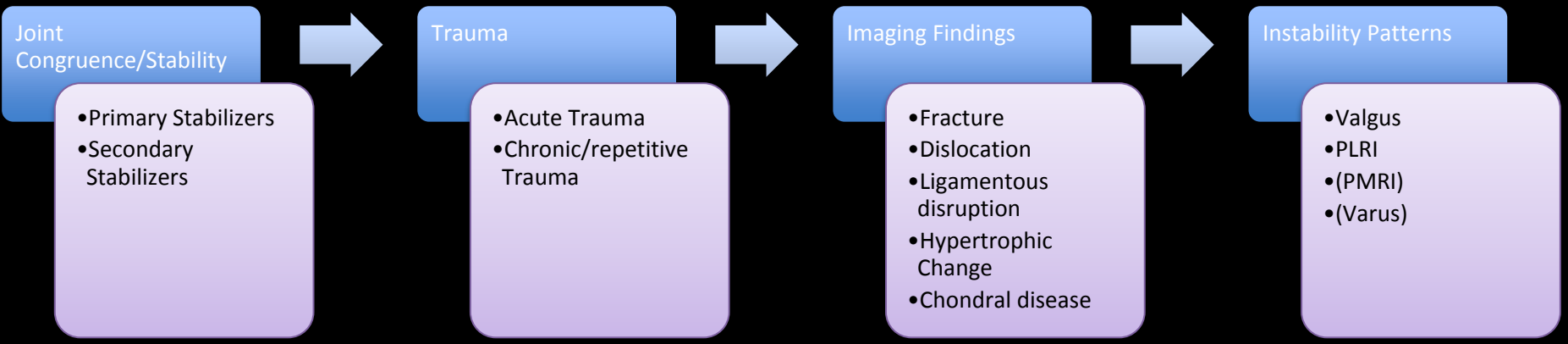
Fundamental Instability Concepts

1) Elbow instability relates to the interactions of underlying bony, capsuloligamentous, and myotendinous structures
2) Failure at specific joint stabilizers leads to common patterns of injury when stresses are applied
3) Instability is a clinical diagnosis, which may be supported or suggested by physical examination and imaging findings

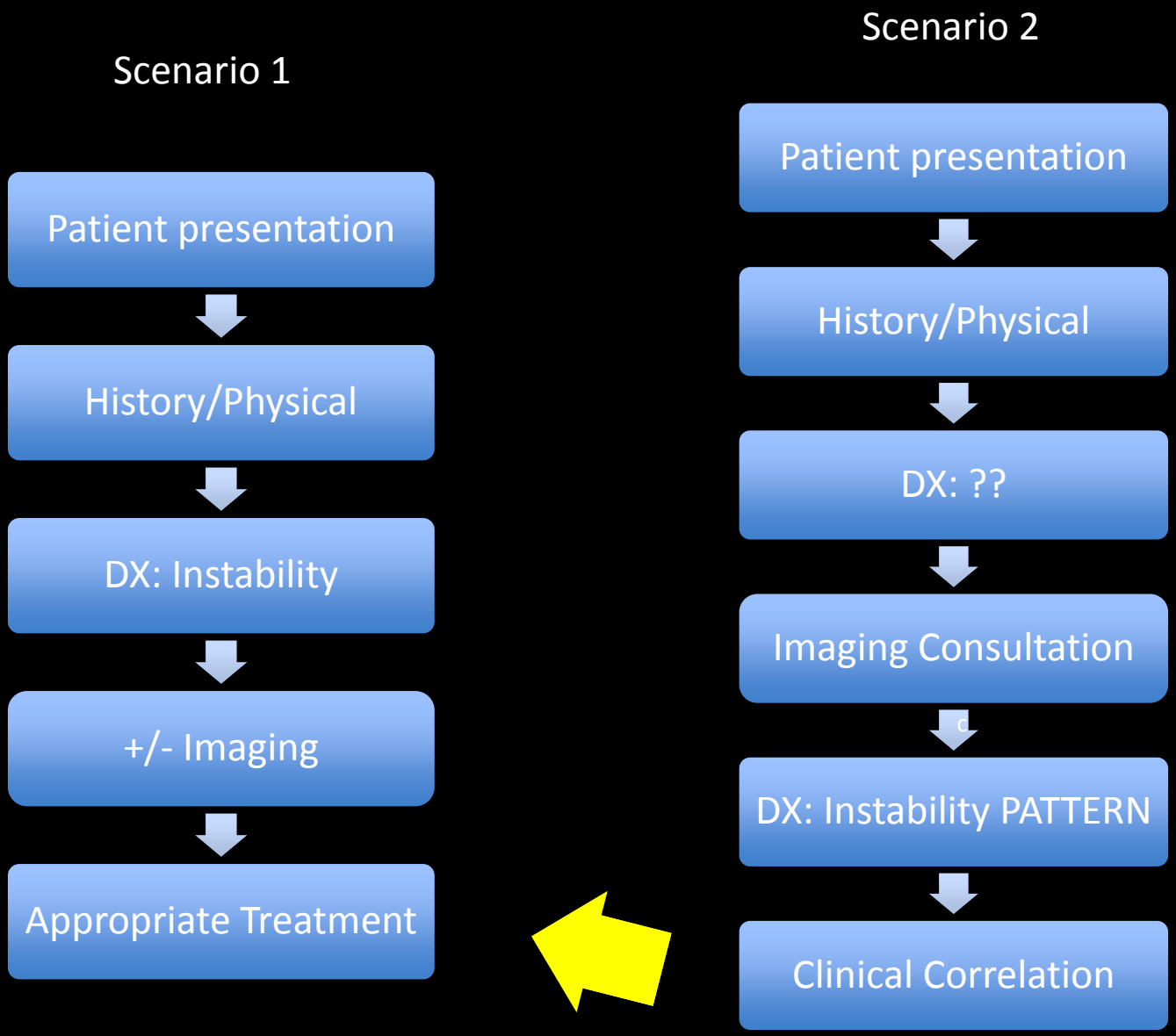
Concept 1


Bony Structures
"Stability"
Capsuloligamentous Structures
Myotendinous Structures

Concept 2


Joint Congruence/Stability
•Primary Stabilizers
•Secondary Stabilizers
Trauma
•Acute Trauma
•Chronic/repetitive Trauma
Imaging Findings
•Fracture
•Dislocation
•Ligamentous disruption
•Hypertrophic Change
•Chondral disease
Instability Patterns
•Valgus
•PLRI
•(PMRI)
•(Varus)

Concept 3

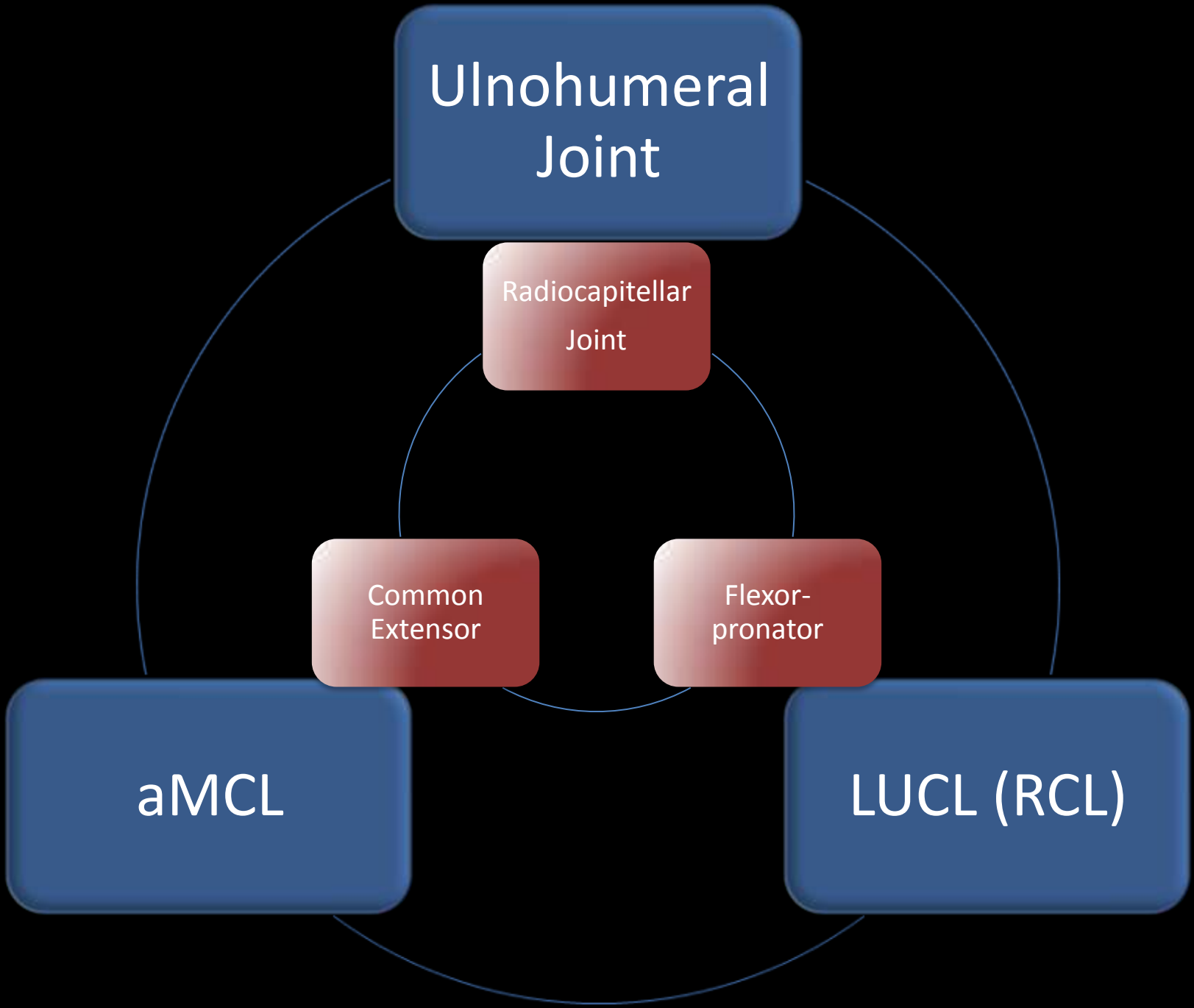

Scenario 1
Patient presentation
History/Physical
DX: Instability
+/- Imaging
Appropriate Treatment
Scenario 2
Patient presentation
History/Physical
DX: ??
Imaging Consultation
DX: Instability PATTERN
Clinical Correlation

Objectives

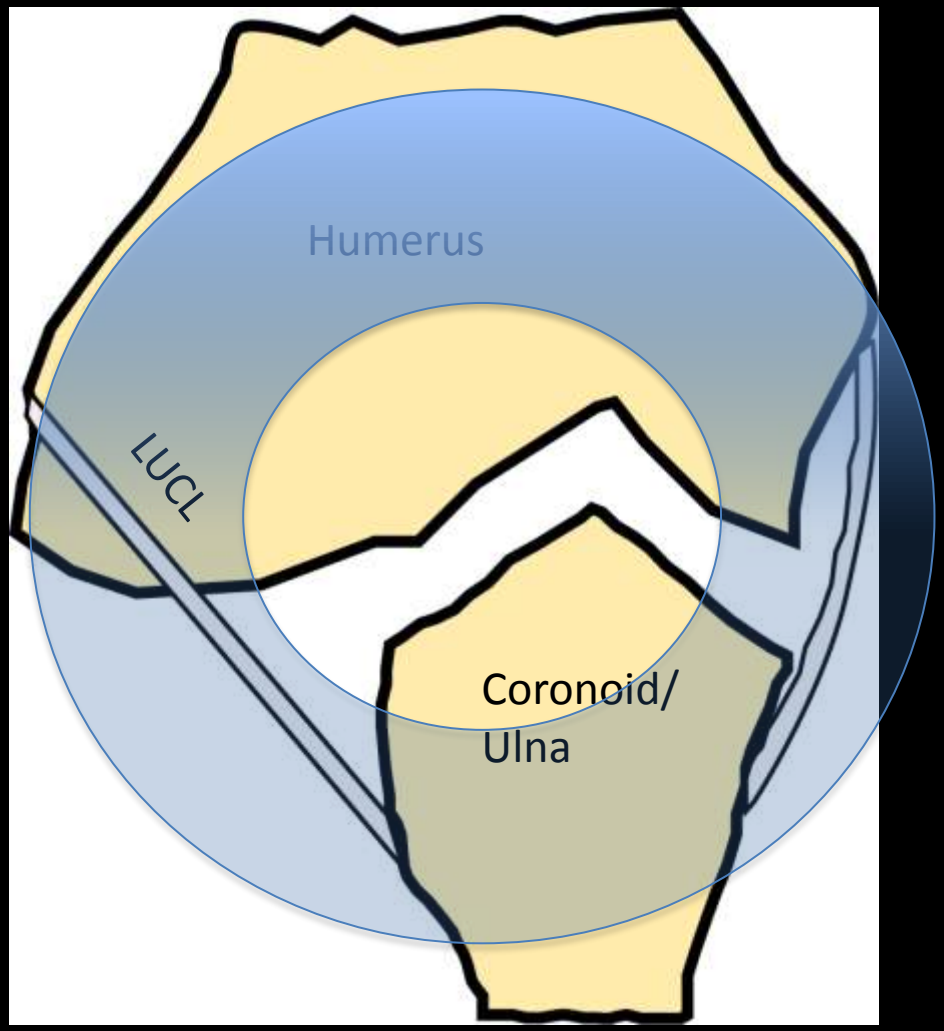
- Review the relevant anatomy of the elbow joint, with emphasis on imaging anatomy
  - Primary stabilizers of elbow
  - Secondary stabilizers of elbow
- Review the common injury patterns at the elbow
- Apply knowledge of functional anatomy and injury patterns to identify instability lesions
  - Valgus
  - PLRI
  - PMRI
- Highlight the importance of imaging in the diagnostic evaluation of patients with elbow trauma/pain

Anatomy - Stabilizers of the Elbow

- Primary Stabilizers
  - Ulnohumeral joint (coronoid process)
  - Medial collateral ligament (anterior band)
  - Lateral ulnar collateral ligament
- Secondary Stabilizers
  - Radiocapitellar joint (radial head)
  - Flexor-Pronator mass
  - Extensor mass
- Dynamic Constraints
  - Muscles which cross the ulnohumeral joint and tighten capsule
    - Anconeus
    - Triceps
    - Brachialis
- *Damage to primary stabilizer will increase load on secondary stabilizers*

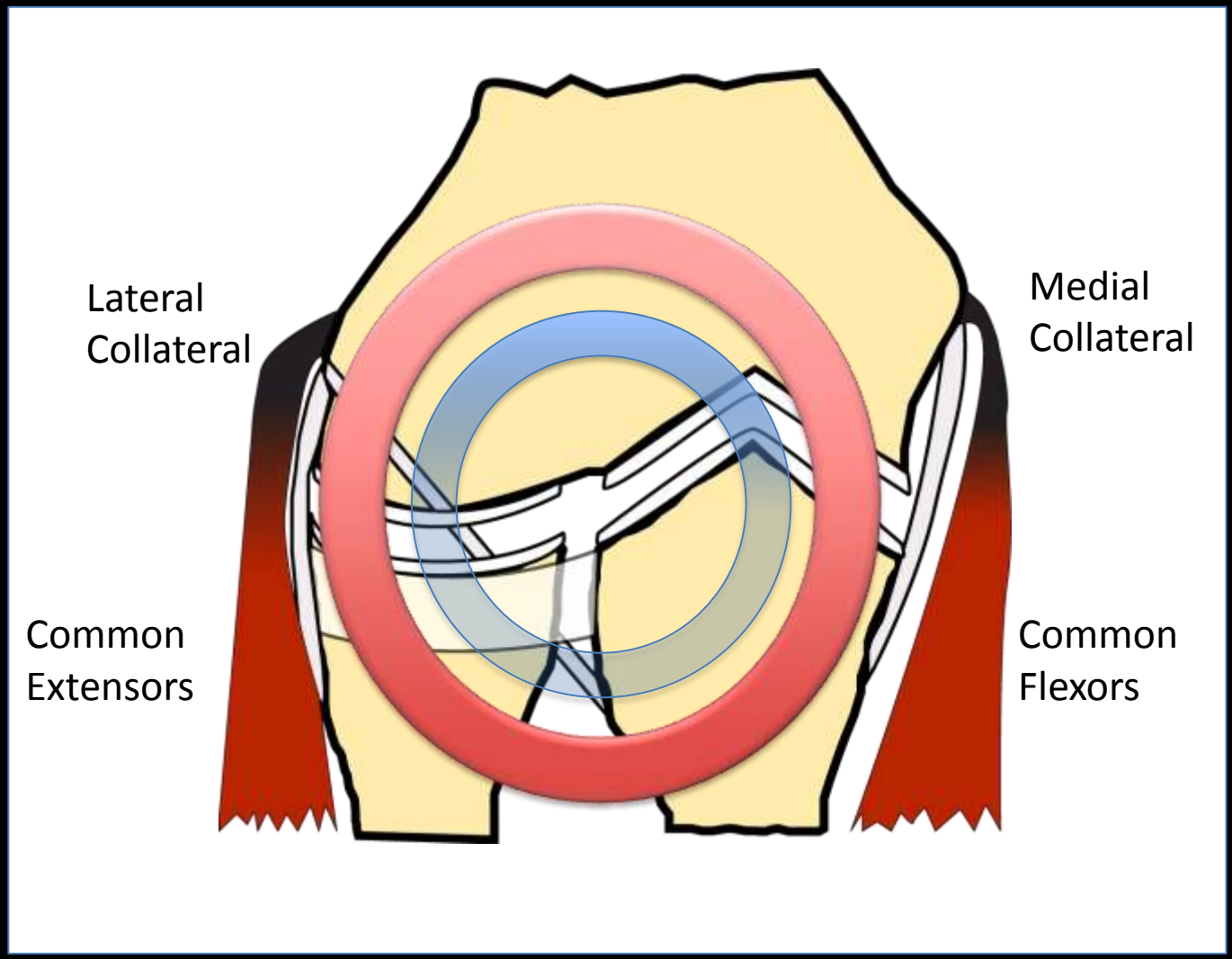

Ulnohumeral Joint
Radiocapitellar Joint
Common Extensor
Flexor-pronator
aMCL
LUCL (RCL)

Primary Stabilizers



Medial
Collateral

Primary and Secondary Stabilizers

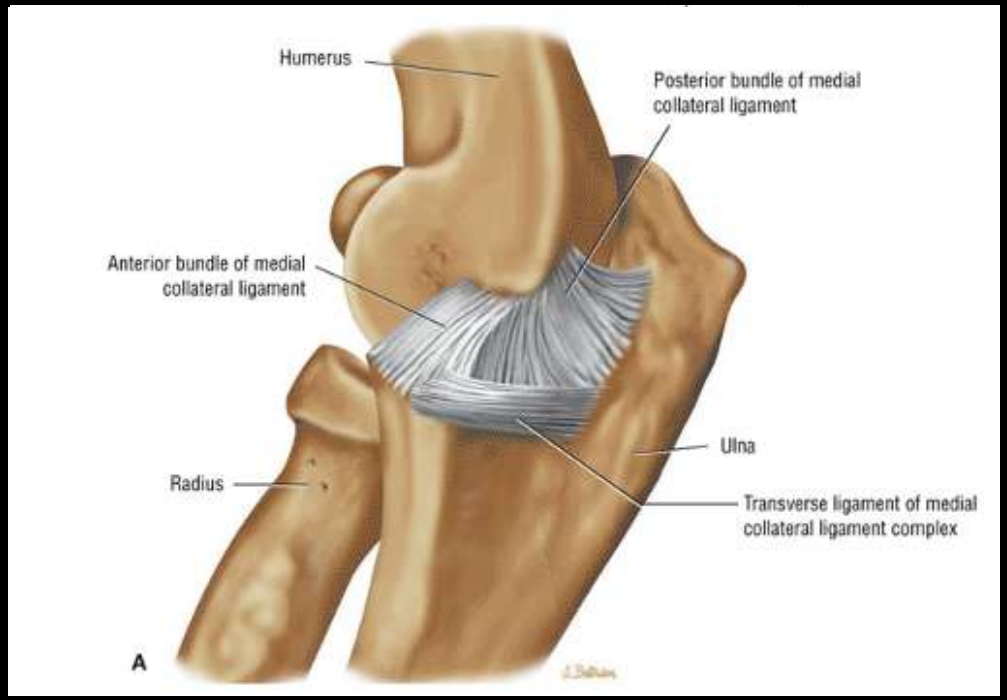


Valgus Injury

- Primary restraint is the medial collateral ligament, anterior bundle
- Radial head is secondary constraint
- Flexor-pronator mass acts as dynamic stabilizer

Valgus – Primary Stabilizer

- Medial Collateral Ligamentous Complex
  - Anterior band
  - Posterior band
  - Transverse band



Valgus – Primary Stabilizer

- Medial Collateral Ligamentous Complex
  - Anterior band
    - Primary valgus restraint
    - Proximal attachment to inferior medial epicondyle
    - Distal attachment to sublime tubercle of coronoid
  - Posterior band
  - Transverse band

Valgus – Primary Stabilizer

- Medial Collateral Ligamentous Complex
  - Anterior band
    - Fan like proximal attachment, often showing increased signal
    - Variable distal insertion, up to 3-4 mm distal to margin of articular cartilage
  - Posterior band
  - Transverse band

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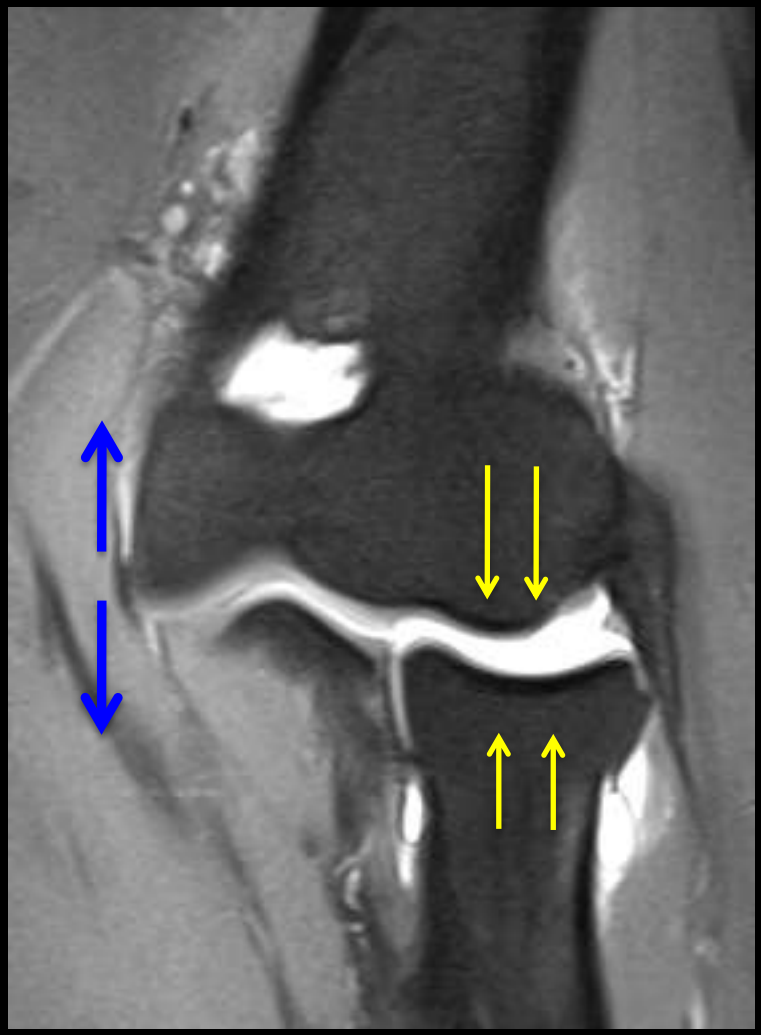
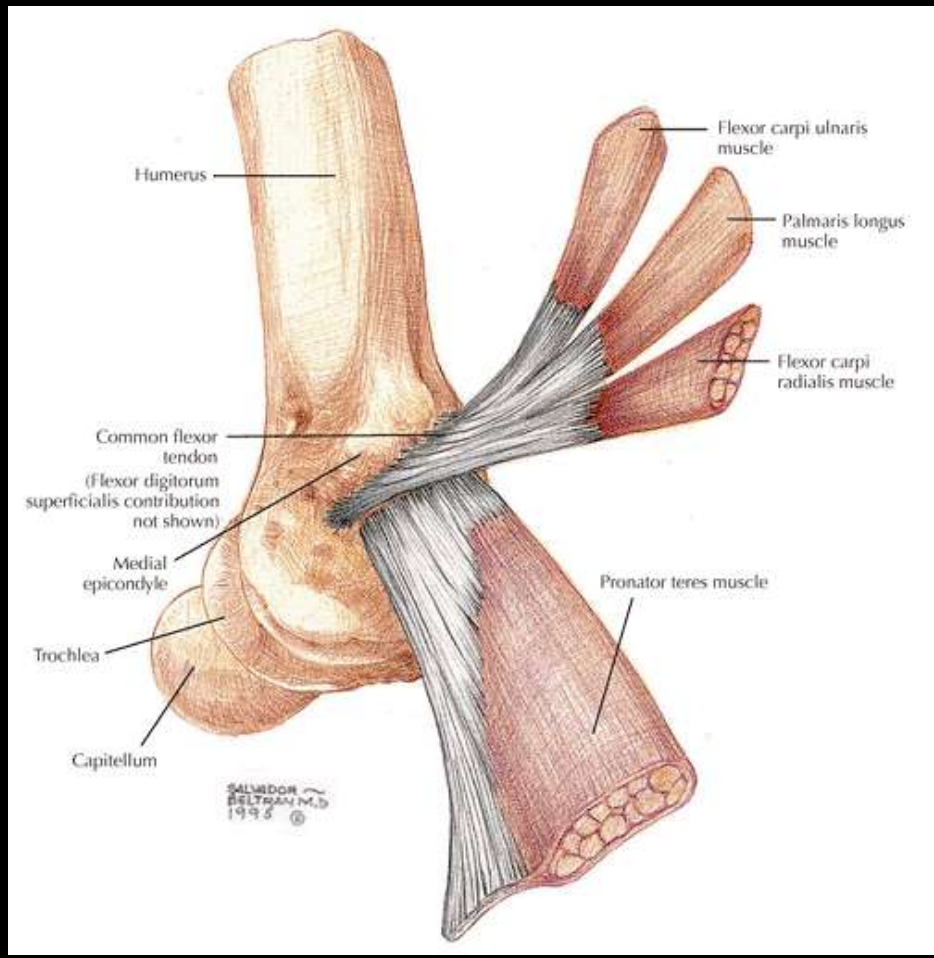
Valgus – Secondary Stabilizers

- Radiocapitellar joint
  - Valgus stabilizer



Valgus – Secondary Stabilizers

- Common Flexors
  - Flexor carpi ulnaris
  - Palmaris Longus
  - Flexor carpi radialis
  - *Pronator Teres*

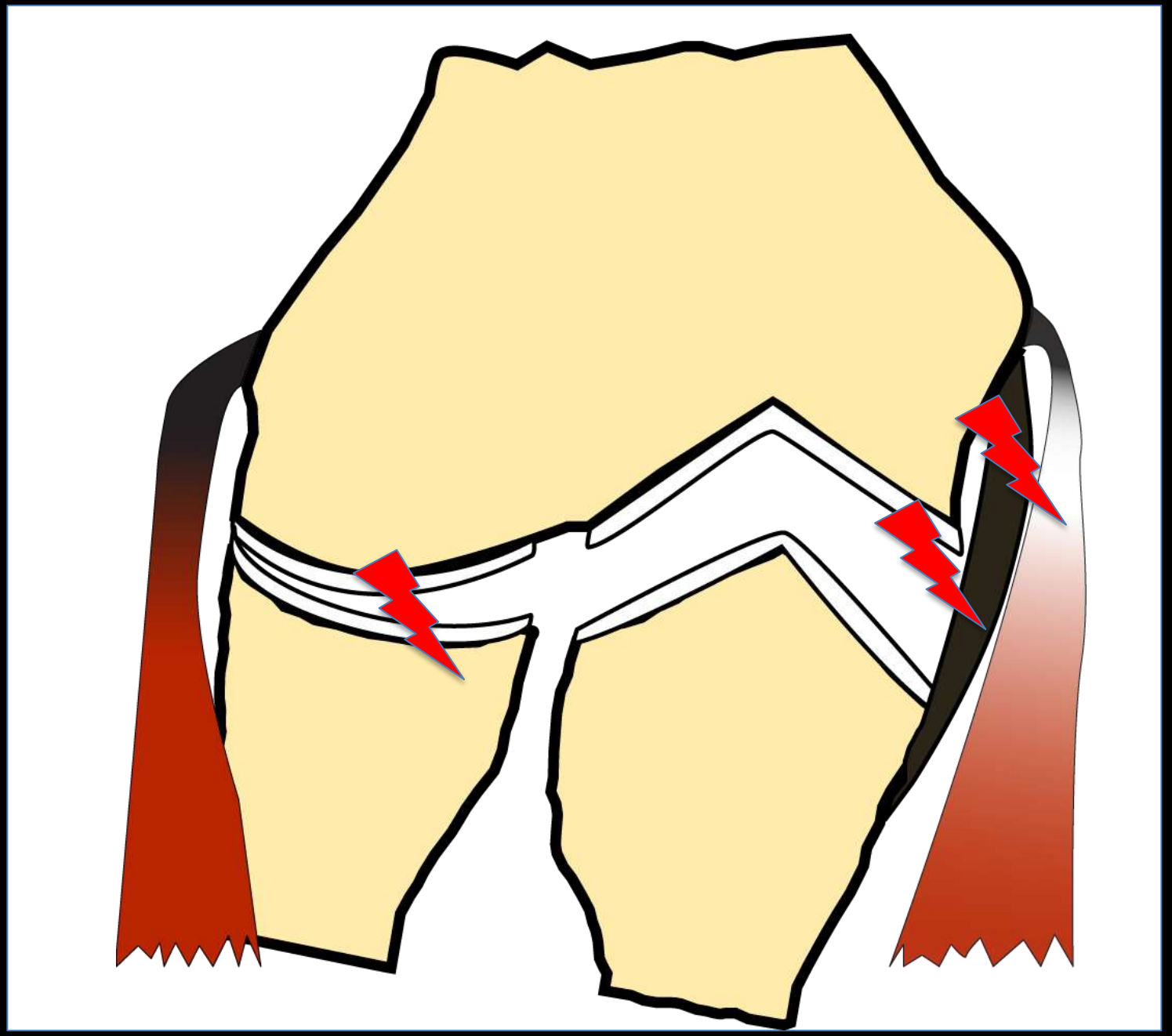


Valgus – Secondary Stabilizers

- Common Flexors
  - Origin at medial epicondyle
  - Proximal and medial to the medial collateral ligament
  - FDS fibers arise from anterior bundle medial collateral ligament

Valgus Injury

- Acute injury: hypervalgus stress
  - Trauma
    - Fall
    - Direct blow
  - Acute on chonic trauma
    - Medial epicondylitis steroid injection
    - Chronic degeneration
- Chronic injury:
  - Repetitive motion/microtrauma
  - Originally reported with javelin throwers
  - Now commonly seen in throwing athletes
    - Late cocking/early acceleration

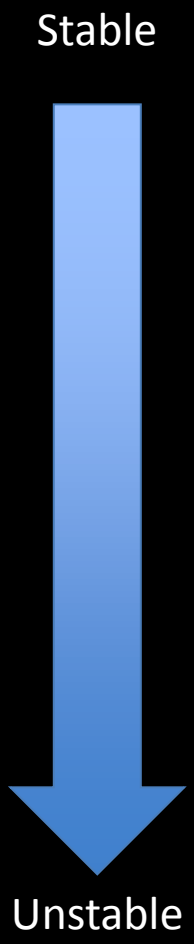


Valgus Injury - Instability

- Valgus injury does not lead to gross subluxation/dislocation
- Instability “symptoms” are not those of impending dislocation
- Rather, instability is manifest as pathology related to abnormal motion
  - Pain
  - OA
  - Ulnar neuritis

Valgus injury - Acute

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



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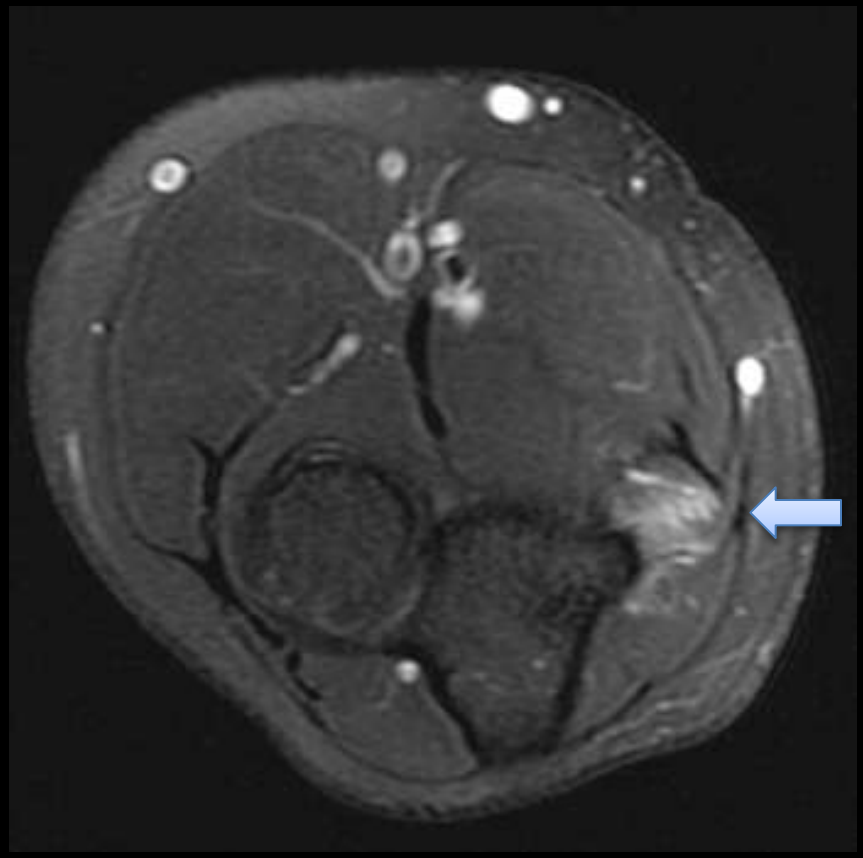

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High grade tear, common flexor tendon

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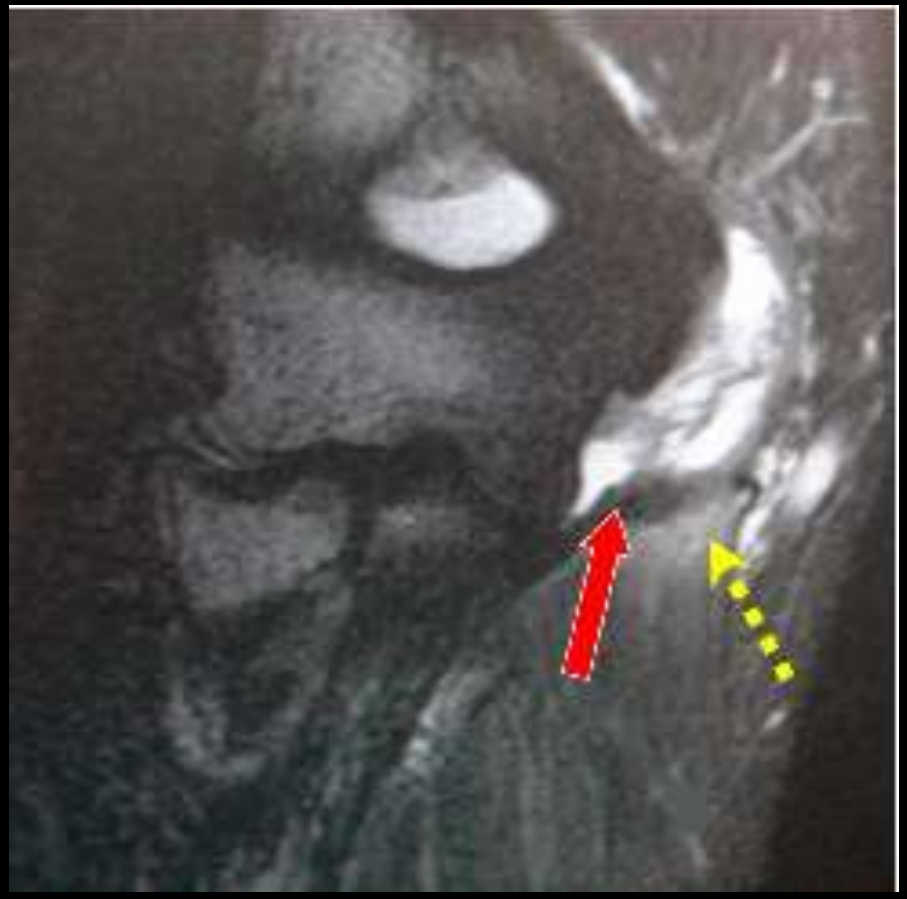
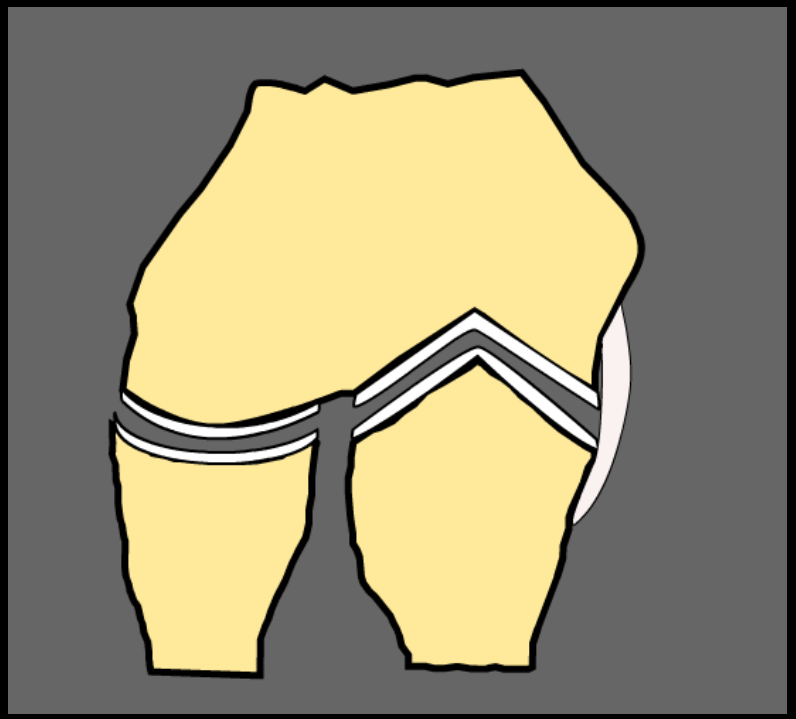


High grade tear MCL and flexor mass

Valgus injury - Chronic

- Repetitive valgus stress leads to spectrum of overuse injuries
- Injury pattern related with patient age



Valgus injury - Chronic

- In pediatric patient, chonrdo-osseous pathology predominates
  - Panner's Disease
  - "Little leaguer's elbow"
    - OCD
    - Medial epicondylitis (apophysitis)

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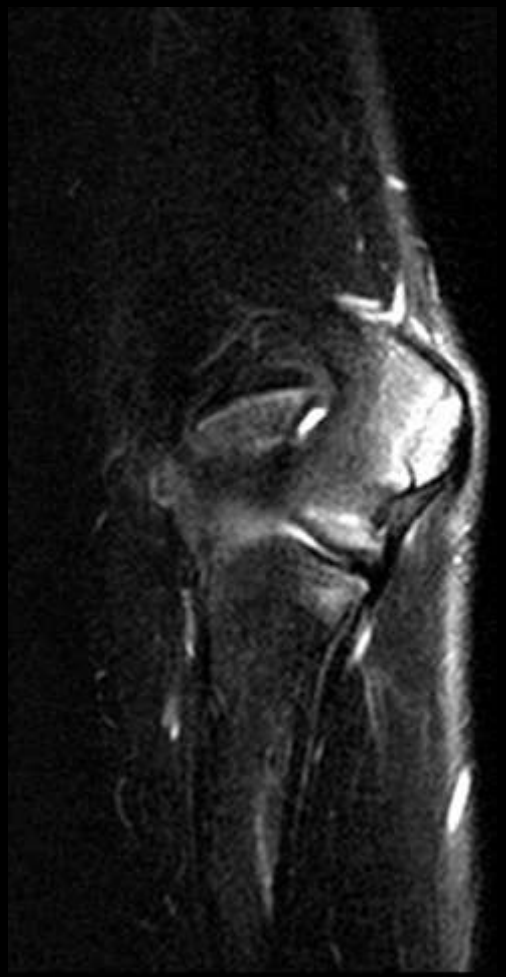
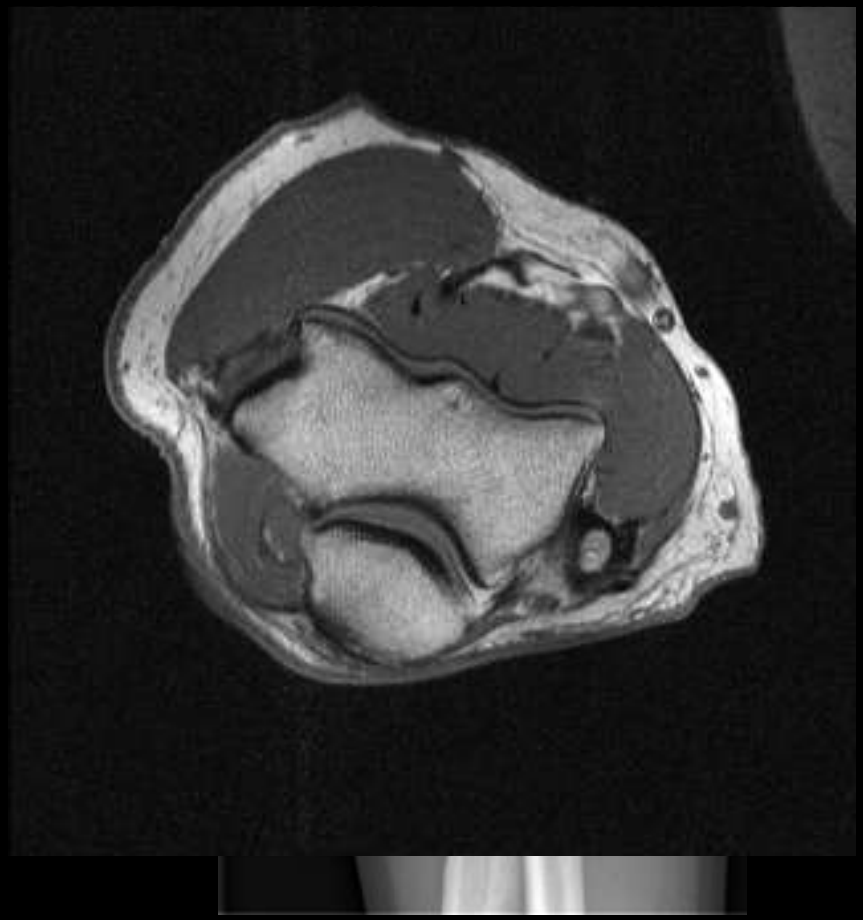


Valgus injury - Chronic

- In adult, ligamentous and hypertrophic bony changes predominate
  - Ligament degeneration
  - Chronic ligament tear
  - Valgus extension overload
  - Ulnar neuritis
- “Medial epicondylitis”

Valgus injury - Chronic

- Ligament Degeneration
- Chronic Tear
- Valgus extension overload
- Ulnar neuritis



Courtesy Dr. M Borso

Valgus injury - Chronic

- Ligament Degeneration
- Chronic MCL tear
- Valgus extension overload
- Ulnar neuritis

T-sign, partial thickness tear

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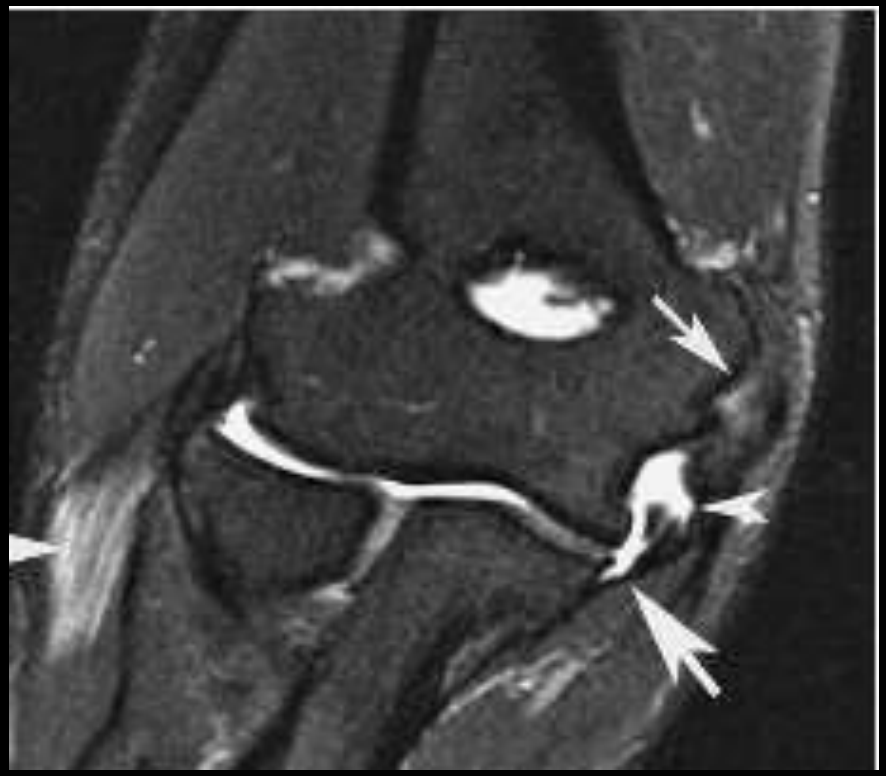

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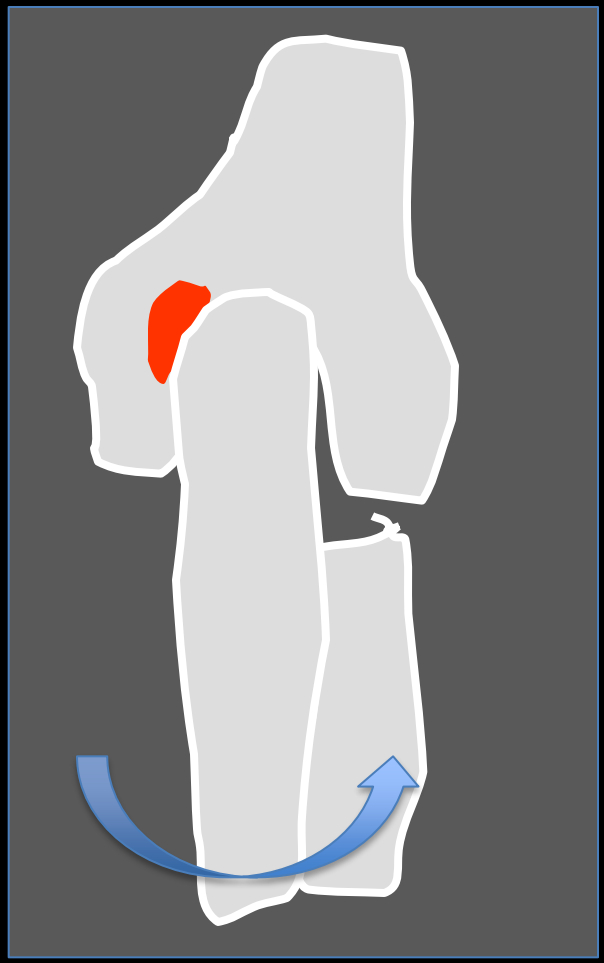

Courtesy Dr. Resnick

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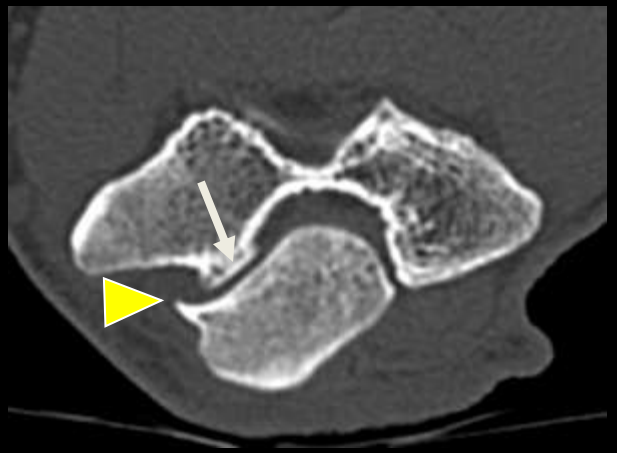
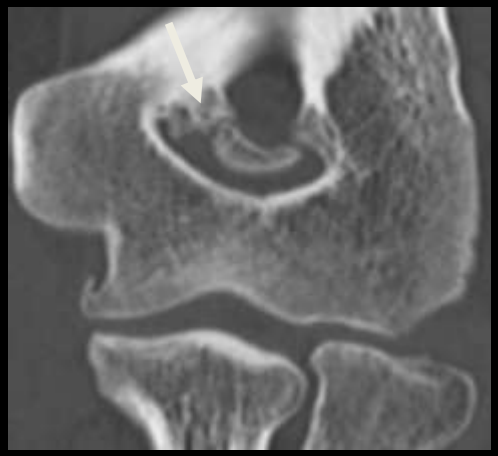
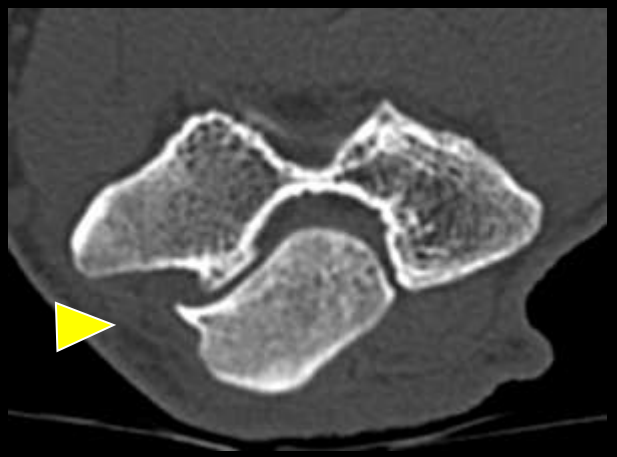




Courtesy Dr. Resnick

Valgus injury - Chronic

- Ligament Degeneration
- Chronic MCL tear
- Valgus extension overload
- Ulnar neuritis
  - Thickened cubital retinaculum
  - Narrowed cubital tunnel related with medial excursion of capsule



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Ouellette 2007

Valgus Injury - Treatment

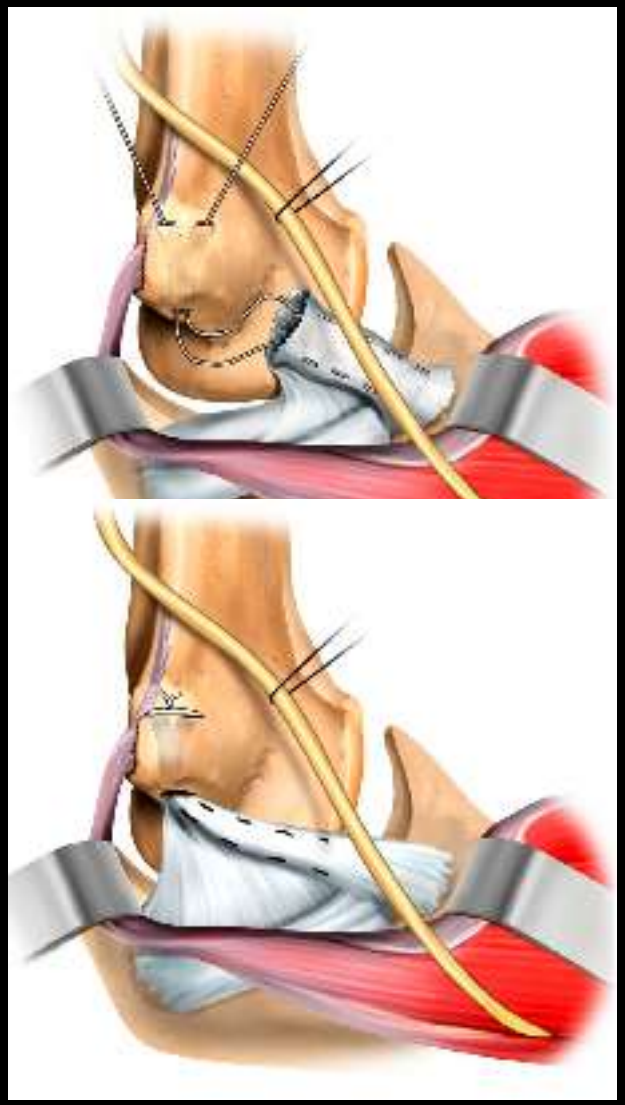
- Conservative management
- Primary repair
- Ligamentous Reconstruction

Valgus Injury - Treatment

- Conservative management
  - May be considered if no desire to return to competitive activity
  - Can lead to chronic valgus instability
    - Repetitive microtrauma/ligamentous insufficiency
    - Acute rupture on chronic tendinosis
  - Ulnar neuritis related with instability
- Primary repair
- Ligamentous Reconstruction

Valgus Injury - Treatment

- Conservative management
- Primary repair
  - Reserved for acute injuries
  - Native ligament/tendon reattachment
  - No ulnar nerve symptoms
- Ligamentous Reconstruction



Valgus Injury - Treatment

- Conservative management
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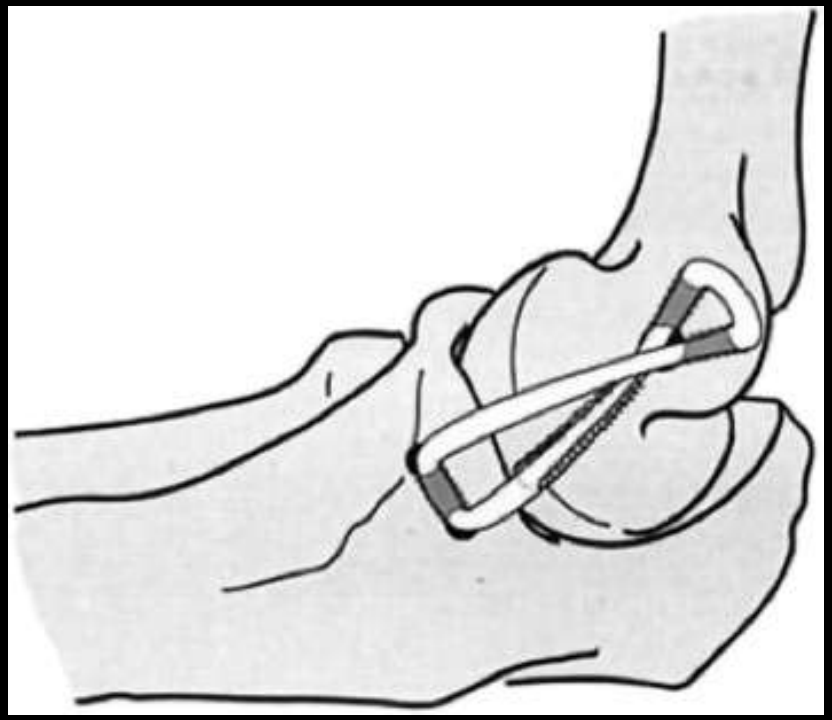
- Ligamentous Reconstruction
  - Chronic Valgus Injury
  - Incompetent tissue
  - Autograft (palmaris tendon)



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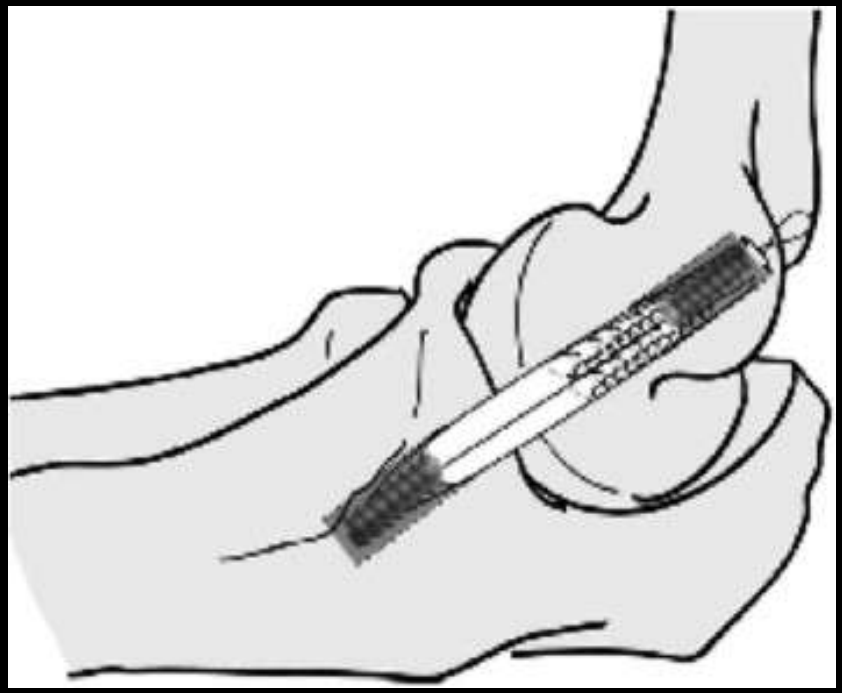
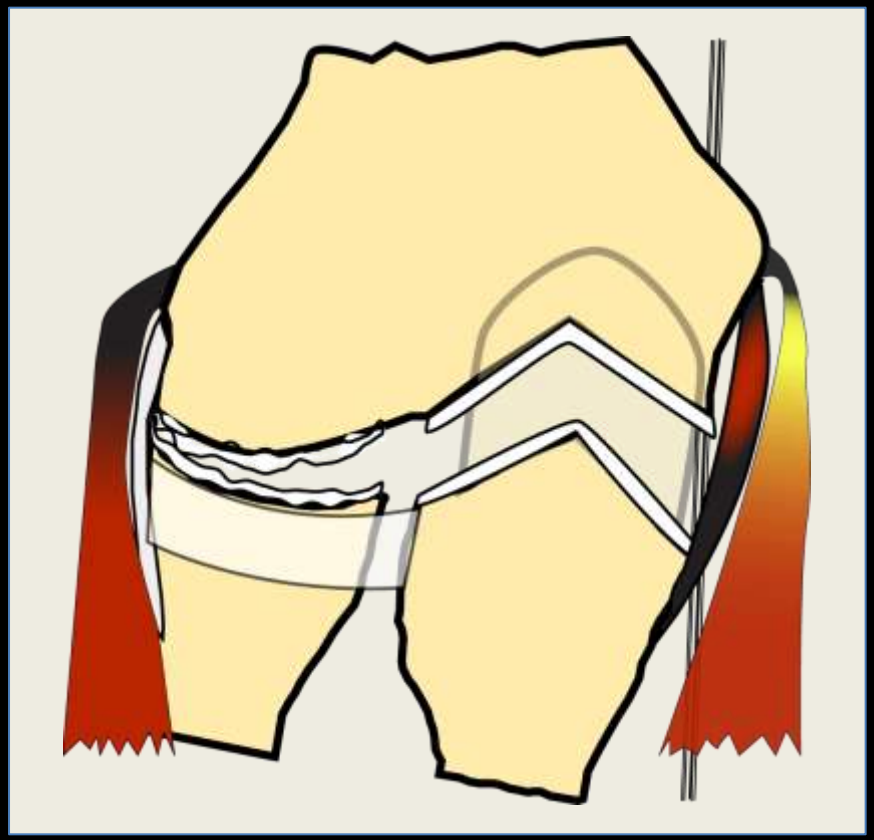


Valgus Injury - Summary

- Spectrum of pathology
  - aMCL
  - Flexor Mass
  - Radiocapitellar joint
  - Ulnar nerve



Switching Gears

Or downshifing, as it may be

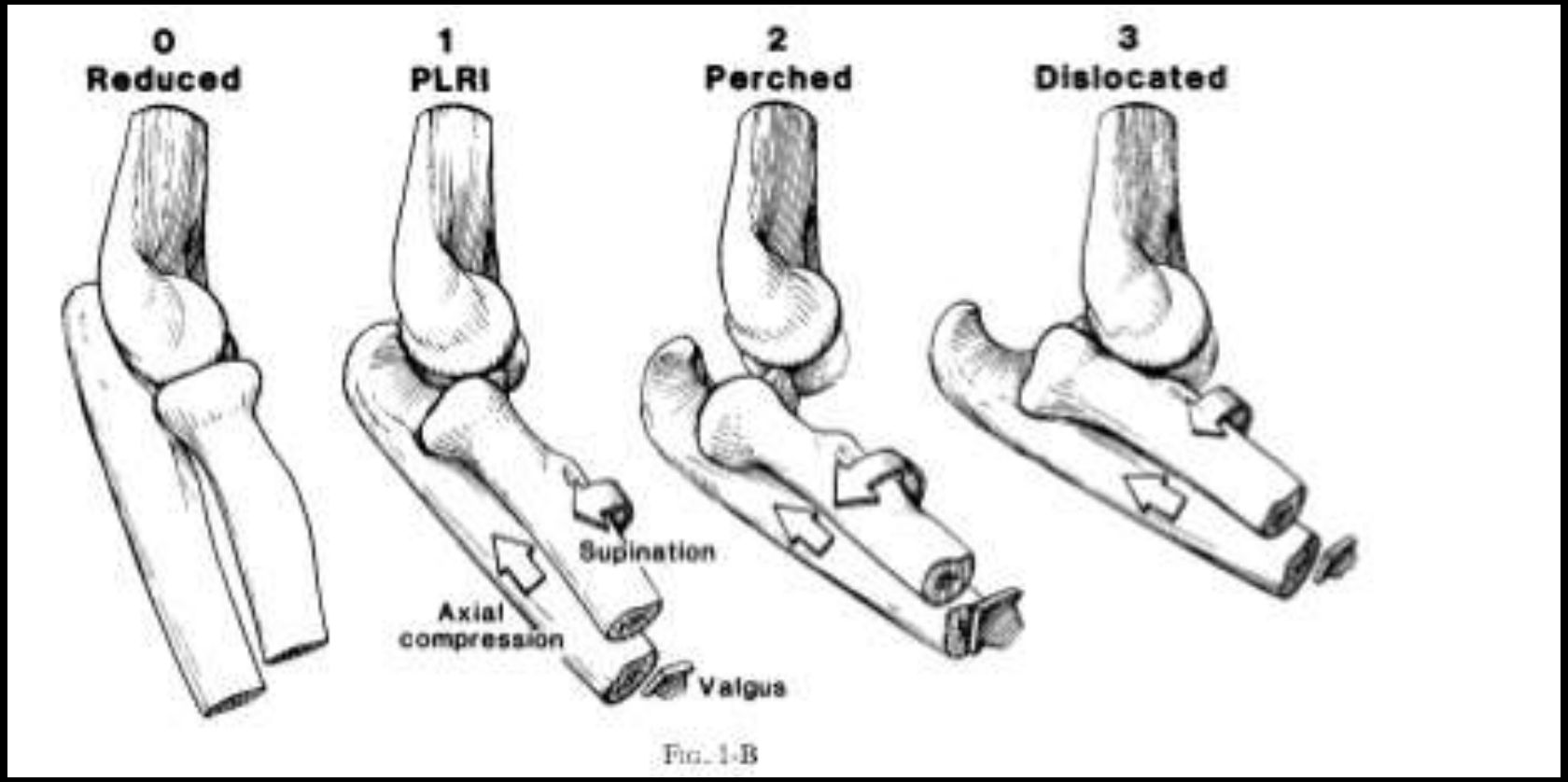

RUNAWAY
TRUCK RAMP

Dislocation and the spectrum of posterolateral instability

Posterolateral rotatory instablity

- Posterolateral rotatory instability (PLRI) originally described 1991
- “Elbow instability” and “PLRI” are used interchangeably in literature
  - Incorrect usage
  - Should always specify the “type” of instability
- PLRI in fact a clinico-pathologic entity on the spectrum of posterolateral subluxation-dislocation

Posterolateral rotatory instability (PLRI)



O'Driscoll et al. - 2000

Significance of PLRI

- Elbow instability was originally recognized by isolated or recurrent dislocation
  - Patient presenting with dislocation has “proven instability”
  - Hyperextension injury was presumed mechanism (lever of olecranon)
  - Rational treatment regimens were not available
- “PLRI” provides anatomic and mechanistic basis for the *majority* of elbow dislocations
  - Primary and secondary stabilizer injury, either acute or chronic

Acute versus Chronic

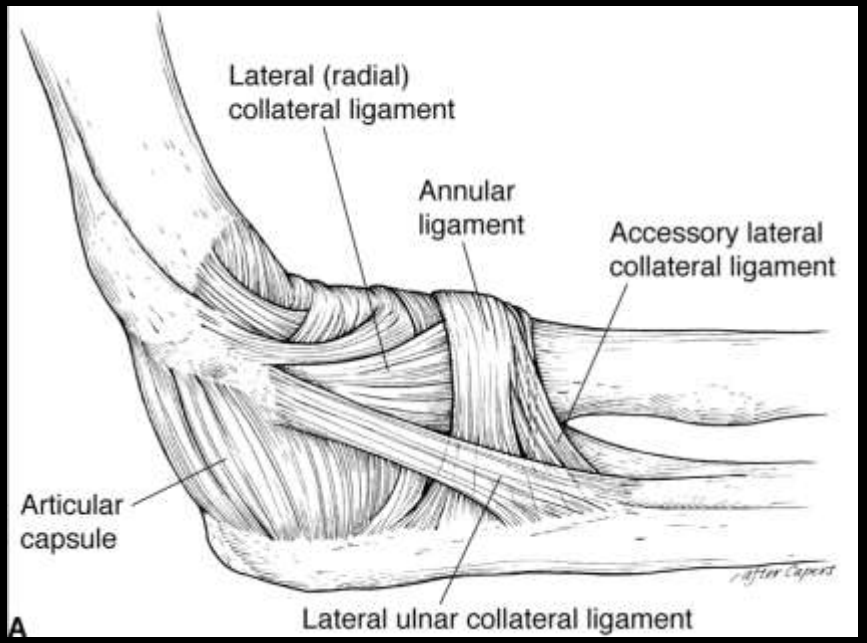
- Acutely unstable elbow often not a diagnostic dilemma
  - Patient presents with dislocation or fracture/dislocation
  - **Imaging** useful to identify extent of injury
- Chronic instability more insidious
  - Patient presentation
    - Pain
    - Clicking
    - Snapping
    - Clunking
    - Locking
  - Physical exam often unremarkable
    - Exam under anesthesia may be needed to elicit positive instability test
  - **Imaging findings** useful to support/suggest diagnosis of instability

PLRI – Stabilizers

- Primary
  - Lateral Collateral Ligamentous complex
  - Coronoid process
  - MCL
- Secondary
  - Radiocapitellar Joint
  - Capsule

PLRI – Primary Stabilizers

- Lateral Collateral Ligamentous complex
  - LUCL
  - RCL
  - Annular ligament



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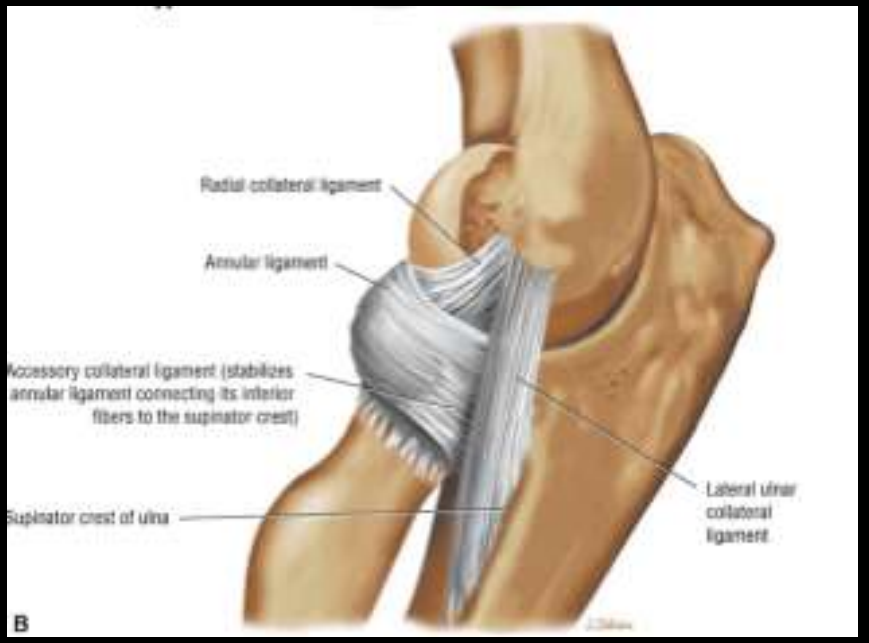


PLRI – Primary Stabilizers

- Lateral Collateral Ligamentous complex
  - LUCL
    - Classically described as the primary ligamentous restraint to posterolateral stress
    - ? Variably seen
  - RCL
  - Annular ligament

PD FS 3T

PLRI – Primary Stabilizers

- Lateral Collateral Ligamentous complex
  - LUCL
    - Extends from lateral epicondyle to tubercle of supinator crest
    - “sling” for radial head
  - RCL
  - Annular ligament

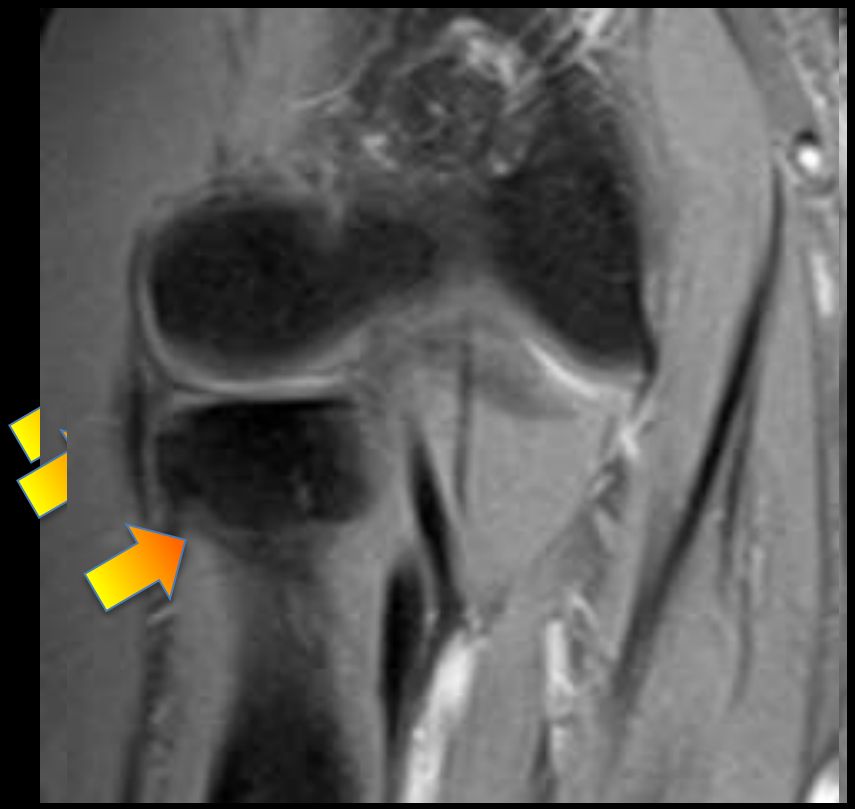
PD FS 3T

PLRI – Primary Stabilizers

- Lateral Collateral Ligamentous complex
  - LUCL
    - Proximally, distinction from RCL difficult on MR
    - Also difficult on surgical exposure
    - Anterior ½ - RCL
    - Posterior ½ - LUCL
  - RCL
  - Annular ligament

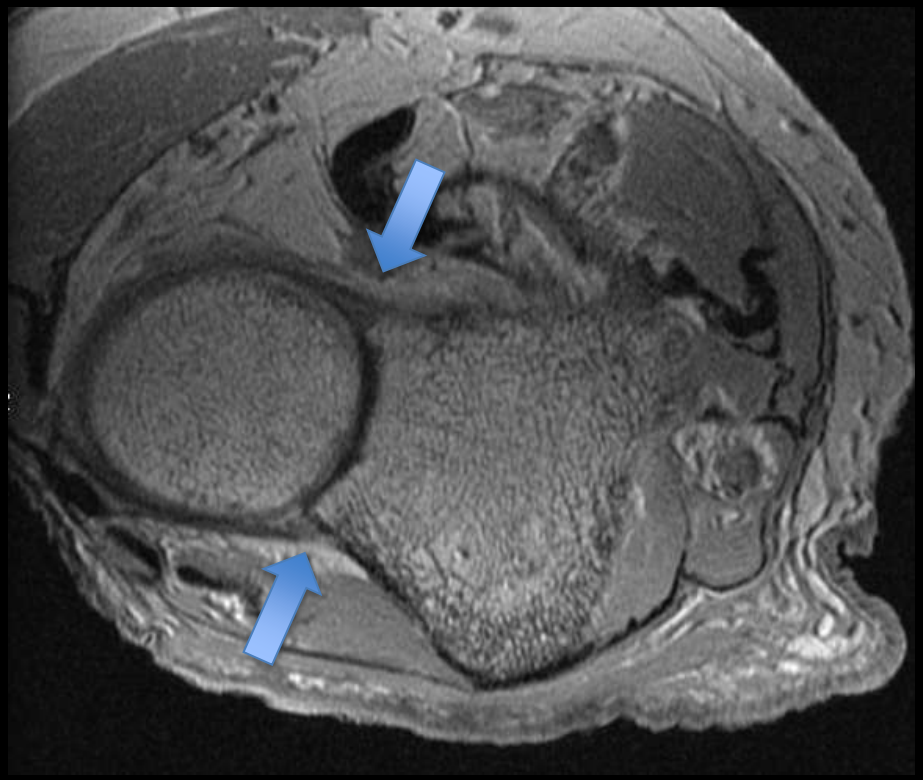
Anatomy – Primary Stabilizers

- Lateral Collateral Ligamentous complex
  - LUCL
  - RCL
    - Contiguous with annular ligament
    - Varus stability and annular ligament stabilizer
  - Annular ligament



Anatomy – Primary Stabilizers

- Lateral Collateral Ligamentous complex
  - LUCL
  - RCL
  - Annular ligament
    - Anterior and posterior attachments onto ulna
    - Ligamentous restraint of PRUJ



PLRI – Primary Stabilizers

- “Lateral Collateral Ligamentous complex”
- LUCL and RCL/annular recently shown to both function in varus/PLRI
  - No instability until both lesions sectioned
- Implication on imaging:
  - “Complete disruption” lateral ligamentous structures when both ligaments disrupted
  - “Partial (high grade)” if intact fibers from the other ligament

PLRI – Primary Stabilizers

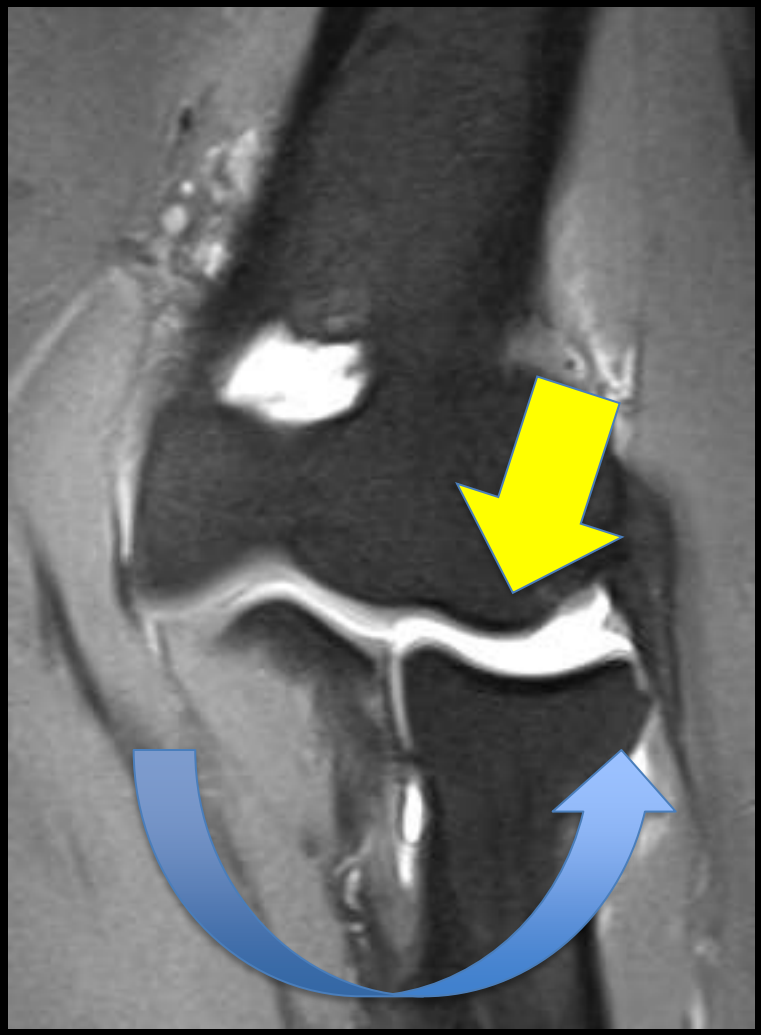
- Lateral Collateral Ligamentous complex
  - Valgus posterolateral rotatory stabilizer

PLRI – Primary Stabilizers

- Coronoid Process
  - Valgus (posterolateral rotatory) stabilizer

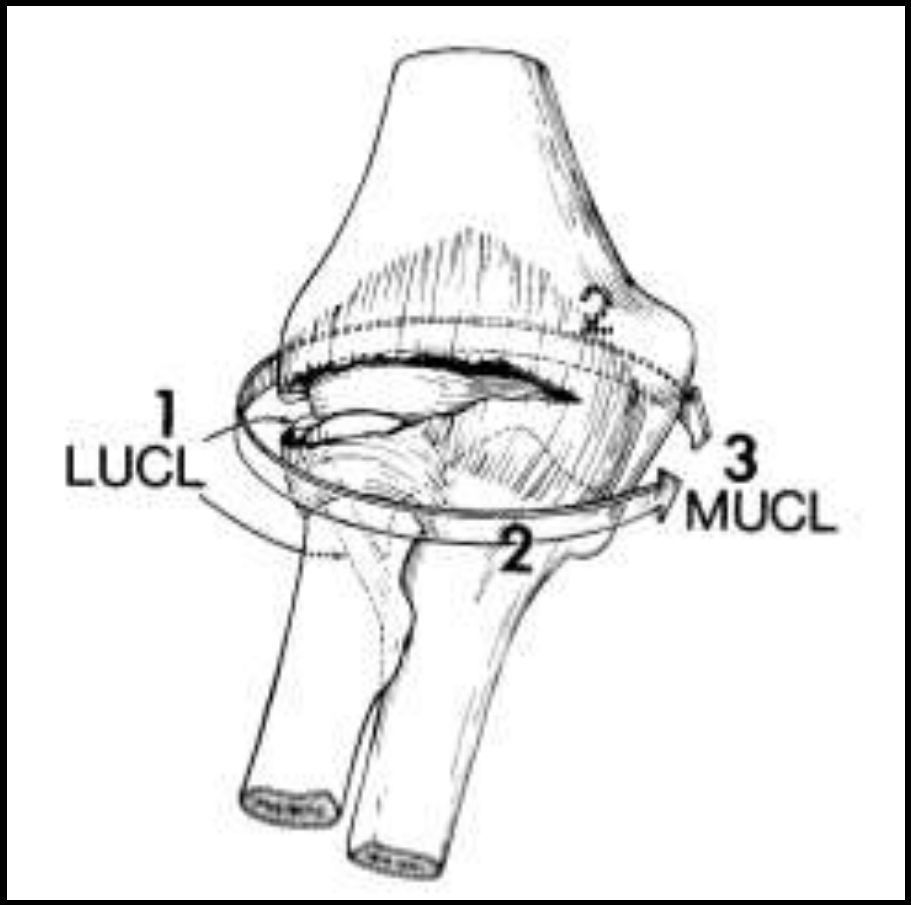
PLRI – Secondary Stabilizers

- Radiocapitellar joint
  - Posterolateral rotatory stabilizer



Acute posterolateral subluxation/dislocation

- Acute trauma results in a subluxation/dislocation
  - Most often FOOSH
- Sequential pattern of injury
  - Circle of Horii



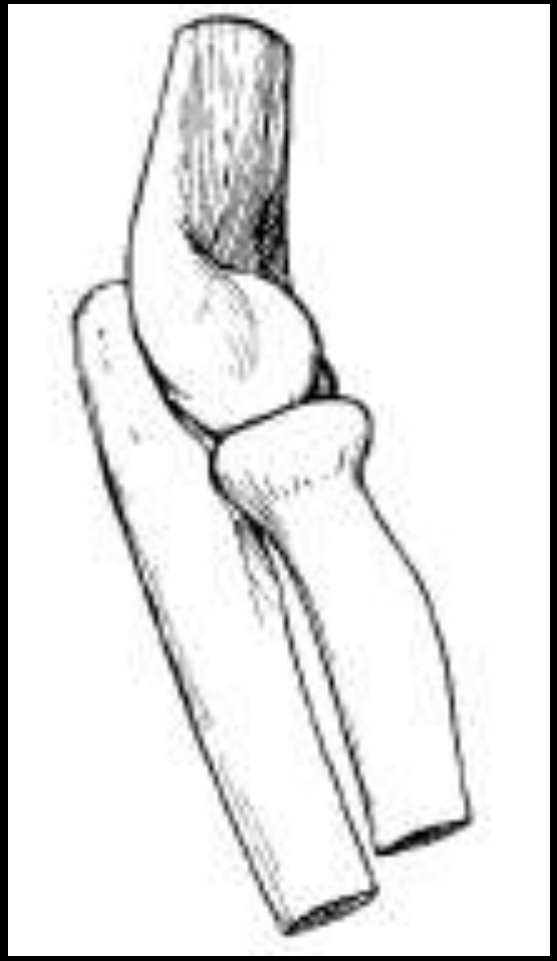
O'Driscoll et al. - 2000

Acute posterolateral subluxation/dislocation

- Acute trauma results in a subluxation/dislocation
  - Most often FOOSH
- Sequential pattern of injury
  1. LCL rupture (PLRI)
  2. Disruption of capsule (perched)
  3. a. MCL (except anterior band)

     b. entire mcl.

     c. complete soft tissue injury



O'Driscoll et al. - 2000

Acute posterolateral subluxation/dislocation

- Acute trauma results in a subluxation/dislocation
  - Most often FOOSH
- Sequential pattern of injury
  1. LCL rupture (PLRI)
  2. Disruption of capsule (perched)
  3. a. MCL (except anterior band)

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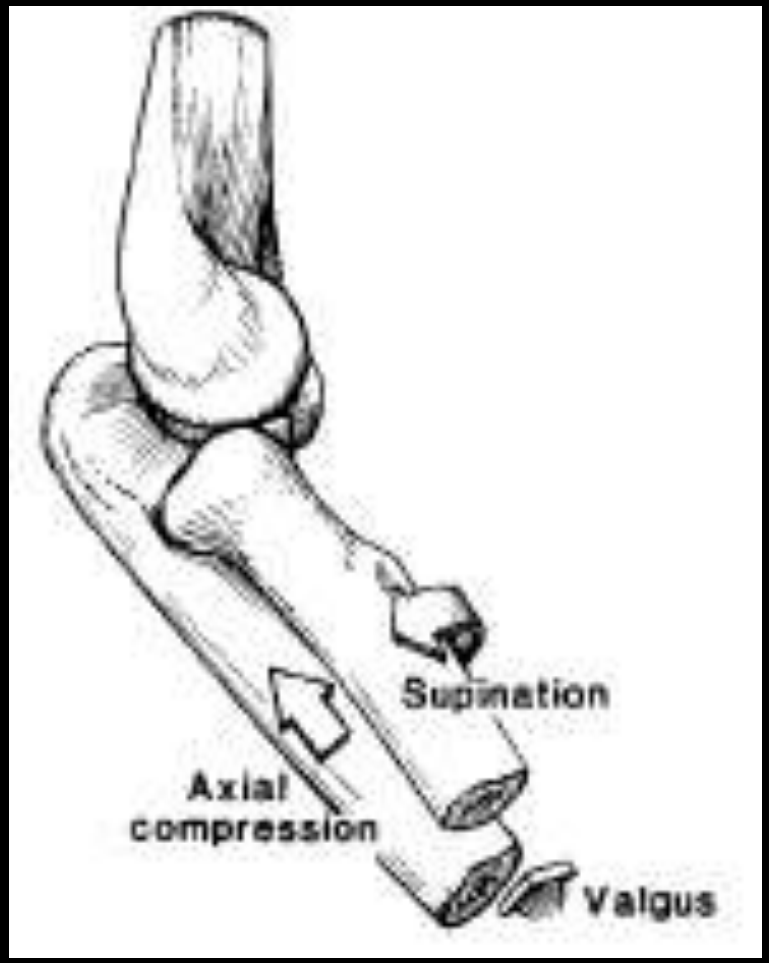

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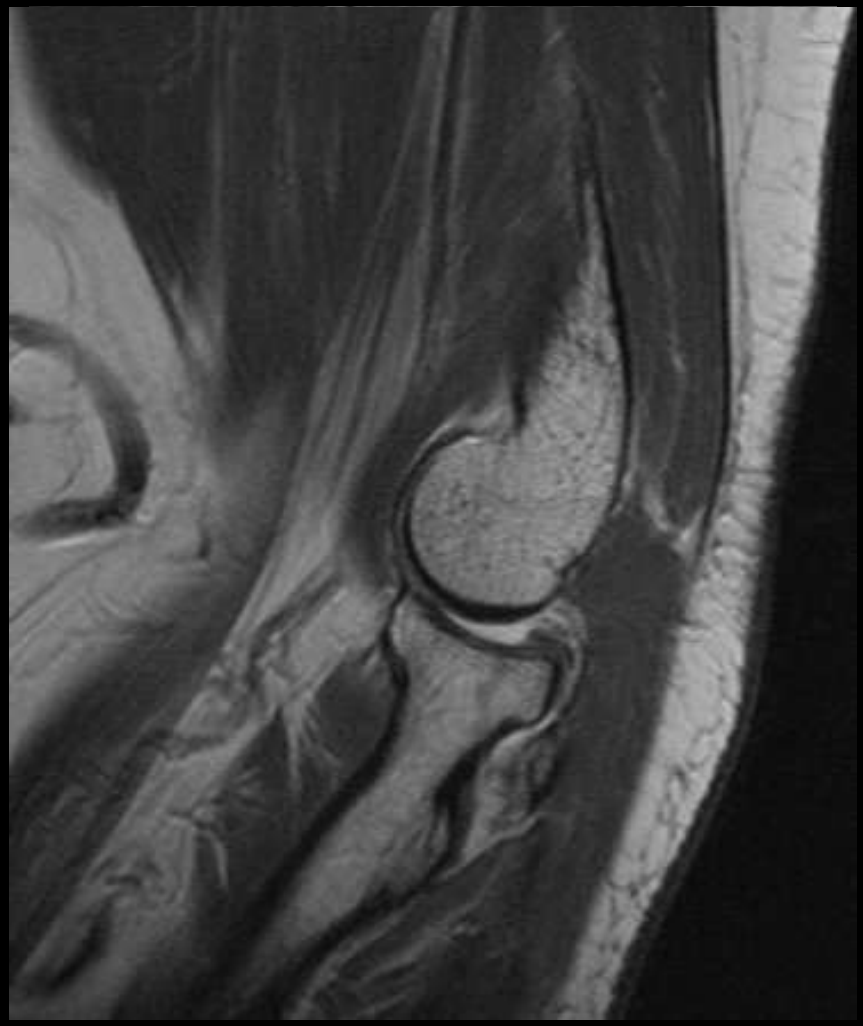

Courtesy Dr. Pathria

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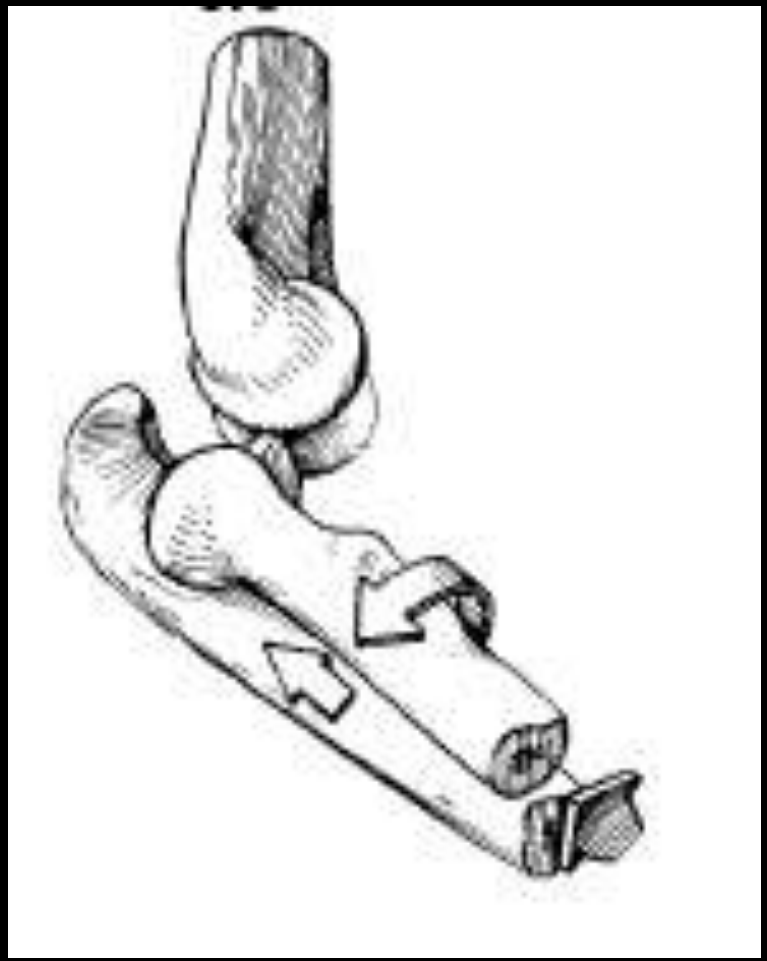

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Courtesy Drs. Pathria/Chung

Acute posterolateral subluxation/dislocation

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     b. Entire MCL

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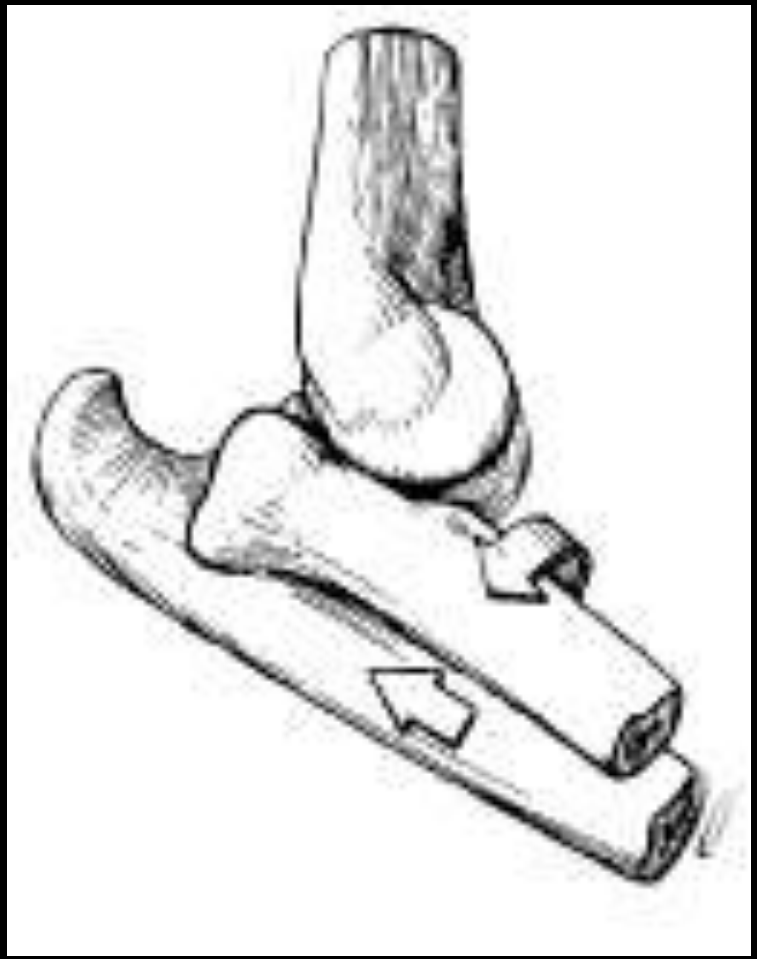

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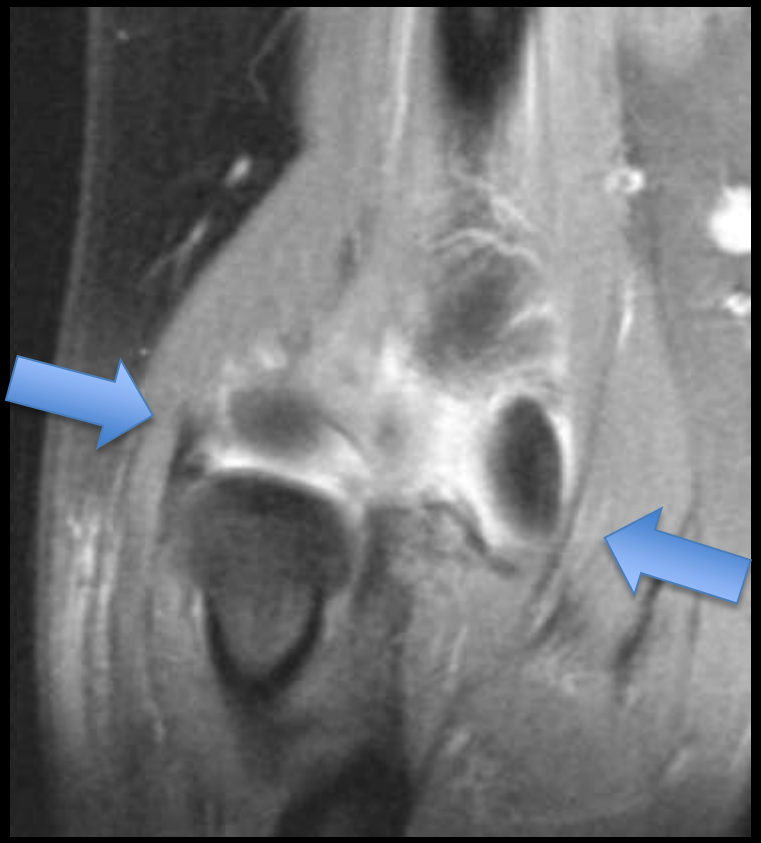


Courtesy Dr. Pathria

Acute posterolateral dislocation

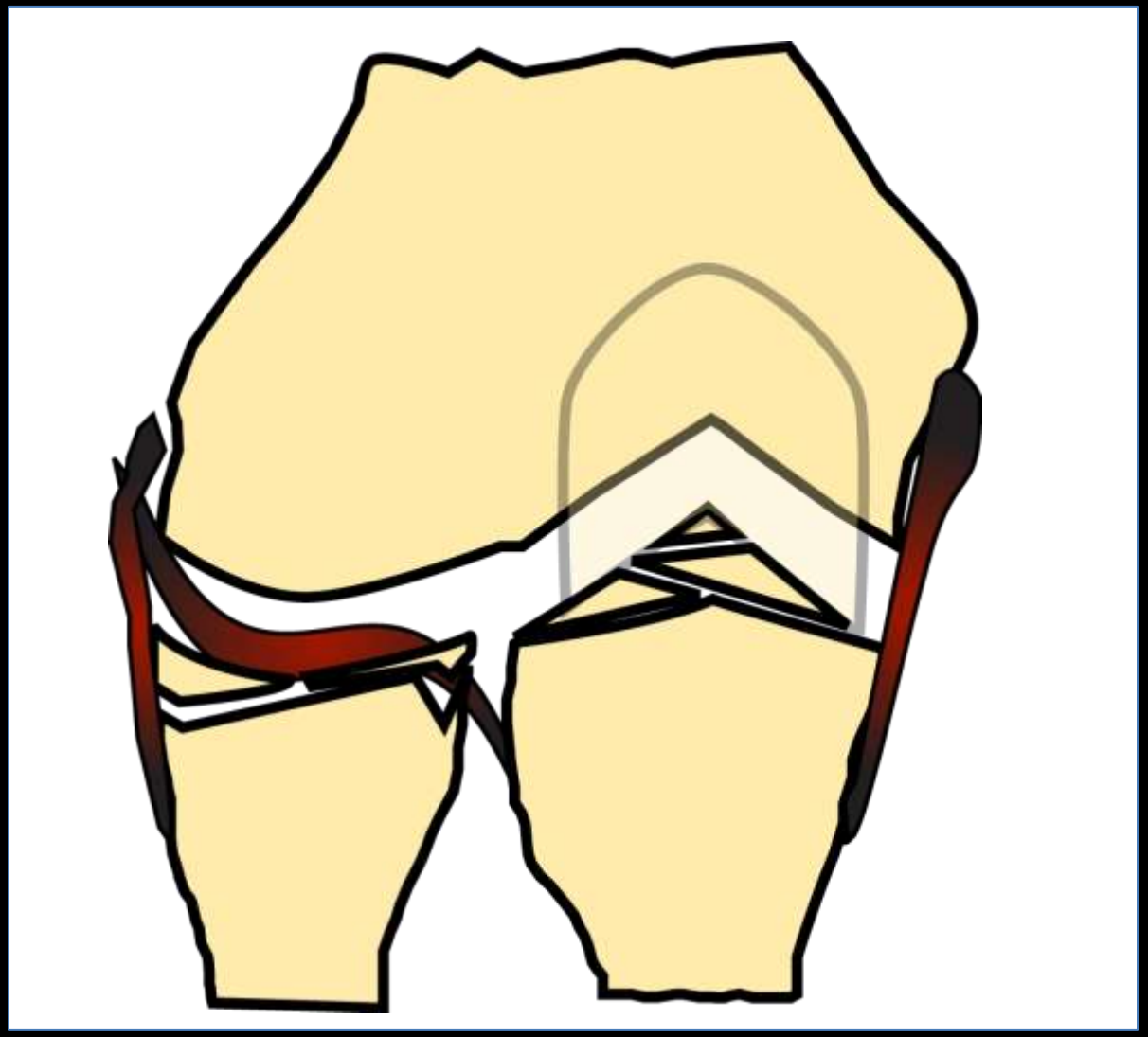
Dislocation

- Simple Dislocation
  - Pure ligamentous injury
- Complex dislocation
  - Ligamentous and bone injury
  - Radial Head Fracture
  - Coronoid Process Fracture
  - Terrible Triad
  - *Posterior Monteggia*
  - *Anterior trans-olecranon fracture dislocation*

Complex Dislocation - Significance

- Fracture implies loss of stabilizer support
  - Increasing instability with associated fractures
- Seemingly trivial fracture can have significant implications with regards to instability
  - Radial head fracture
  - Coronoid tip fracture
- “Terrible triad” injury associated with complicated outcomes

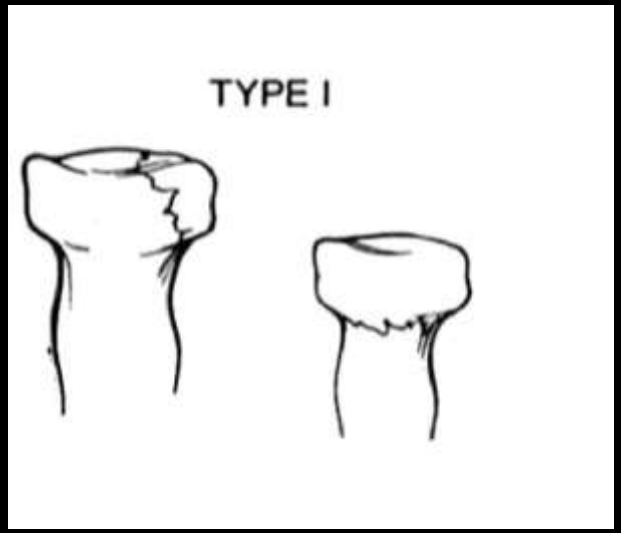
Complex Dislocation - Significance



Brief aside regarding radial head and coronoid fractures

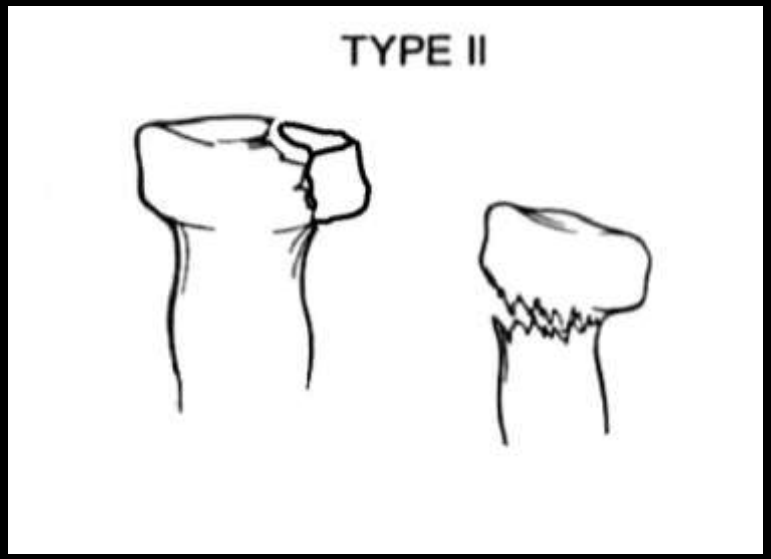
Radial Head Fractures

- Mason classification (Modified)
  - Type 1 : <2mm articular surface displacement
    - Conservative treatment
  - Type 2: > 2mm, >30% articular surface
  - Type 3: comminuted fracture
  - *Type 4: any fracture pattern following dislocation*



Radial Head Fractures

- Mason classification (Modified)
  - Type 1 : <2mm articular surface displacement
  - Type 2: > 2mm, >30% articular surface
    - Debated treatment
  - Type 3: comminuted fracture
  - *Type 4: any fracture pattern following dislocation*



Radial Head Fractures

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  - Type 2: > 2mm, >30% articular surface
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    - Resection versus ORIF/arthroplasty
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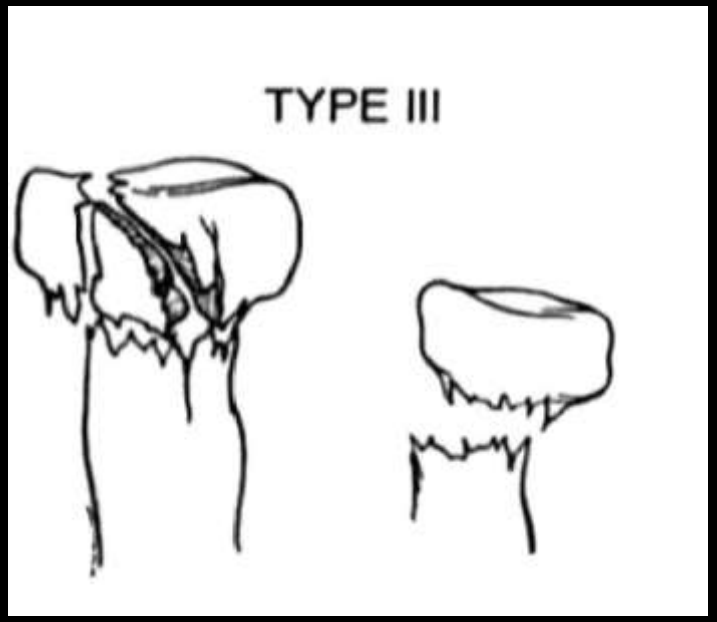

Radial Head Fractures

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  - Type 1 : <2mm articular surface displacement
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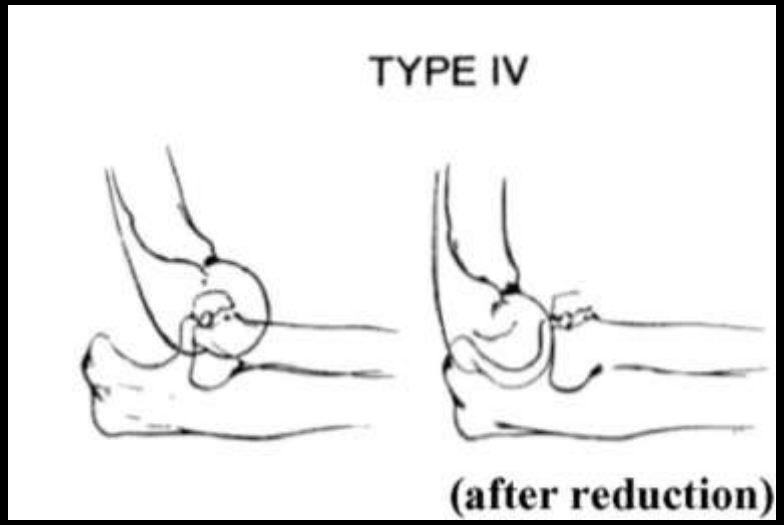
  - Type 3: comminuted fracture
  - *Type 4: any fracture pattern following dislocation*
    - *Stabilizer recruitment*
    - *Strongly consider ORIF/arthroplasty*



Radial head fracture - Treatment

- Excision
- ORIF
- Arthroplasty

Radial head fracture - Treatment

- Excision
- ORIF
- Arthroplasty

Radial head fracture - Treatment

- Excision
- ORIF
  - Miniplate
  - Herbert Screw
- Arthroplasty

Radial head fracture - Treatment

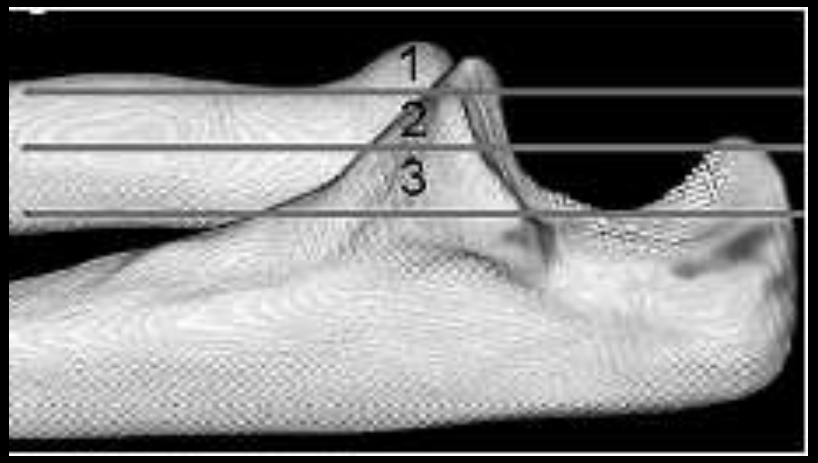
- Excision
- ORIF
- Arthroplasty

Radial head fracture - Treatment

- Excision
- ORIF
- Arthroplasty
  - Essex Lopresti fx

Coronoid Fracture

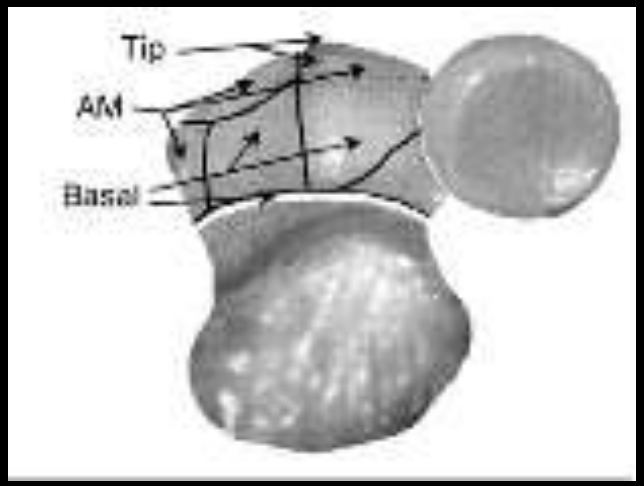
- Regan Morrey classification
  - Type 1 – tip “avulsion”
  - Type 2 - <50% of process
  - Type 3 - >50 %
- Inconsistent treatment based on fracture type
- Treatment originally advocated for Type 3
- *Instability more important*



Doornberg 2006

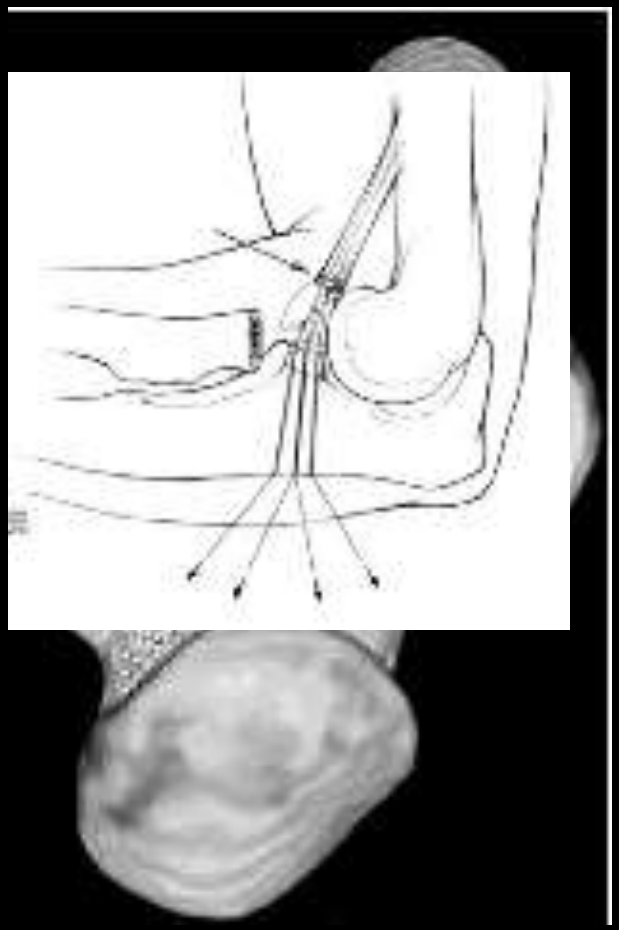
Coronoid Fracture

- O'Driscoll classification
  - Based on fracture patterns
  - Associated with mechanism
  - Difficult to evaluate (CT required)



Coronoid Fracture

- O'Driscoll classification
  - Based on fracture patterns
    - Type 1 – transverse tip
      - Posterolateral dislocation/Terrible triad injury
      - Treatment via sutures
    - Type 2 – anteromedial facet
    - Type 3 – base



Doornberg 2006

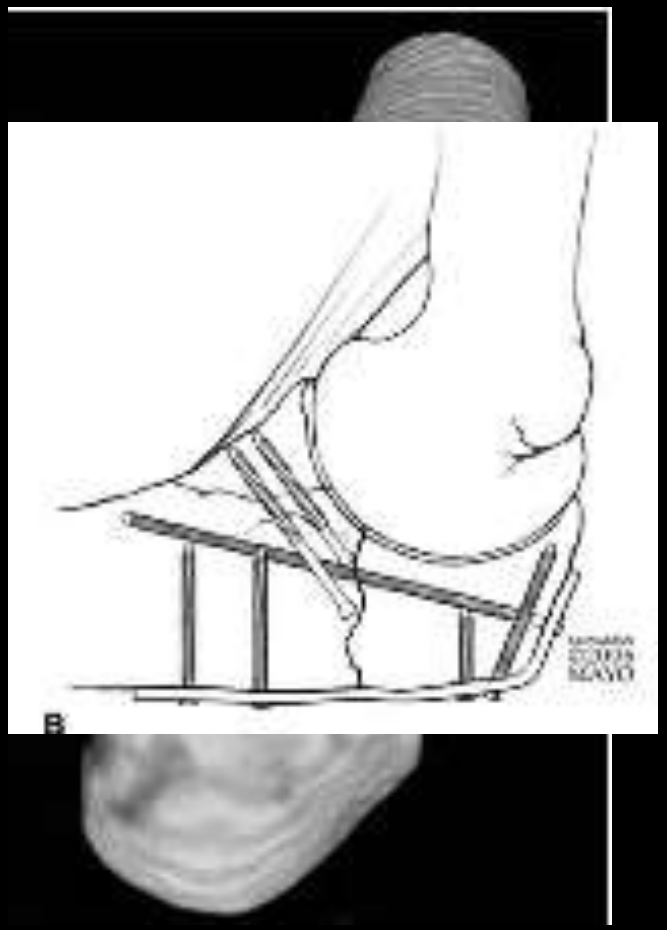
Coronoid Fracture

- O'Driscoll classification
  - Based on fracture patterns
    - Type 1 – transverse tip
    - Type 2 – anteromedial facet
      - Varus posteromedial instability
      - Treatment via anteromedial plate and screw
    - Type 3 – base

Doornberg 2006

Coronoid Fracture

- O'Driscoll classification
  - Based on fracture patterns
    - Type 1 – transverse tip
    - Type 2 – anteromedial facet
    - Type 3 – Base
      - Olecranon fracture/dislocations
      - Medial plate/screw



Doornberg 2006

Terrible triad injury

- Posterolateral dislocation
- Radial head fracture
- Coronoid fracture

Terrible triad injury

- Poor outcomes
- Damage to multiple supporting structures
- Unstable, even in splint/cast
- Complex treatment algorithms
  - Surgeons will be aggressive

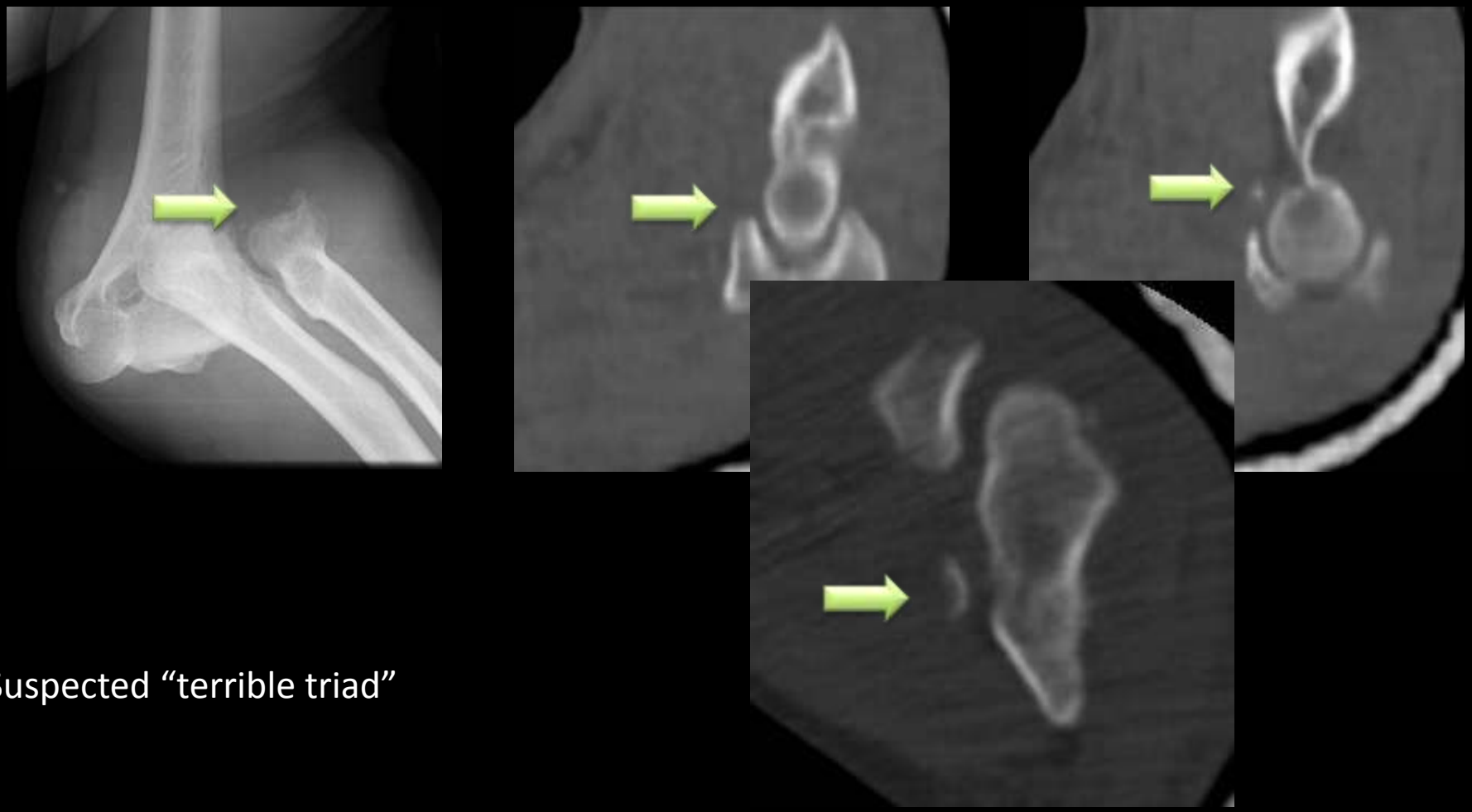
Matthew 2009

Terrible triad injury

- Posterolateral dislocation
- Radial head fracture
- Coronoid fracture

Matthew 2009

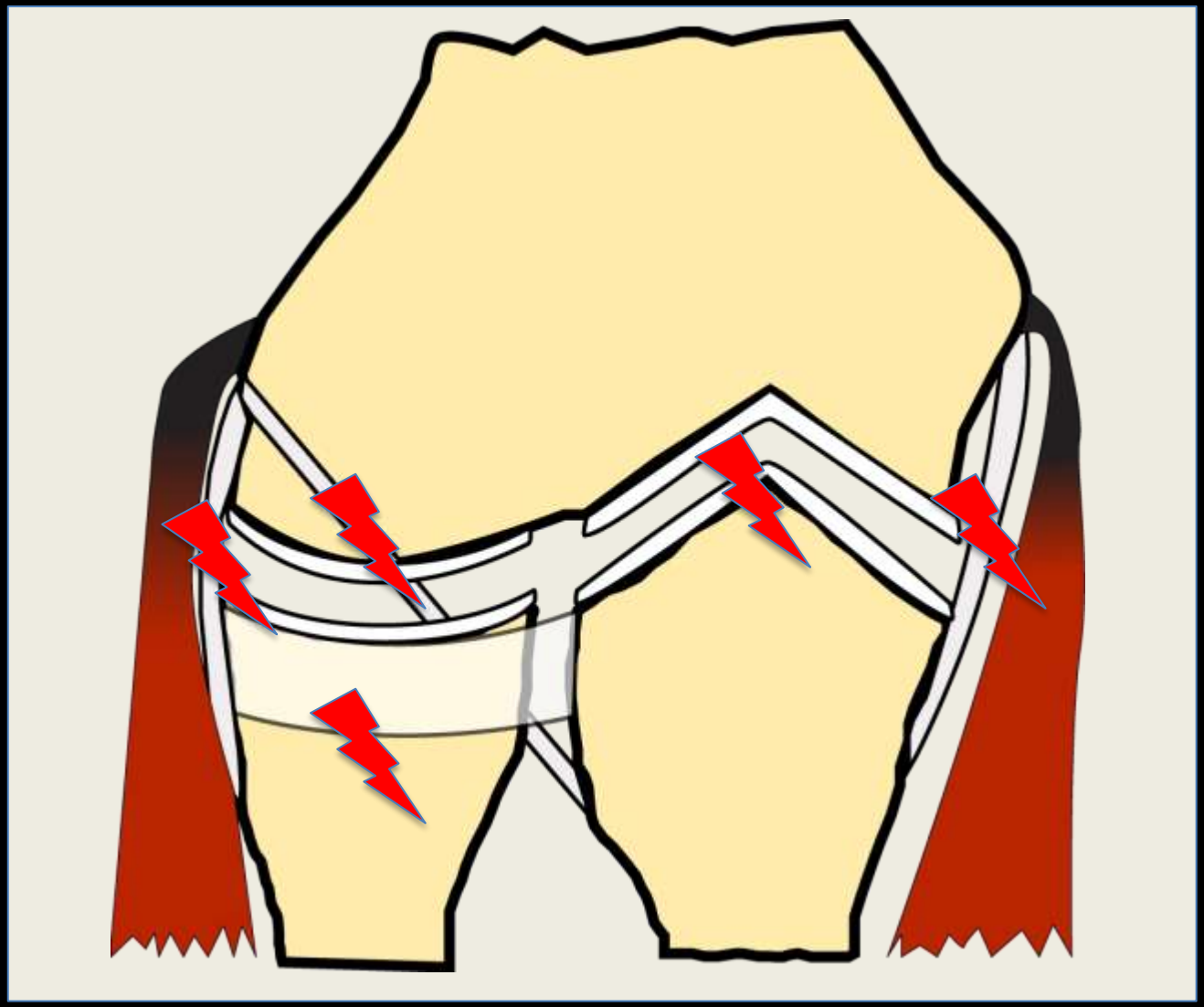
Terrible triad injury



Suspected “terrible triad”

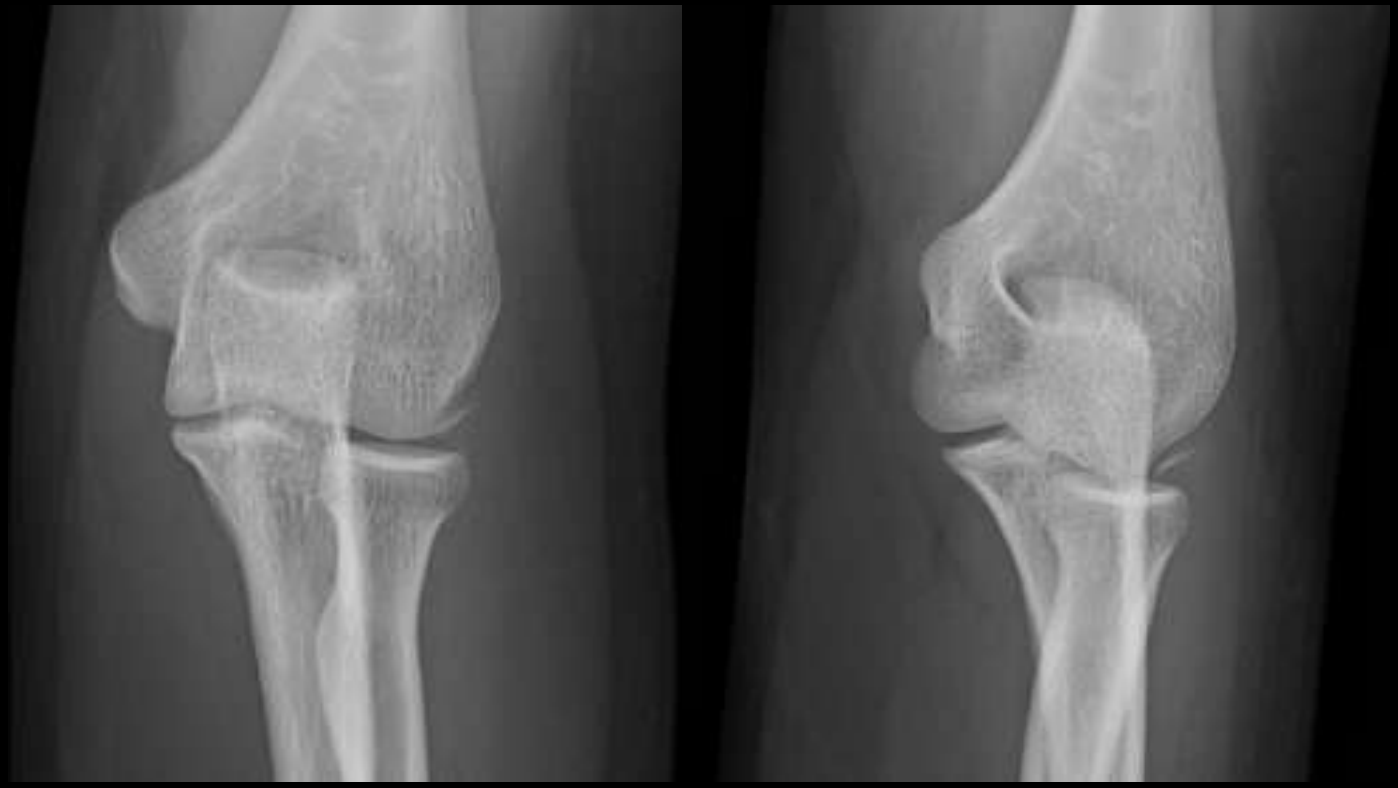
Imaging of PLRI

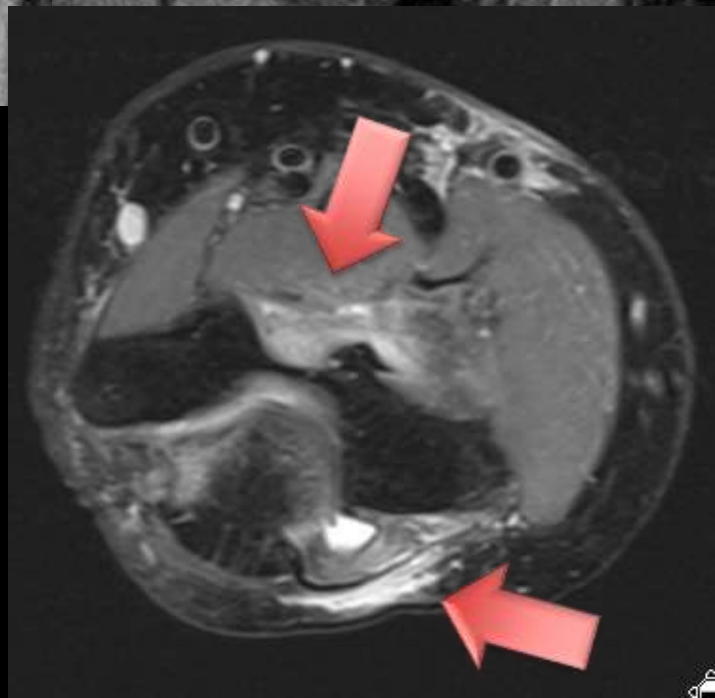
- Radiologist may not have history of subluxation/dislocation
- Instability will be suggested based on damage to primary and secondary stabilizers
    - LUCL/RCL
    - Radial head
    - Coronoid Process
    - MCL



Acute PLRI

Define injuries

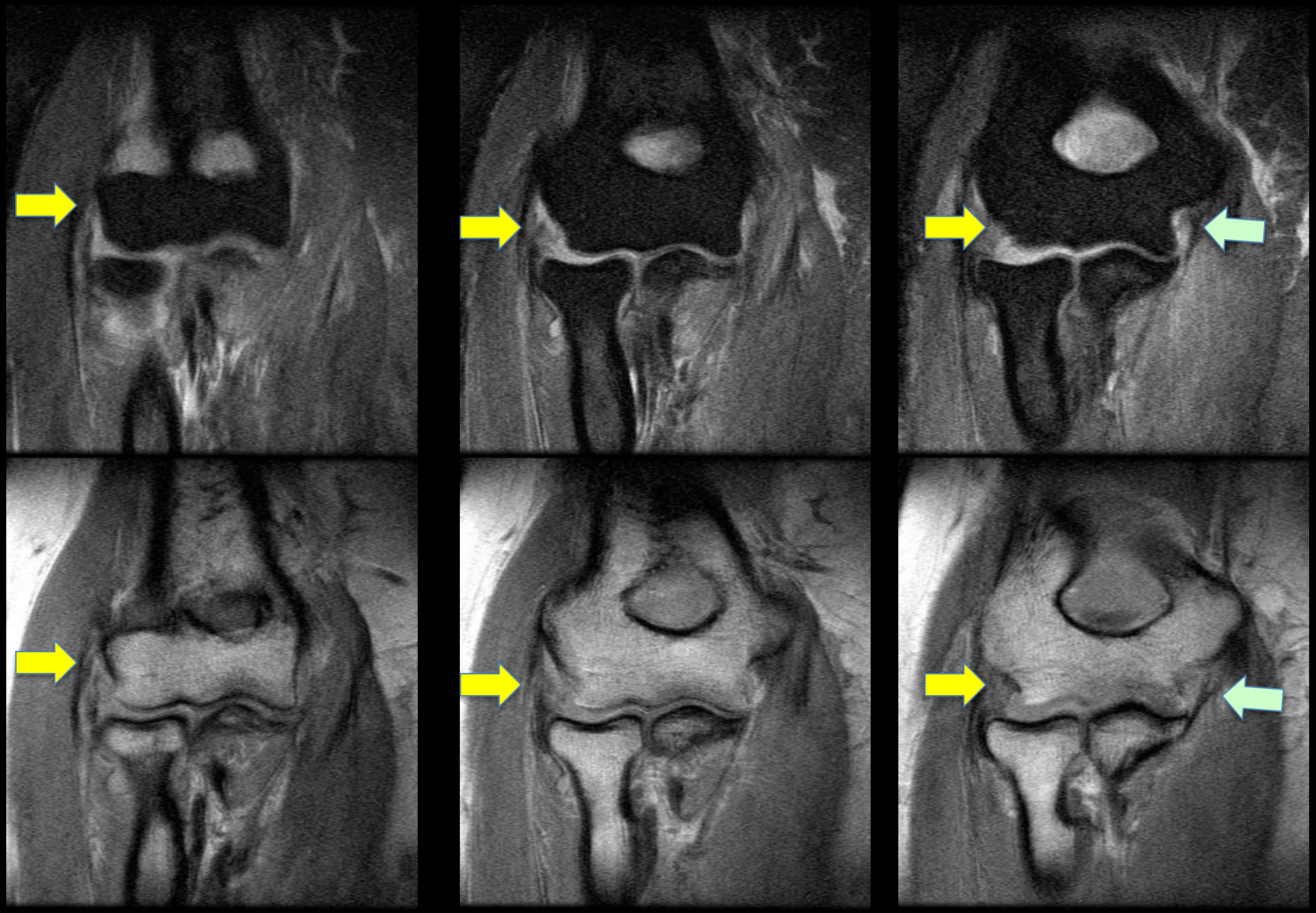




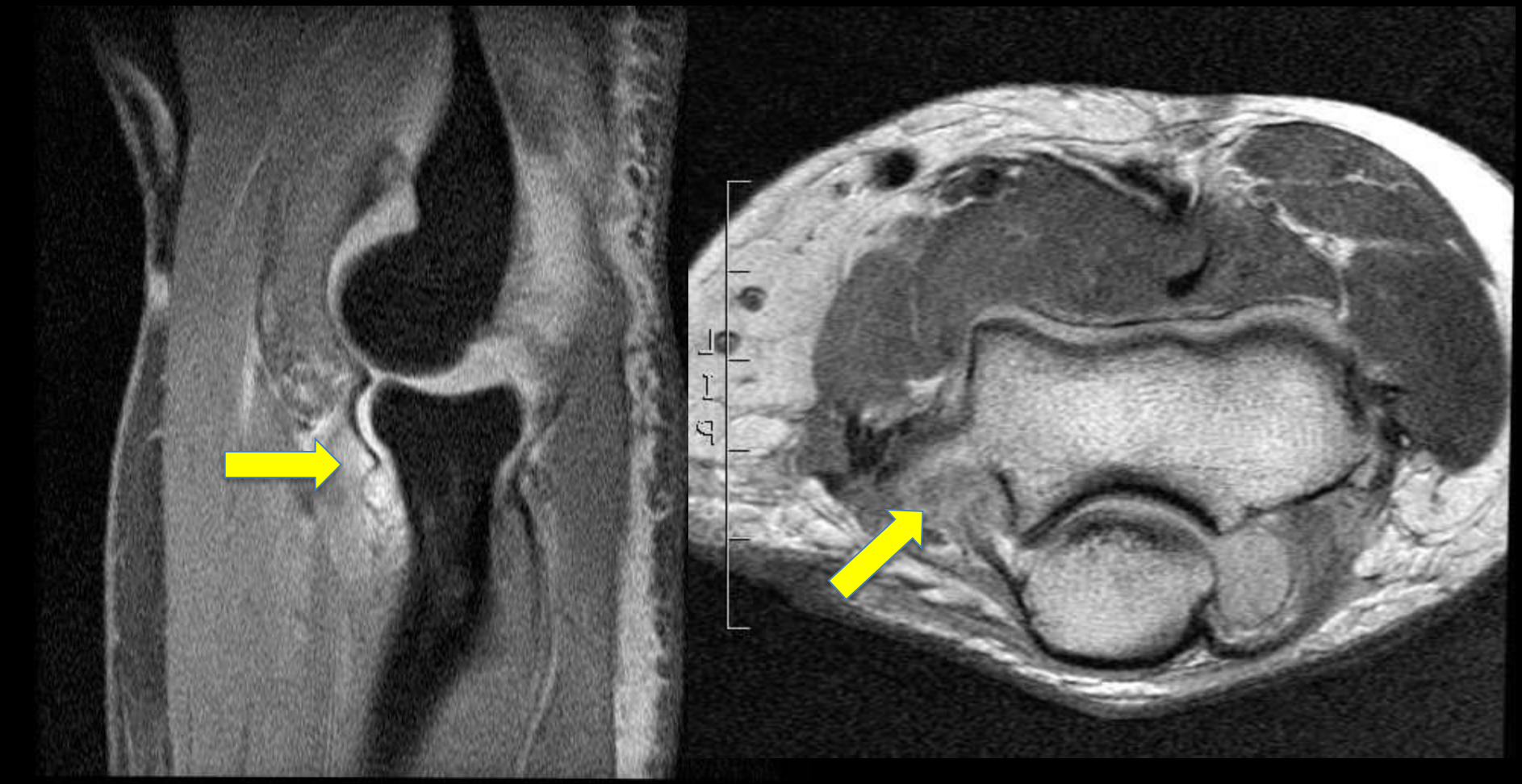
Acute avulsion RCL/LUCL from humeral attachment

Capsular injury

Stage 2



Courtesy Dr. Pathria

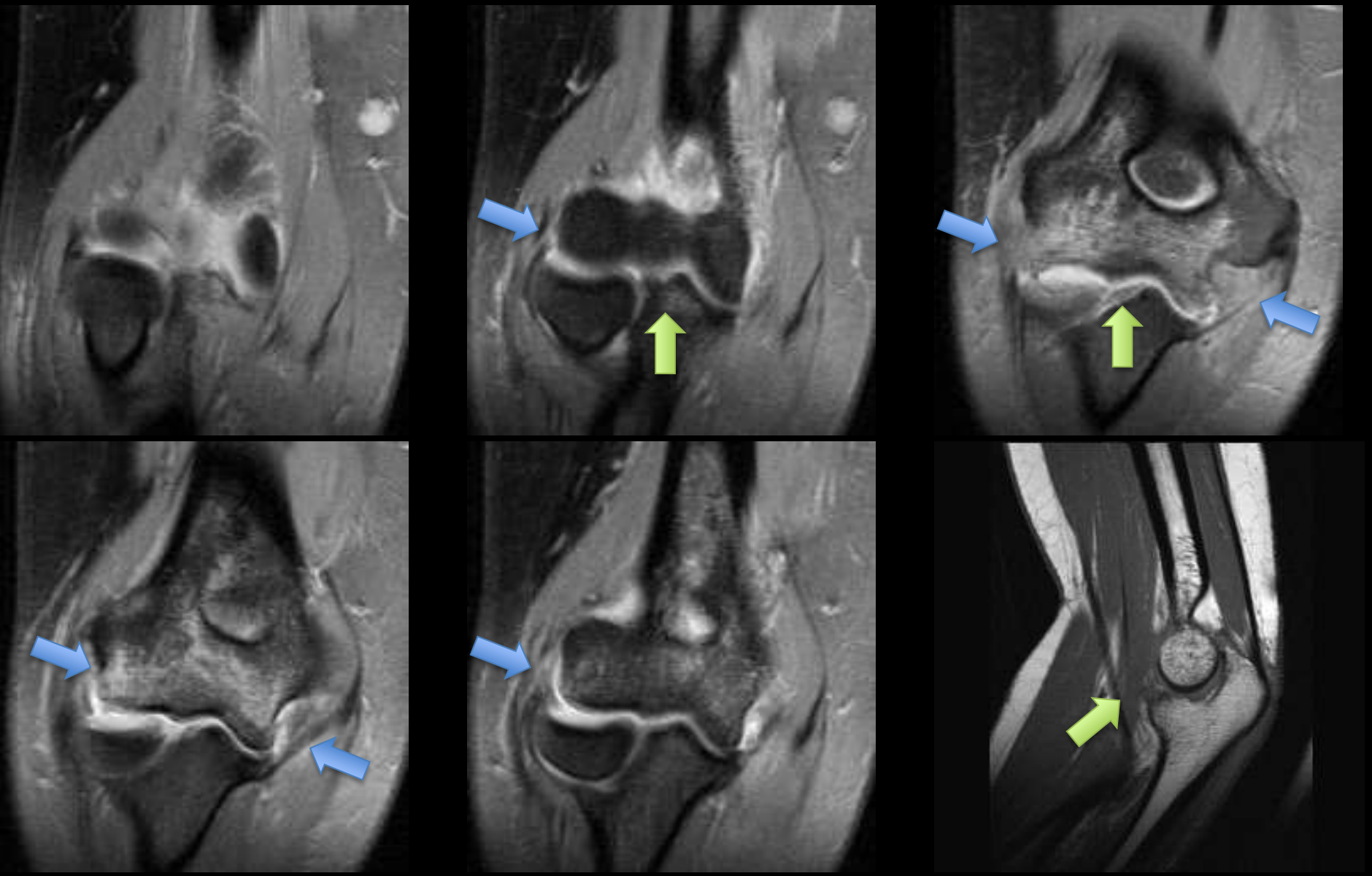


Stage 3a PLRI

Courtesy Dr. Pathria

Courtesy Dr. Pathria

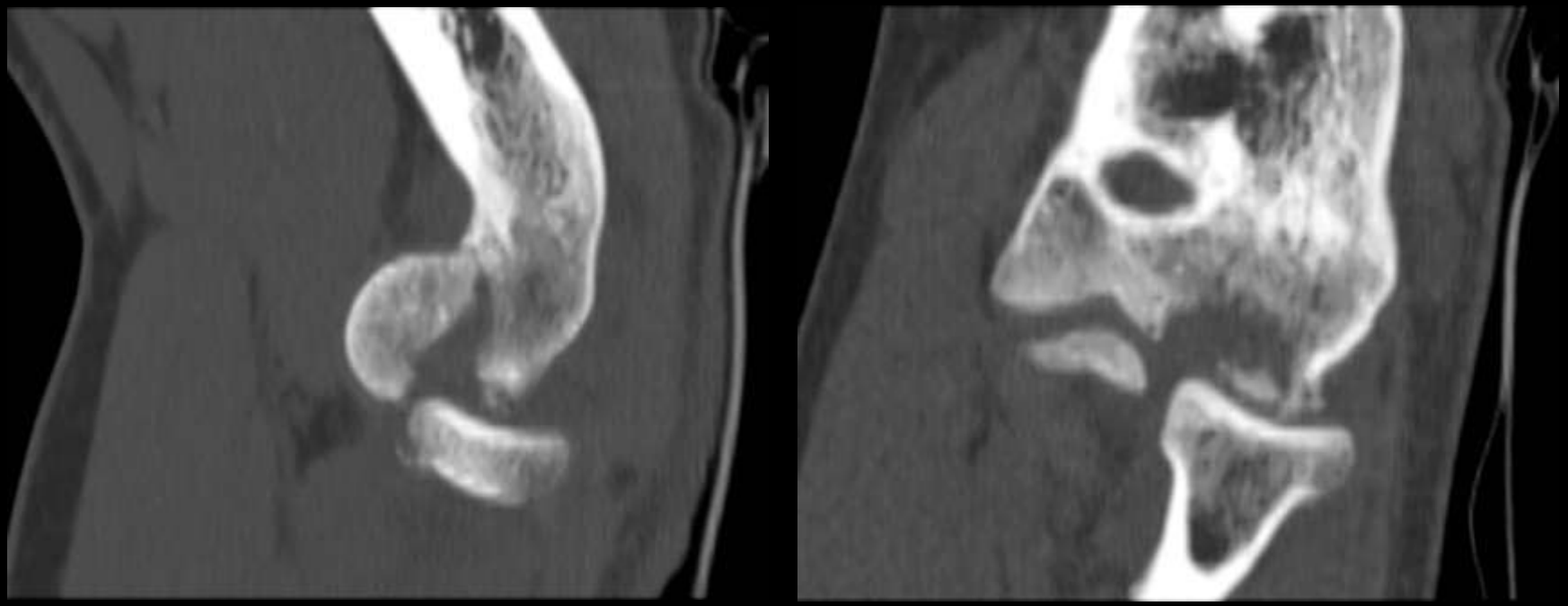
Courtesy Dr. Pathria



Stage 3b PLRI with coronoid tip fracture

Courtesy Dr. Pathria

Courtesy Dr. Pathria



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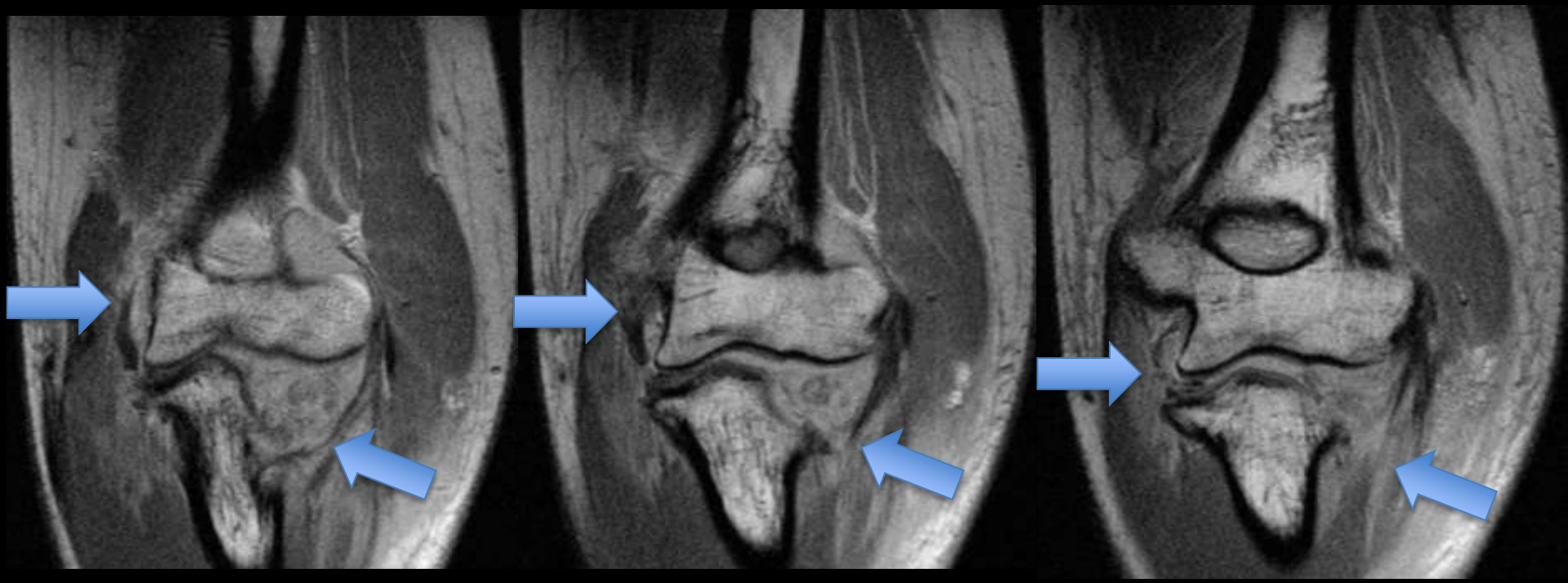


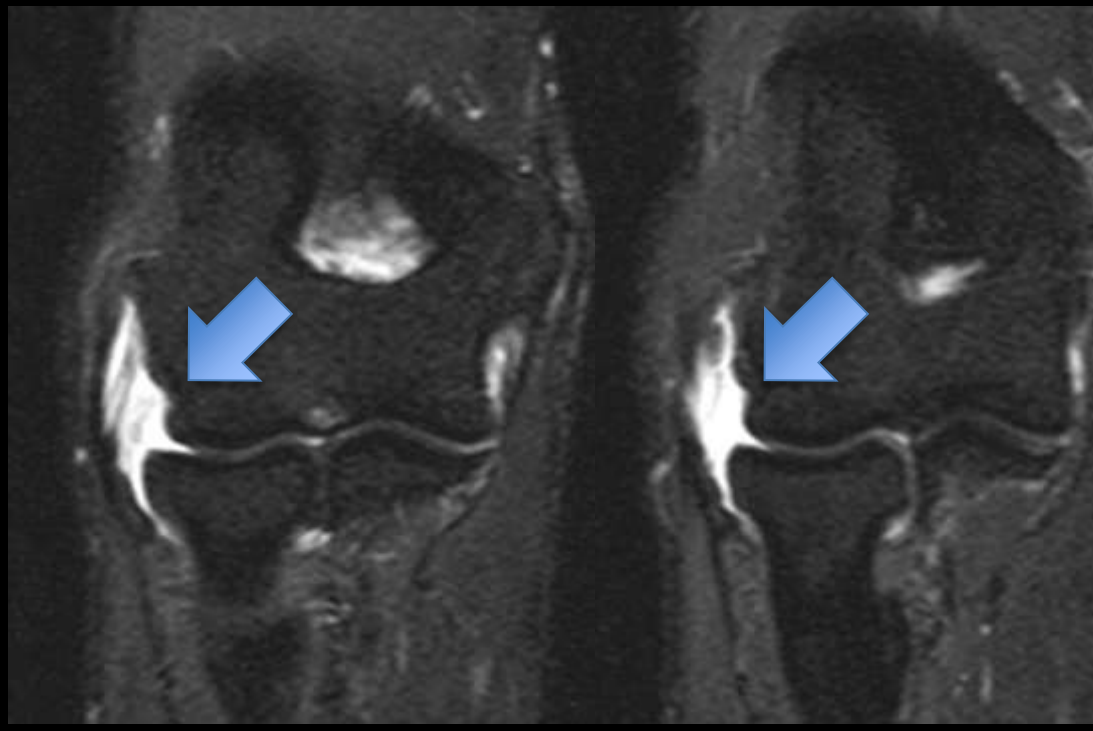
Courtesy Dr. Pathria

Chronic PLRI

Suggest instability

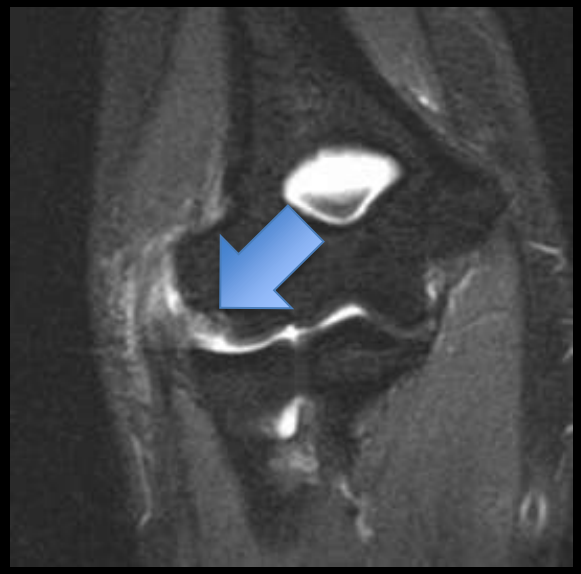
Chronic PLRI

- Post traumatic
  - Inadequate healing
- Iatrogenic
- Chronic soft tissue overload
- Connective tissue disorders



Chronic PLRI

- Post traumatic
- Iatrogenic
  - Surgical violation of lateral supporting structures
    - Lateral epicondyle release
    - Access to lateral compartment
  - Radial head resection
  - Steroid use
- Chronic soft tissue overload
- Connective tissue disorders



Chronic PLRI

- Post traumatic
- Iatrogenic
- Chronic soft tissue overload
  - Cubitus Varus deformity
  - Cructhes
- Connective tissue disorders

Abe, 1997

Chronic PLRI

- Post traumatic
- Iatrogenic
- Chronic soft tissue overload
- Connective tissue disorders
  - Ehlers Danlos

PLRI – additional findings

Posterior Capitellar Impaction

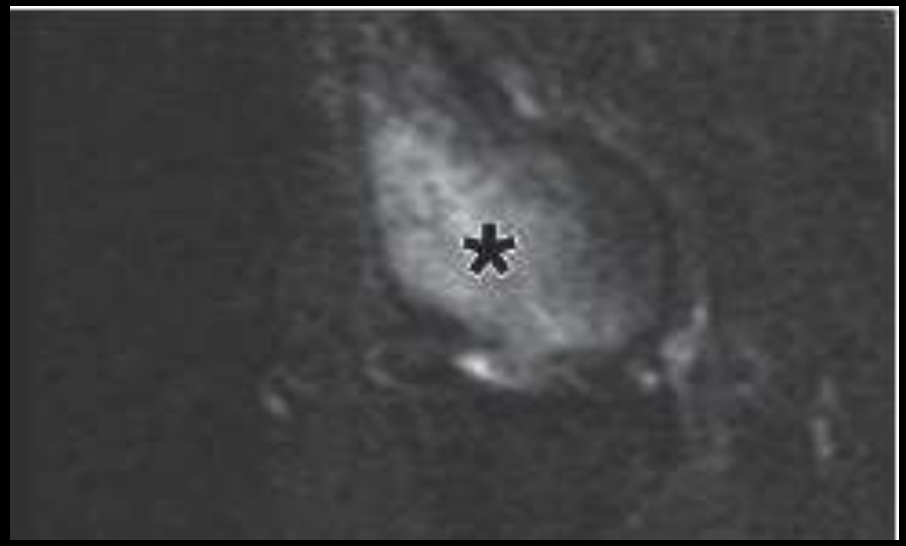
- Osteochondral impaction fracture of posterior capitellum
- “Hill-Sachs” equivalent

I Shoulder Elbow Surg Volume 7, Number 2

Posterior Capitellar Impaction

I Shoulder Elbow Surg Volume 7, Number 2

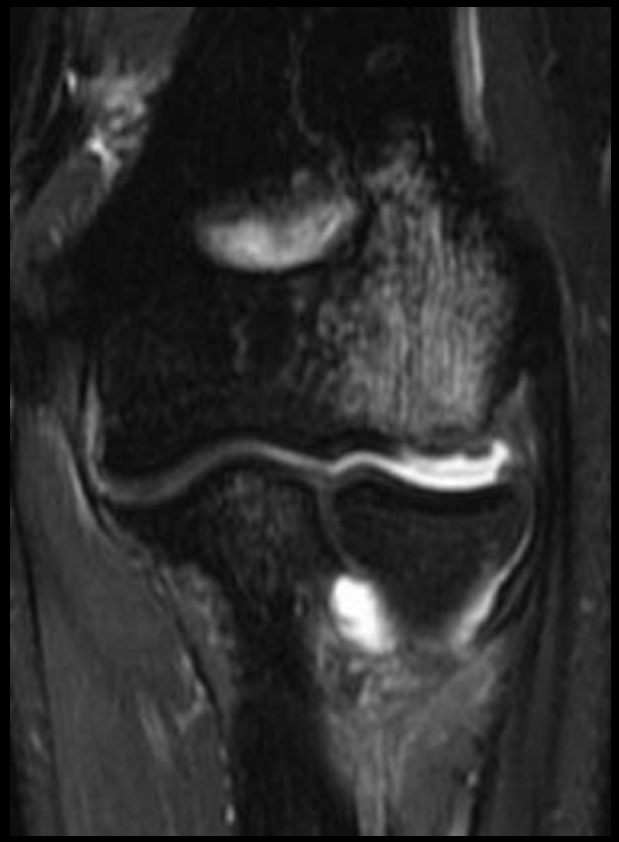
Posterior Capitellar Impaction



AJR 2008; 190:435–441

Posterior Capitellar Impaction





Courtesy Dr. Pathria

Posterior Capitellar Impaction

AJR 2008; 190:435–441

Pitfall- Pseudodefect of Capitellum

- Junction of lateral epicondyle with posterior capitellar chondral surface
- Trough-like indentation a normal finding on sag and coronal images
- Lack of marrow edema helpful

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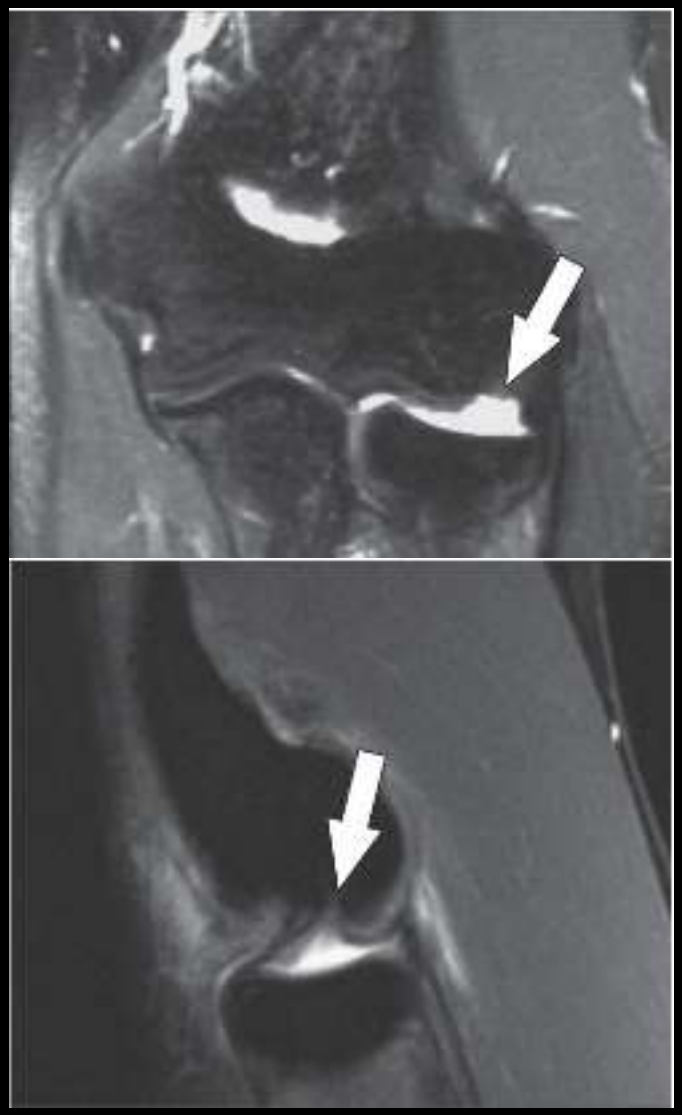


AJR 2008; 190:435–441

Osborne-Cotterill

- First described 1966
- Recurrent dislocations
- “an osteochondral fracture in the posterolateral margin of the capitellum with or without a crater or shovel-like defect in the radial head”
- No description of ligamentous pathology

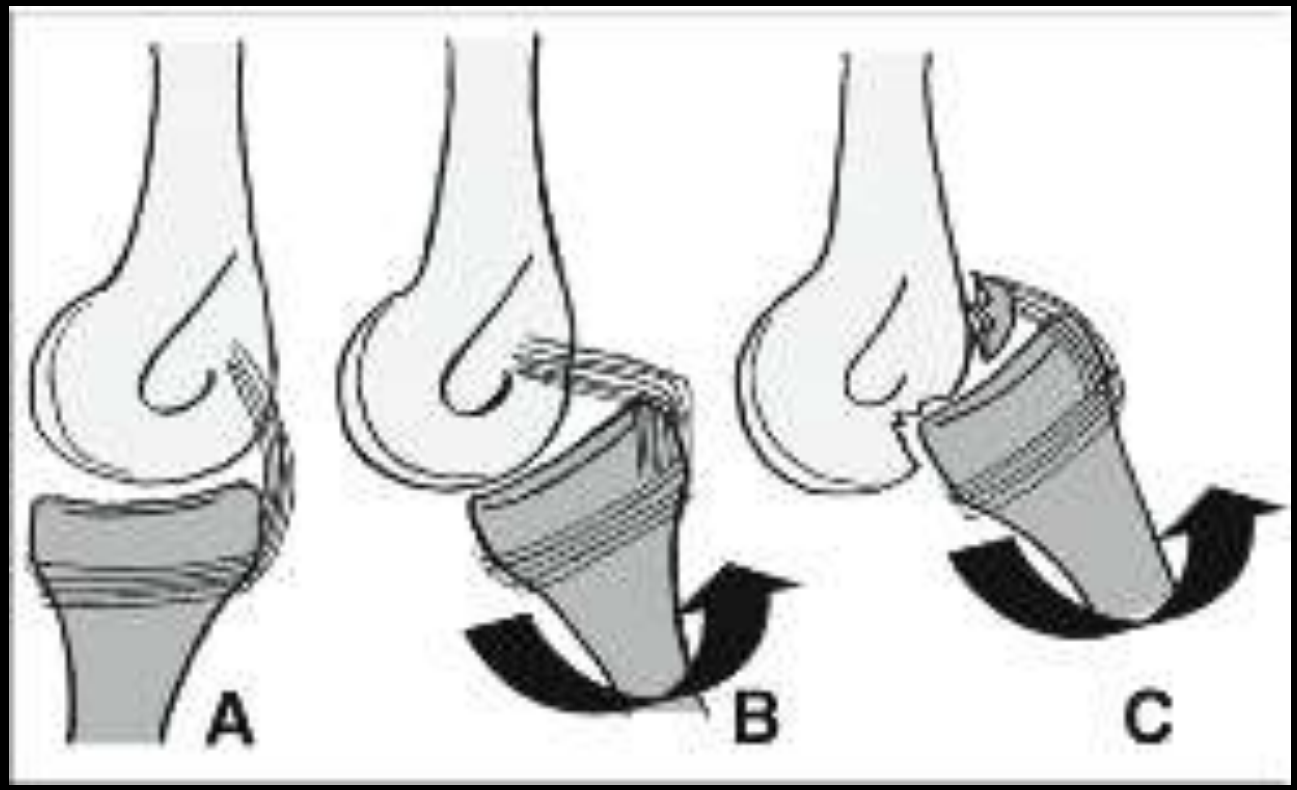
AJR 2008; 191:727–729

Osborne-Cotterill

- Recently described in patients with PLRI
- Shear fracture from posterolateral capitellum
- Poor coverage of radial head in extension
- *Probably on spectrum of posterior capitellar impaction fracture*

AJR 2008; 191:727–729

Osborne-Cotterill

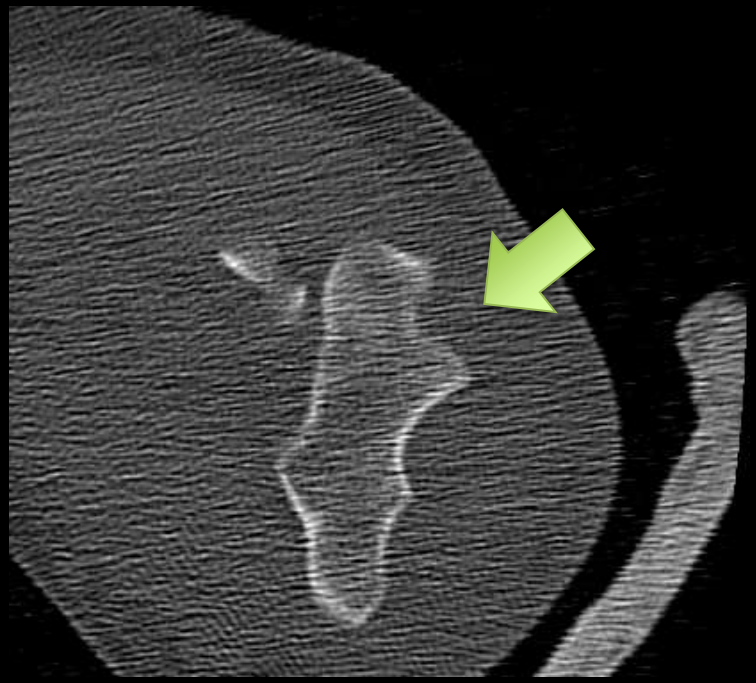


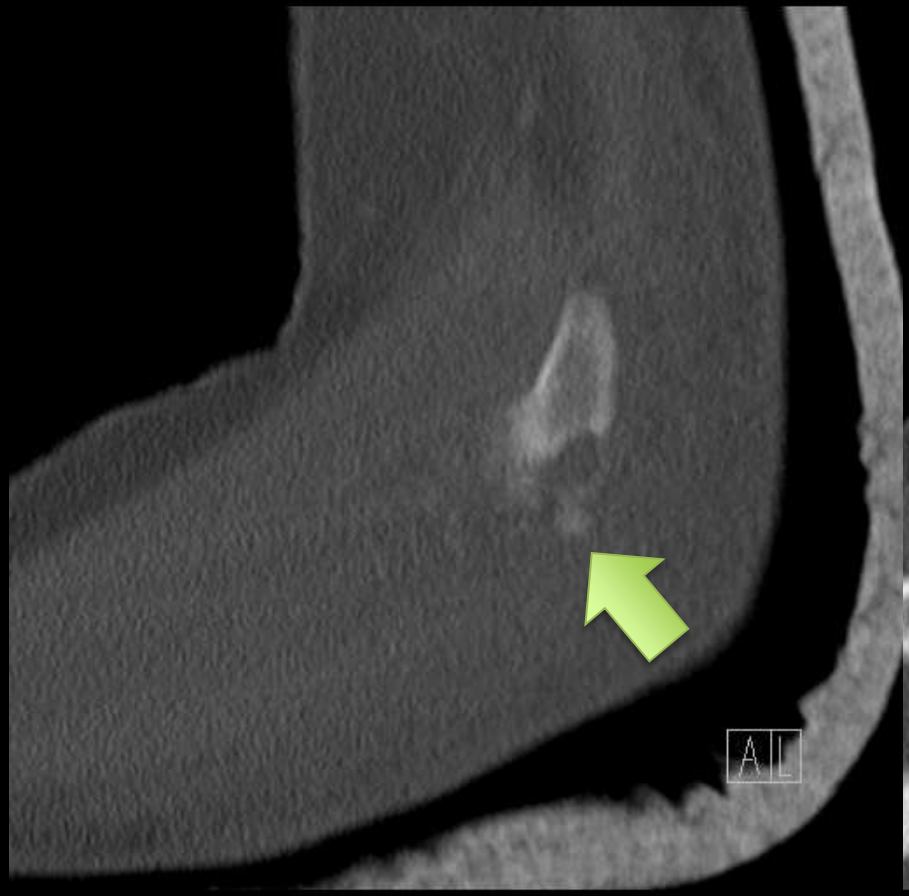
AJR 2008; 191:727–729

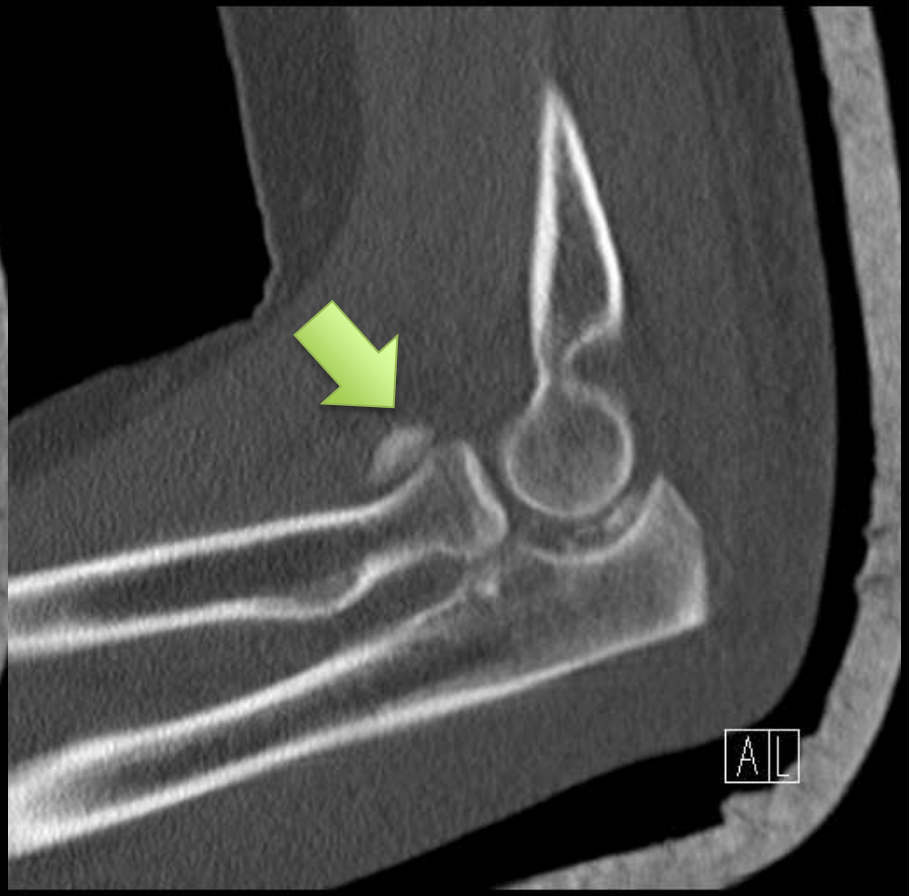
Osborne-Cotterill

AJR 2008; 191:727–729

Osborne-Cotterill? Posterior Impaction?




A
L


A
L

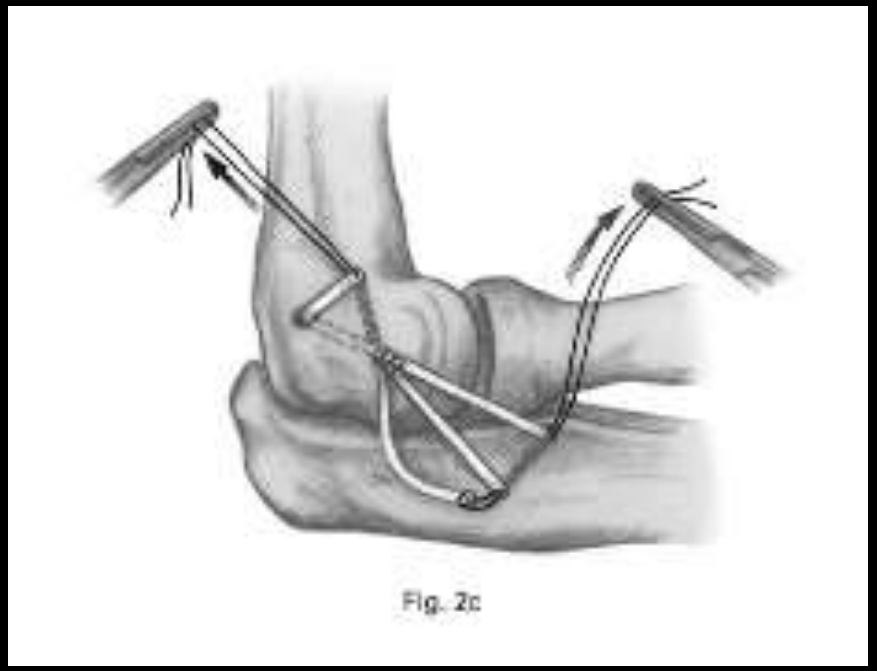
“Drop” Sign

- Lateral view
- Measure ulnohumeral distance
- Greater than 4 mm associated with instability in small series

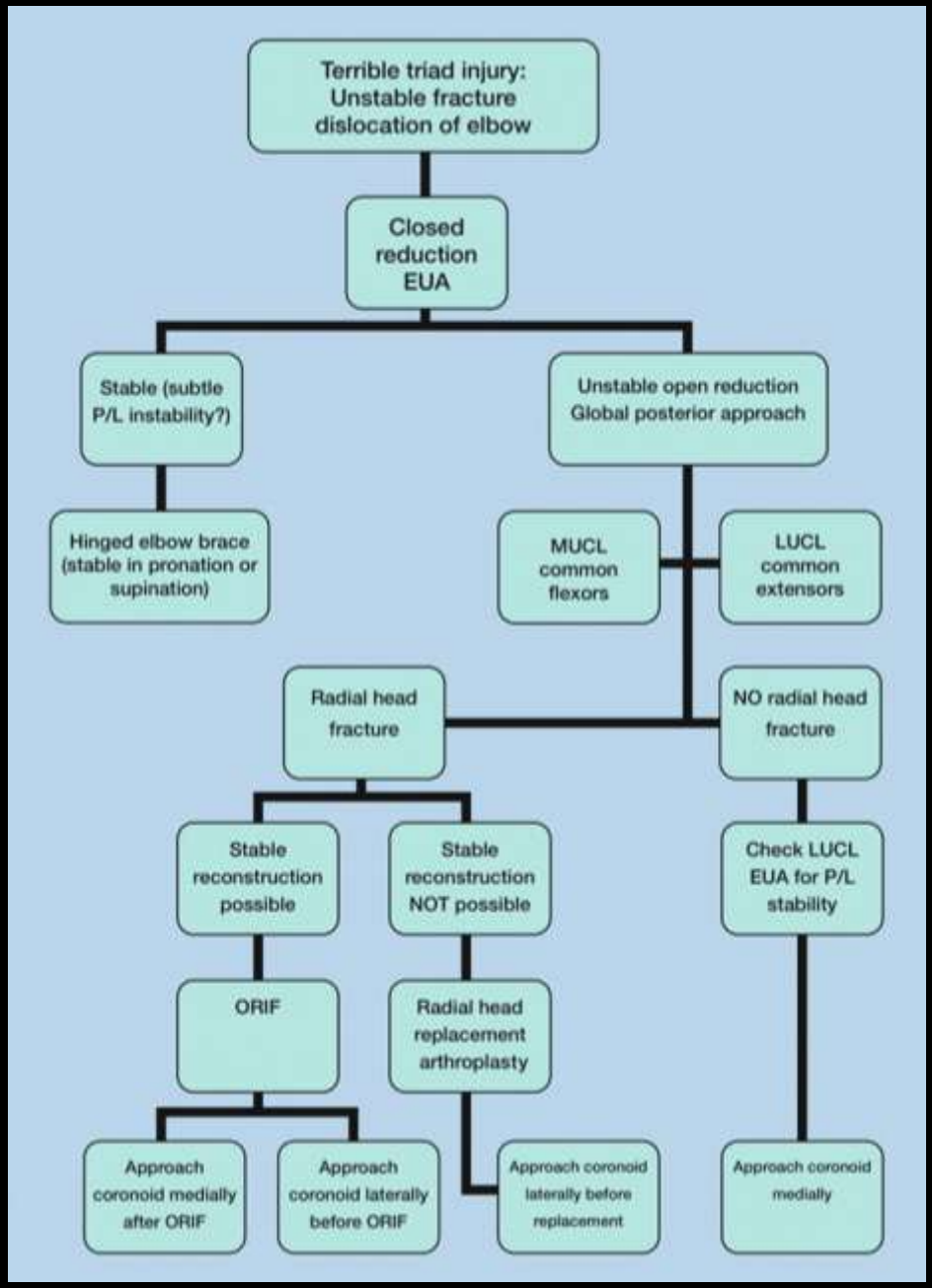
PLRI - treatment

- Acute simple
  - Conservative treatment based on stage of soft tissue injury
- Acute complex
  - Fracture fixation
  - Primary ligament repair or reconstruction (LUCL)
- Chronic
  - Ligament Reconstruction (LUCL)

YOUR READ MATTERS!



Sanchez-Sotelo, 2003


Terrible triad injury: Unstable fracture dislocation of elbow
Closed reduction EUA
Stable (subtle P/L instability?)
Unstable open reduction Global posterior approach
Hinged elbow brace (stable in pronation or supination)
MUCL common flexors
LUCL common extensors
Radial head fracture
NO radial head fracture
Stable reconstruction possible
Stable reconstruction NOT possible
Check LUCL EUA for P/L stability
ORIF
Radial head replacement arthroplasty
Approach coronoid medially after ORIF
Approach coronoid laterally before ORIF
Approach coronoid laterally before replacement
Approach coronoid medially

PLRI - treatment

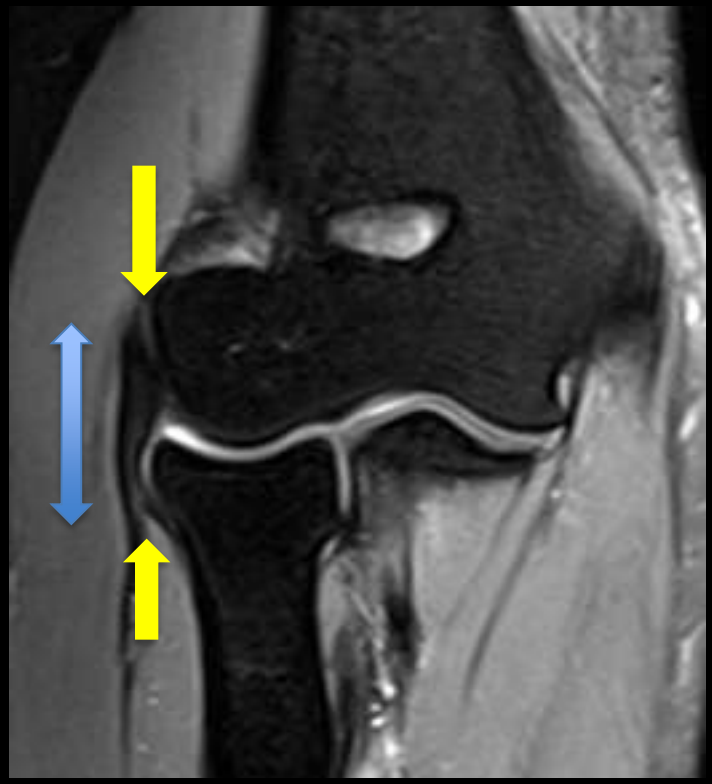
- Balance between maintaining ROM and congruency
  - Avoid contractures
  - Allow for anatomic healing
- Focused on key stabilizers
- Treatment likely aggressive in terrible triad injury

Varus Injury Patterns

- Pure varus injury
  - Isolated varus instability rare
- Varus posteromedial rotatory instability (PMRI)
  - Recently described in association with anteromedial coronoid fracture
  - LCL injury
  - +/- MCL injury

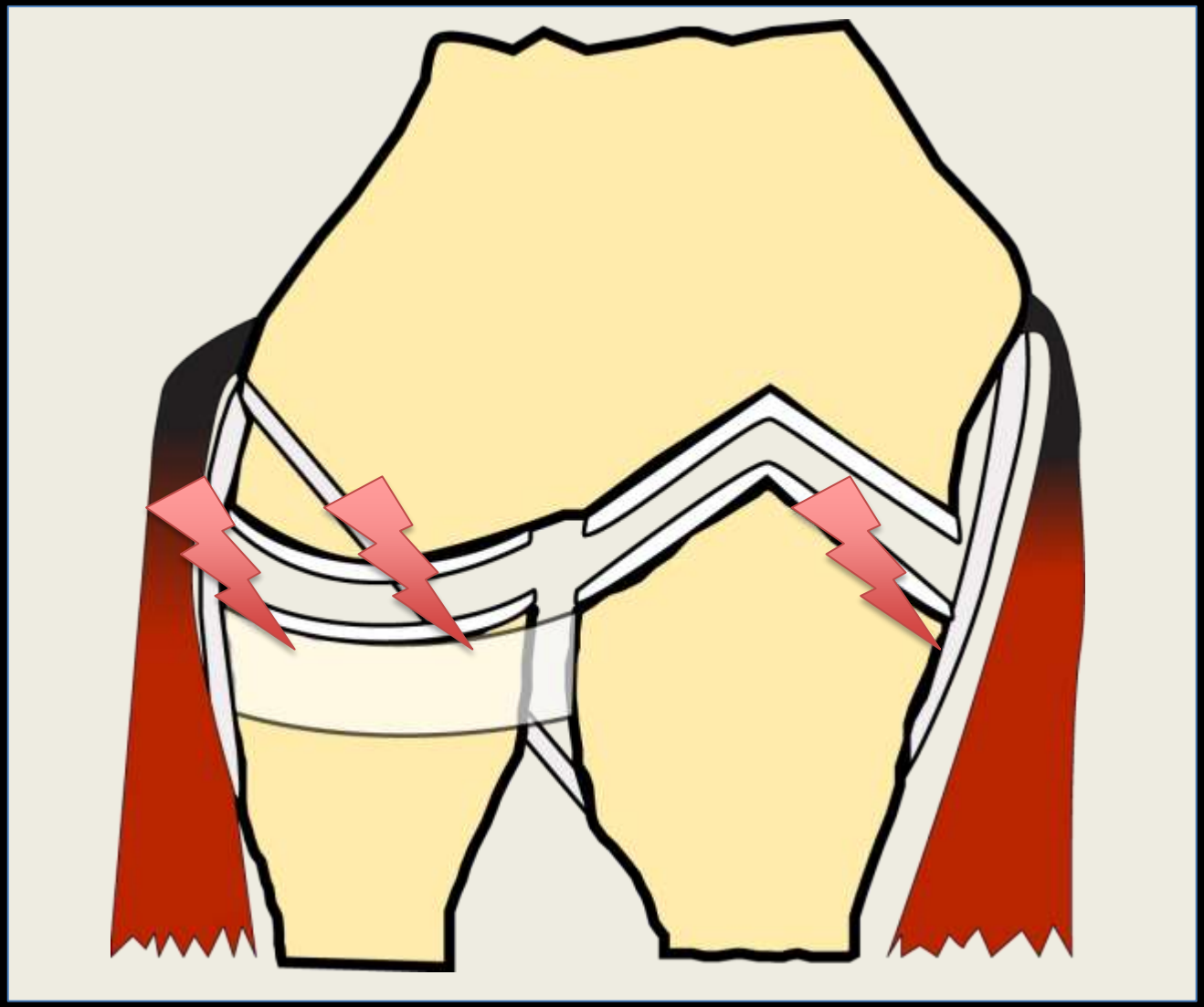
PMRI – Primary Stabilizers

- Lateral Collateral Ligamentous complex
  - Varus stabilizer



PMRI – Primary Stabilizers

- Coronoid Process
  - Varus (posteromedial rotatory) stabilizer



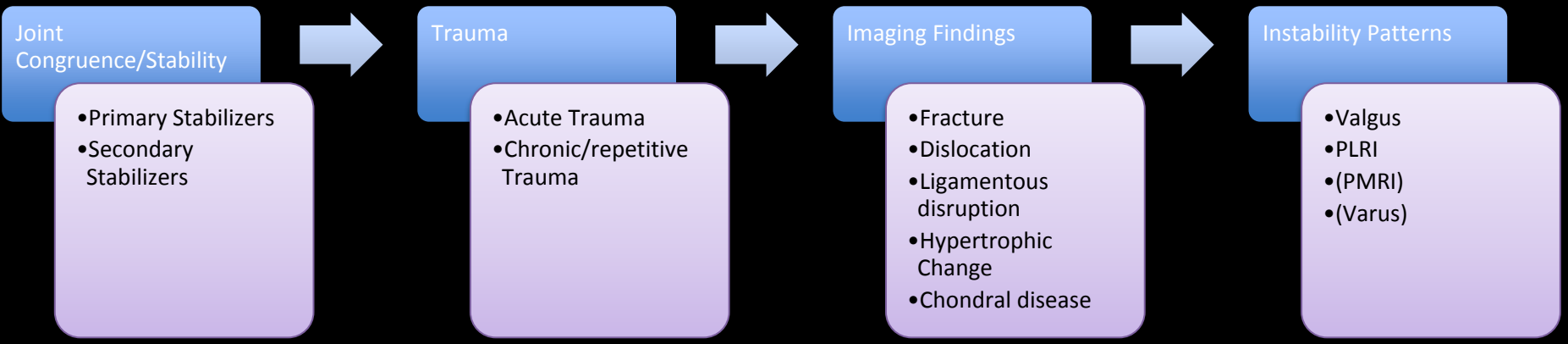
PMRI

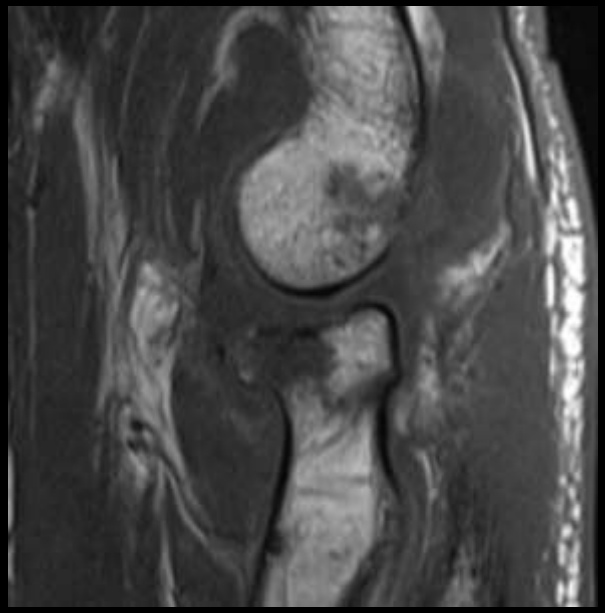
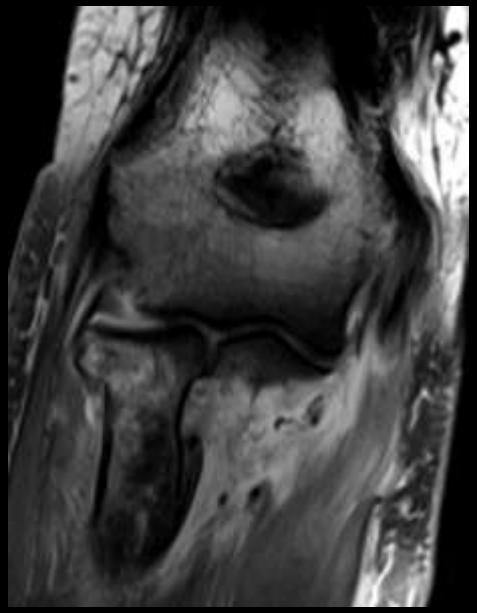
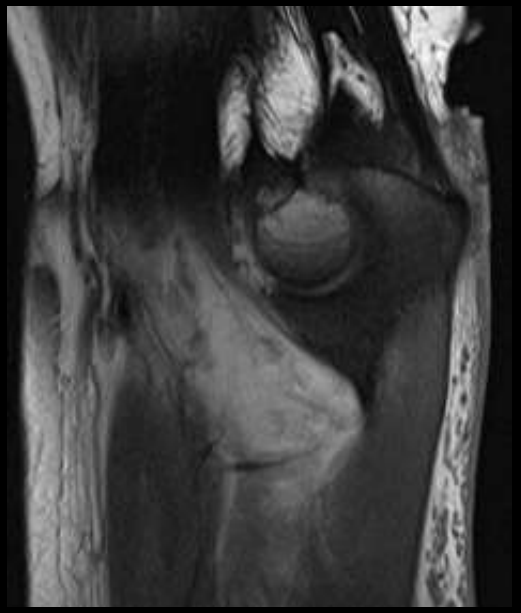
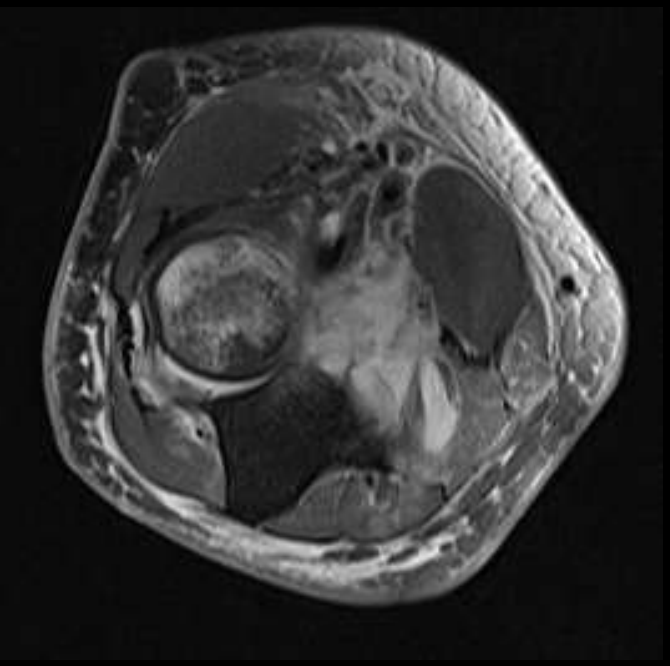
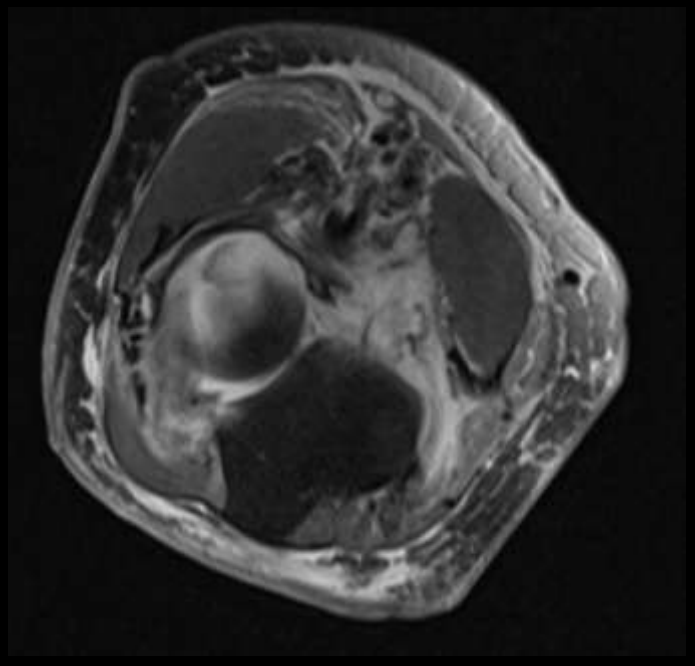
- Anteromedial coronoid fracture
  - O'Driscoll type 2
  - Look for involvement of sublime tubercle (MCL)
  - ORIF

PMRI

Doornberg, 2006

Concept 2


Joint Congruence/Stability
•Primary Stabilizers
•Secondary Stabilizers
Trauma
•Acute Trauma
•Chronic/repetitive Trauma
Imaging Findings
•Fracture
•Dislocation
•Ligamentous disruption
•Hypertrophic Change
•Chondral disease
Instability Patterns
•Valgus
•PLRI
•(PMRI)
•(Varus)

badness….

Thank you

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