Sports Related Injuries of the Elbow

James Wolff, MD
6/11/2009

Objectives

- MRI Protocol
- Osseous Anatomy and Pathology
  - Fractures/osteochondral lesions
- Capsular Anatomy and Pathology
- Ligament Anatomy and Pathology
  - Ulnar collateral ligament complex
  - Valgus instability
  - Radial collateral ligament complex
  - Varus instability
  - Posterolateral rotary instability
  - Elbow dislocation
- Tendon Anatomy and Pathology
  - Epicondylitis and overuse syndromes
  - Biceps tendon
  - Brachialis tendon
  - Triceps tendon
- Summary

MRI Protocol

- Positioning:
  - Supine with arm extended along side
  - Prone with arm extended overhead (swimmer's position)
    - Larger patients
    - Scanners that do not tolerate off-center imaging
    - Limitations: significant rotation of the proximal radius/ulna given pronated positioning limiting evaluation of the collateral ligaments and common tendon origins
- Extremity surface coil
- FOV 10-16 cm, 3-4 mm image thickness, 256 x 256 matrix
- Three imaging planes with axes for coronal and sagittal images derived from a transaxial scout (parallel and perpendicular to the axis of the humeral condyles)
  - Axial images acquired from the distal humeral metaphysis through the radial tuberosity
  - Collateral ligaments optimally visualized utilizing a 20 degree posterior oblique coronal plane in relation to the humeral diaphysis with the elbow extended and a coronal plane aligned with the humeral diaphysis with the elbow flexed 20-30 degrees
- Specialized flexed abducted supinated (FABS) position may provide better visualization of the biceps tendon
- Standard or FSE MR with occasional supplementation with gradient echo or STIR images

Resnick et. al., Kijowski et. al.

FABS

Chew et. al.

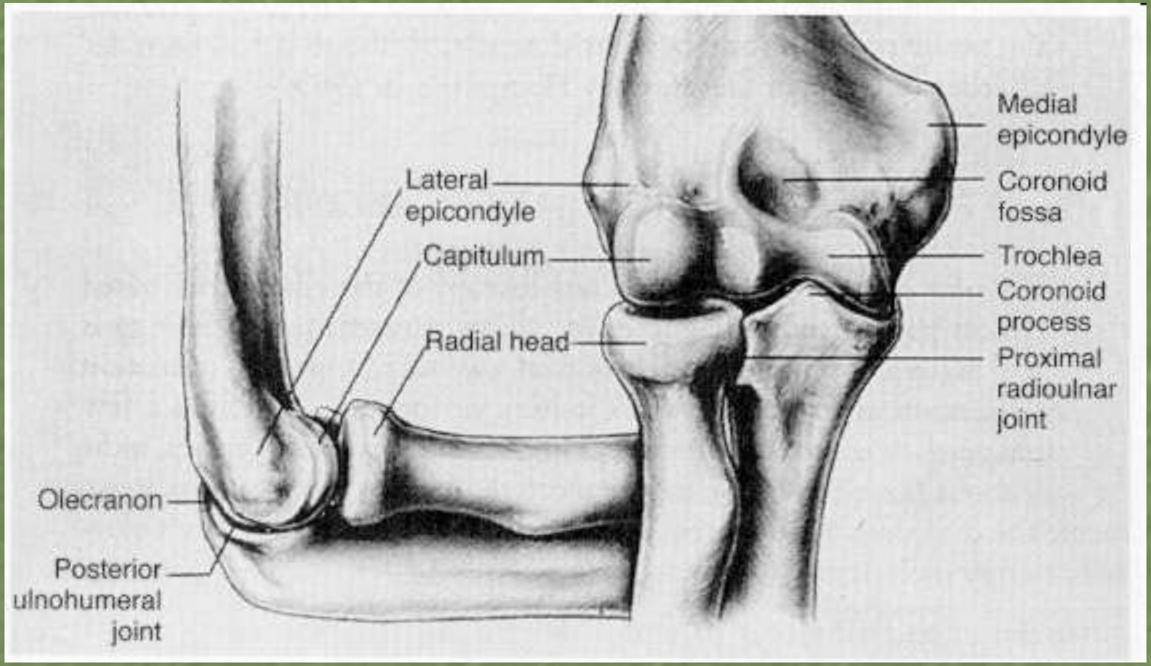
MR Arthrography (5 cc's)

Trochoginglymoid Joint

- Ulnohumeral joint
  - flexion/extension
  - hinge or ginglymoid joint
  - allows for ~150 degrees of elbow flexion
- Radiocapitellar and proximal radioulnar joints
  - axial rotation
  - trochoid joints
  - allows for ~75 degrees of forearm pronation and ~85 degrees of forearm supination

Kijowski et. al.

Basic Osseous Anatomy



Plancher et. al.

Pseudodefect of the Capitellum

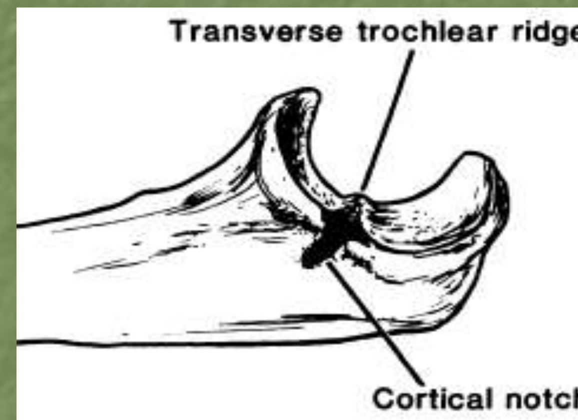
Kijowski et. al., Chung et. al.

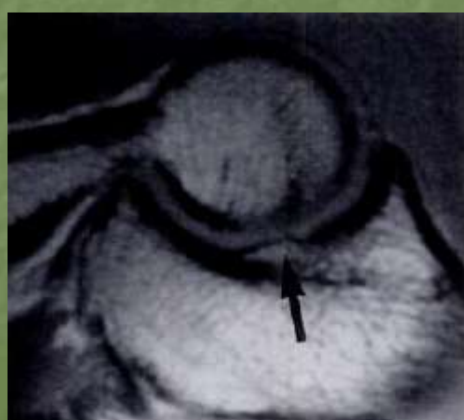
Pseudodefect of the Trochlear Groove or Sigmoid Notch

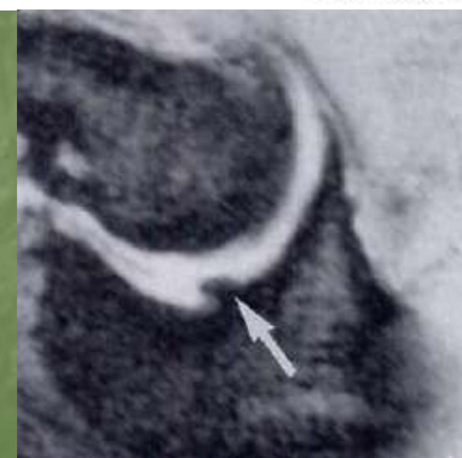
- Inward tapering of the trochlear groove of the ulna at the junction of the coronoid process and the olecranon

Rosenberg et. al., Chung et. al.

Trochlear Ridge







Rosenberg et. al.

Fat Pad Locations

Kijowski et. al.

Acute Medial Elbow Trauma – Valgus Force

- Compression of the humeroradial articulation
  - Osteochondral injury of the capitellar surface
  - Radial head/neck fracture
- Opening of the medial joint space with possible insufficiency of the medial supporting structures
  - Capsule
  - Ulnar collateral ligamentous complex
  - Common flexor tendon

Chung et. al.

Olecranon Stress Fractures in the Throwing Athlete

- Repetitive microtrauma caused by olecranon impingement or excessive triceps tensile stress
- Baseball players, javelin throwers
- Posteromedial pain most severe in the acceleration and follow-through phases of throwing
- Treatment
  - Conservative (one failed case required subsequent bone grafting)
  - Excision
  - Arthroscopically assisted fixation

Cain et. al., Kijowski et. al.

Cain EL et. al.

15 yr old male baseball pitcher with lateral elbow pain

Kijowski et. al.

Osteochondritis Dissecans

- "Compressive forces during the throwing motion are theorized to cause adaptive changes in the subchondral blood supply of the humeral capitellum, resulting in osteochondral injury and loose bodies from the capitellum or radial head." – "**repetitive microtrauma**"
- Emphasis placed on the valgus stress during the cocking phase of throwing with resulting significant compressive load at the radiocapitellar joint
- Definite relationship with baseball pitching and competitive gymnastics
- Treatment options:
  - Conservative with avoidance of throwing (favored in the absence of loose bodies, mechanical symptoms or failure of extended nonoperative treatment)
  - Operative with excision of loose bodies, capitellum debridement or fragment fixation
  - Autograft transplantation

Cain et. al., Stubbs et. al.,
Kijowski et. al.

OCD – competing theories

- Repetitive trauma – poorly vascularized capitellum (especially the anterolateral aspect)

- Genetic factors

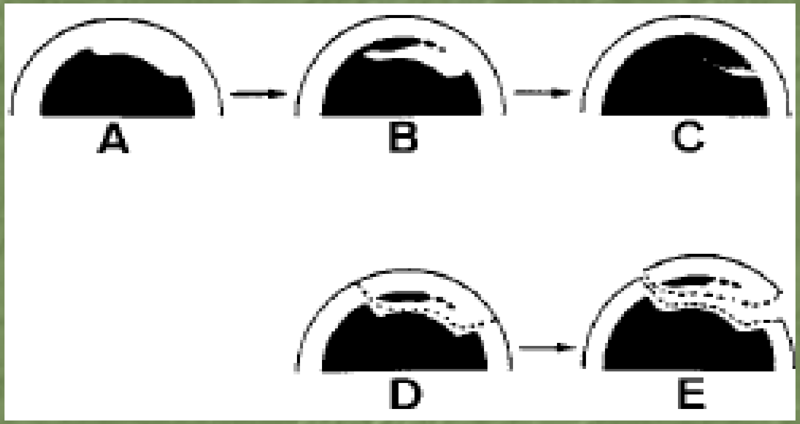
- Biomechanical properties in the articular cartilage overlying the radial head and capitellum – central portion of the radial head is stiffer than the adjacent capitellum possibly leading to increased strain in the lateral capitellum during high valgus stress

Kijowski et. al.

OCD - Variations

Takahara et. al.

Natural Course of OCD



- A: Localized subchondral bone flattening with thickening of the overlying cartilage
- B: New bone formation
- C: Union of newly formed bone with underlying bone
- D: Repetitive forces can make fragments unstable
- E: Unstable fragment fails to unite and is displaced into the joint

Takahara et. al.

OCD – Role of Imaging

- Evaluate intergrity of the overlying cartilage
- Determine the stability/viability of the separated bone fragment
  - Interface of the osteochondral lesion – presence of fluid/granulation tissue (i.e., increased T2 signal or ring of enhancement) signals instability; role of MRA
  - Enhancement of the fragment signals viability; intact vasculature
- Note the presence of intraarticular bodies
  - Role of MRA
- Some reports suggest that early stages of the disease demonstrate regions of low T1 and normal T2 signal

Chung et. al., Kijowski et. al.

OCD – Normal Healing




Takahara et. al.

Distinguishing from Panner's disease

- Osteochondrosis of the humeral capitellum
- Affects ages of 7-12 (vs. 12-15) during period of active ossification of the capitellar ephysis
- Fragmentation of the capitellar ossification center with irregular areas of relative sclerosis intermixed with rarefaction
- Benign, self-limiting condition with osteochondral bodies never forming

Kijowski et. al.

Panner's disease

Capsular Anatomy and Pathology

- 2-layer capsule
  - Deep synovial layer
  - Superficial fibrous capsule
- Fat pads are interposed between the two layers
- Synovial fringe – i.e., septal remnant or incomplete plicae

Chung et. al.

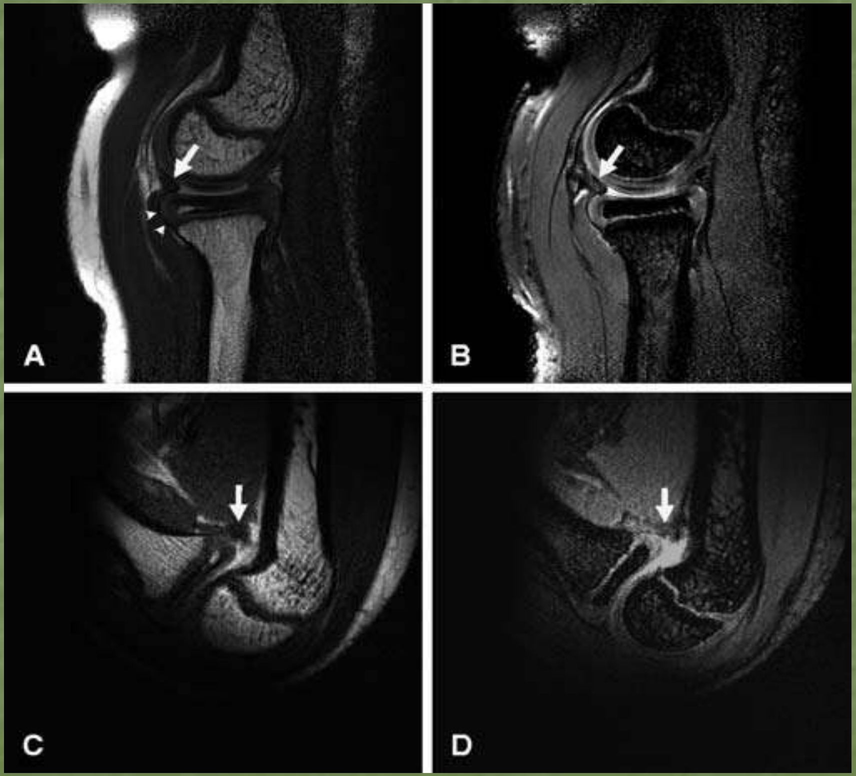
Synovial Fringe

- Synovial fold is a remnant of a septum which divides the joint during normal embryonic development
- Folds in the humeroradial joint classified into anterior or posterior types (lateral types being comparatively rare)

Fukase et. al., Chung et. al.

Painful Snapping Elbow

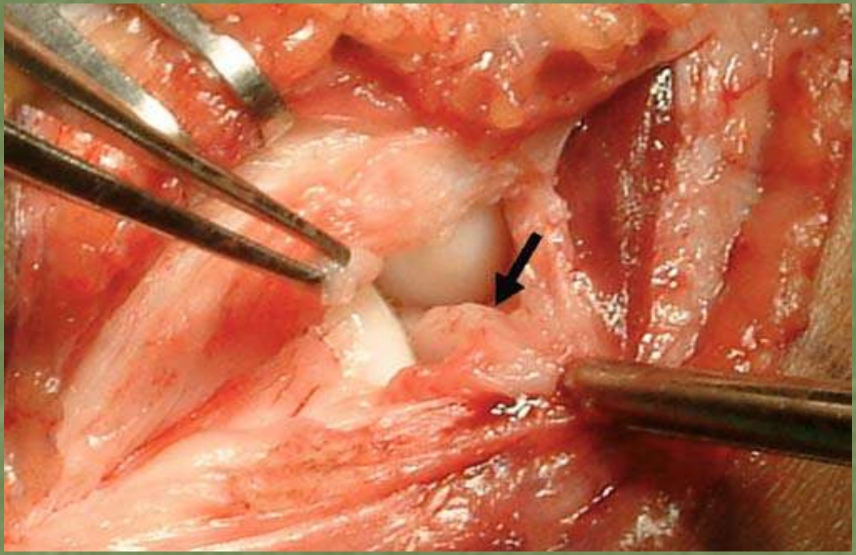
- With flexion, compression between the capitellum and radial head forces the synovial fold to move out of the humeroradial joint and slip over the radial head anteriorly (thus the "snapping" sensation)
- Repetition of the "snapping" action results in degeneration and eventual hypertrophy of the fold leading to symptomatology



Fukase et. al.

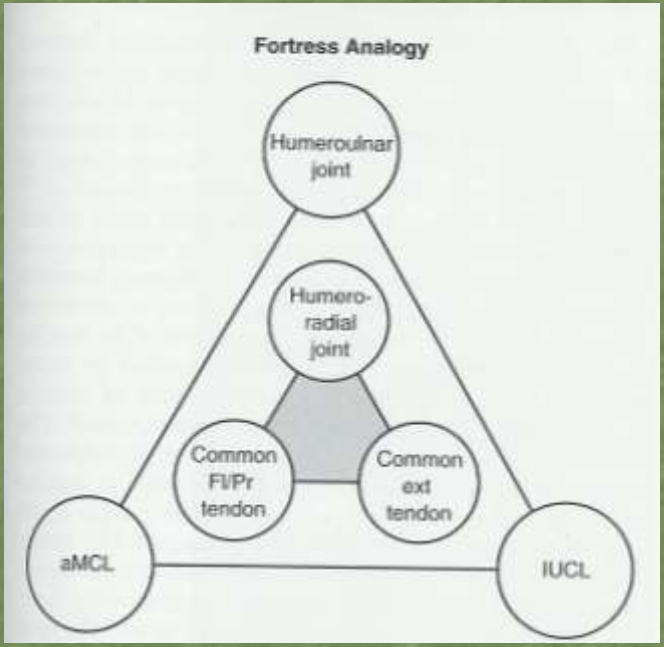
Painful Snapping Elbow - Treatment

Treatment includes operative resection



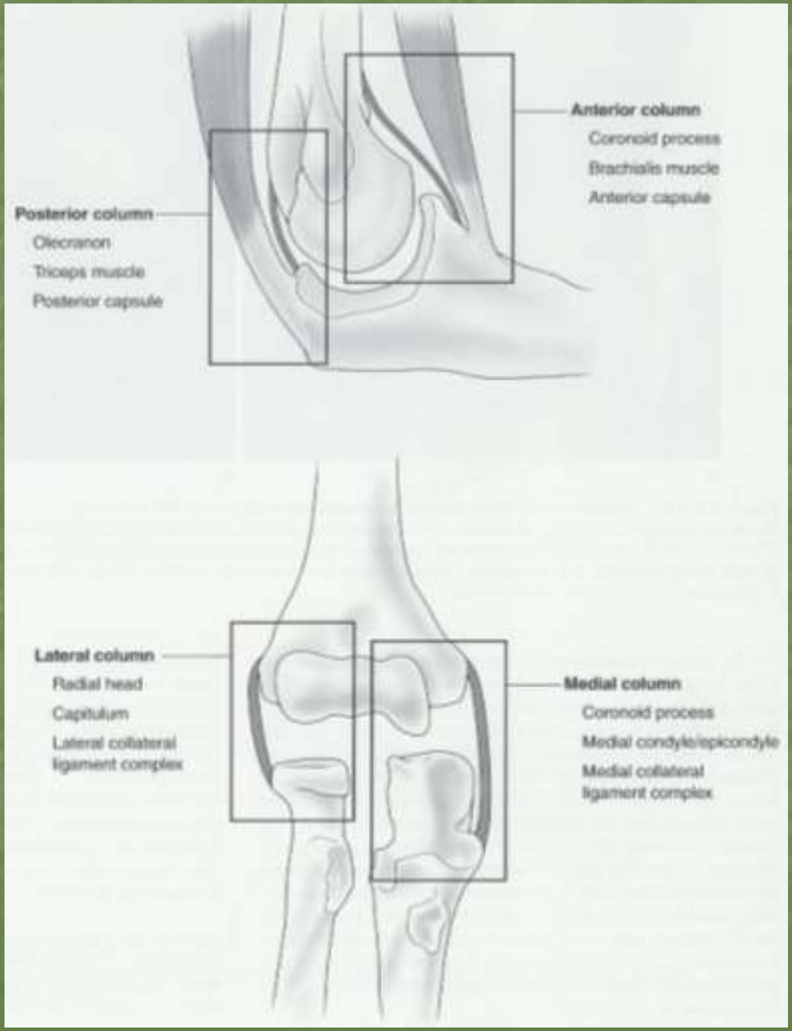
Fukase et. al.

Stabilizing Structures of the Elbow



Resnick et. al.

Four Column Theory



Resnick et. al.

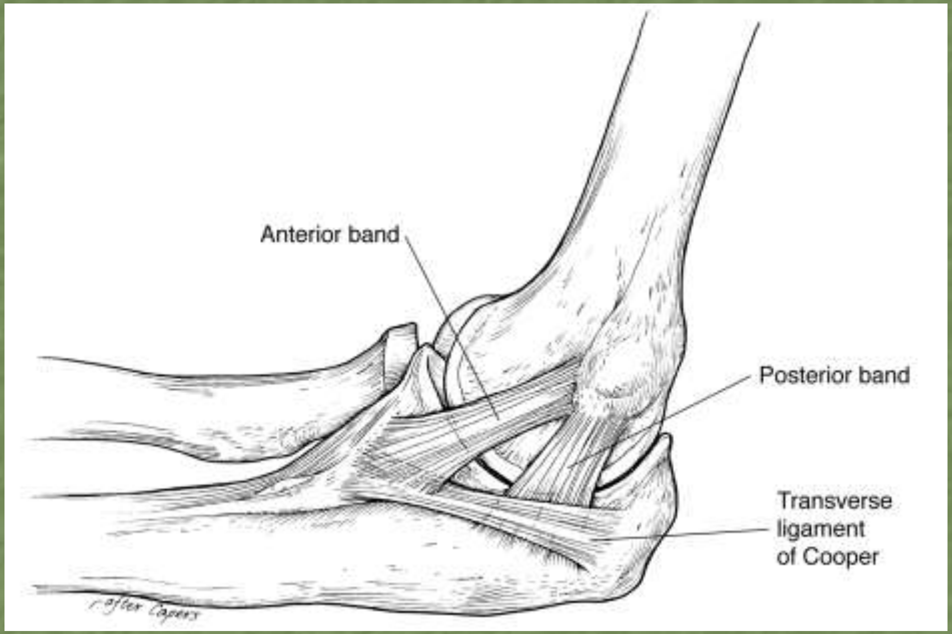
Ulnar Collateral Ligament

- Originates from the central 65% of the anteroinferior surface of the medial epicondyle

- 3 bundles
  - Anterior bundle taut from full extension to 60 degrees of flexion; strongest and stiffest with distal attachment on the sublime tubercle
    - Anterior band (taut 0-60 degrees)
    - Posterior band (taut 60-120 degrees)

  - Posterior bundle taut from 60 to 120 degrees of flexion attaching in a broad fashion along the medial ulna

  - Transverse bundle (aka, Cooper's ligament) bridging the bases of the anterior and posterior bands



Chung et. al., Mehta et. al.,
Kijowski et. al.

UCL in Throwing Athletes

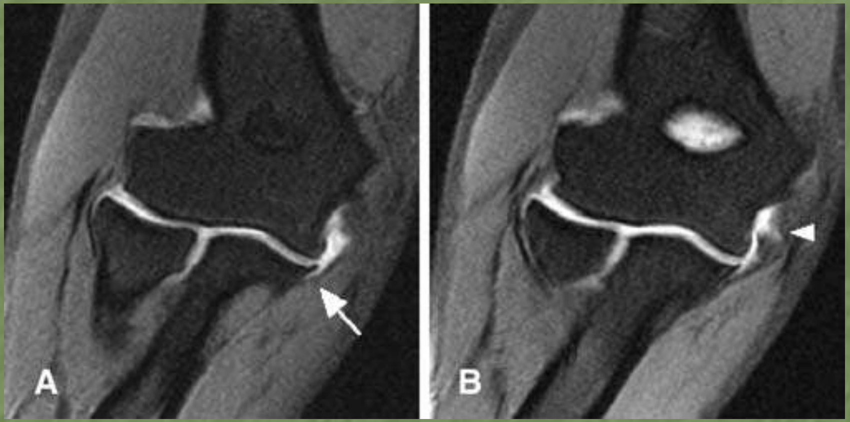
- Anterior bundle of the UCL is the primary restraint to valgus stress
- Radial head is a secondary restraint
- Transition from the late cocking phase to early acceleration places extreme valgus stress on the medial structures of the elbow

Hyman et. al.

Anterior Bundle – normal vs. high-grade partial tear

Kaplan et. al., Kijowski et. al.

UCL Tears - MRA

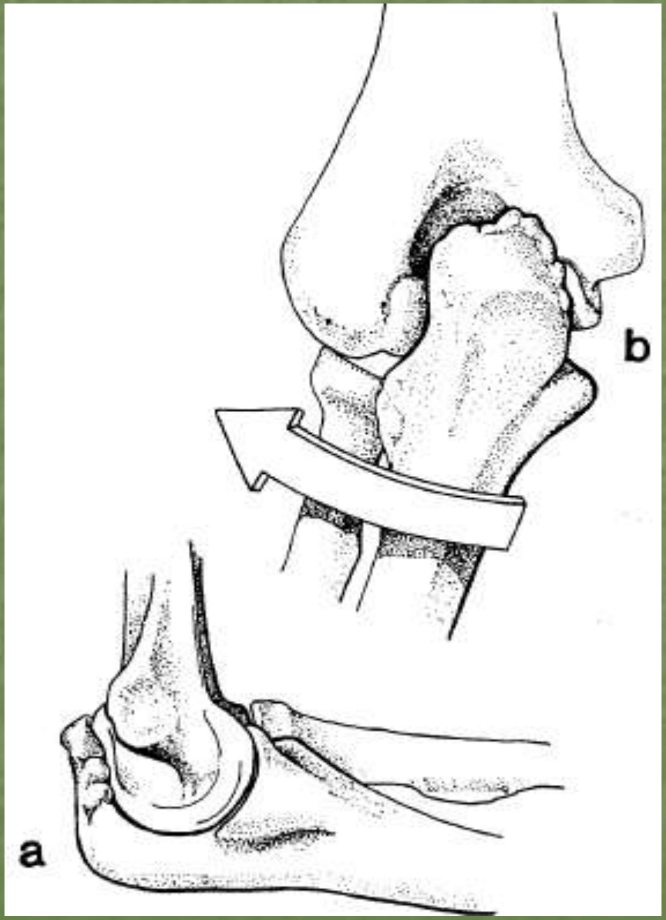


- Ulnar collateral recess – potential space beneath the medial epicondyle measuring ~3mm in length positioned between the anterior bundle of the UCL and the medial aspect of the humeral trochlea
- Distal portion of the anterior bundle inserts within 1mm of the articular surface of the coronoid process

Kijowski et. al.

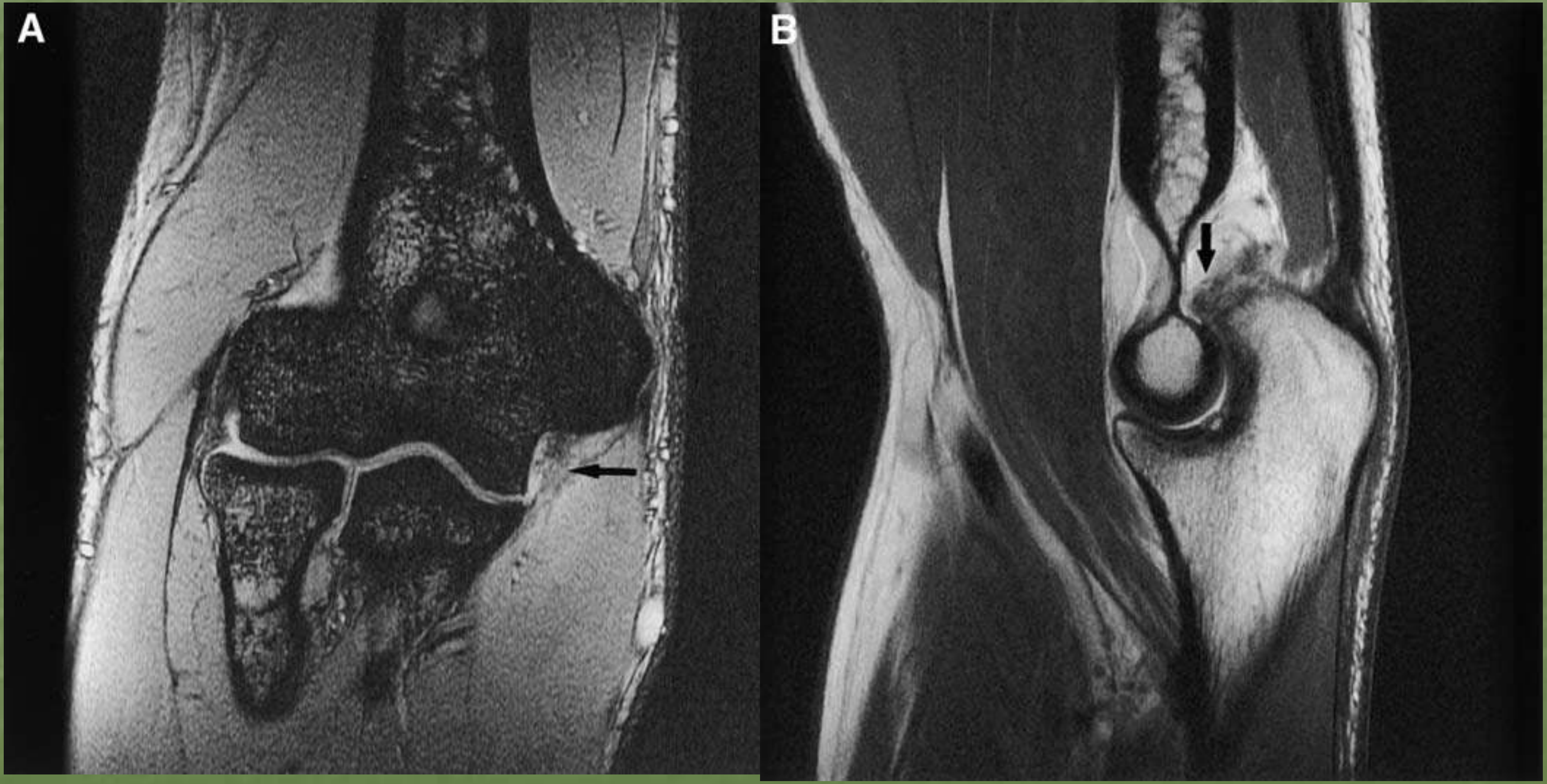
Valgus extension overload syndrome

- Anterior bundle of the UCL is intact but attenuated secondary to repetitive microtrauma sustained during overhead throwing
- This attenuation allows the posteromedial olecranon tip to impinge against the medial aspect of the olecranon fossa during the early and late acceleration phases of throwing
- Impingement results in the formation of olecranon tip (posteromedial) osteophytes and articular cartilage damage overlying the posteromedial trochlea
- Loose bodies may form
- Valgus laxity may lead to excessive medial tension and subsequent pathology



Kijowski et. al., Cain et. al.

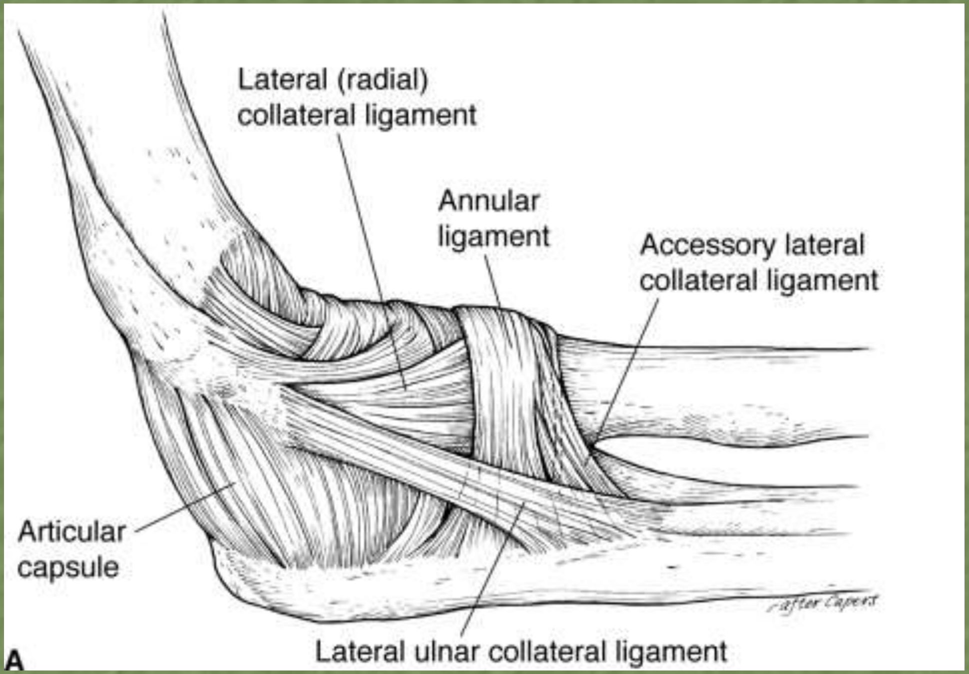
Partial MCL tear with fractured posteromedial olecranon osteophyte in a case of posteromedial impingement syndrome



Kaplan et. al.

Radial Collateral Ligament

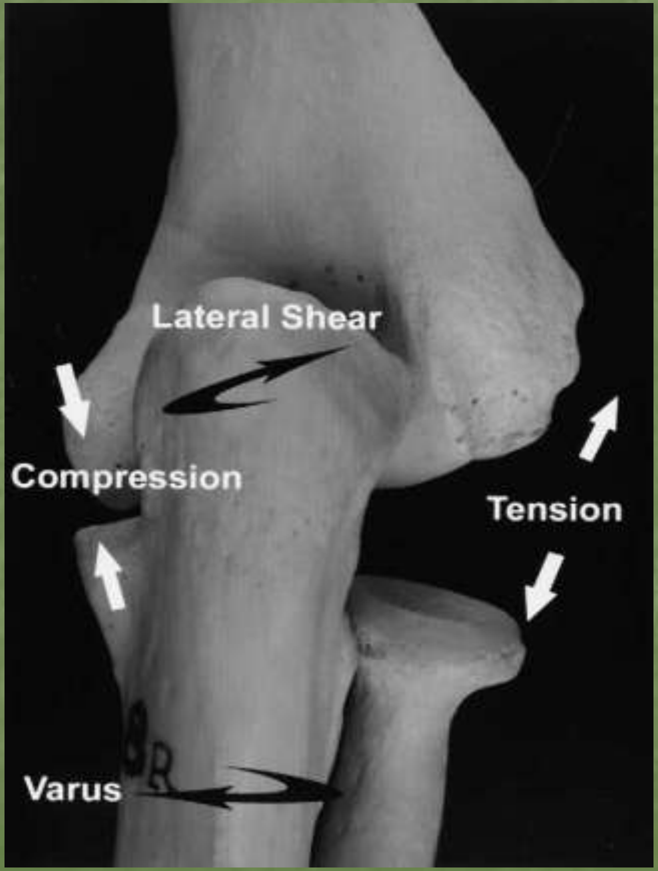
- Radial collateral ligament – triagular band that extends from the lateral epicondyle to the annular ligament and remains taut throughout normal flexion/extention
- Annular ligament – circular in shape extending around the radial head/neck junction, attaching to the anterior and posterior margins of the radial notch of the ulna; restraining ligament, maintaining position of the radial head
- Lateral ulnar collateral ligament extends from the lateral epicondyle posteriorly to cradle the head/neck junction of the radius before inserting on the supinator crest of the ulna; taut in flexion /extension and one of the primary stabilizers of the elbow
- Accessory lateral collateral ligament – extends from the annular ligament to supinator crest; not uniformly present, but may stabilize annular ligament in varus stress



Chung et. al., Mehta et. al.

Varus Instability

- Mechanism: stress applied to the medial side of the articulation, resulting in compression on that side, with opening of the lateral articulation and subsequent insufficiency of the radial collateral ligament
- Must inspect both RCL and annular ligament given intimate association



Chung et. al.

Varus Instability

Cotton et. al., Chung et. al.

Posterolateral Rotary Instability

"best defined as a three-dimensional kinematic disturbance of joint motion in which the radius and ulna subluxate with respect to the distal part of the humerus, such that the bones of the forearm displace into a position of external rotation and valgus during flexion of the elbow"

Resnick et. al.

PLRI - Mechanism

- "fall on out-stretched hand"
- Axial compressive force during flexion as the body approaches the ground
- Body rotates internally on the elbow while the forearm rotates externally on the humerus
- All the while supination is occurring at the elbow
- Summation:
  - Valgus
  - Supination
  - Axial compression

Chung et. al.

PLRI – Distinction from Radial Head/Elbow Dislocation

- Insufficient LUCL allows posterior subluxation or dislocation of the radial head with secondary rotary subluxation of the ulnohumeral joint
- Annular ligament remains intact, and thus the proximal radius/ulna move as a unit
- This is in contradistinction to radial head/elbow dislocation where the annular ligament is torn, allowing the radial head and proximal ulna to dissociate from one another

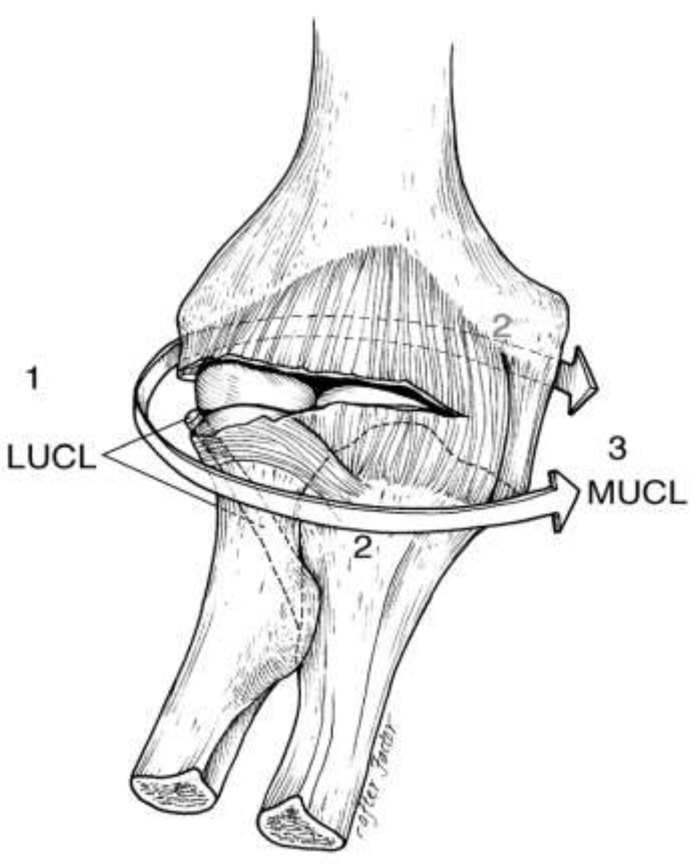
Kijowski et. al.

PLRI - Additional Causes

- Iatrogenic
  - Prior radial head resection or lateral ligamentous release
- Chronic overuse (prolonged use of crutches)
- Generalized ligament laxity
- Chronic cubitus varus deformity
- Lateral epicondylitis with repeated corticosteroid injections into the region of the lateral tendons

Resnick et. al.

Posterolateral Rotary Instability



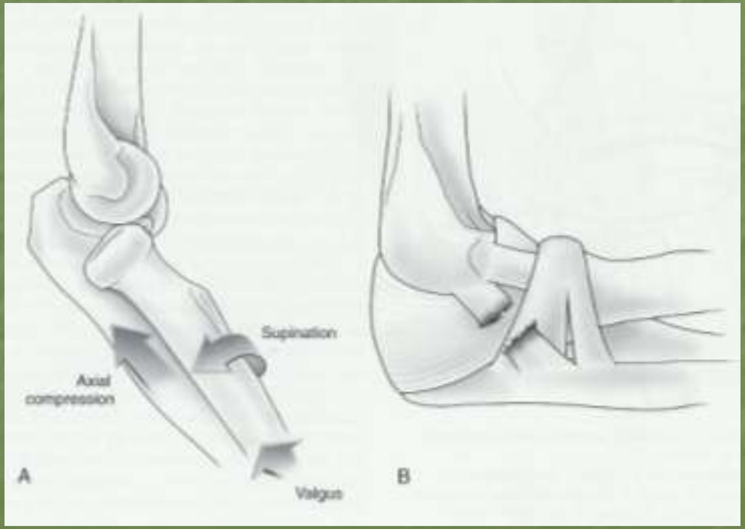
Three-stage circle-like soft-tissue disruption (aka Horri circle)

- Stage 1: LUCL disruption
- Stage 2: anterior and posterior capsule disruption
- Stage 3: MCL disruption

Mehta et. al., Resnick et. al.

PLRI – Stage 1

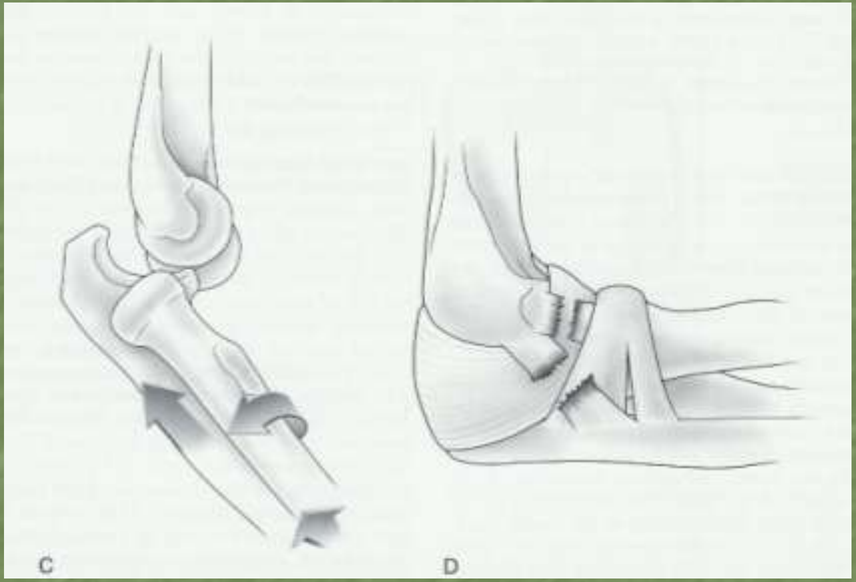
Disruption of the LUCL (proximal portion) with posterolateral subluxation of the elbow



Resnick et. al., Kijowski et. al.

PLRI – Stage 2

The elbow dislocates incompletely so that the coronoid is perched under the trochlea. The RCL, and anterior and posterior portions of the capsule, are disrupted in addition to the LUCL.



Chung et. al., Kaplan et. al.

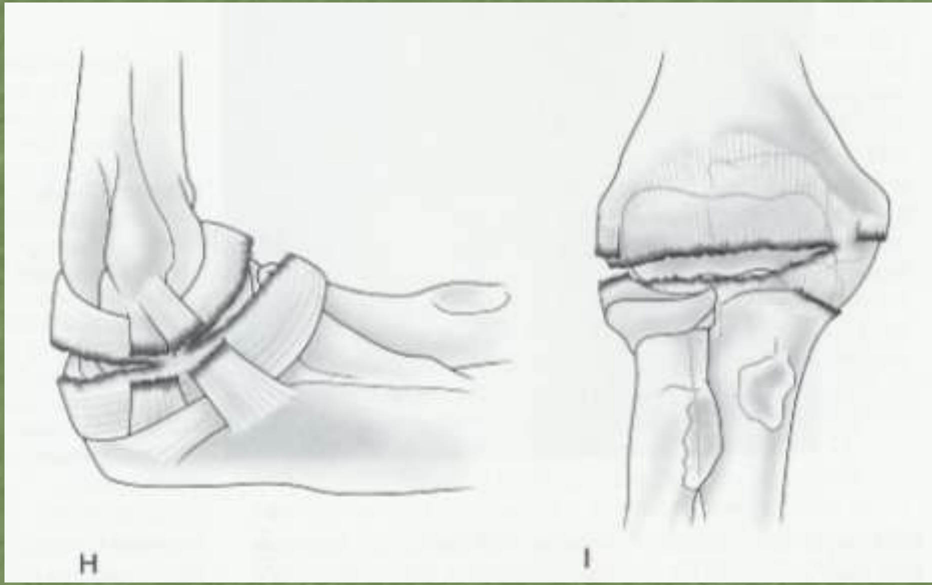
PLRI – Stage 3A

Posterior band of the MCL is injured; the anterior band of the MCL remains intact with the elbow stable to valgus stress after reduction

Resnick et. al., Chung et. al., Kaplan et. al.

PLRI – Stage 3B

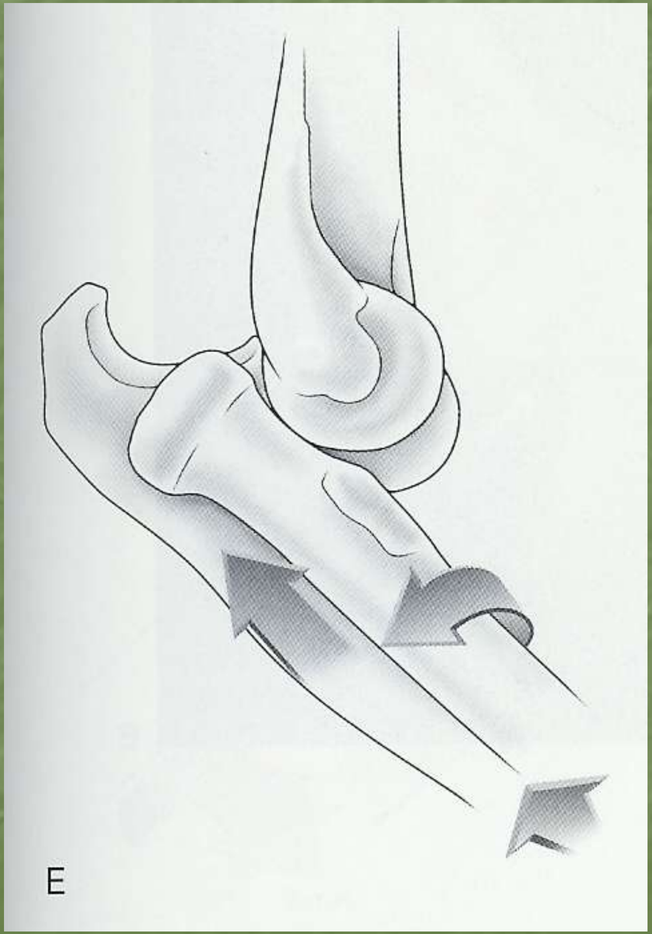
The anterior band of the MCL is disrupted with an unstable elbow under varus, valgus, and rotational stress



Resnick et. al., Chung et. al., Kaplan et. al.

PLRI – Stage 3C

Disruption of remaining soft tissue-stabilizing structures (i.e., origins of the common flexor and extensor tendons)



Resnick et. al., Chung et. al., Kaplan et. al.

Sequelae of PLRI

- Inability to maintain full extension
- Posterior subluxation of the radial head with respect to the capitellum

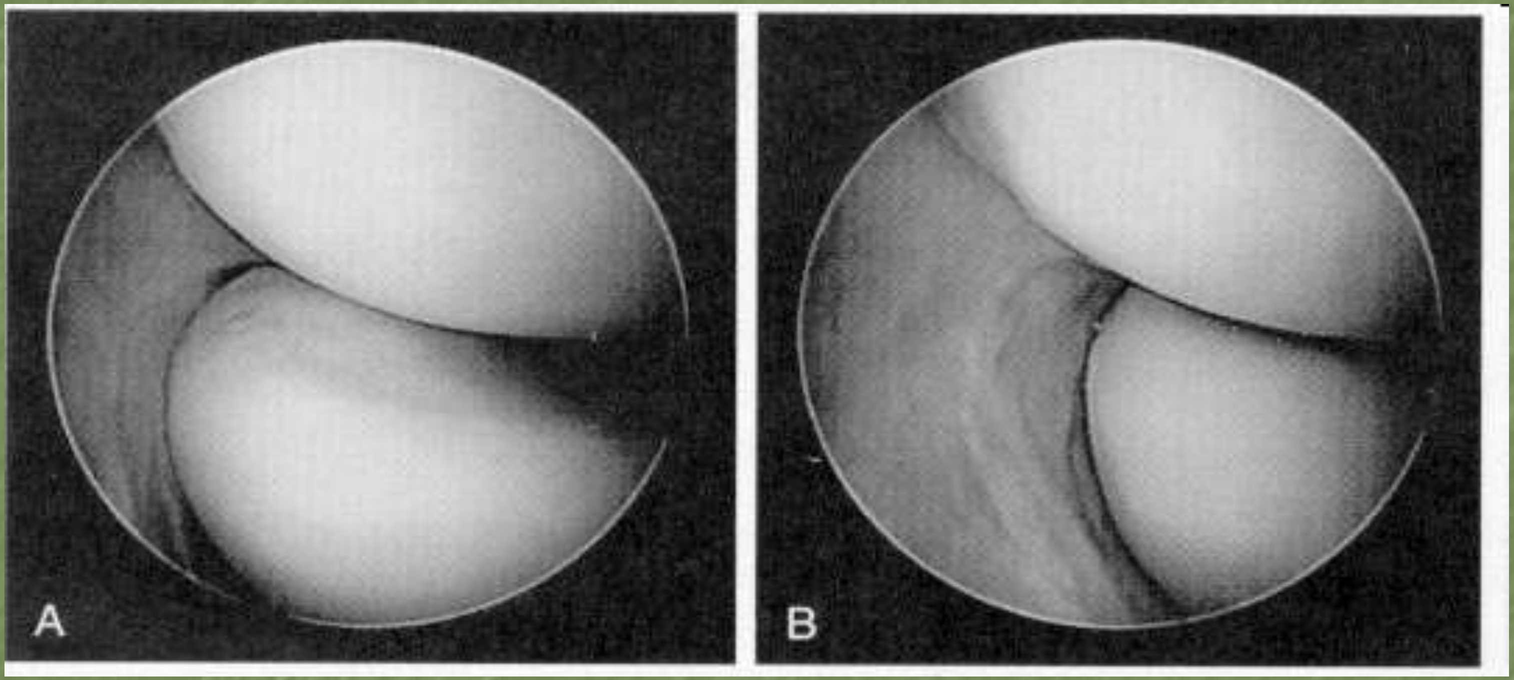
Kaplan et. al.

Lateral Pivot Shift Test

- With the arm at the side in supination, a valgus and axial compression force is placed on the elbow
- As the elbow is flexed to 20-30 degrees, there is posterior subluxation or dislocation of the radial head and secondary rotary subluxation of the ulnohumeral joint
- Further flexion cause a sudden palpable and visible reduction of the radiohumeral joint

O'Driscoll et. al.

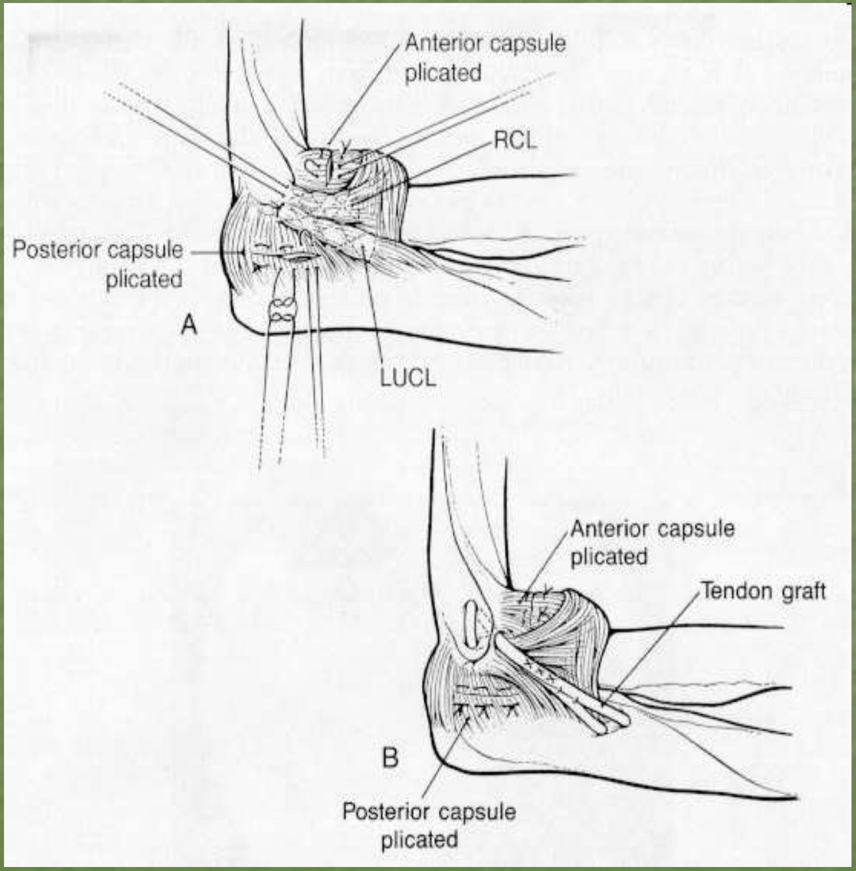
Arthroscopic Evaluation of PLRI



…illustrating posterior subluxation of the radial head

Smith et. al.

PLRI Repair



- Repair of the LUCL by imbrication and reattachment to its insertion point on the lateral epicondyle along with plication of the redundant posterolateral capsule

  Versus

- Reconstruction of the ligament with a free tendon graft and capsular plication

Smith et. al.

Elbow Dislocation

- Mechanism: fall on the out-stretched hand leading to posterior displacement of the olecranon on the humerus
- Combination of valgus, supination and axial forces
- Disruption of a soft tissue ring that progresses from posterolateral through the anterior and posterior capsule to the MCL
- Essential lesion for a complete dislocation must involve the MCL
- Relationship between PLRI and dislocation described as a continuum rather than a distinction

Plancher et. al., Smith et. al.

Fracture dislocation

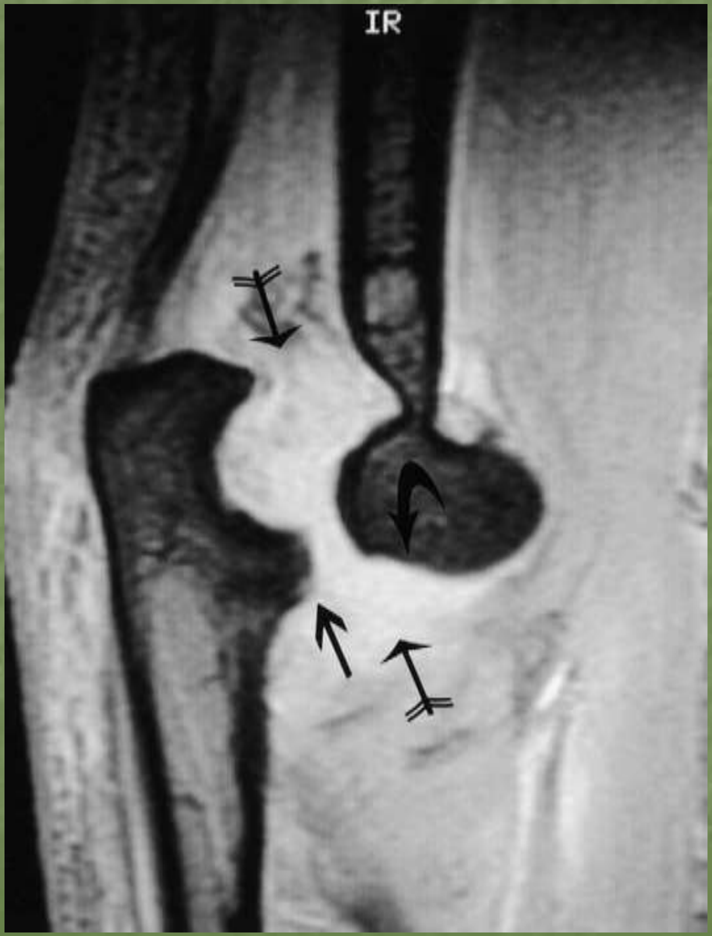
- In complex dislocations, greater amounts of axial, valgus and rotational forces are applied
- Fractures most commonly involve the coronoid and radial head with less frequent involvement of the humeral epicondyles
- "terrible triad"
  - Radial head fracture
  - Coronoid fracture
  - MCL tear
- The small flake fracture of the coronoid is not an avulsion fracture but rather a shear fracture
- With disruption of the ring of soft tissues from posterolateral to medial, the capsule is also disrupted allowing joint fluid to dissect through the soft tissue planes of the forearm. This negates an indirect radiographic sign of trauma in the elbow, that of the joint effusion

Chung et. al., Plancher et. al.

Fracture dislocation

Points to note:

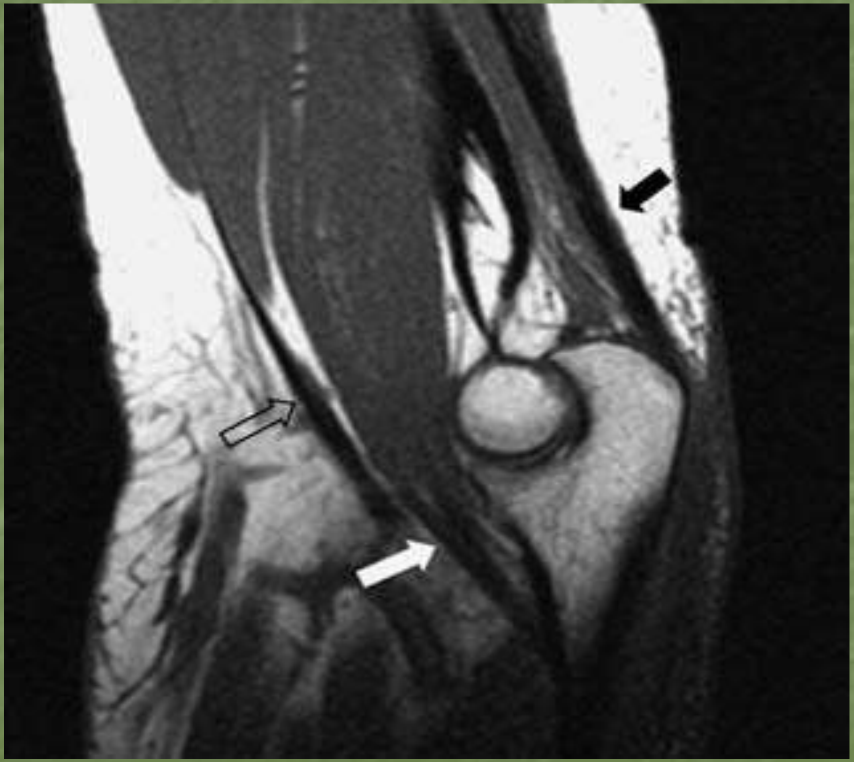
- Anterior subluxation of the humerus
- Coronoid process fracture
- Irregularity of the articular surface of the olecranon
- Disruption of the anterior and posterior capsule



Chung et. al.

Tendon Anatomy

- Lateral
  - Supinator
  - Brachioradialis
  - Extensors of the hand and wrist
- Medial
  - Pronator teres
  - Palmaris longus
  - Flexors of hand and wrist
- Anterior
  - Biceps brachii
  - Brachialis
- Posterior
  - Triceps
  - Anconeus



Chung et. al., Kijowski et. al.

Lateral Epicondylitis

- Pathologic condition of the common extensor tendon at its origin from the lateral epicondyle
- Excessive use of the wrist extensor muscles
- a.k.a. – "tennis elbow" (affecting up to 50% of tennis players at some point) although condition far more common in non-tennis players and non-athletes for that matter
- 40-60 yrs of age with equal sex distribution

Kijowski et. al.

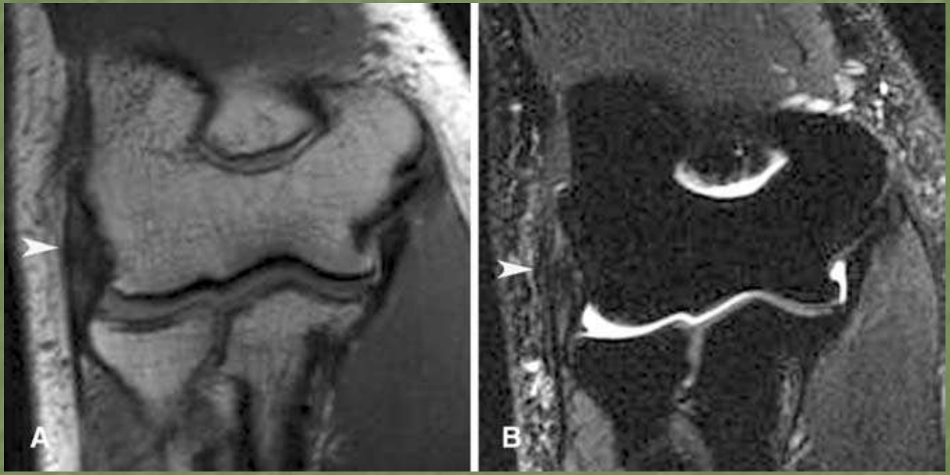
Lateral Epicondylitis - Pathology

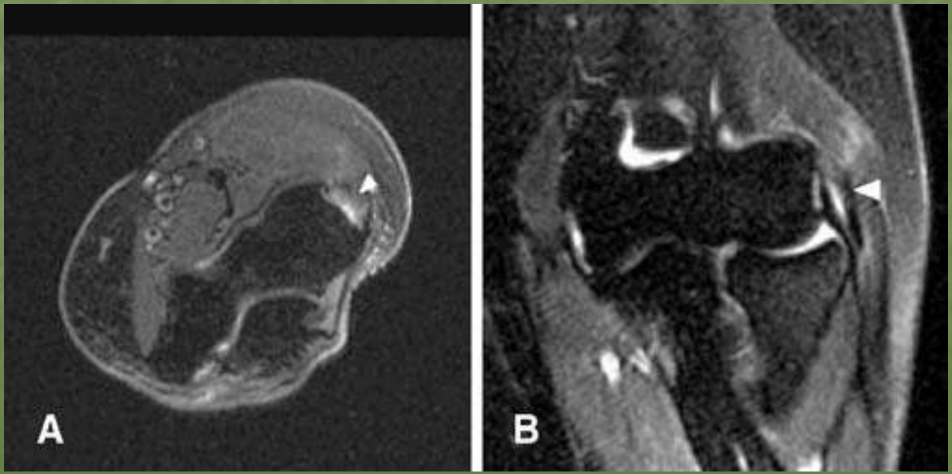
- Incomplete healing response to an initial microscopic or macroscopic avulsion injury of the common extensor tendon origin
- Typically involves the origin of the extensor carpi radialis brevis
- Histologic analysis reveals disruption of collagen bundles, vascular and fibroblast proliferation, and focal hyaline degeneration
- Widespread mucopolysaccharide infiltration and new bone formation noted at the bone-tendon junction
- No evidence of inflammatory process within the diseased tendon but rather repair process in response to tissue damage

Kijowski et. al.

Lateral Epicondylitis – Imaging Features

- Radiographs:
  - usually normal but may show dystrophic calcification adjacent to the lateral epicondyle
- MRI:
  - Thickening of the common extensor tendon origin with increased signal on both T1 and T2
  - Thinning of the tendon origin with fluid-like signal on T2 representing disruption of collagen fibers versus areas of mucoid degeneration and neovascularization without fiber disruption
  - Secondary findings:
    - Anconeus muscle edema
    - Periostitis of the lateral epicondyle
    - Fluid accumulation in the radial head bursae





Kijowski et. al.

Lateral Epicondylitis – Important Considerations

- Thickening and abnormal signal within the common extensor tendon origin are seen in asymptomatic patients
- Abnormal signal may be seen in and around the common extensor tendon origin for up to 1 month following a corticosteroid injection
- Must inspect the underlying LUCL, especially in patients who fail conservative therapy; surgical therapy for lateral epicondylitis with debridement of the common extensor tendon origin can further destabilize a joint in patients with a combined injury

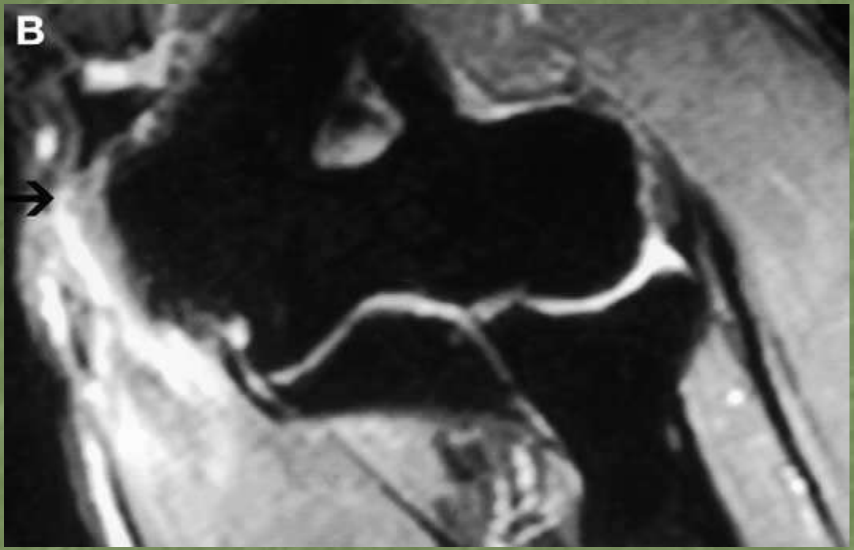
Kijowski et. al.

Medial Epicondylitis

- Pathologic condition of the common flexor tendon origin
  - Flexor carpi radialis
  - Pronator teres
- Much less common that lateral epicondylitis
- Mainly seen in athletes and associated with repetitive valgus and flexion forces
  - **Golfers**
  - Racquetball and tennis players
  - Swimmers
  - Baseball pitchers
  - Javelin throwers
- May be associated with ulnar neuropathy and injuries to the MCL
- Histologically similar to lateral epicondylitis
- Imaging also similar with a continuum from tendinosis to partial or full-thickness tear

Kijowski et. al.

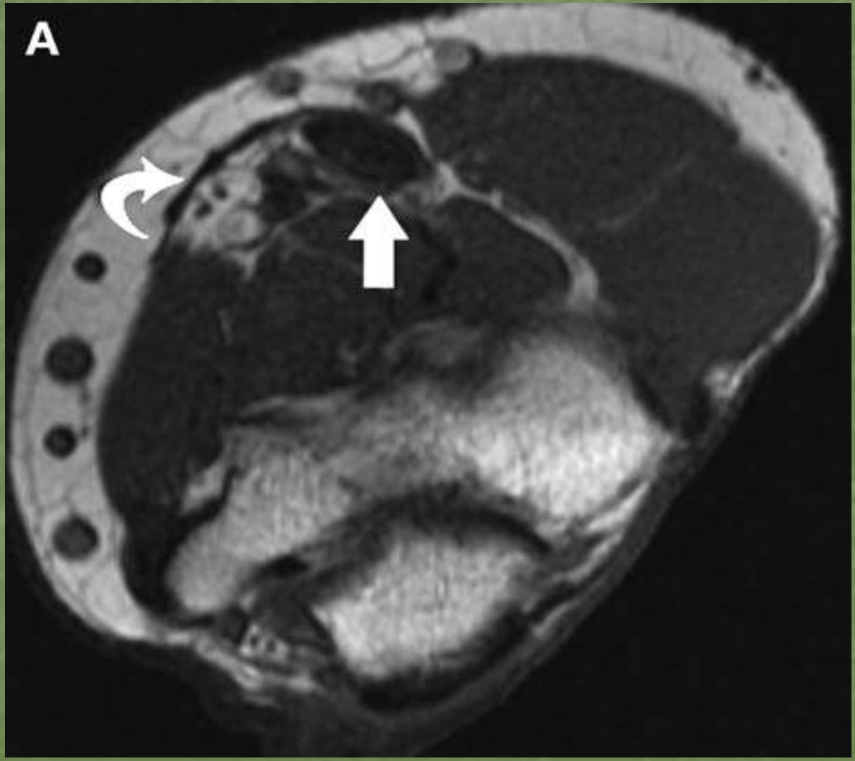
Medial Epicondylitis - Imaging



Chung et. al.

Biceps Tendon - Anatomy

- 2 heads – long and short heads
- These join to form a common tendon 6-7cm above the elbow joint line
- Common tendon traverses the antecubital fossa to dive to its attachment on the radial tuberosity
- Bicipital aponeurosis or lacertus fibrosus
  - Arises from the musculotendinous junction
  - Passes across the brachial artery
  - Merges with the fascia that covers the pronator teres and superficial flexors of the forearm
- Distal biceps tendon does not have a tendon sheath but rather a bursa (cubital bursa) intimately associated with its attachment to the radial tuberosity



Chung et. al.

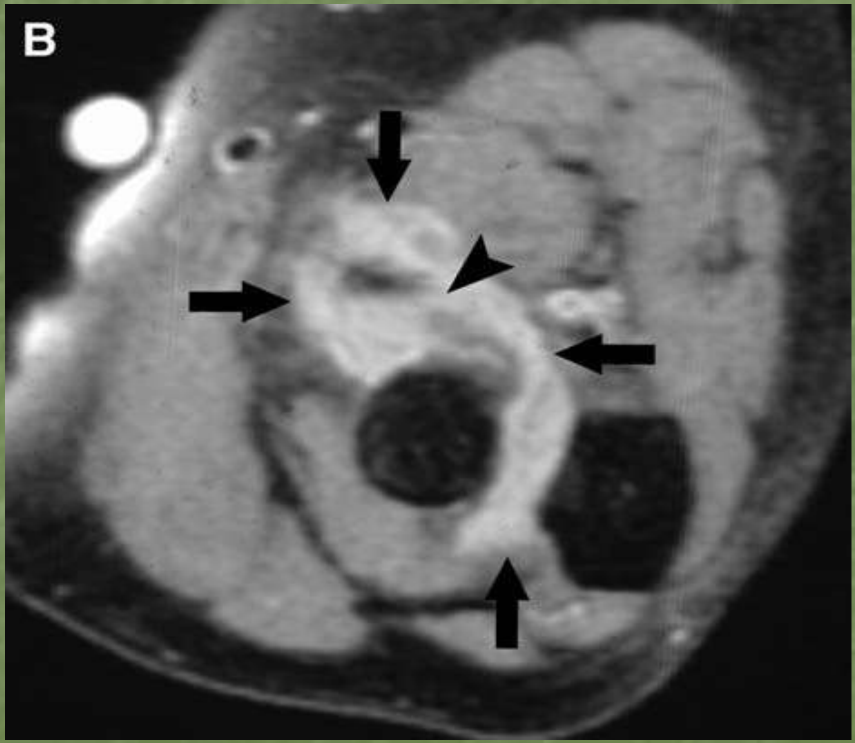
Biceps Tendon Injury

- Distal rupture relatively rare (<5% of all biceps tendon injuries)
- Partial vs. complete
- Result of a single traumatic event with or without underlying preexisting changes
- Mechanism: forceful hyperextension on a flexed and supinated forearm
- Most tears occur at the insertion site on the radial tuberosity
- Intrasubstance tears and tears at the musculotenonous junction are rare
- If the aponeurosis is disrupted, the tendon will retract proximally into the arm
- Classic history of mass in the atecubital fossa

Kijowski et. al., Teh et. al.

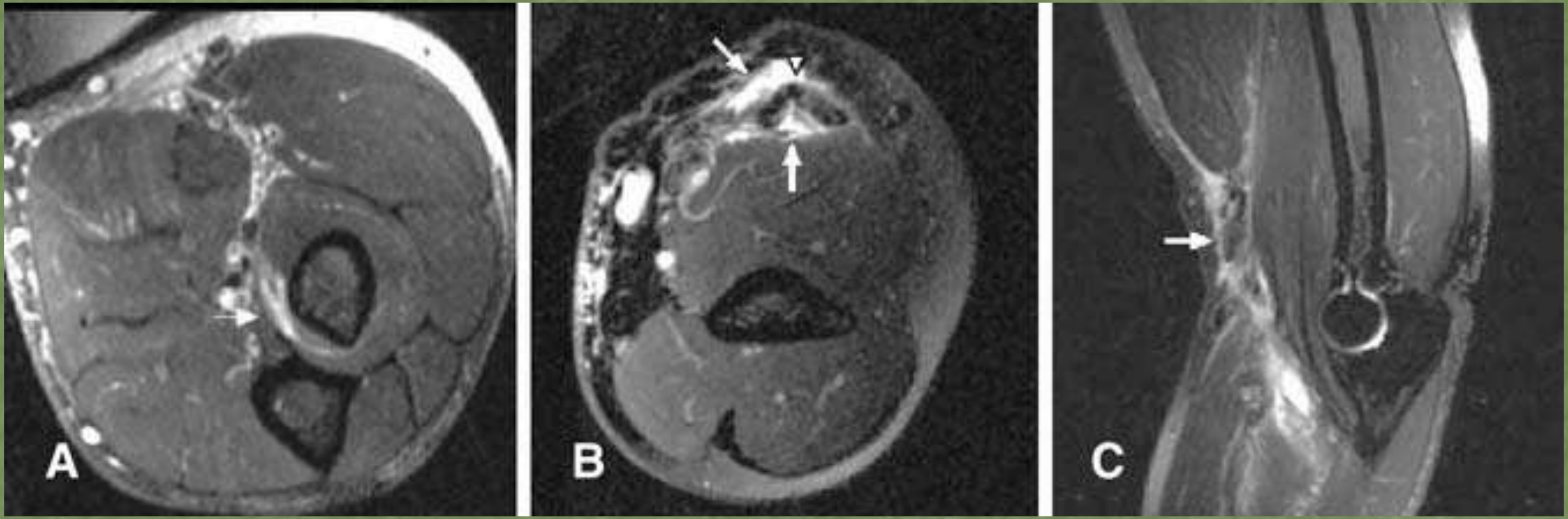
Biceps Tendon Injury - MRI

- Axial imaging plane allows optimal visualization
- Evaluate morphology, signal intensity and integrity of attaching fibers to distinguish between tendinosis, partial tears and complete tears
- Evaluate integrity of the lacertus fibrosus
- Secondary signs include:
  - Bone marrow edema within the radial tuberosity
  - Fluid with the cubital bursa



Kijowski et. al., Chung et. al.

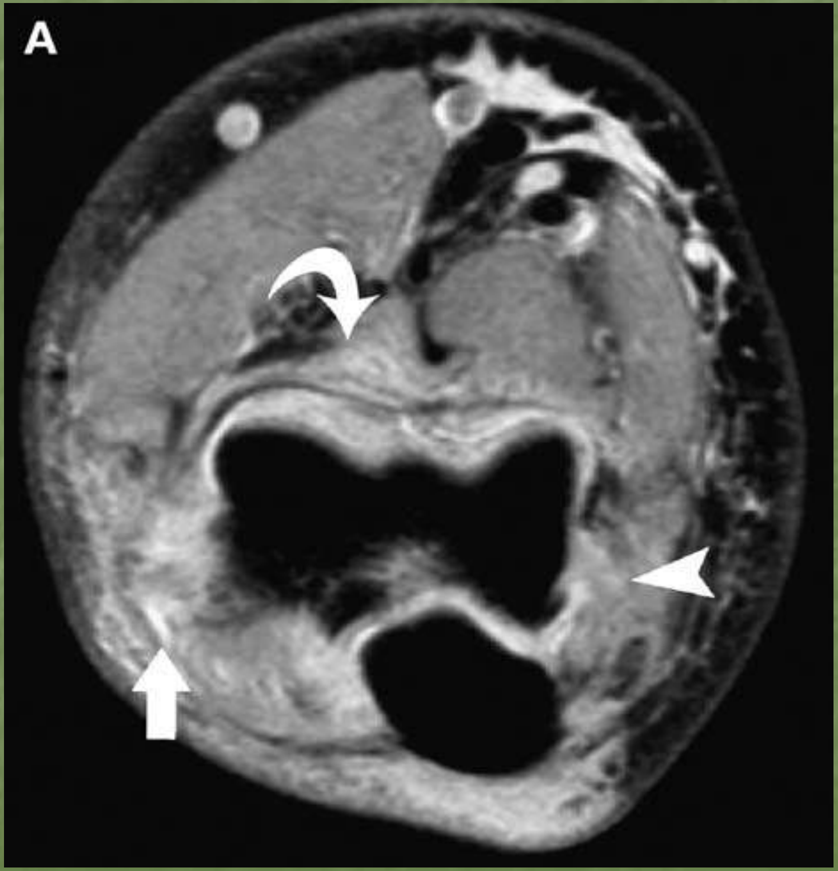
Complete Biceps Rupture



Kijowski et. al.

Brachialis Tendon Injury

- "Climber's elbow"
- Can also be injured with repetitive pull-ups, hyperextension or repeated forceful supination
- Best visualized in the axial imaging plane (looking for the myotendinous junction)



Chung et. al.

Triceps Tendon Anatomy

- 3 muscle bellies:
  - Long head
  - Lateral head
  - Medial head
- Long head arises from the infraglenoid tubercle of the scapula and descends into the arm between the teres major and minor muscles
- Lateral head originates from the posterior and lateral surfaces of the humerus and from the lateral intermuscular septum
- Medial head arises from the posterior surface of the humerus, medial and below the radial groove, and from the medial and lower part of the lateral intermuscular septum
- Combined tendon descends to attach to the upper surface of the olecranon process of the ulna and to the antebrachial fascia near the anconeus muscle/tendon

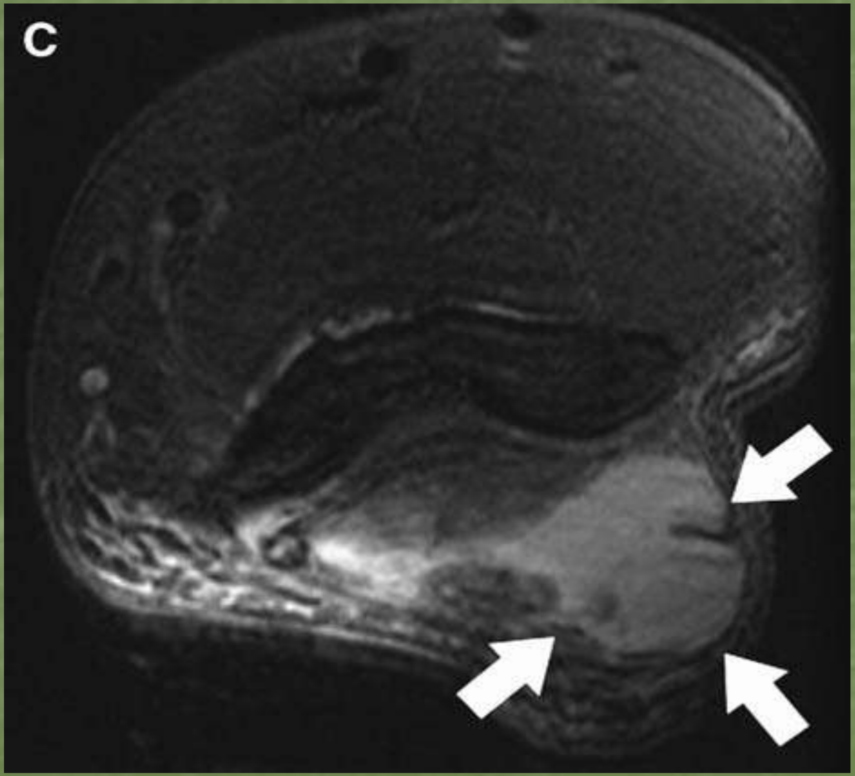
Chung et. al.

Triceps Tendon Injury

- Rupture is rare
- Mechanisms:
  - Direct blow to the triceps insertion
  - Deceleration force applied to the extended arm with contraction of the triceps (i.e., fall on an outstretched hand)
- Most ruptures occur at the insertion site rather than the musculotendinous junction/muscle belly
- Complete ruptures are more common than partial tears
- Secondary findings:
  - Olecranon bursitis
  - Subluxation of the ulnar nerve
  - Fracture of the radial head

Chung et. al., Kijowski et. al.

Triceps Tendon Rupture



Kijowski et. al., Chung et. al.

Summary

- Wide spectrum of pathology affects the elbow in the athlete – particularly in the throwing athlete
- Detailed knowledge of anatomy and pathology facilitates accuracy of imaging diagnosis

References (1)

- Cain EL, Dugas JR, Wolf RS, Andrews JR. Elbow Injuries in Throwing Athletes: A Current Concepts Review. American Journal Of Sports Medicine (2003) 31(4):621-635.
- Chew ML. Radiographics 2005; 25:1227-1237
- Chung CB, Chew FS, Steinbach L. MR imaging of tendon abnormalities of the elbow. Magn Reson Imaging Clin N Am (2004) 12:233-245.
- Chung CB, Kim HJ. Sports injuries of the elbow. Magn Reson Imaging Clin N Am (2003) 11:239–253.
- Cotton A, Jacobson J, Brossmann J, 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 (1997) 204:806-812.
- Fukase N, Kokubu T, Fujioka H, Iwama Y, Fujii M, Kurosaka M. Usefulness of MRI for diagnosis of painful snapping elbow. Skeletal Radiol (2006) 35:797–800.
- Tudor Hughes, MD
- Hyman J, Breazeale NM, Altchek DW. Valgus Instability of the Elbow in Athletes. Clinics in Sports Medicine (2001) 20(1).

References (2)

- Hyman J, Breazeale NM, Altchek DW. Valgus Instability of the Elbow in Athletes. Clinics in Sports Medicine (2001) 20(1).
- Kaplan LJ, Potter HG. MR Imaging of Ligament Injuries to the Elbow. Magnetic Resonance Imaging Clinics of North America (2004) 12:221–232.
- Kijowski R, Tuite M, Sanford M. Magnetic resonance imaging of the elbow. Part I: Normal anatomy, imaging technique, and osseous abnormalities. Skeletal Radiol (2004) 33:685–697.
- Kijowski R, Tuite M, Sanford M. Magnetic resonance imaging of the elbow. Part II: Abnormalities of the ligaments, tendons, and nerves. Skeletal Radiol (2005) 34:1–18.
- Mehta JA, Bain GI. Posterolateral Rotatory Instability of the Elbow. J Am Acad Orthop Surg (2004) 12:405-415.
- Plancher KD, Lucas TS. Fracture Dislocations of the Elbow in Athletes. Clinics in Sports Medicine (2001) 20(1).

References (3)

- Resnick D, Kang HS, Pretterklieber ML. Internal Derangements of Joints 2nd edition (2007).
- Rosenberg ZS, Beltran J, Cheung Y, Broker M. MR Imaging of the Elbow: Normal Variant and Potential Diagnostic Pitfalls of the Trochlear Groove and Cubital Tunnel. AJR (1995) 164:415-418.
- Smith JP, Savoie FH, Field LD. Posterolateral Rotary Instability of the Elbow. Clinics in Sports Medicine (2001) 20(1).
- Stubbs MJ, Field LD, Savoie, FH. Osteochondritis Dissecans of the Elbow. Clinics in Sports Medicine (2001) 20(1).
- Takahara M, Ogino T, Takagi M, Tsuchida H, Orui H, Nambu T. Natural Progression of Osteochondritis Dissecans of the Humeral Capitellum: Initial Observations. Radiology (2000) 216:207–212.
- Teh J, Sukumar V, Jackson S. Imaging of the elbow. Imaging (2003) 15:193–204.
- www.worldortho.com