

# Elbow Pain in the Throwing Athlete

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# Disclosure

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**I do not have financial or other relationships with the manufacture(s) of any commercial services discussed in this educational activity.**

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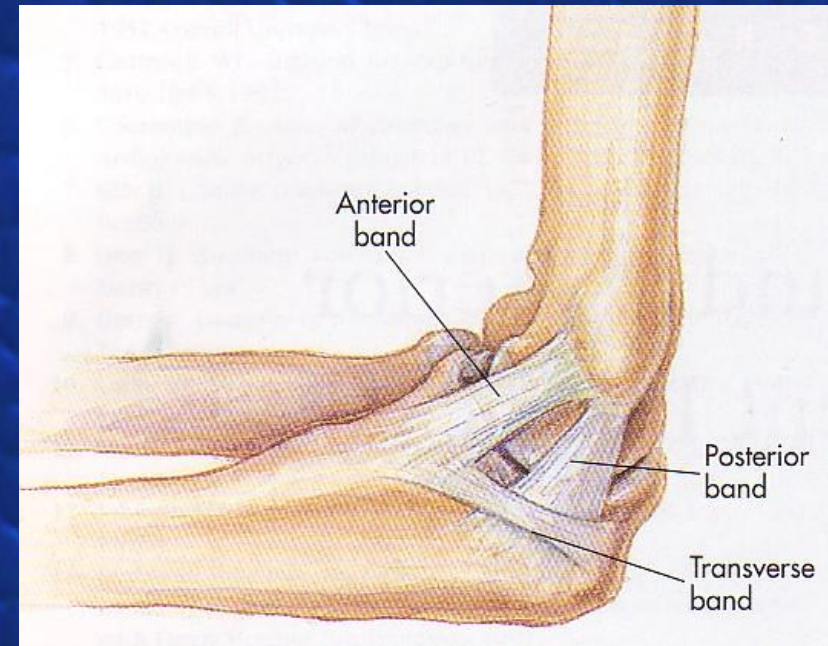
# Outline

- **Anatomy/Functional Anatomy**
- **Throwing Motion**
- **Common Pathologic Conditions**
- **Work-up**
- **Treatment/Outcomes**



# Elbow Stability

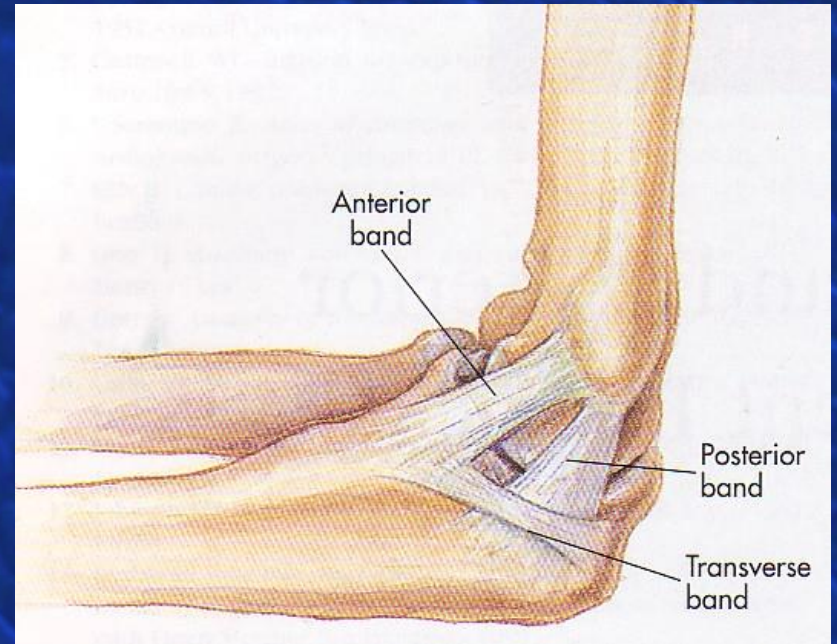
- **1° Stabilizers**
  - **Ulnohumeral Articulation**
    - 50% Elbow stability
    - 25% of pitchers s/p olecranon debridement require UCL reconstruction
    - Strain in UCL increases with >3mm posteromedial olecranon resection
  - **UCL**
    - Valgus Stress
  - **LUCL**
    - Varus Stress





# Elbow Stability

- **2° Valgus Stabilizers**
  - Radiocapitellar Articulation
  - FCU
    - 1° dynamic stabilizer
  - FDS
    - 2° dynamic stabilizer



# Overhead Throwing

- Throwing motion is similar across sports
  - Baseball pitch, tennis serve, javelin throw, football pass, volleyball spike
- Rapid forceful extension of the elbow
- Valgus stress and pronation of the supinated forearm





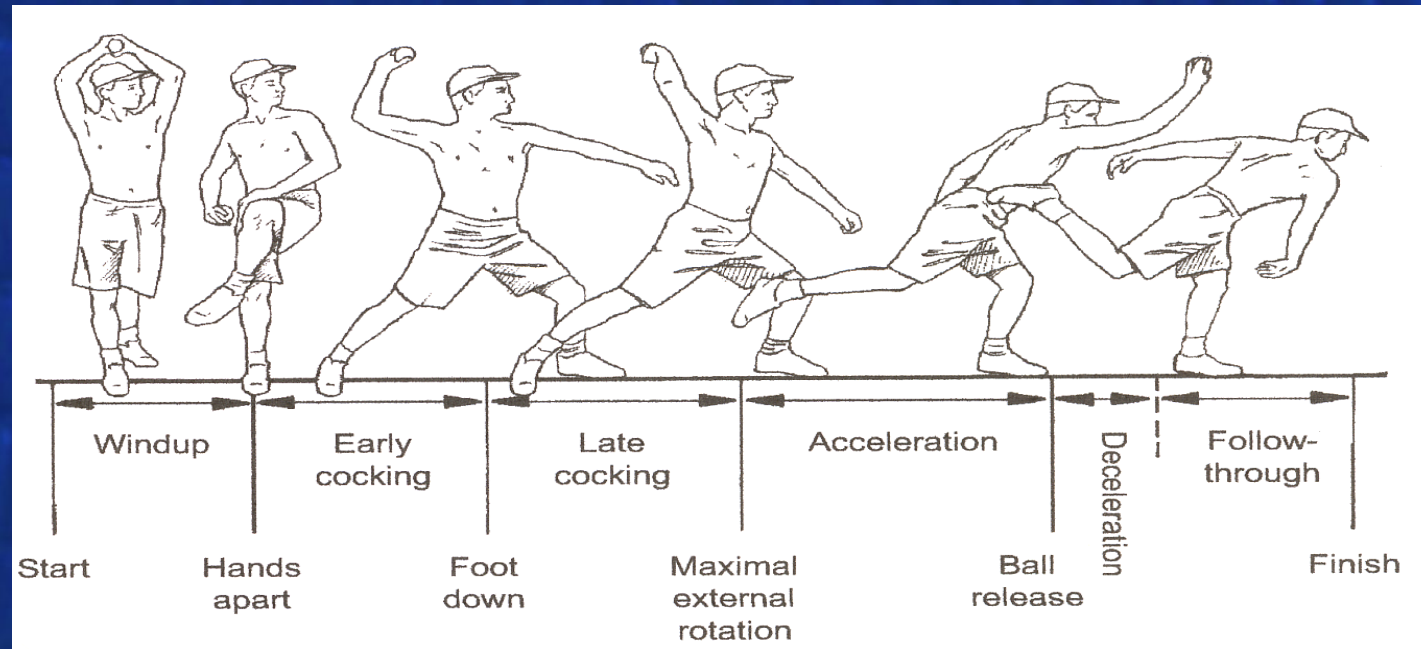
# Effects of Throwing on Elbow

- Angular velocity reaches  $3,000^{\circ}/\text{sec}$  as elbow extends from  $110^{\circ}$ - $20^{\circ}$  flexion
- 64N/m valgus torque at elbow
  - UCL tensile strength: 33 N/m
- 500 N compressive force on radiocapitellar joint
- Majority of injuries secondary to repetitive overload rather than acute trauma



# Stages of Overhead Throwing

- **Baseball Pitch**
  - **Best Studied**
  - **Divided into 5 stages**





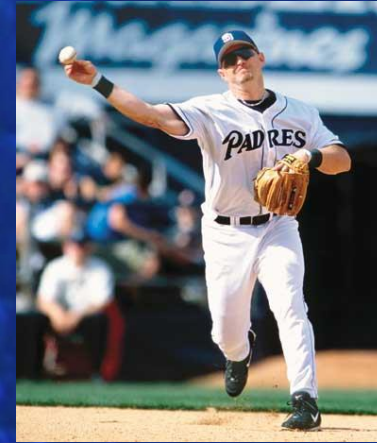
# Stage IV: Acceleration

- Rapid acceleration of the UE
- Large forward-directed force on the extremity
  - Results:
    - IR & adduction humerus
    - Rapid elbow extension
    - Large valgus stress across elbow
- Most injuries occur in this phase; large stress/load across medial elbow structures



# Stage V: Deceleration/Follow Through

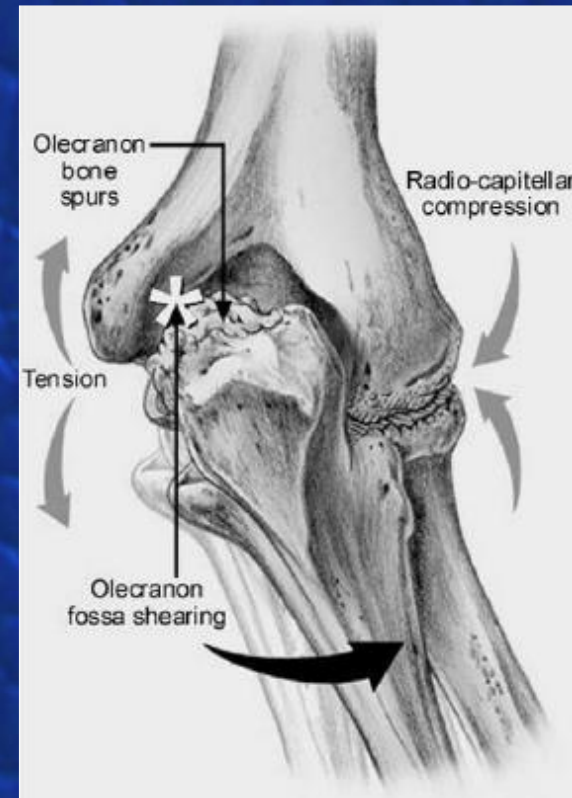
- Dissipation of all kinetic energy
- Ends with full extension elbow
  - Shear stress in posterior compartment
- Rapid forceful decel of the UE
  - rate of  $500,000^{\circ}/\text{sec}$





# Biomechanics of Throwing

- **Net effect:**
  - **Tensile Stress - Medially**
  - **Shear Stress - Posteriorly**
  - **Compression- Laterally**
- **Together → Valgus Extension Overload Syndrome**



# Differential Diagnosis

## Medial

UCL

Ulnar neuritis

Medial  
epicondylitis

Flexor pronator  
tendinosis/rupture

## Posterior

Olecranon  
osteophytes

Loose bodies

Olecranon stress  
fractures

## Lateral

OCD of the  
capitellum

Radiocapitellar  
plica



# History

- **Acuity**
  - Acute vs Chronic
- **Age**
  - Skeletal Maturity
- **Location of Pain**
  - Elbow is geographic



# History

- **Preceeding Events**
  - changes in training regimen
  - number pitches/events
- **Accuracy, velocity, stamina, strength**
- **Phase of throwing**
- **Associated Neurovascular Complaints**
  - Paresthsia
  - Hand clumsiness
  - Cold intolerance

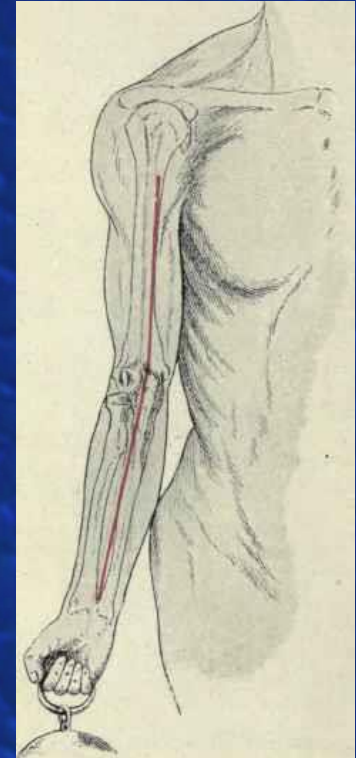




# Physical Examination

- **Inspection**

- **Resting position**
  - Effusion- elbow flexed  $70^{\circ}$  -  $80^{\circ}$
- **Carrying angle**
  - May be larger (adaptive not necc pathologic)
  - Professional throwers (valgus angles  $> 15^{\circ}$ )
- **Ecchymosis**



# Physical Examination

- **ROM**

- **AROM/PROM**

- Normal: F/E 0 -140° P/S 80-90°
    - Crepitus, pain, mechanical sx (chondral lesion/loose body)

- **Endpoints**

- Hard in extension - (osteophytes)

- **Flexion contracture**

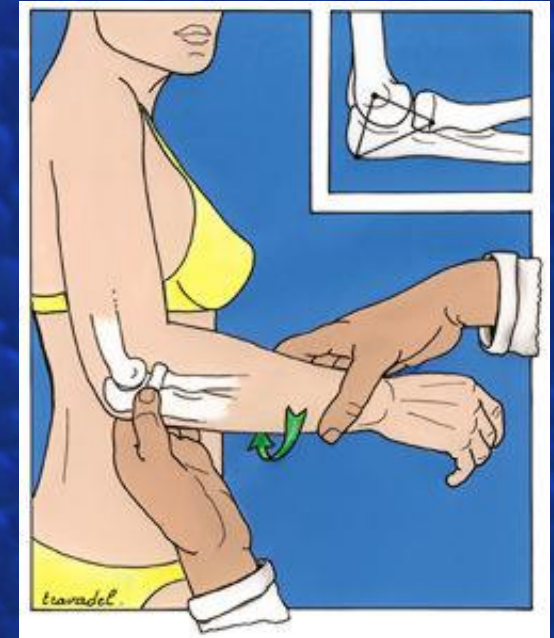
- May or May not be pathologic (50% professional pitchers + flex contracture)





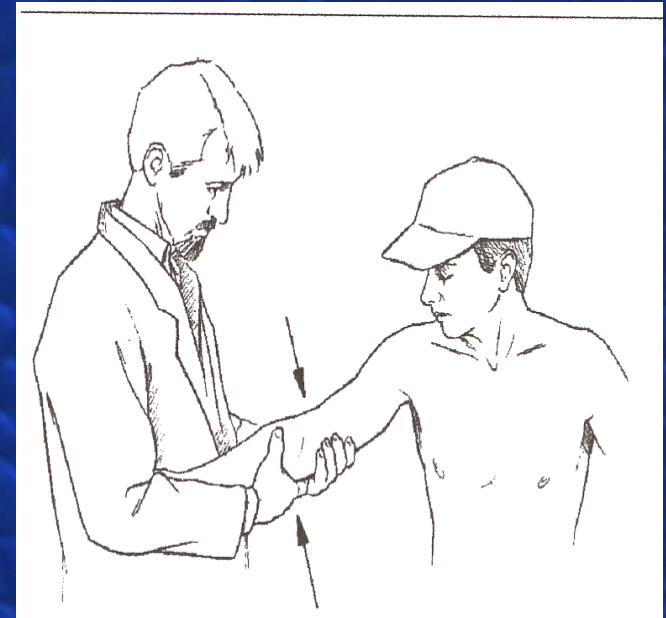
# Physical Examination

- **Palpation**
  - Geographic- tender over pathology
  - Bony landmarks
    - Fx, Stress Fx, Insertional tendinitis
  - Soft tissues
    - Biceps/Triceps, Extensor Mass, Flexor-Pronator Mass
      - Be alert to possibility deeper pathology/instability
  - Neurovascular structures
    - Ulnar Nerve
      - Tinels
      - Subluxation



# Physical Examination

- **Strength**
  - Compare to unaffected extremity
- **Stability**
  - **Medial Instability**
    - Valgus stress test
    - Milking maneuver
  - **Lateral Instability**
    - Uncommon in throwers
  - **Valgus Extension Overload Test**
    - Posterior medial osteophytes





# Imaging

- **Plain Radiographs**
  - AP, Lateral, 2 Oblique Views
    - Osteophytes, calcifications (UCL), OCD, loose bodies
  - Stress Radiographs
    - Fallen out favor
- **CT Scan/Bone Scan:**
  - olecranon stress fx
- **MRI**
  - +/- Arthrogram





# Differential Diagnosis

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Loose bodies

Olecranon stress  
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## Lateral

OCD of the  
capitellum



# Differential Diagnosis

## Medial

UCL

Ulnar neuritis

Medial  
epicondylitis/  
apophysitis

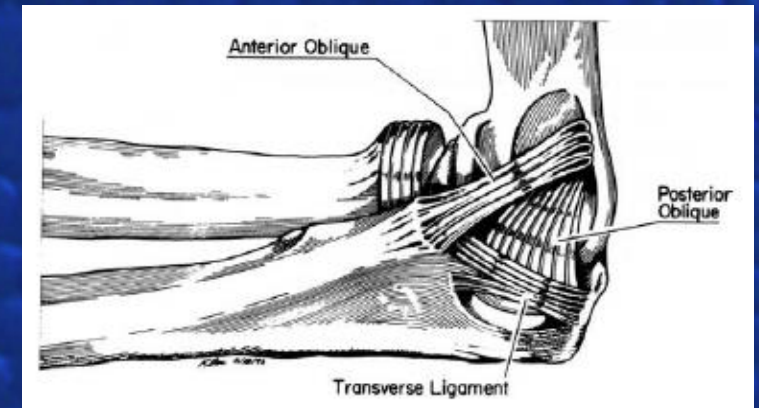
Flexor pronator  
tendinosis/rupture



# UCL Injuries

- **Valgus Stability of Elbow**

- **1° Stabilizer**
  - Ulnar collateral ligament
- **2°**
  - Radio-capitellar joint
  - Flexor-Pronator Mass
    - FCU > FDS > PT



- **Mid-range of motion from 20-120°**

- Unlocked ulno-humeral joint



# Ulnar Collateral Ligament

- **3 Bundles**

- **Anterior Bundle**

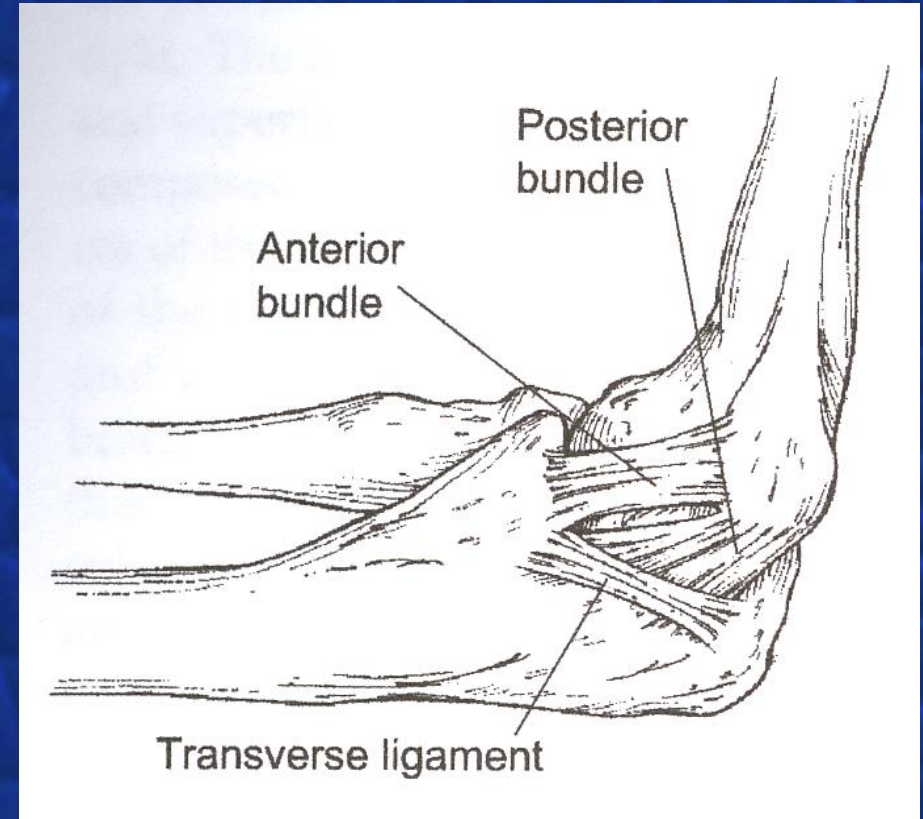
- Anterior Oblique Ligament
    - Inf Med Epi- Sublime Tub

- **Posterior Bundle**

- Posterior Oblique Ligament
    - Inf Med Epi- Sigmoid Notch/post coronoid

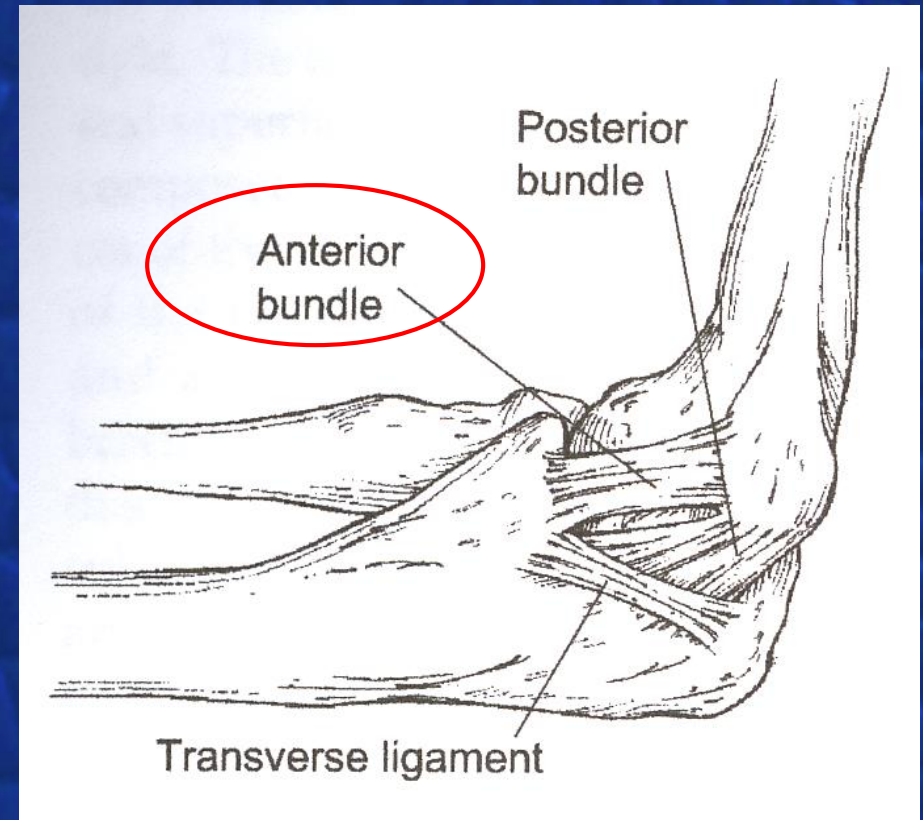
- **Transverse Ligament**

- Olecranon-Coronoid



# Ulnar Collateral Ligament

- **3 Bundles**
  - **Anterior Bundle**
    - 2 Bands
      - Anterior Band
      - Posterior Band





# Ulnar Collateral Ligament

- **3 Bundles**

- **Anterior Bundle**

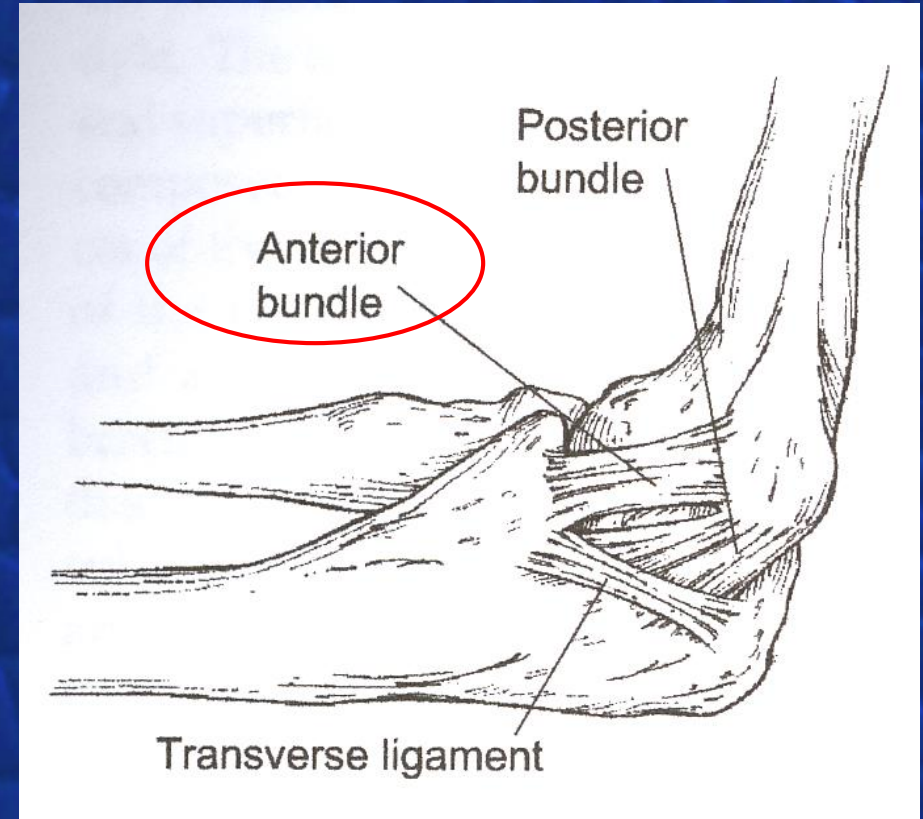
- **2 Bands**

- **Anterior Band**

- 1° stabilizer @ lower flexion angles (<90)

- **Posterior Band**

- 1° stabilizer @ higher flexion angles (>90)



# UCL Injury: Pathophysiology

- Throwing Motion Generates:

Large Valgus & Extension Forces



Tensile Stress along Medial Structures



Repetitive Tensile Stresses- Leads to microtrauma to UCL



May lead to UCL attenuation or failure





# UCL Injury: Presentation

- Soreness along inner elbow during and after throwing
- Occasionally report episode of giving way or sudden severe pain ± popping sensation
- Pain
  - acceleration
  - ball release
  - point of impact in hitting the ball



# UCL Injury: Presentation

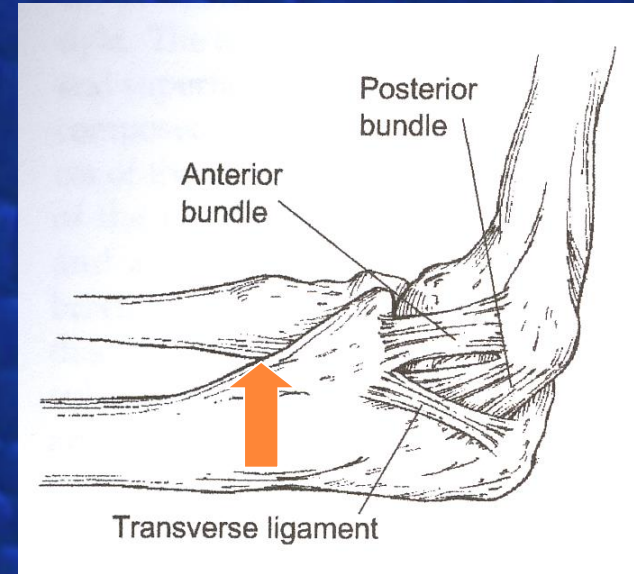
- Loss of pitch velocity/  
control
- +/- Ulnar nerve  
symptoms
- Catching or locking of  
the elbow if loose  
bodies are present





# UCL Injury: Physical Exam

- Point tenderness 2 cm distal to medial epicondyle
- Laxity/Pain with valgus stress
- Absence of pain with resisted wrist flexion (epicondylitis)
- Ecchymosis in acute injury



# UCL Injury: Physical Exam

- **Valgus Stress Test**

- Classically described with elbow flexed 20-30°
- Moving Valgus Stress Test
  - supine, with humerus maximally ER
  - Valgus stress throughout flexion/extension
  - 100% sensitive/75% specific





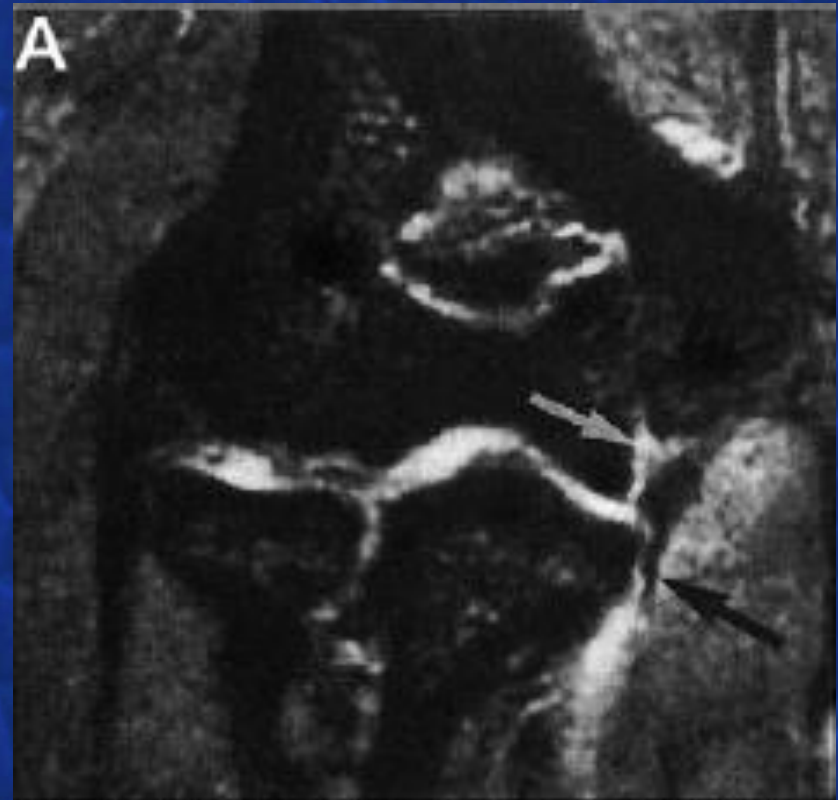
# UCL Injury: Physical Exam

- **Milking Maneuver**
  - Shoulder abd 90°, Elbow flex 90°
  - Examiner grabs thumb; applies valgus stress
  - Valgus stress on elbow flexed >90°
  - Pain is positive finding
    - Often at sublime tubercle



# UCL Injury: Imaging

- **X-rays**
  - Calcification
  - Avulsion
- **Stress Xrays**
  - Used less frequently
  - > 3mm opening positive
  - Increased opening common in throwers
- **MRI**
  - +/- Arthrogram is the study of choice





# UCL Injury: Treatment

- Non-Operative Rx
  - Indications
    - Non-throwing athlete
    - Non-throwing arm
    - Low demand patient
    - Partial Tears
  - Rehab
    - 2-6 wks “Active Rest”
      - Brace (no valgus stress)
      - Rest, Ice, NSAIDs, Motion
    - Functional Exercises/Plyometrics
      - Flexor pronator strengthening
    - Interval throwing program





# UCL Injury: Treatment

- **Operative Rx**

- **Indications**

- Acute rupture
    - Complete tear thrower
    - Partial tears that failed Rehab
    - Symptomatic tears in non-thrower, that failed Rehab

- **Technique**

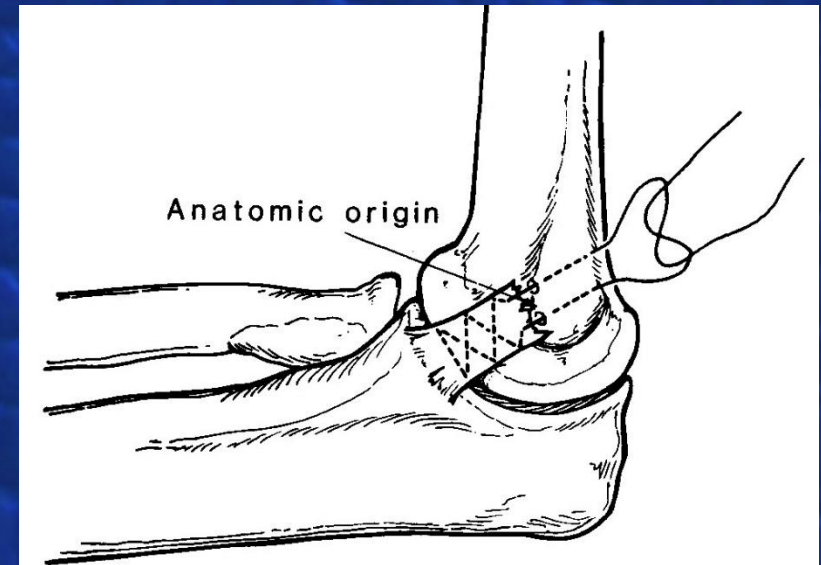
- Repair vs Reconstruction?





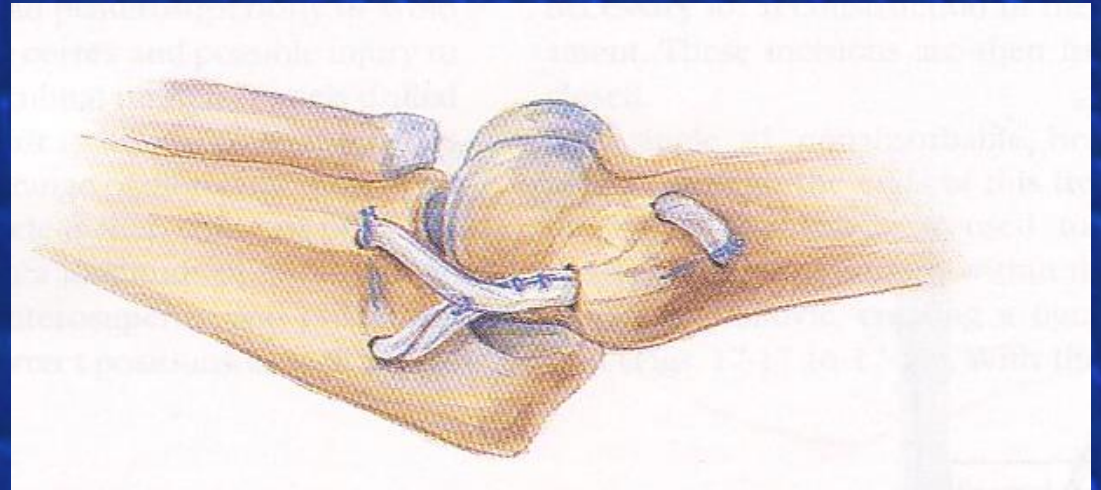
# UCL Injury: Treatment

- **UCL Repair:**
  - Historically was the mainstay of Rx
  - Several comparative studies demonstrated superior results w/ reconstruction
  - Currently Limited Indications for Repair:
    - Acute proximal avulsions
    - Pediatric population (Savoie)
    - Good quality ligament



# UCL Injury: Treatment

- UCL Reconstruction:
  - Rx of Choice:
    - Reconstruction of the Anterior Bundle of the UCL w/ free tendon graft
  - Multiple Grafts Choices
    - **Palmaris Longus**
      - Contra-lateral?
    - Hamstring
    - Plantaris
    - 4th Toe Extensor
    - Allograft





# UCL Injury: Treatment

- **UCL Reconstruction: Historical Perspective**
  - 1986, Jobe et al. 1<sup>st</sup> to report results of reconstructive technique
    - “Tommy John” Procedure
  - Prior to this, UCL tear in a throwing athlete was a career ending injury





# UCL Injury: Treatment

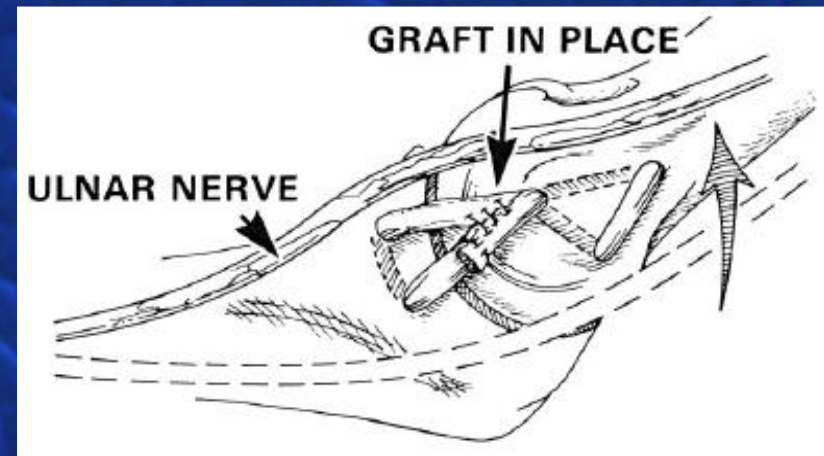
- Multiple Reconstruction Techniques
  - Classic “Tommy John”
  - Modified “Tommy John”
  - Docking Procedure
  - Interference Screws
  - Hybrid Reconstruction
  - Bone Anchor Reconstruction





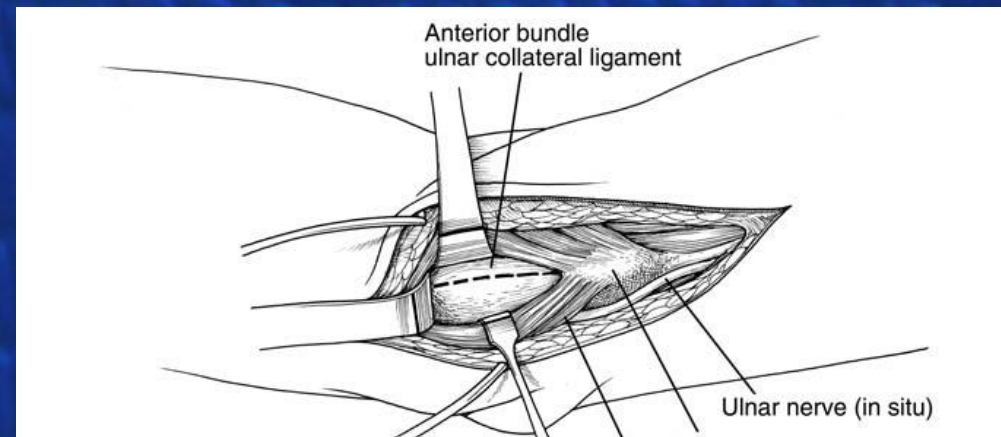
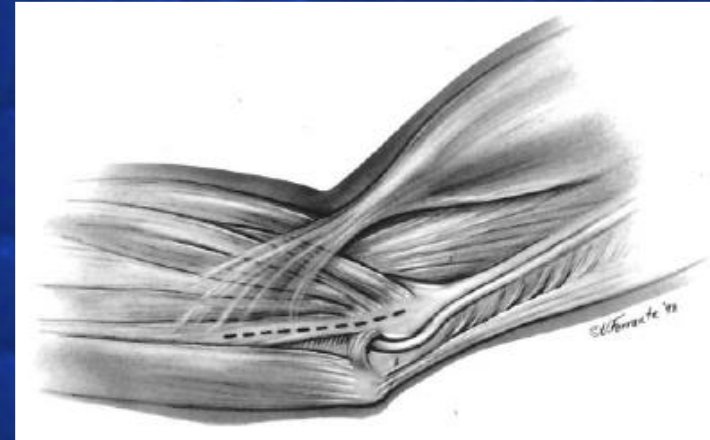
# UCL Injury: Treatment

- UCL Reconstruction: Classic “Tommy John”
  - Extensive medial exposure
  - Transected and reflected flexor pronator mass
  - Free tendon graft recon, w/ bone tunnels through the posterior humeral cortex
  - Submuscular ulnar nerve transposition
- Excellent exposure, at expense significant morbidity associated with nerve transposition and muscle detachment



# UCL Injury: Treatment

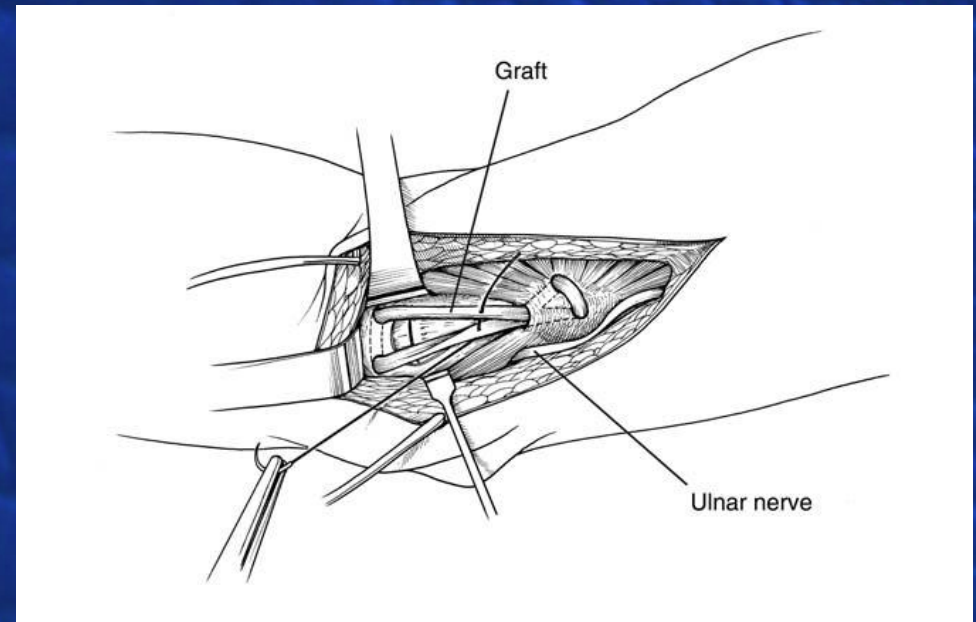
- **UCL Reconstruction: Modifications**
  - **Modified “Tommy John”**
    - Muscle-splitting approach vs. elevation of flexor-pronator mass without detachment
    - Ulnar nerve transposition uncommon





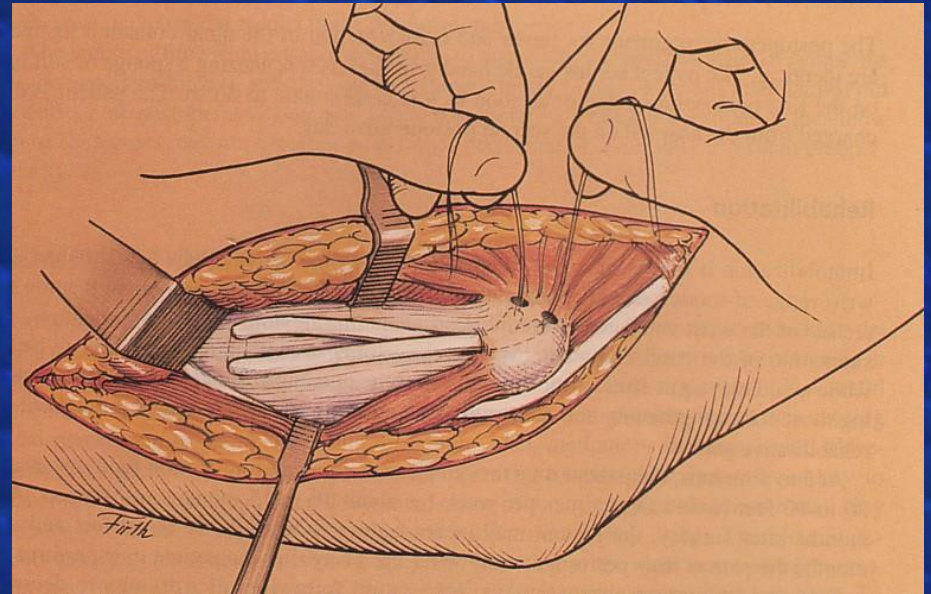
# UCL Injury: Treatment

- **UCL Reconstruction: Modifications**
  - **Modified “Tommy John”**
    - Bone tunnel in Ulna
    - Anteriorly directed converging tunnels in medial epicondyle



# UCL Injury: Treatment

- **UCL Reconstruction: Modifications**
  - **Docking Procedure**
    - Two Drill Holes in Ulna
    - One drill hole in Humerus (blind end humeral tunnel)
    - Less bone tunnels





# UCL Injury: Treatment

- UCL Reconstruction: Results

- Systematic Review (AJSM 2008 Vitale et al.)

- 8 (Level III) retro, cohort studies
    - Athletes underwent recon w/ min 1 yr f/u

- Muscle splitting > flexor takedown

- 87% vs. 70% excellent results
      - 7% vs. 23% complications
      - 6% vs 20% ulnar neuropathy

- Docking procedure > figure-8

- 90-95% versus 76% excellent outcomes
      - 8% vs. 4% ulnar neuropathy

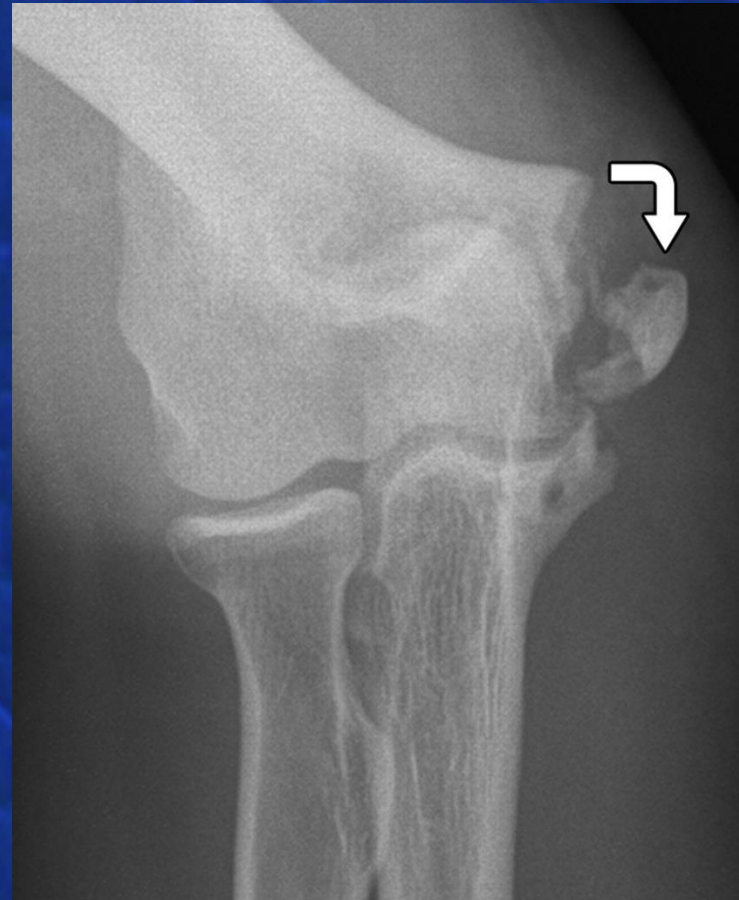
No transposition > transposition  
89% versus 75% excellent  
outcomes

6% versus 14% complications  
2 fold decrease in neuropathy



# UCL Injury: Treatment

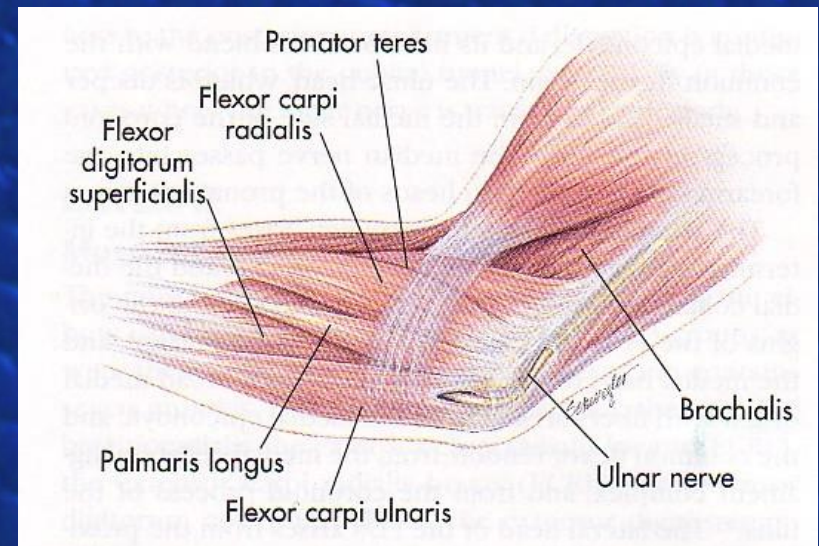
- UCL Reconstruction: Results





# Flexor-Pronator Tendinosis/ Medial Epicondylitis

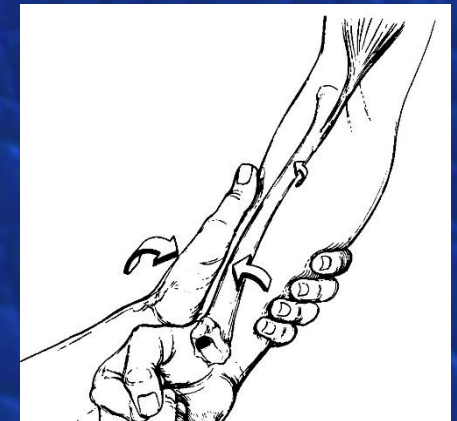
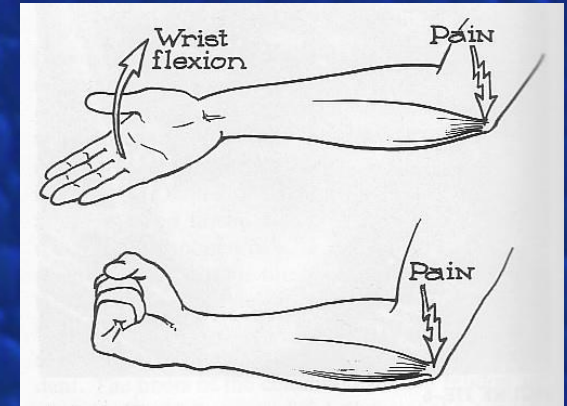
- Common flexor-pronator tendon at medial epicondyle
- Dynamic stabilizers to valgus stress in throwing elbow
- Wide spectrum of injuries
  - Mild overuse to acute tears



# Flexor-Pronator Tendinosis/ Medial Epicondylitis

- Presentation
  - Insidious onset of medial elbow pain
  - Late cocking/acceleration
- Exam
  - TTP medial epi, over muscle distal/anterior
  - Pain with wrist flexion/pronation
  - No pain w/ valgus stress

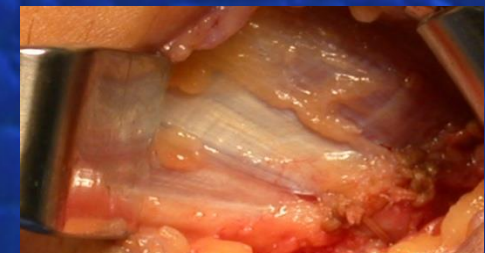
\*\* Concomitant valgus instability, may be underlying cause of sx & must be addressed at time of Rx





# Flexor-Pronator Tendinosis/ Medial Epicondylitis

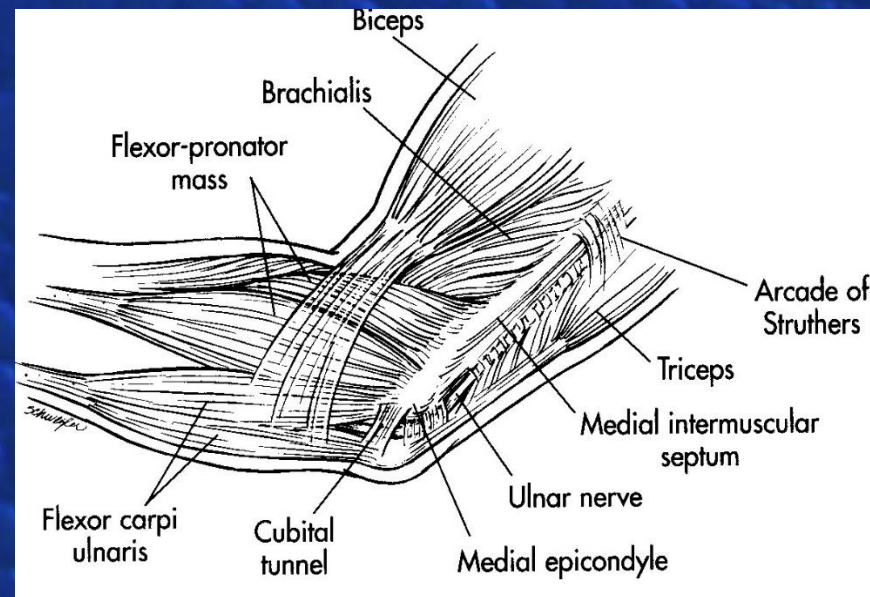
- Treatment
  - Non-Op
    - Main stay of Rx (90% success)
      - Phase I - Rest, NSAIDS, +/- Injection
      - Phase II- Stretching, pain free strengthening, counterforce brace
      - Phase III - Interval Throwing program, mechanics
      - Cortisone? PRP?
  - Operative Debridement/Repair
    - Refractory sx, muscle tears
    - 86-97% Good/Excellent Results in athletes (Jobe 1991, Morrey 1995)





# Ulnar Neuropathy

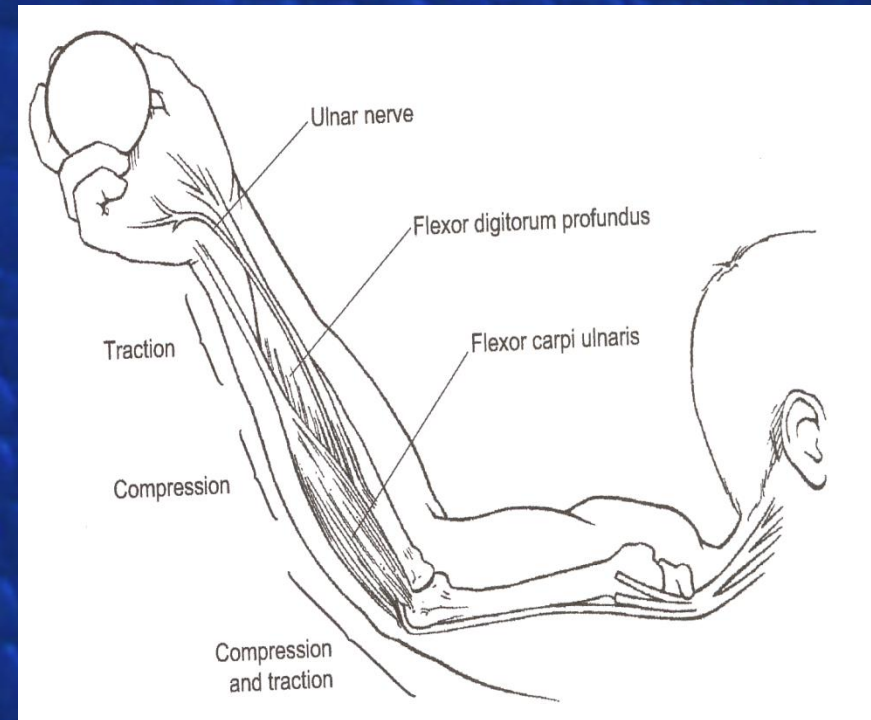
- Ulnar Nerve Sx Common
  - 40% of athletes w/ valgus instability develop ulnar neuritis
  - 60% of throwers w/ medial epicondylitis have ulnar nerve sx
- Susceptible to injury
  - Tight path it follows
  - Subcutaneous location
  - Considerable excursion required





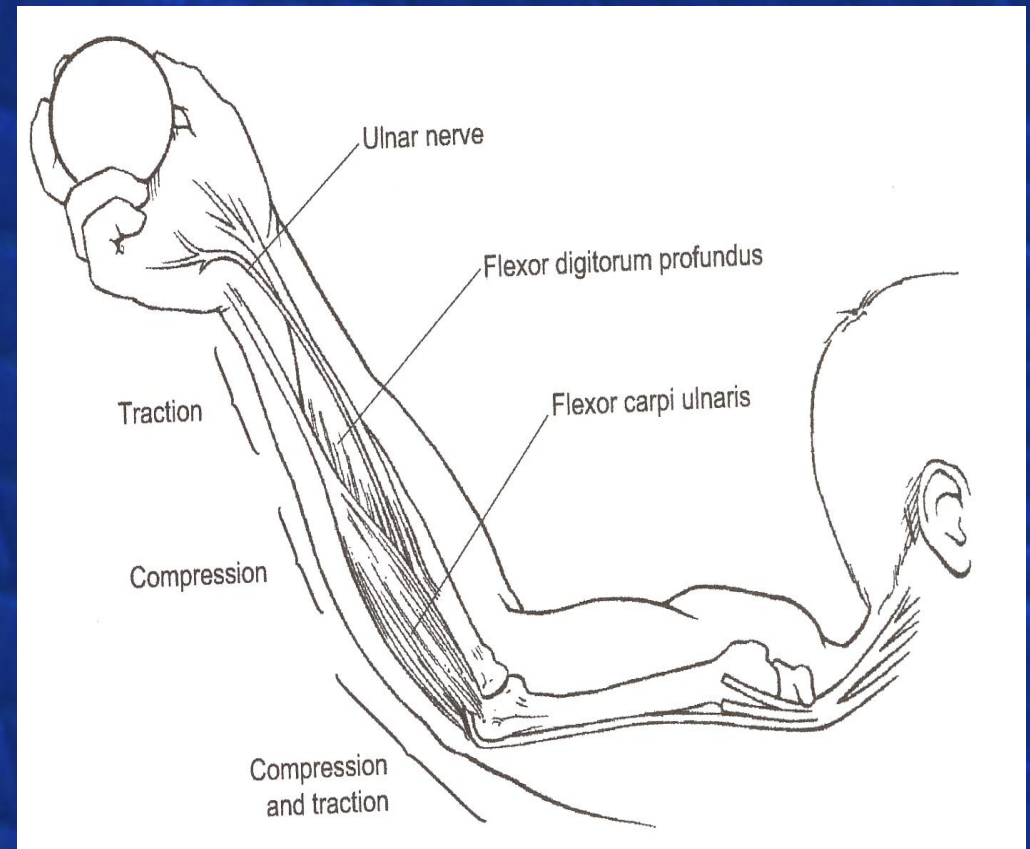
# Ulnar Neuropathy

- Ulnar Nerve Irritation:
  - Traction-
    - Valgus Stress
  - Compression
    - Adhesions
    - Osteophytes
    - Muscle hypertrophy
    - Inflamed UCL (floor cubital tunnel)
  - Friction
    - Subluxation



# Exacerbation of Ulnar Nerve Compression w/ Throwing

- Elbow flexion, wrist extension and shoulder abduction → 6x increase in intraneural pressure compared to resting level
- Made worse by chronic changes of valgus overload
- Prolonged and repeated pressure elevations lead to nerve fibrosis and ischemia

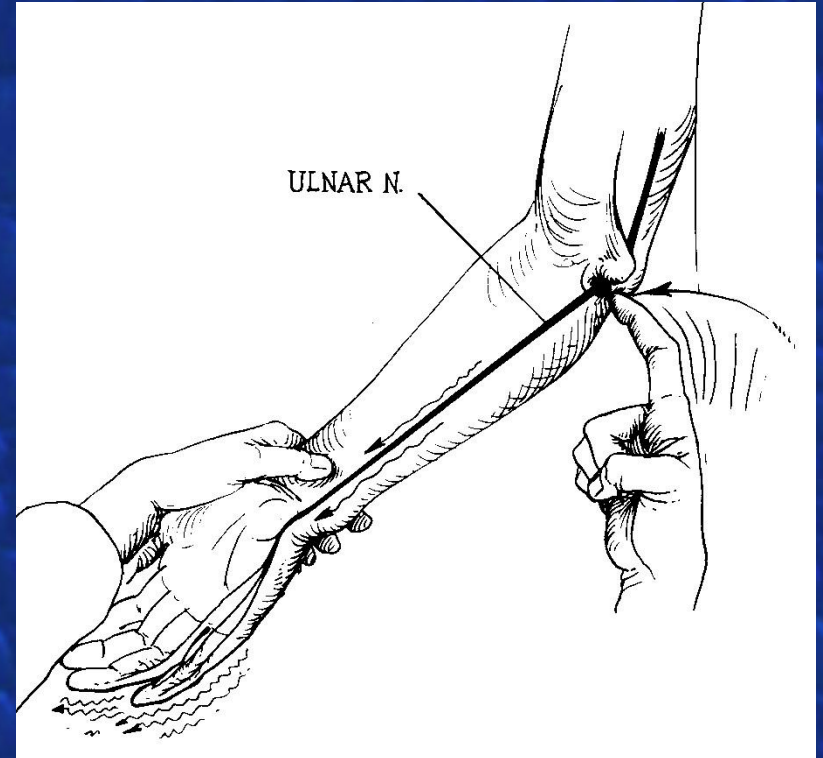




# Evaluation of Ulnar Neuropathy

- Elbow pain w/ radiation down medial aspect of forearm into hand
- Clumsiness, heaviness, paresthesias, **loss control**
- Painful snapping w/ recurrent subluxations
- + Tinels, Flexion Test

\*\* R/O Concomitant UCL  
Instability/ Flexor Tendinosis



# Treatment of Isolated Ulnar Neuropathy

## Nonoperative

Rest, ice, NSAIDs

Brief immobilization/Night splints

Injections not recommended

**85% Success Rate**

## Operative

Decompression\*

Medial epicondylectomy\*

Subcutaneous vs Submuscular  
Transposition

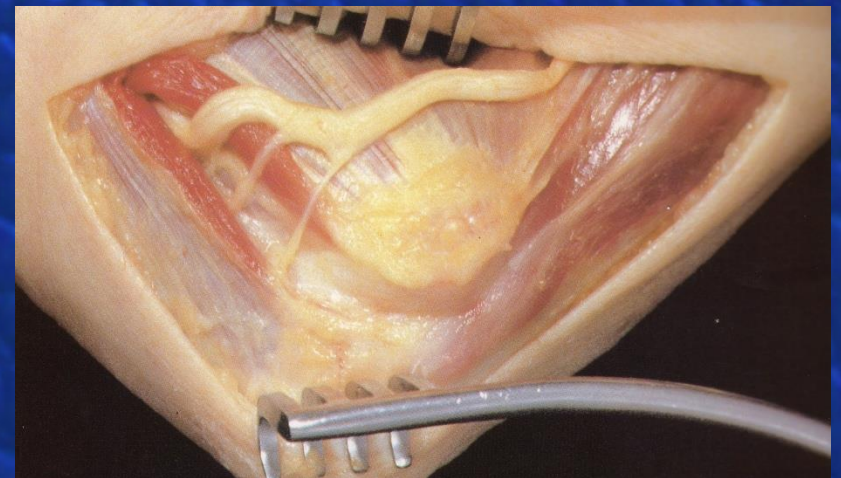
\* Poor results in throwers





# Operative Management Ulnar Neuropathy

- Submuscular Transposition
  - Protects from trauma (Contact Athletes)
  - Longer rehab secondary to healing of flexor-pronator origin
- Subcutaneous Transposition
  - Minimizes disruption of flexor-pronator musculature (Throwers)
  - More vulnerable to direct trauma
- Improvement depends on stage of symptoms
- 4-6 months to return to full activity



# Isolated Ulnar Neuropathy: Op Results

- Del Pizzo
  - 60% return to play with submuscluar
  - *Am J Sports Med* 1977
- Rettig and Ebben
  - 95% return to play after subcutaneous transfer
  - *Am J Sports Med* 1993
- Andrews
  - 7 of 8 pro players returned after subcutaneous transposition
  - *Am J Sports Med* 1995

Current Recs: subcut ulnar nerve transposition in throwers





# Differential Diagnosis

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## Posterior

Olecranon  
osteophytes

Loose bodies

Olecranon stress  
fractures

## Lateral

OCD of the  
capitellum

# Differential Diagnosis

## Posterior

Olecranon  
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# Differential Diagnosis

## Posterior

Olecranon  
osteophytes

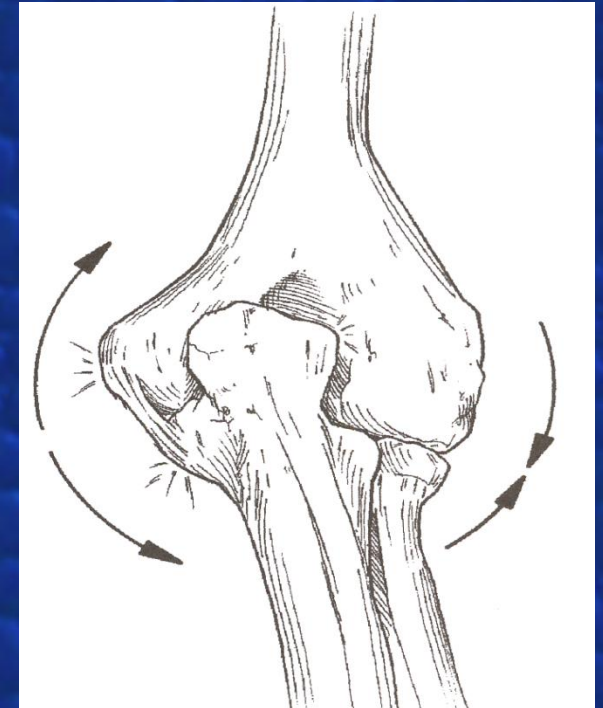
Loose bodies

Olecranon stress  
fractures

Posterior  
Impingement

# Posterior Impingement

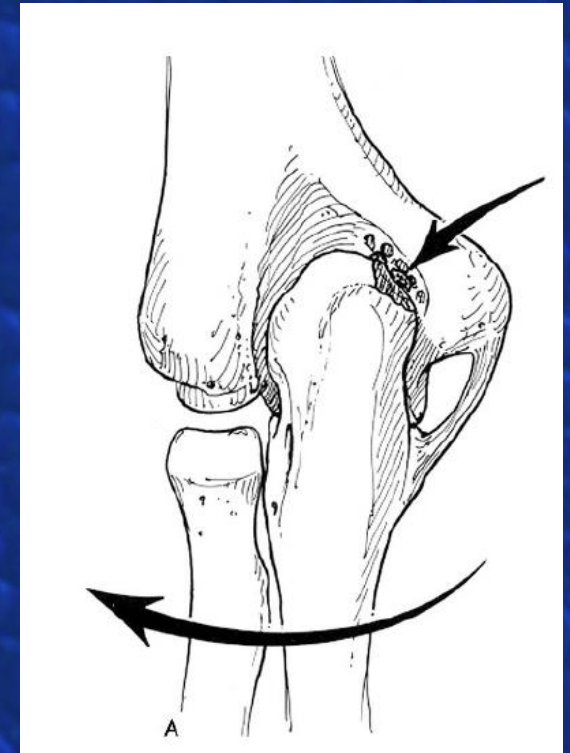
- Cause : Valgus Extension Overload
  - Repetitive combo of hyperextension, valgus & supination
  - Causes abutment of medial olecranon against fossa
- Result: Posterior Impingement
  - Synovitis, osteophyte and/or loose body formation in the posteromedial elbow of throwers





# Posterior Impingement

- Evaluation
  - Posterior pain, effusion, locking, crepitus, loss of extension
  - TTP posteromedially, pain forced extension
  - Xrays- osteophytes/loose bodies
  - MRI- most sensitive test
  - **Must r/o/address medial instability**
- Initial Rx: Conservative
  - RICE
  - NSAIDS/ Cortisone
  - PT, Interval Throwing



# Posterior Impingement

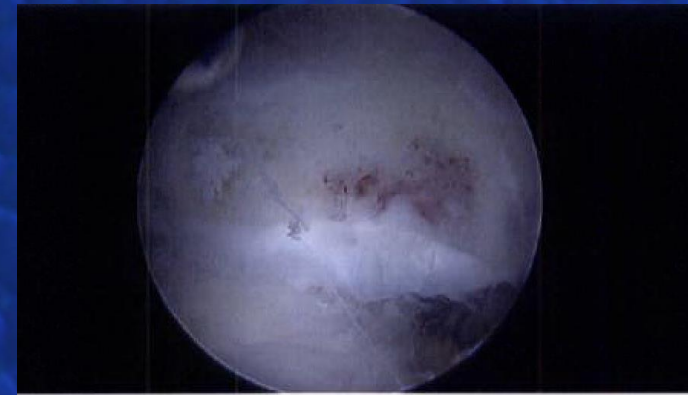
- Operative Treatment
  - Arthroscopic Debridement
    - Debridement of olecranon osteophytes
    - Removal loose bodies
    - Chondroplasty
  - Must address concomitant instability if present
  - Avoid excessive osteophyte removal; overzealous removal may expose UCL to increased stresses





# Results

- Andrews et al. 1995
  - 56 pro players
  - posterior osteophyte excision +/- UCL or ulnar nerve transposition
  - 70% returned to play at 24 months
  - 41% required re operation for repeat debridement
- Reddy et al. 2000
  - 187 patients with elbow arthroscopy
  - 104 for posterior impingement
  - 92% good to excellent results at avg 42 months
  - 85% Baseball players RTP
- Current Recs- Arthroscopic debridement +/- UCL stabilization procedure, may improve sx but caution pt, may require additional procedures



# Olecranon Stress Fractures

- Repetitive microtrauma by olecranon impingement or excessive triceps tensile stress
- Posterior elbow pain
- TTP over olecranon
- MRI, CT diagnostic





# Olecranon Stress Fractures

- Treatment
  - Initial treatment w/ rest
  - May require ORIF in competitive thrower w/ 6.5 or 7.3 mm cannulated screw



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Medial  
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Flexor pronator  
tendinosis/rupture

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## Lateral

OCD of the  
capitellum

Radiocapitellar  
plica



# Differential Diagnosis

Lateral

OCD of the  
capitellum

Radiocapitellar  
plica



# Osteochondritis Dissecans of the Capitellum

- OCD
  - injury to subchondral bone that results in loss of structural support for cartilage
- Etiology
  - Unclear, repetitive microtrauma





# Osteochondritis Dissecans of the Capitellum

- Presentation
  - Insidious onset, poorly localized lateral pain
  - Worse w/ activity
  - +/- mechanical sx
  - May experience loss extension
- Imaging
  - Xrays
    - Radiolucency lesion
  - MRI



# Osteochondritis Dissecans of the Capitellum

- Treatment
  - Still evolving, no consensus
  - Natural hx not understood
    - Lesion progression
- Conservative Rx
  - Stable lesions, younger pts
  - Activity modification, Rest
- Operative Rx (Arthroscopy)
  - Unstable lesions, Loose bodies
  - Debridement +/- abrasion chondroplasty
  - OATS





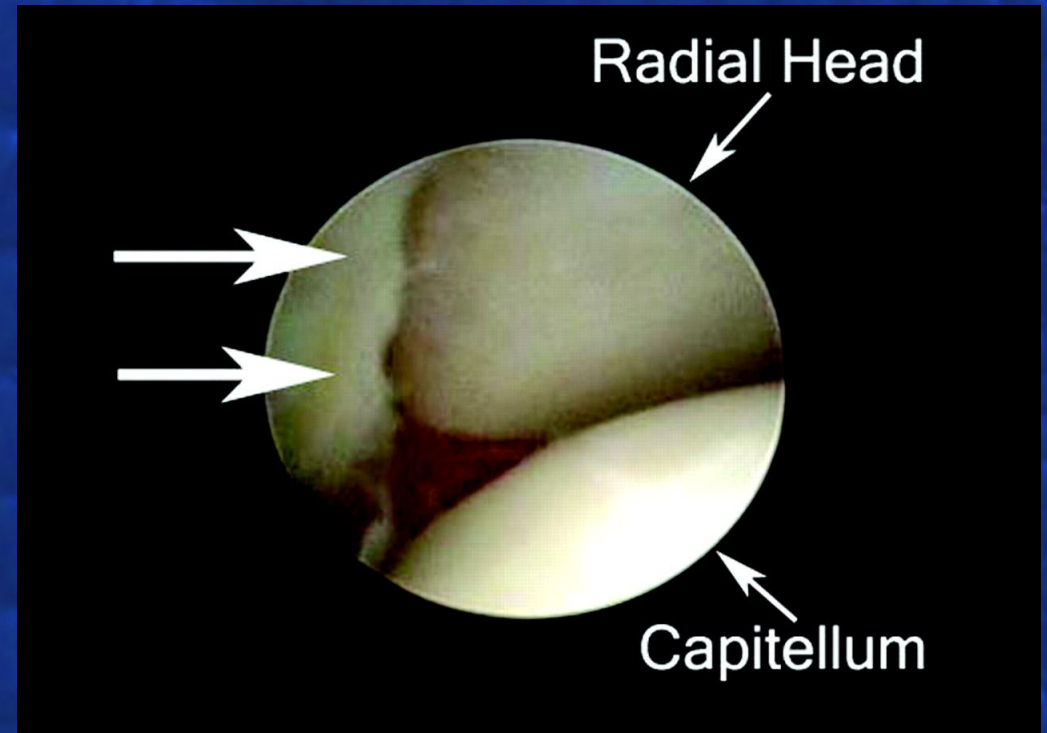
# Osteochondritis Dissecans of the Capitellum

- Panner's Disease
  - Self-limited osteochondrosis of capitellum
  - Children < 10
  - Resolves with rest



# Radiocapitellar plica

- Tenderness to palpation
- Pain with flexion-extension of pronated forearm





# Summary

- Overhead throwing- Large valgus and extension moments
- Medial tensile, lateral compression and posterior shear
- Common pathologic mechanism for elbow conditions
- Many of the pathologic conditions in throwers are related to elbow instability
- Dx and treating elbow instability, key for successful outcomes; regardless of presenting condition

