

# SHOULDER INJURIES IN THE THROWING ATHLETE

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# Learning Objectives

- ▣ Discuss common overhead throwing injuries and summarize their surgical options and the research behind each technique.
- ▣ Describe throwing biomechanics and their implication in injuries.
- ▣ Explain evaluation and imaging of common shoulder pathologies in the overhead athlete.
- ▣ Discuss the difference between anterior vs posterior shoulder pain.
- ▣ Explain total motion concept and its associated research.

# The Overhead Thrower

## Introduction - Injuries

- ▣ Shoulder & elbow injuries are common in baseball – and appear to be increasing
- ▣ In professional baseball:
- ▣ **28 %** of all injuries occur to the shoulder joint
- ▣ 22 % of all injuries occur to elbow joint
- ▣ Length of injury time is increasing – days on the disabled list days

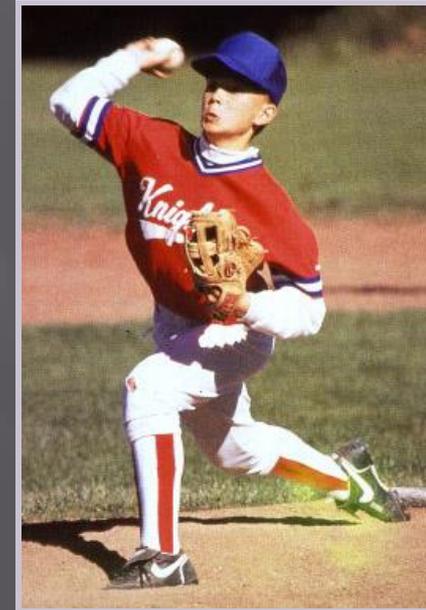
*Conte et al: Am J Spts Med '01*

- ▣ In youth baseball – 50 % of players (9-14) complained of elbow or shoulder pain

*Lyman et al: Am J Spts Med '02*

- ▣ Number of injuries increasing & age decreasing – UCL injuries

*Petty, Andrews, Fleisig: AJSM '04*



# The Overhead Thrower

## Introduction-Injuries

Why the increase in injuries at all levels of baseball???

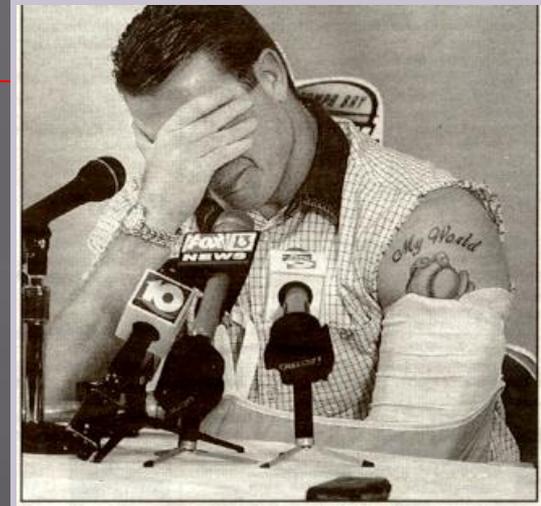
Factors that influence injury rates:

- *Number of pitches per game*
- *Number of games per year*
- *Number of years throwing*
- *Type of pitches*
- *Arm fatigue*
- *Size of players*
- *Technique & Skill level*

*Lyman, Fleisig, et al: AJSM '02*

*Lyman, Fleisig, et al: Med Sci Spts Ex '01*

*Olsen, Fleisig, et al: AJSM '06*



# Introduction

Throwing creates significant forces across the shoulder leading to injuries of the rotator cuff, glenoid labrum, and joint capsule

# BIOMECHANICS (Fleisig)

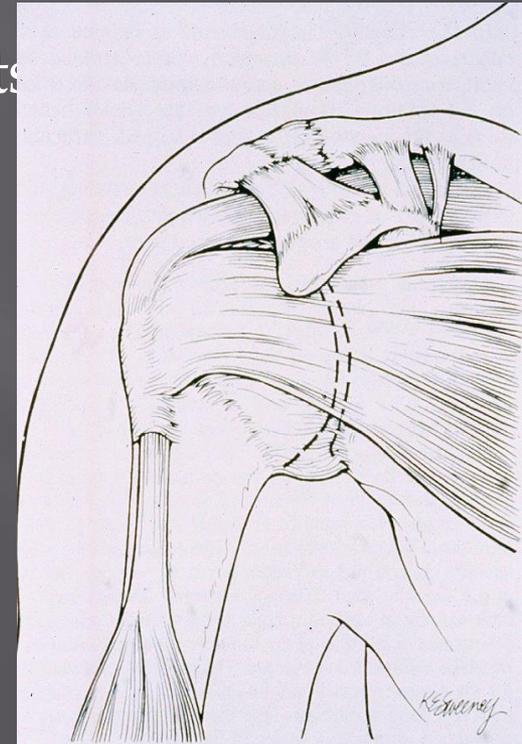
- ▣ Extreme external rotation
- ▣ Shoulder abduction at 90 degrees
- ▣ Shoulder angular velocity  $7,000^\circ / \text{sec}$
- ▣ Anterior translation of GH joint  $\frac{1}{2}$  body weight
- ▣ Distractive forces up to body weight
- ▣ Overuse due to repetitive stresses



# SHOULDER BIOMECHANICS

## Dynamic stabilizers

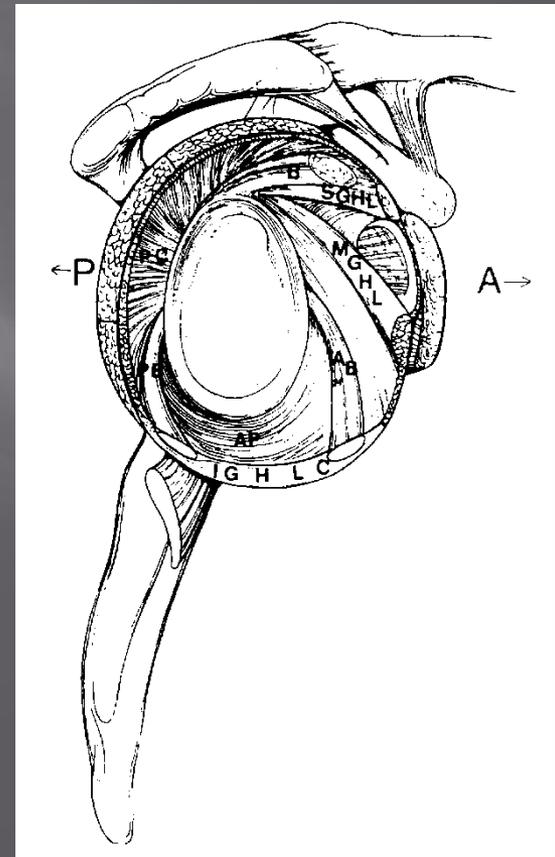
- ▣ Rotator cuff
  - Primary stabilizer by eccentric contraction
  - Humeral head depressor and prevents superior migration of humeral head
  - Provide a fulcrum for the deltoid
- ▣ Biceps tendon: humeral head depressor
- ▣ Scapulothoracic musculature
  - Most underappreciated



# SHOULDER BIOMECHANICS

## Static Stabilizers

- ▣ Glenohumeral ligaments are important stabilizers
- ▣ Inferior GH ligament is most important in anterior stability
- ▣ Lax structures may lead to secondary impingement

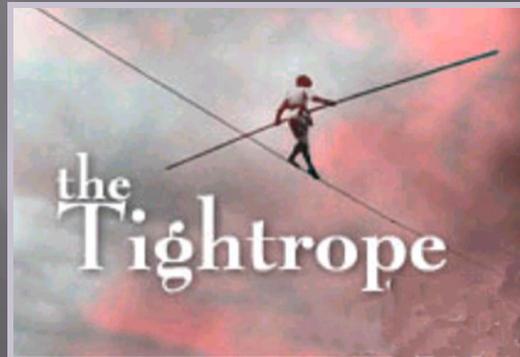


# Paradox of the Thrower's Shoulder



*“Loose enough to throw, but stable enough to prevent symptoms”*

*Wilk: AJSM '02*



# History

- ▣ Chief complaint
- ▣ Mechanism of injury
- ▣ Sport involved & position
- ▣ Prior treatment

# History

## Symptoms

- ▣ Pain: duration, location, throwing
- ▣ Weakness
- ▣ Instability
- ▣ Mechanical symptoms
- ▣ Loss of motion
- ▣ Neurosensory changes

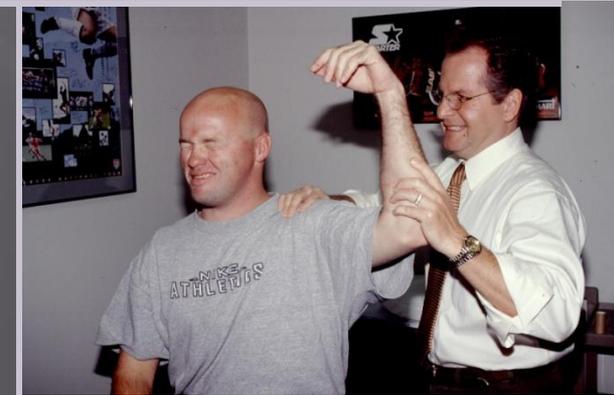
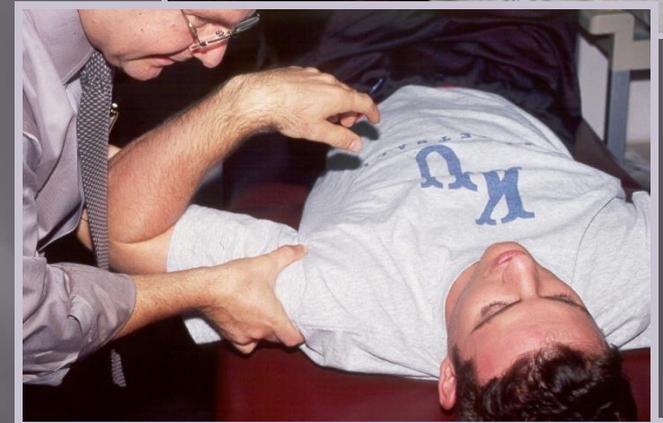
# Shoulder Pain

## *Clinical Presentation*

Due to repetitive stress & fatigue/weakness

- Sharp pain in specific locations
- Coracoid process/biceps pain
- Looseness/slipping/catching
- **Dead arm feeling**
- **Loss of velocity/control**

▣ Symptoms often appear as *“tendonitis”*



# Physical Examination

- ▣ Inspection
- ▣ Palpation
- ▣ Range of motion
- ▣ Neurovascular exam
- ▣ Strength testing
- ▣ Special tests
- ▣ Cervical spine
- ▣ Stability testing

# Inspection



# Palpation







# Shoulder Standard Radiograph “Throwers Series”

- ▣ AP of shoulder
- ▣ Profile of GH joint/True AP
- ▣ Stryker view
- ▣ Axillary view

C: 2047.5, W: 4095.0

R



C: 2047.5, W: 4095.0

4/22/2009, 3:43:00 PM



R

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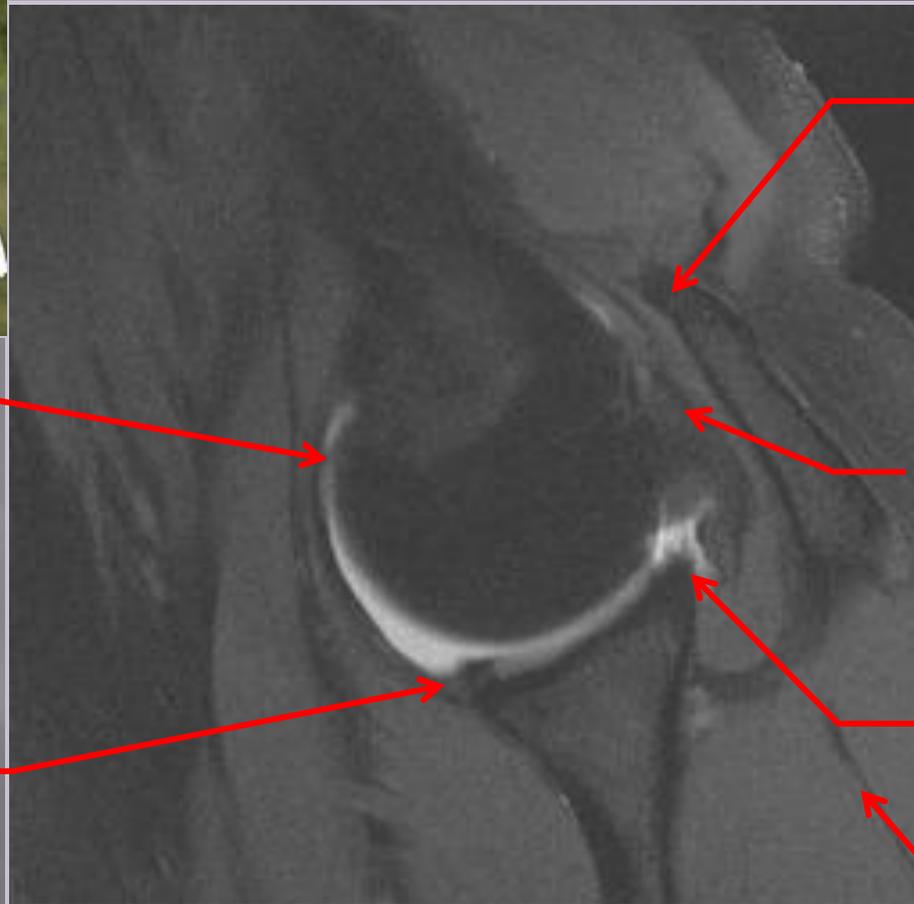
# Ancillary Tests

- ▣ Arthrogram
- ▣ CT arthrogram
- ▣ EMG
- ▣ Isokinetic testing
- ▣ Clinical biomechanical testing

# Arthrogram MRI



# MRI - ABER View in Throwers



*Acromion*

*IGL  
Anterior band*

*Supraspinatus*

*Anterior labrum  
(inferior)*

*Posterior labrum  
(superior)*

*Infraspinatus*

# Andrews, Wilk, Reed et al: Sprng Trn '00

- ▣ 31 asymptomatic professional baseball pitchers
- ▣ MRI of glenohumeral joint
- ▣ 28/31 (90 %) abnormal glenoid labrum
- ▣ 27/31 (87 %) abnormal rotator cuff appearance
- ▣ 12/31 (39%) humeral head changes
- ▣ *All pitchers were pain-free at time of study*

# SHOULDER PAIN IN THE THROWER



*Anterior vs. Posterior*



# Anterior Shoulder Pain in Throwers

## Etiology

- ▣ RC tendinitis/tear
- ▣ Anterior deltoid strain
- ▣ Anterior instability/Capsular tear
- ▣ Biceps tendinitis – subluxation
  - *Be Aware!*
- ▣ Coracoid Impingement

# Anterior Shoulder Pain in Throwers

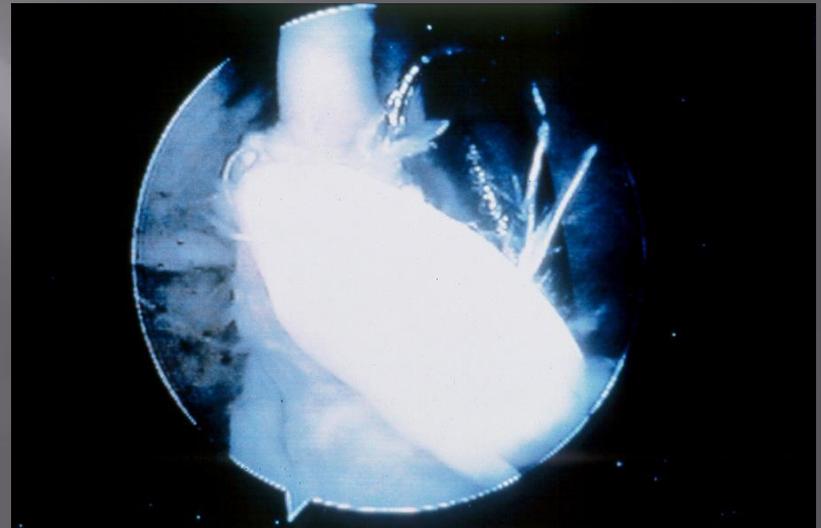
## Etiology (cont'd)

- ▣ Biceps tendon labral complex tear
- ▣ Functional labral tears
- ▣ Distal clavicle osteolysis
- ▣ Teres major avulsion
- ▣ *CAUTION*: posterior laxity can produce *anterior* shoulder pain

# Posterior Shoulder Pain in Throwers

## Etiology

- ▣ Posterior rotator cuff tendinitis/tear
- ▣ Post. laxity
- ▣ Post. Labral tears
- ▣ Post. Capsulitis
- ▣ Teres minor strain



# Posterior Shoulder Pain in Throwers

## Etiology (cont'd)

- ▣ Throwers exostosis (Bennett's Lesion)
- ▣ Teres major/Lat intramuscular tear

# Posterior Shoulder Pain in Throwers

## Etiology (cont'd)

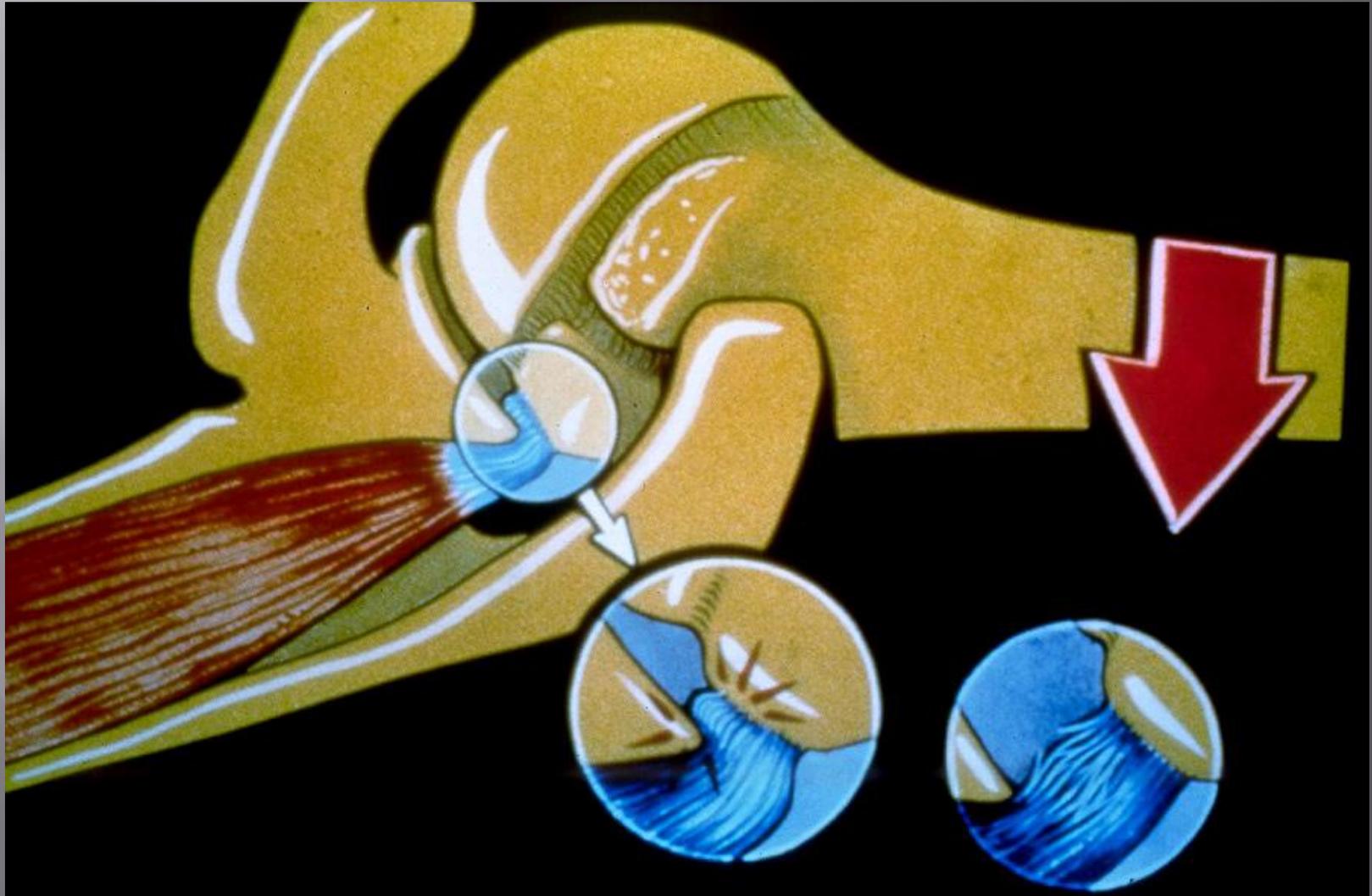
- ▣ Suprascapular nerve injury
  - *traction vs. compression*
- ▣ Long thoracic nerve injury
- ▣ Quadralateral space syndrome

# Internal Impingement

## *Definition*

- ▣ An over-rotation phenomenon in throwers:
  - *associated with increased Glenohumeral translation and “rotational instability”*

# Rotational Instability



# Internal Impingement (Meister)

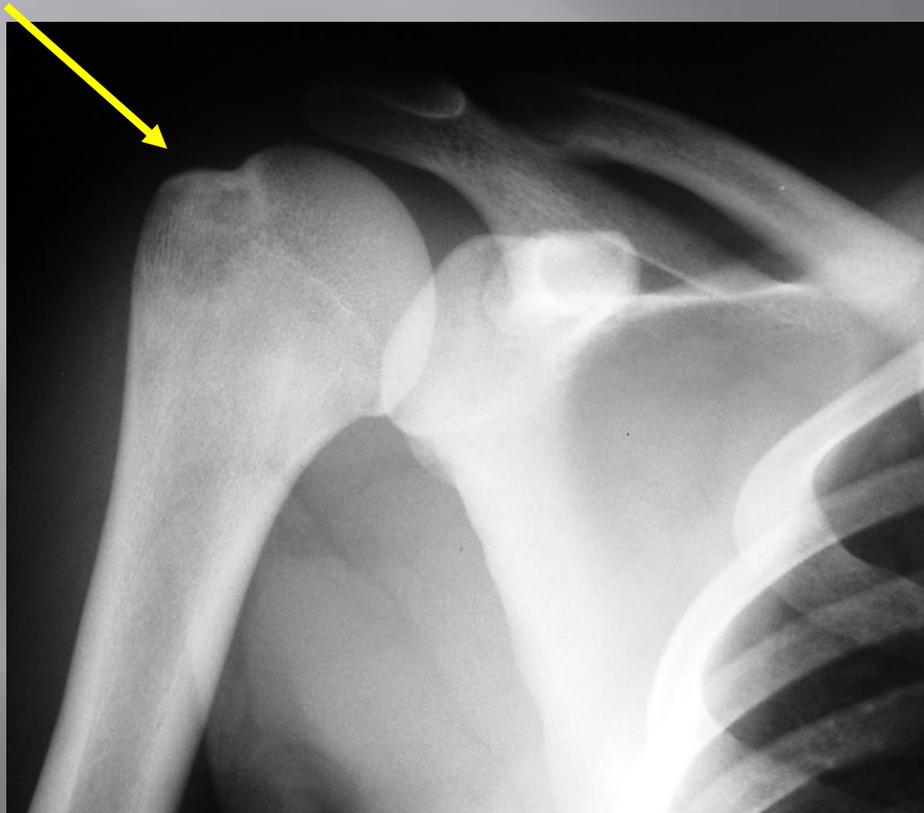


# POSTERIOR APPREHENSION TEST



# Internal Impingement

## X-Ray and MRI Findings



# What is the cause of Internal Impingement?

Rotational laxity (anterior capsular laxity)

or

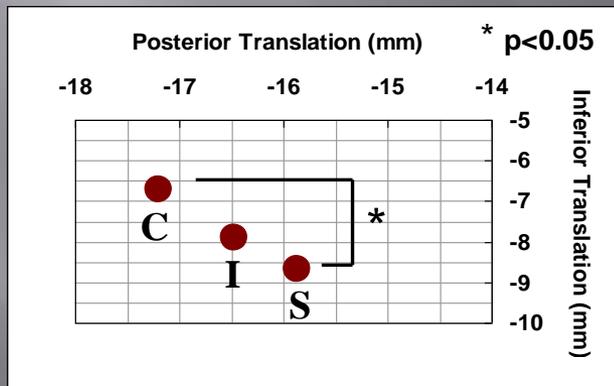
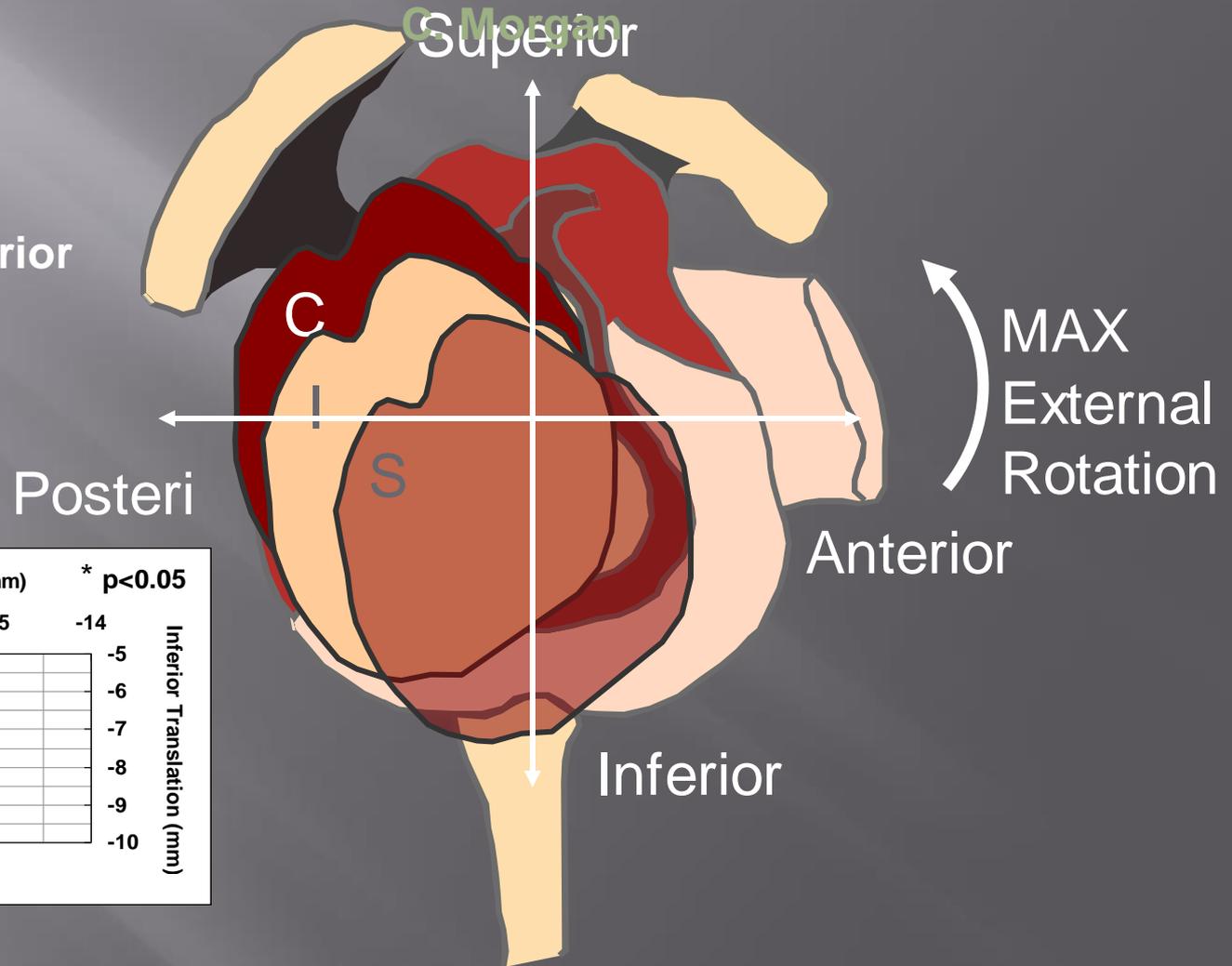
Posterior capsular contracture  
(Glenohumeral internal rotation deficit – GIRD)

Morgan



# Humeral Head Position with Respect to the Glenoid Following Maximum External Rotation

- I: Intact
- S: Stretched
- C: Simulated Posterior Contracture



## Arthroscopic Pathology



Partial Undersurface  
Infraspinatus Tear



Posterior Labral Detachment  
With "Peel-Off"

# “Peel-back Phenomenon”

## Morgan & Burkhart

### Normal Anatomy

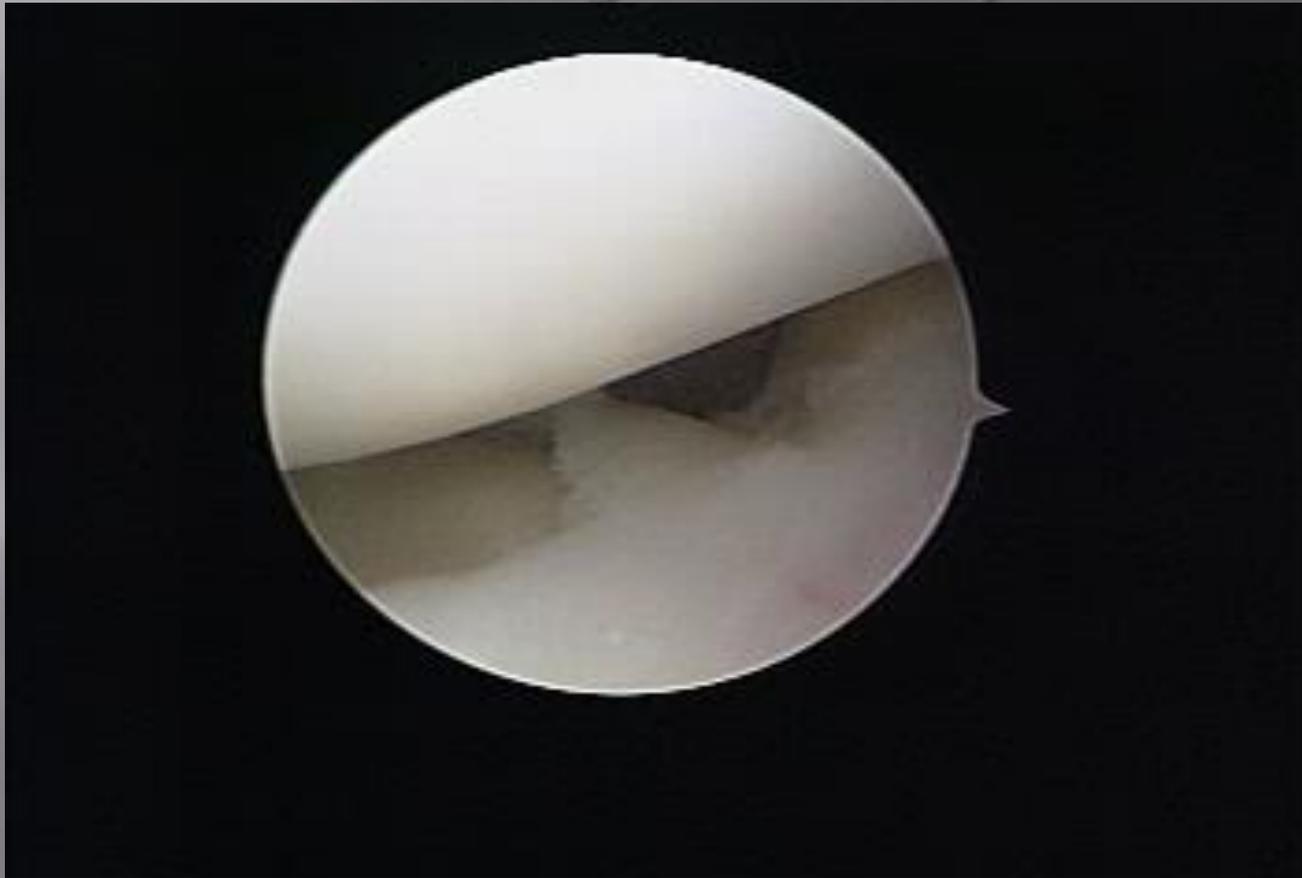


Right shoulder, anterior portal

# “Peel-back Phenomenon”

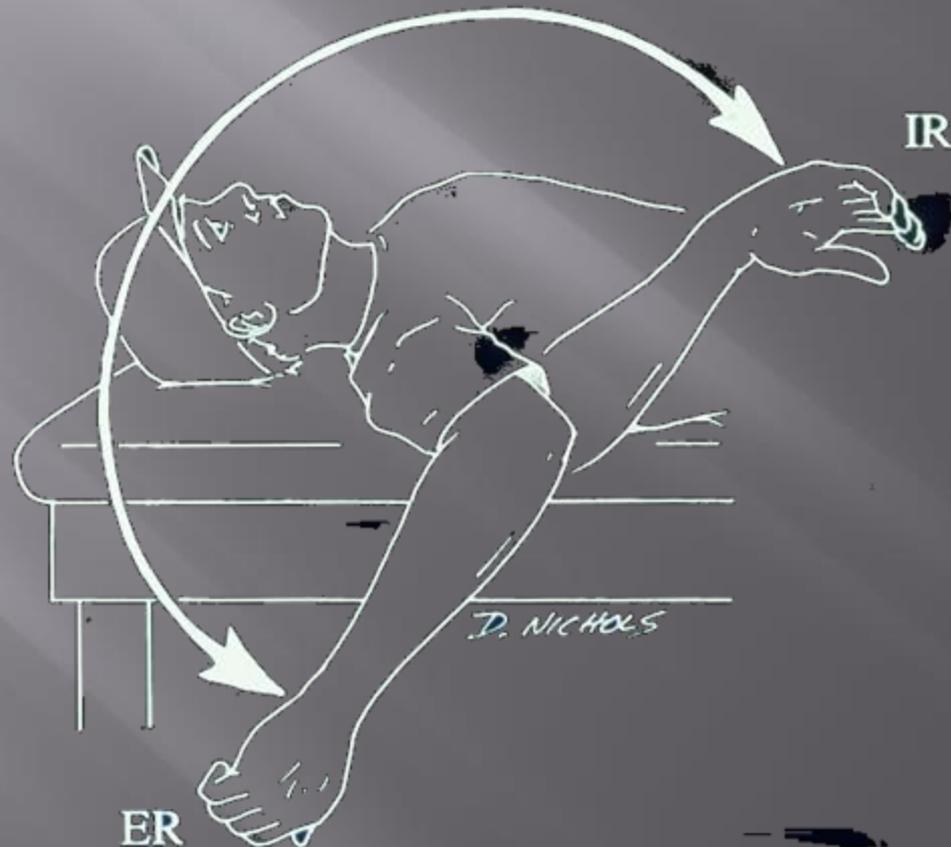
Morgan & Burkhart

Pathologic Anatomy



Left shoulder, posterior portal

# “TOTAL MOTION” CONCEPT WILK & ANDREWS



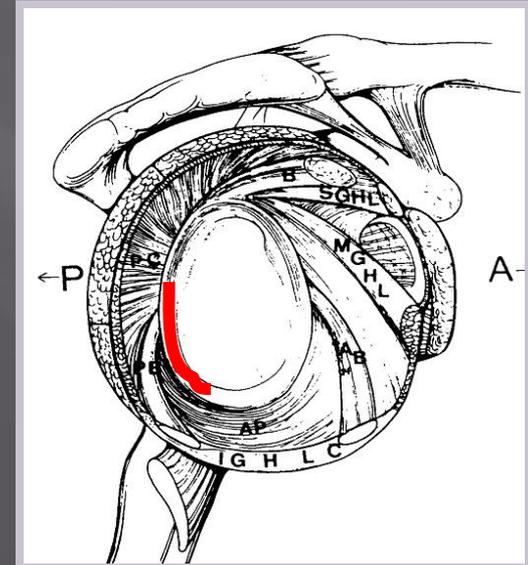
# Loss of Internal Rotation

## *GIRD Concept - Morgan*

- ▣ **GIRD:** *Gross Internal Rotation Deficit*
- ▣ Loss of IR compared to non-throwing shoulder
- ▣ *Shoulder at risk = GIRD >20 degrees*
- ▣ Treatment: stretching  
Nonresponders –  
capsulotomy

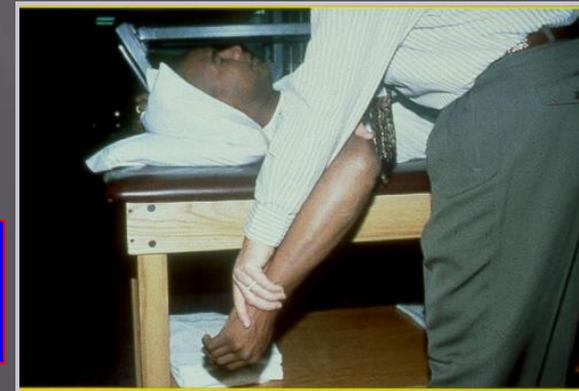
Post. Inf. Capsulotomy

*Morgan CD: Unpub '05*



# Wilk, Crenshaw, Reed, et al: 99-05

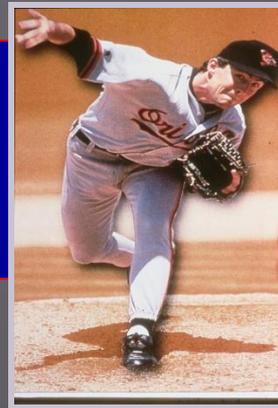
- Examined ROM in 842 professional baseball pitchers
- Data from '99 to '05
- ER @ 90 deg abduction:
  - Dominant:  $129 \pm 10$  deg
  - Non-Dom:  $121 \pm 9$  deg.
- IR @ 90 abduction:
  - Dominant:  $61 \pm 9$  deg
  - Non-Dom.  $68 \pm 8$  deg
- Total Motion:  $190 \pm 14$



**Total Motion Equal Bilateral !!!**

# The Thrower's Shoulder

## *Why the loss of IR*



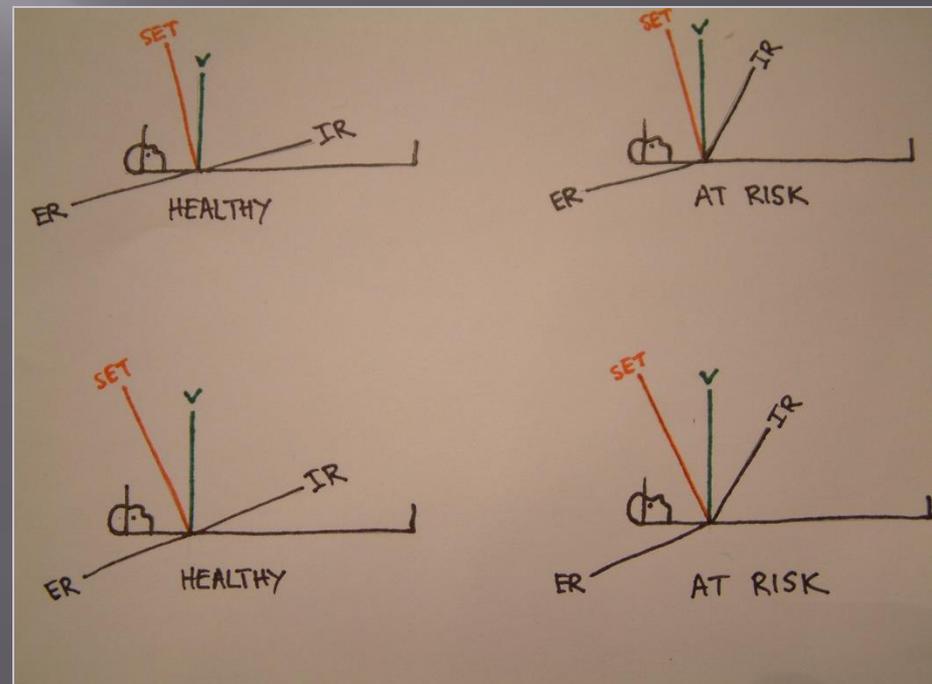
- During ball release & deceleration phase of pitching
- Large distraction forces – 1X BW
  - Fleisig: J Biomech '99*
- Significant muscle activity decelerating arm - eccentrics
  - *Teres Minor: 84% ± 52 %MVIC*
  - *Infraspinatus: 37% ± 20 %MVIC*
  - *Posterior Deltoid: 60% ± 28 %MVIC*

*DiGiovine: JSES '92*

*Large Eccentric Forces Generated During this Phase*

# When is GIRD / posterior capsular contracture really present?

- ▣ The total arc of motion is decreased by  $>20$  degrees in the throwing shoulder
- ▣ IR is generally less than contralateral shoulder by  $> 20$  degrees, but ER is nearly equal



**Posterior Capsular  
Tightness Does Not  
Account for Increases in  
External Rotation**

# MOST COMMON SHOULDER PATHOLOGY

PARTIAL ARTICULAR-SIDE  
ROTATOR CUFF REPAIR  
(PASTA LESIONS)

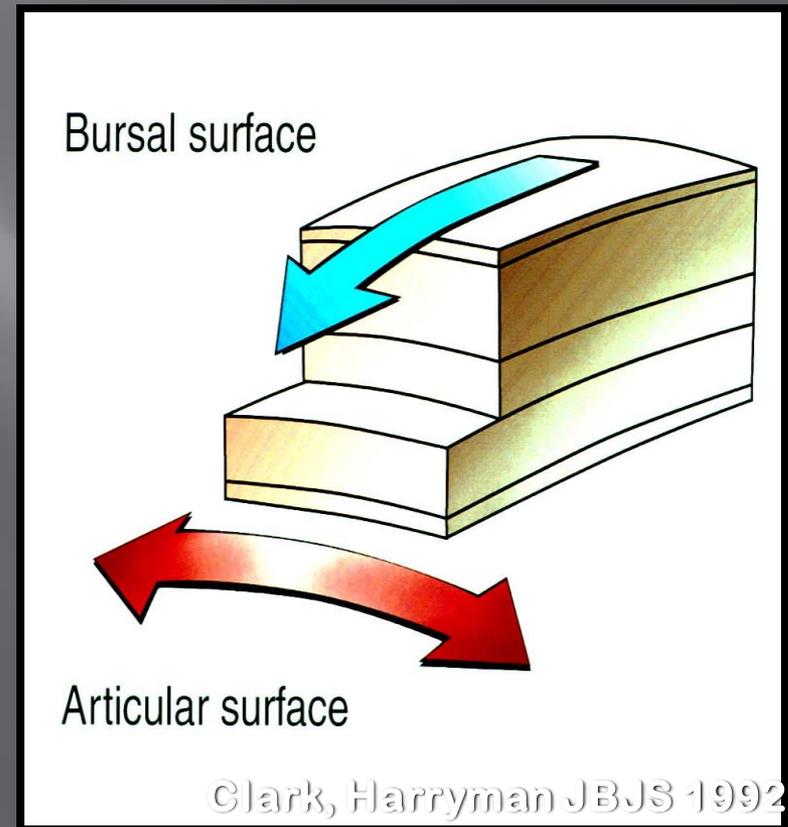
# Partial Thickness Rotator Cuff Tears

- ▣ More common source of pain than previously appreciated
- ▣ Not a singular condition
- ▣ Results from variety of insults to cuff producing different locations (intratendinous, bursal vs articular surface) and patterns of failure
- ▣ Most common on articular surface
- ▣ Different mechanisms can co-exist
- ▣ Do not heal spontaneously, may progress
- ▣ **Commonly associated w/ Internal Impingement**

# Etiology - IT Factors

“Intra-tendinous tearing ... suggests the presence of shear within the tendon.”

Fukuda



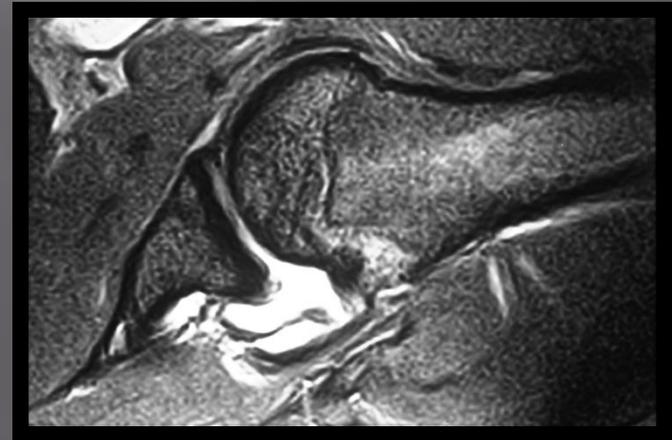
# Imaging

- ▣ MR Arthrogram – best demonstrates lesion

Sagittal



ABER

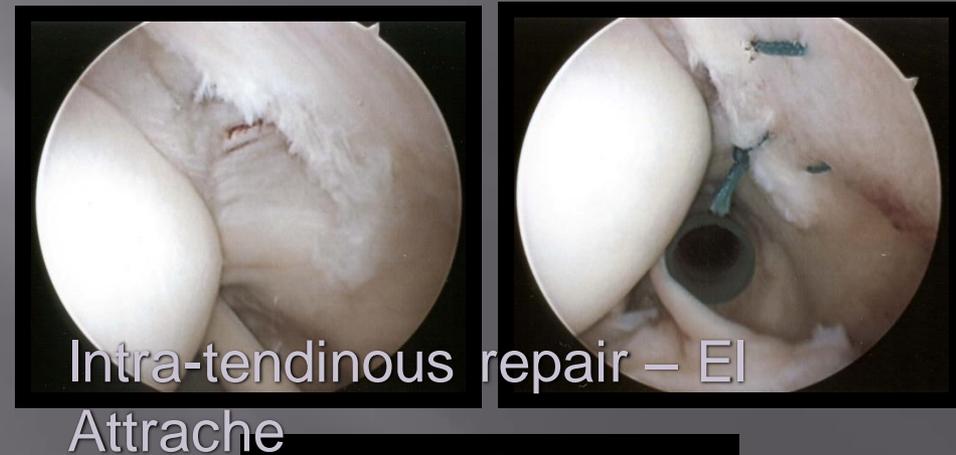


# Surgical Options for Rotator Cuff Disease in Throwers

1. Arthroscopic debridement
2. Arthroscopic debridement and acromioplasty
3. Arthroscopic rotator cuff intra or transtendionus repair for partial undersurface tears  $\pm$  mini-acromioplasty
4. All arthroscopic repair for full thickness tears + acromioplasty
5. Arthroscopic acromioplasty and mini-open rotator cuff repair for full thickness tears

# Surgical Treatment of PASTA Lesions

- ▣ If 25% of cuff is torn, debride the undersurface of the tendinosis tissue. If delaminated consider Intratendinous repair? Acromioplasty is usually not needed
- ▣ If 50% of cuff is torn – arthroscopic repair to footprint; intratendinous repair if delaminated
- ▣ If  $\geq 75\%$  of cuff is torn, complete and repair both laminae at their respective anatomic

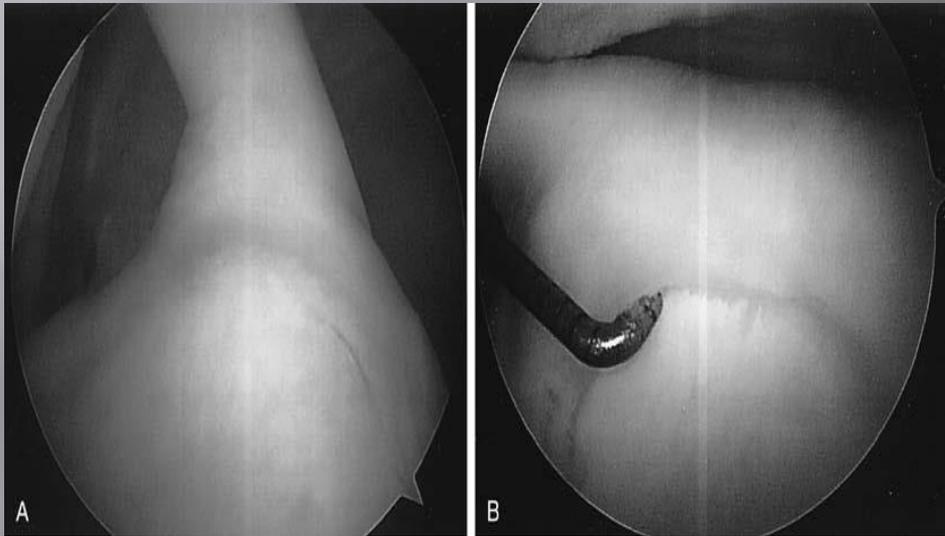


# Superior Labral Injuries (SLAP)

- ▣ Andrews *AJSM* 1985
  - Noted superior labral injuries in 73 overhead athletes
- ▣ Snyder *Arthroscopy* 1990
  - First to coin the term “SLAP” (Superior Labrum Anterior and Posterior) lesions
  - Retrospective review of 700 shoulder arthroscopies from 1985-1989
  - 27 pts with SLAP lesions (3.9% incidence)

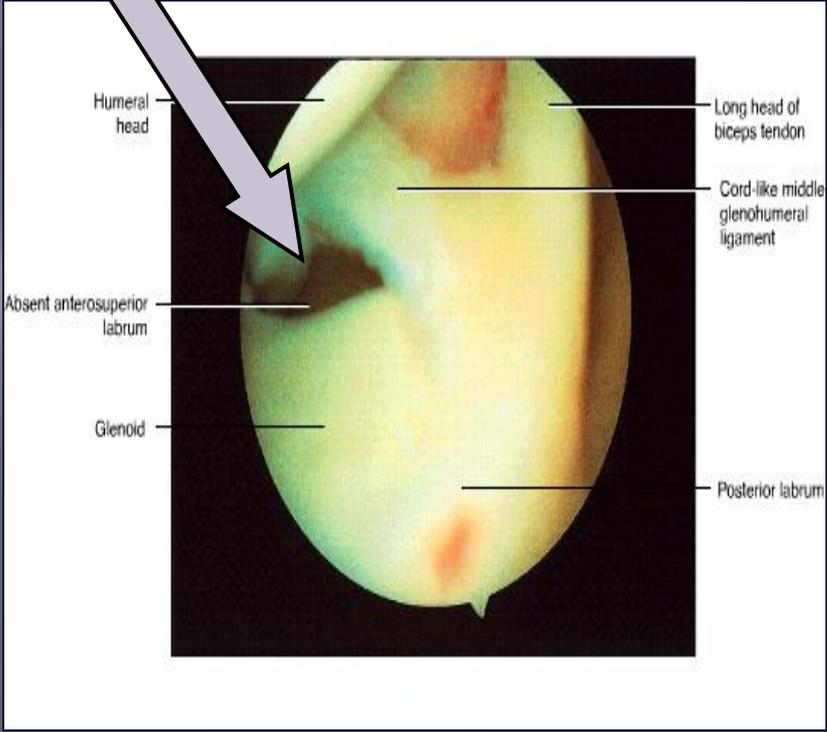
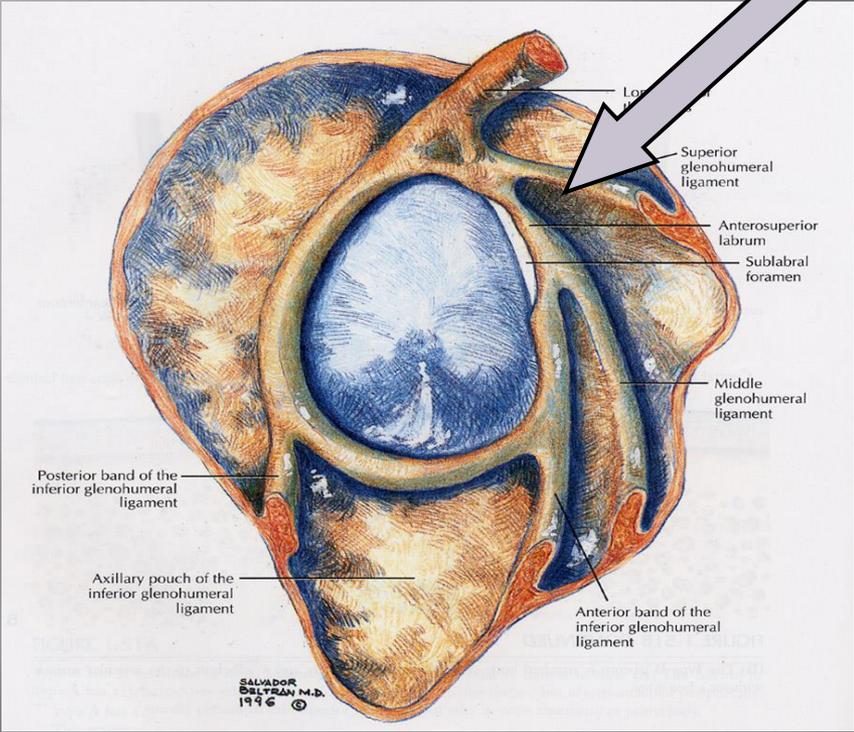
# Superior Labral Anatomy

□



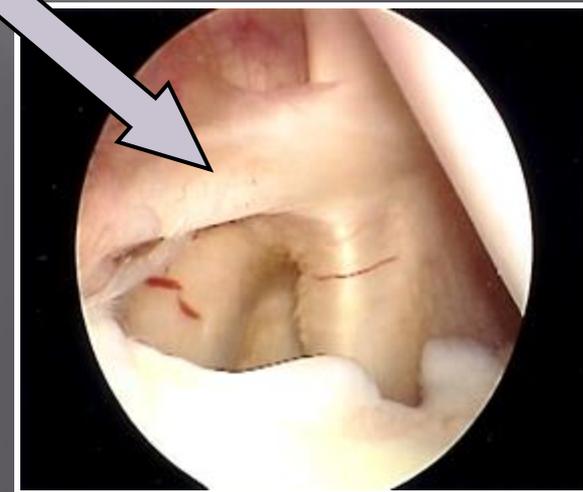
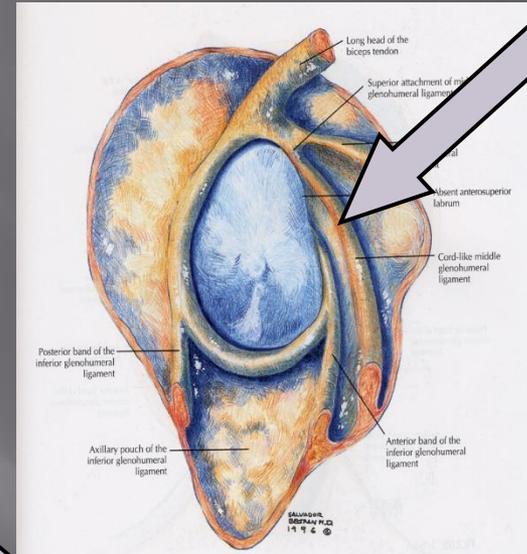
- Superiorly the biceps tendon has a close relationship with the glenoid labrum. The biceps tendon inserts onto the supraglenoid tubercle after its entry into the joint through the rotator interval. The fibers of the biceps tendon blend into the fibers of the labrum *and* capsule surrounding this insertion

# Normal Variations of the Glenoid Labrum Sub-labral Hole

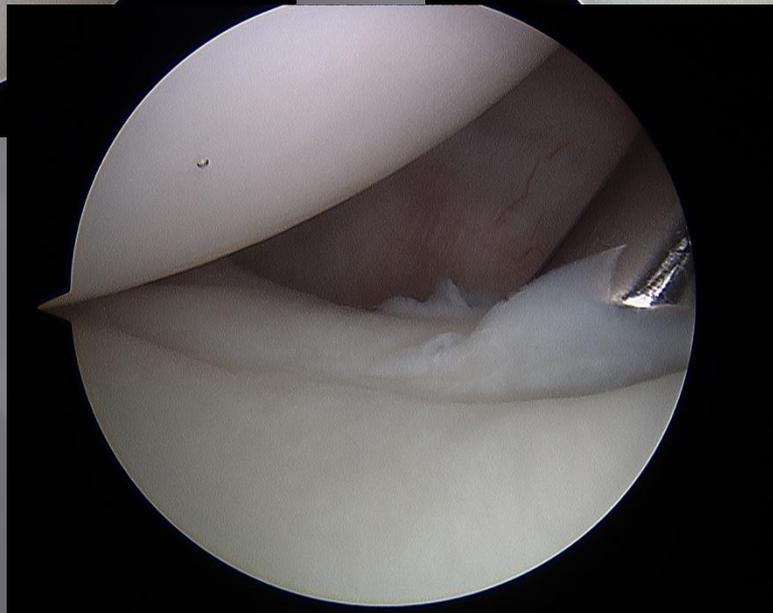
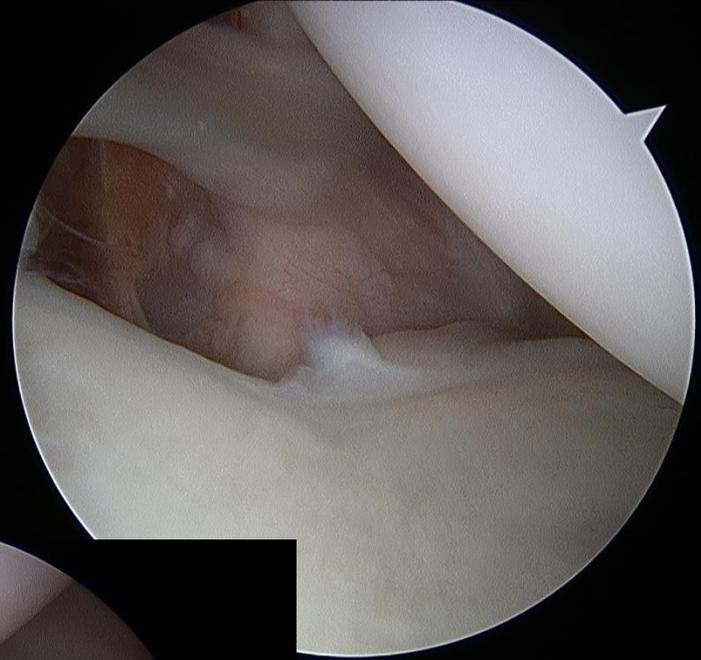
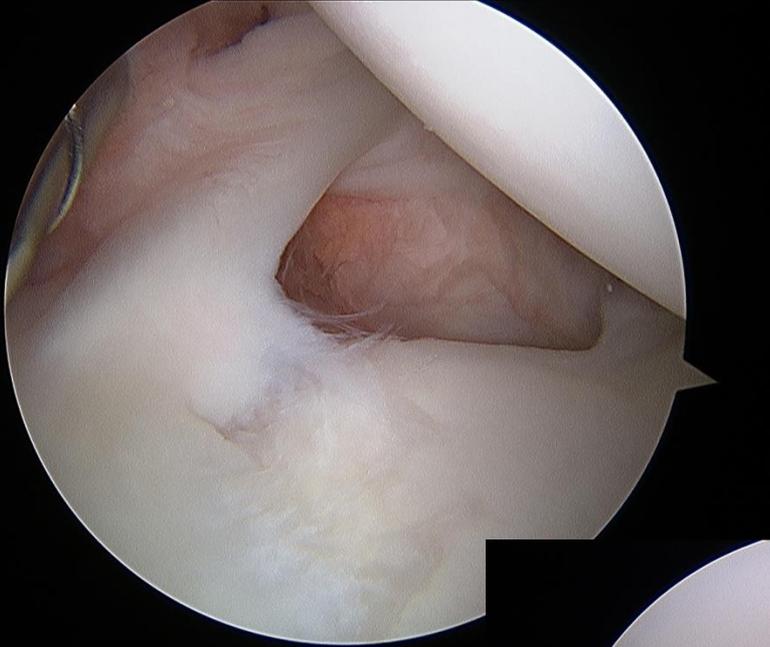


# Normal Variant- Buford Complex

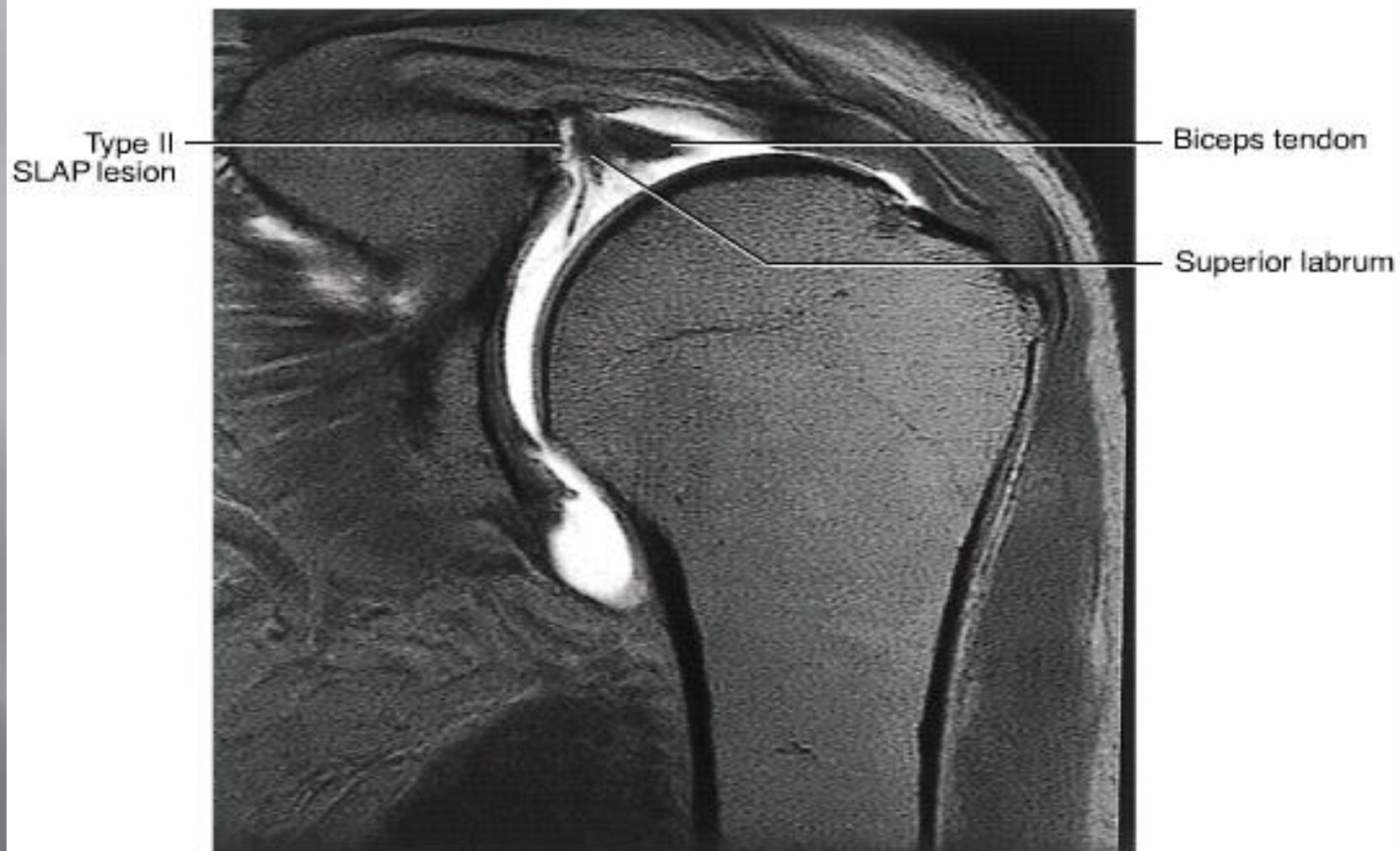
- ❑ Cordlike middle glenohumeral ligament attaching to the base of the biceps anchor
- ❑ Absence of labral tissue on the anterior superior glenoid
- ❑ Fixation leads to diminished external rotation



# Buford Complex



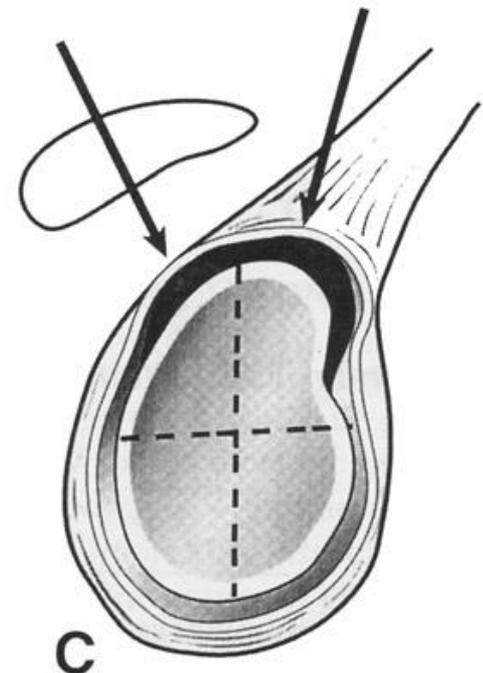
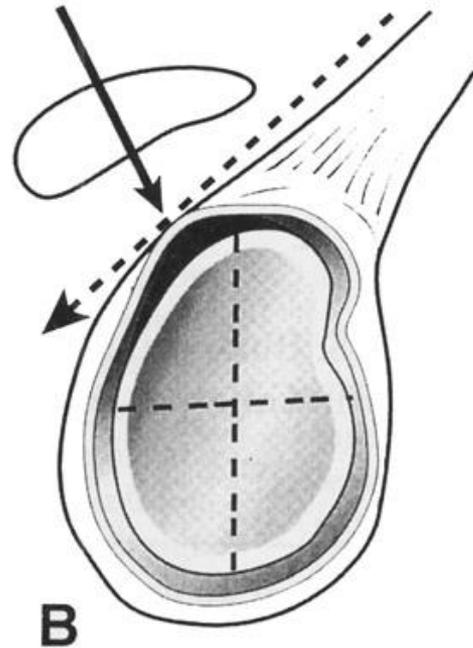
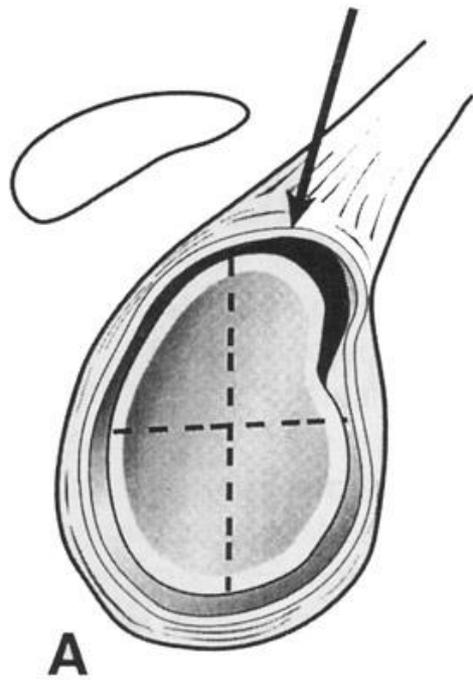
# SLAP Lesions



# SLAP II subtypes

- ▣ Morgan, Burkhart, et al., *Arthroscopy*, 1998
- ▣ 3 distinct type II lesions - anatomic location:
  1. Anterosuperior (37%) - nonthrowing trauma
  2. Posterosuperior (31%) - “Posterior SLAP”
    - leads to posterosuperior subluxation
    - anterior pseudolaxity (+ drive-through sign)
    - secondary internal impingement lesion – partial RCT
    - Jobe relocation test + (85% sensitive, 68% specific)
  3. Combined anterior & posterior (31%)

# SLAP II subtypes



# SLAP Physical Exam

- ▣ Subtle
- ▣ Provocative tests
  - O'Brien
  - Crank
  - Pain Provocation Test
  - Biceps Load Test
- ▣ Beware of concomitant associated pathology
  - impingement, instability, RTC tears

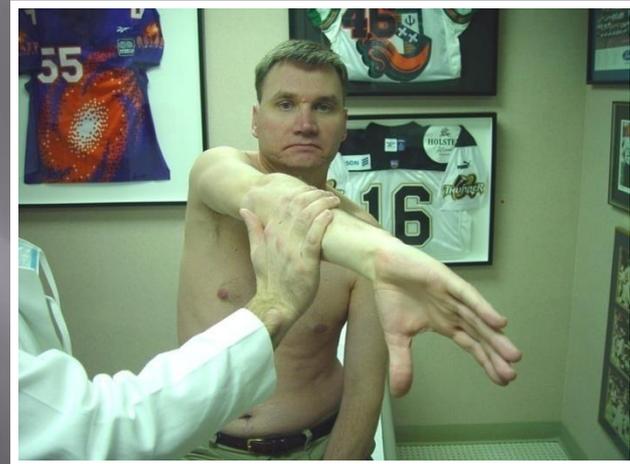
# PE of Shoulder - Special Tests

- Impingement sign
- Impingement test
- Hawkins sign
- “Empty-the-can” test
- Drop arm test
- Abduction sign
- Jerk test
- Posterior stress test
- Push-pull test
- Lift-off sign
- Load and shift test
- Cross-arm adduction sign
- Yergason’s test
- Feagin test
- Biceps load test I & II
- Jahnke test
- Ludington’s test
- DeAquin’s test
- Lippmann’s test
- Heuter’s sign
- Norwood stress test
- Anterior release test
- Apprehension test
- Fulcrum test
- Fulcrum maneuver
- Crank test
- Anterior&posterior drawer test
- Relocation test
- Apprehension suppression test
- Posterior impingement sign
- Compression-rotation test
- Active compression test
- Clunk test
- Biceps tension test/Speed’s test
- Napoleon’s sign
- Whipple test
- Anterior slide test/Kibler’s test
- Fukuda test
- SI AP test of Field

# Active Compression Test (O'Brien's)

## ▣ O'Brien et al. *AJSM* 1998

- ▣ Pt standing, arm FF 90° w/ elbow extended
- ▣ Arm adducted 10° to 15°
- ▣ Max IR (thumb points down); examiner applies resisted downward force to arm
- ▣ Pt then max supinates arm, and maneuver repeated
- ▣ **Positive test** - Pain elicited during 1st maneuver and reduced on



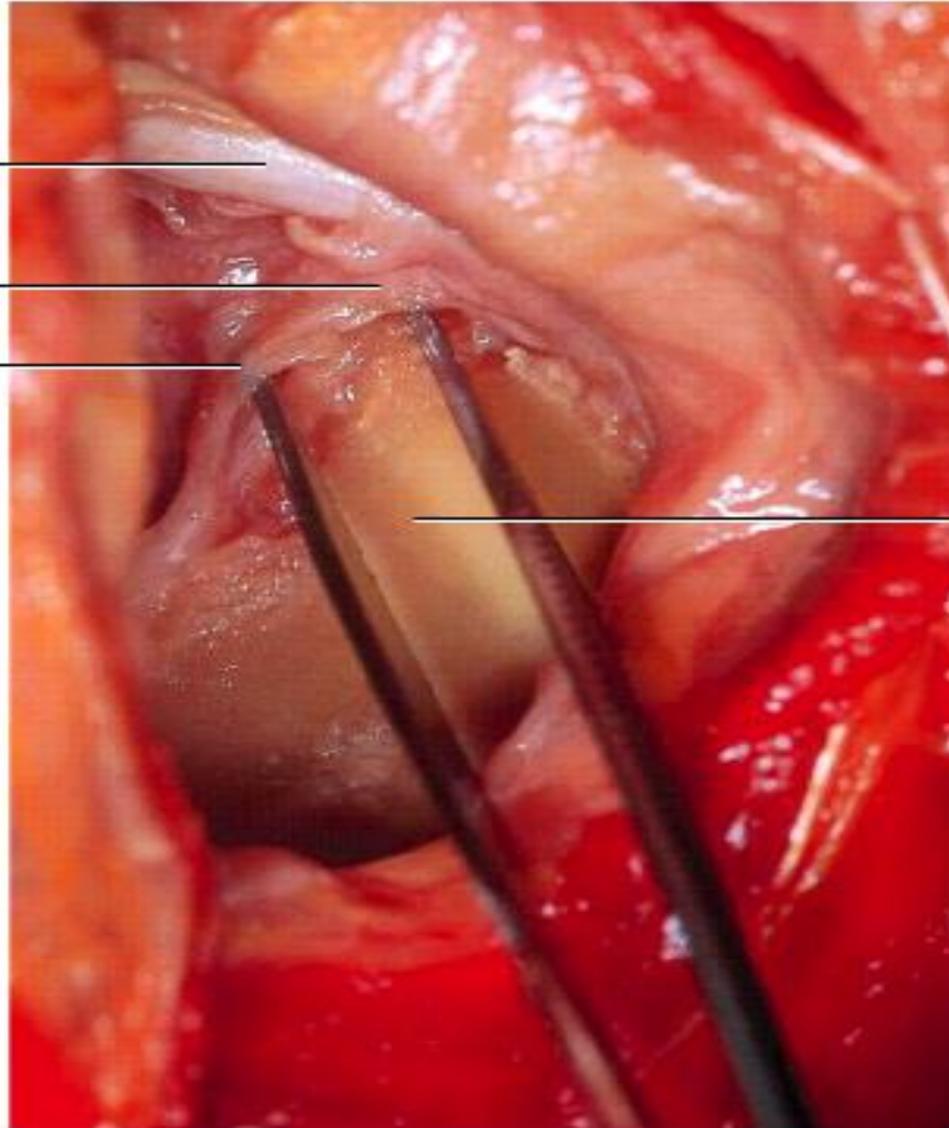
# Crank Test

- ▣ Liu et al. *AJSM* 1996
  - Pt upright or supine, arm elevated 160° in scapular plane
  - Humerus loaded axially w/ max IR and ER
  - **Positive test**
    - ▣ Pain, with or without click
    - ▣ Reproduction of symptoms during activity



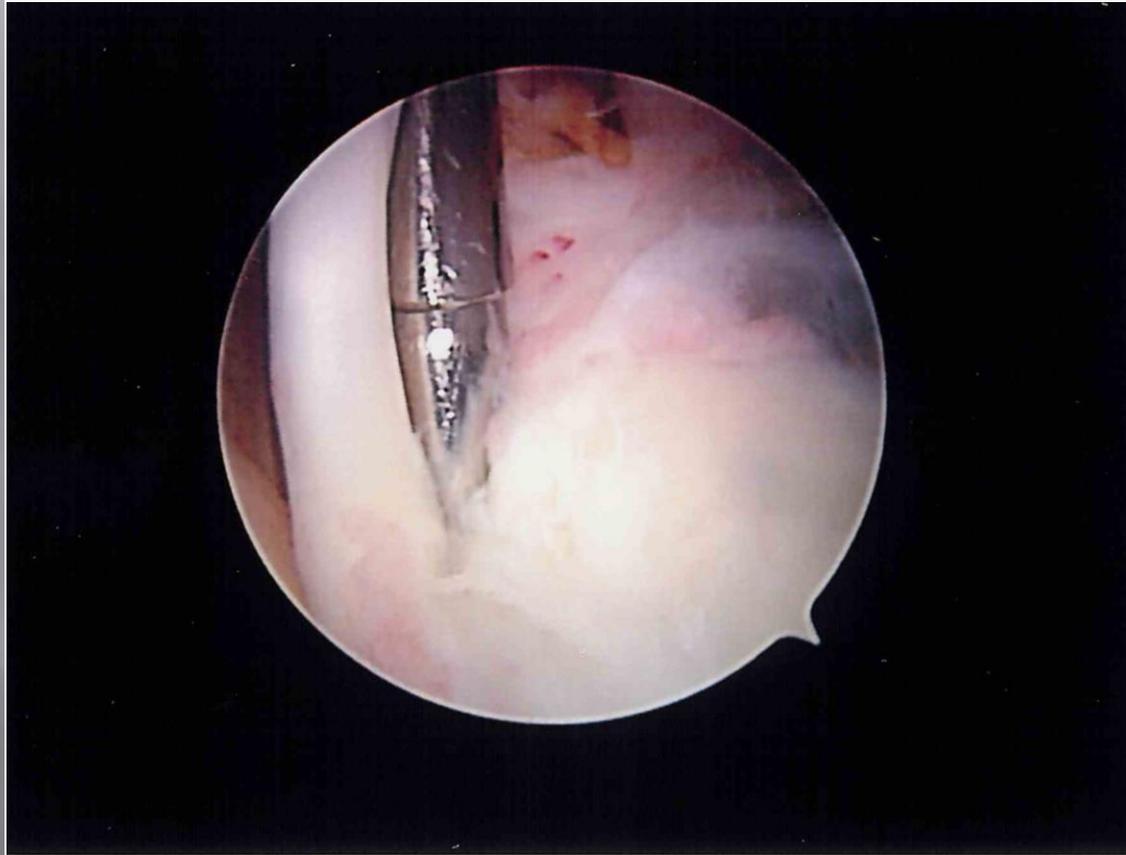
# SLAP II

Biceps tendon  
Detached superior labrum  
Anterosuperior extension of type II SLAP lesion

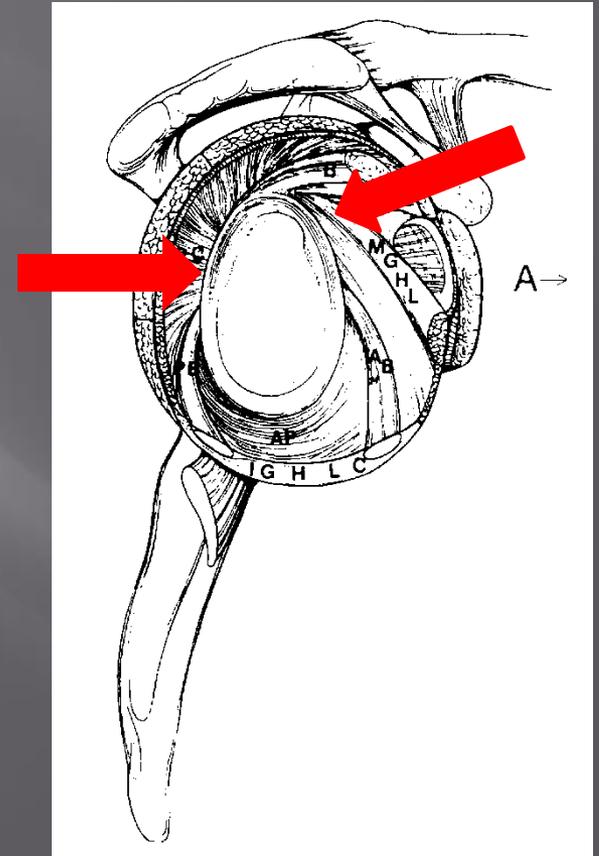


Glenoid

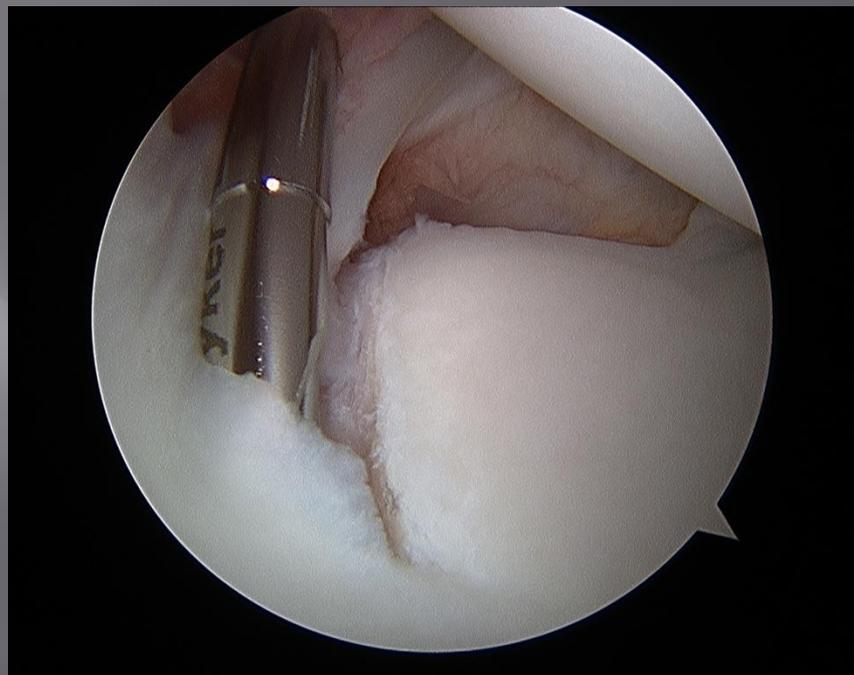
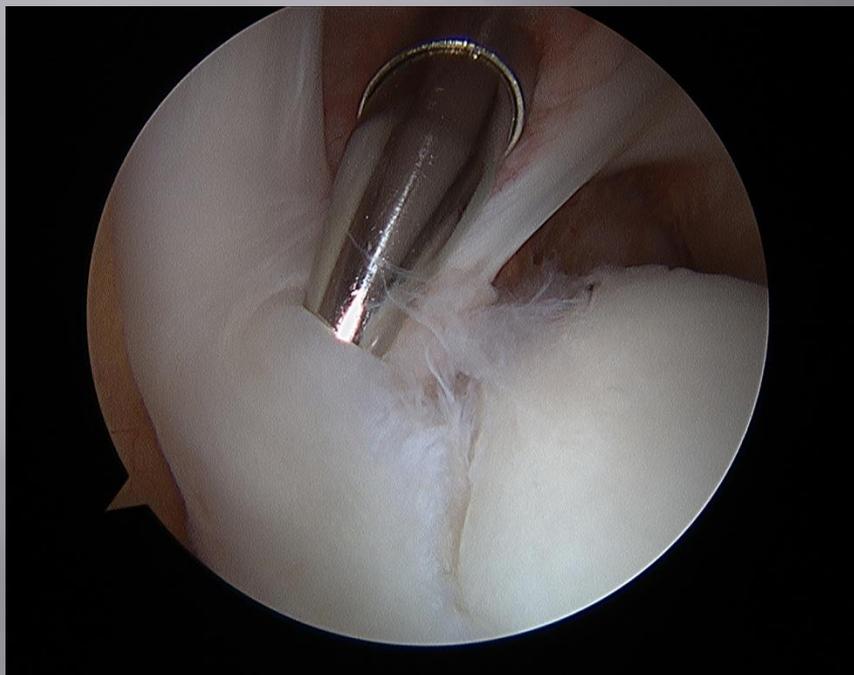
# SLAP II



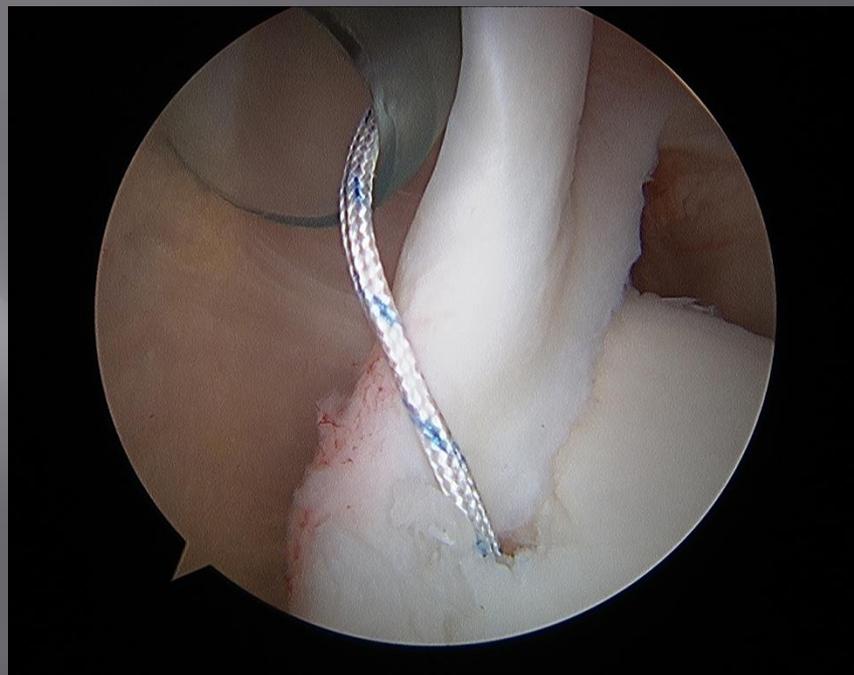
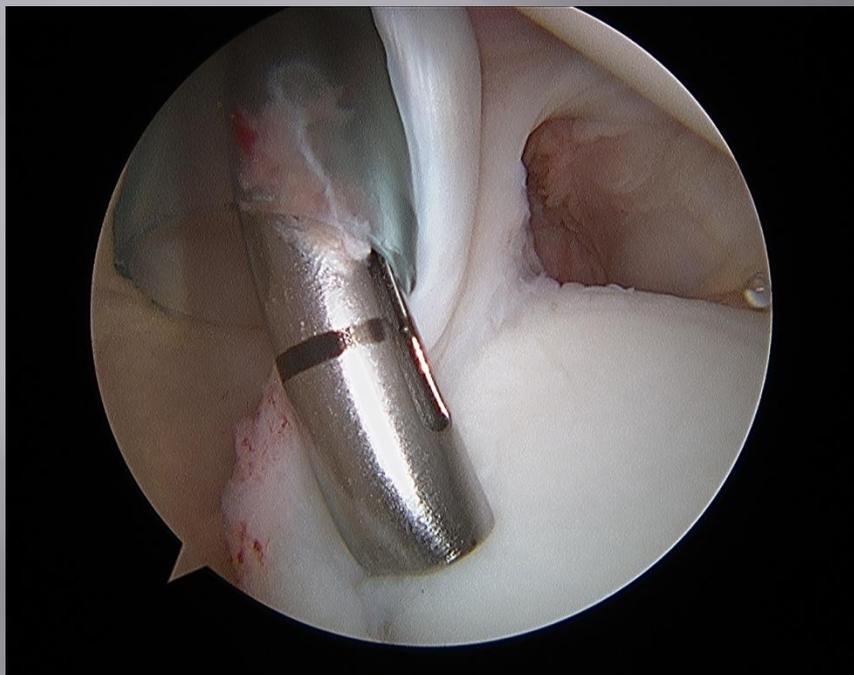
# Surgical Set-up



# SLAP Repair

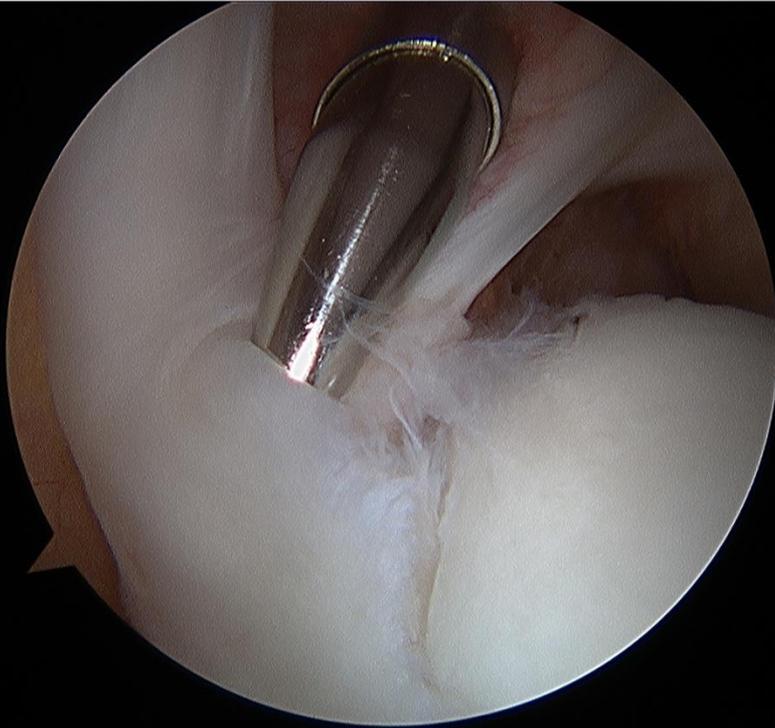


# SLAP Repair

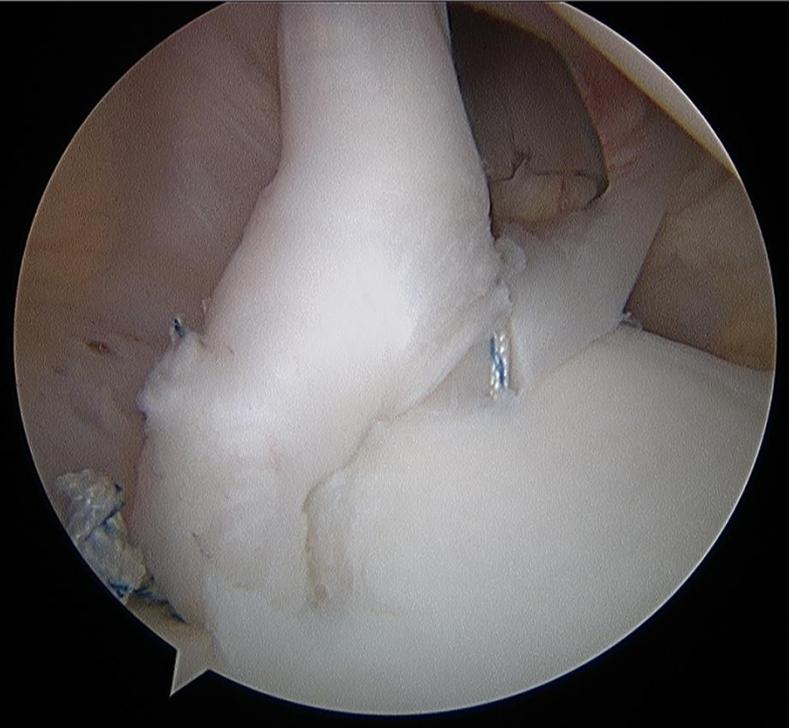


# SLAP Repair

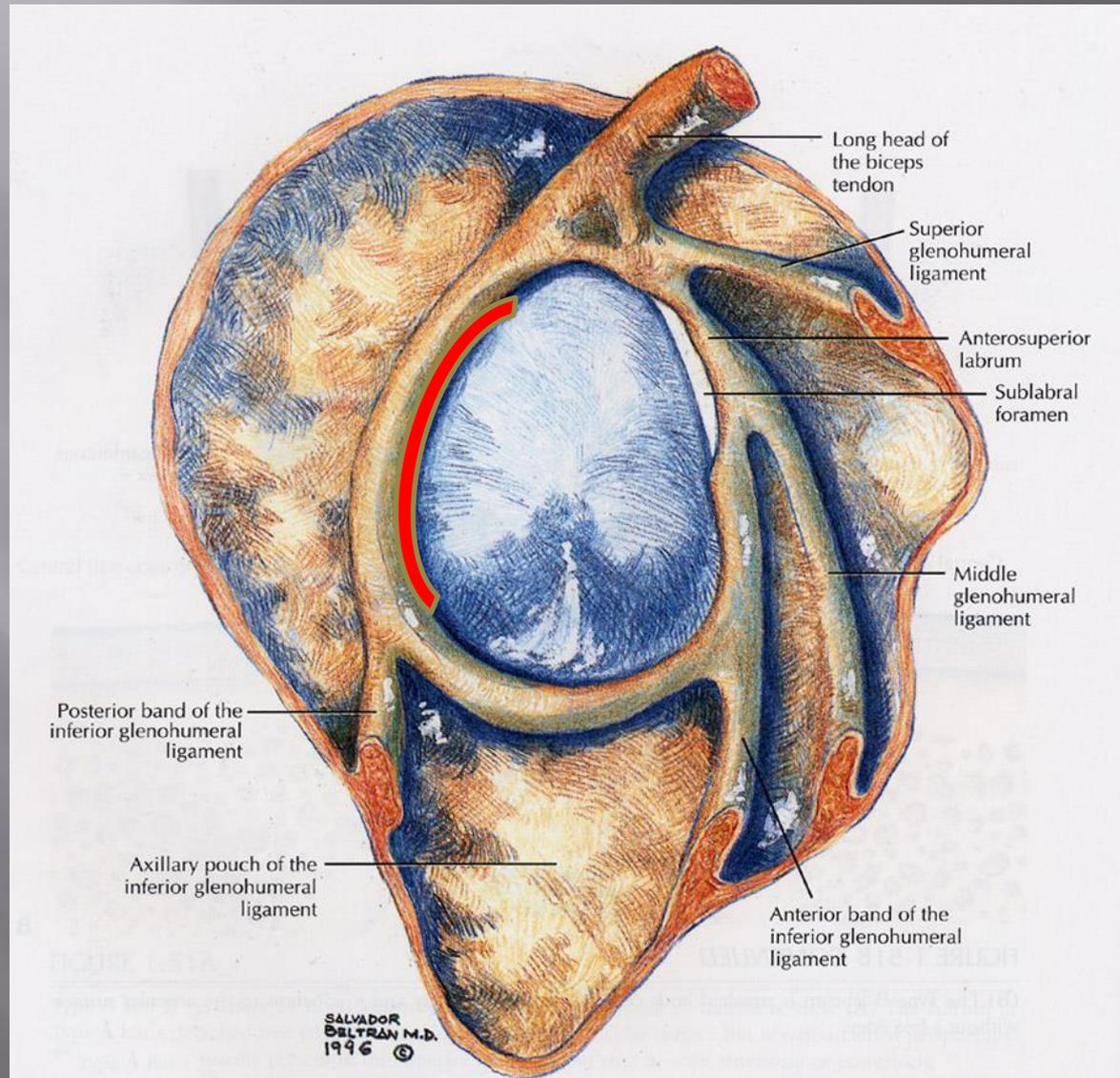
BEFORE



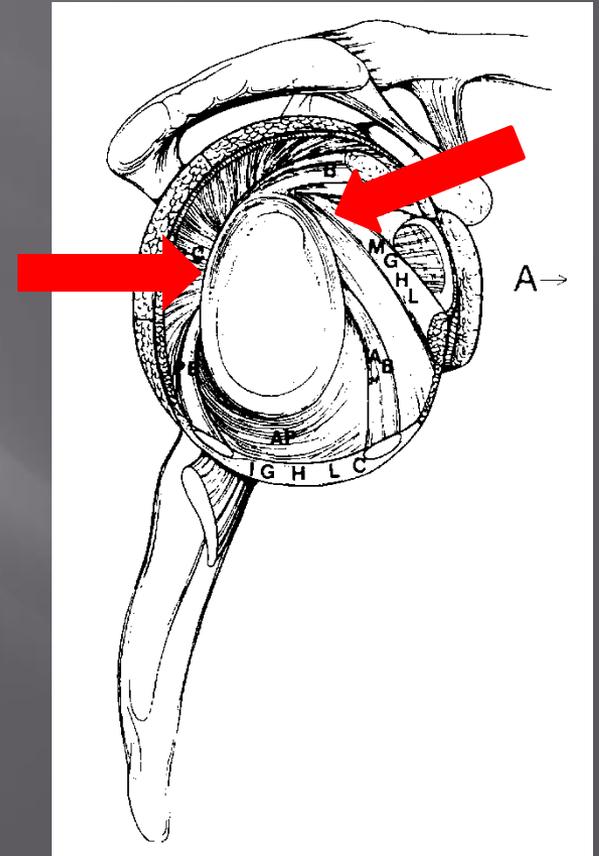
AFTER



# Posterior Labral Pathology



# Surgical Set-up



# Debridement of posterior labrum and preparation of bony bed



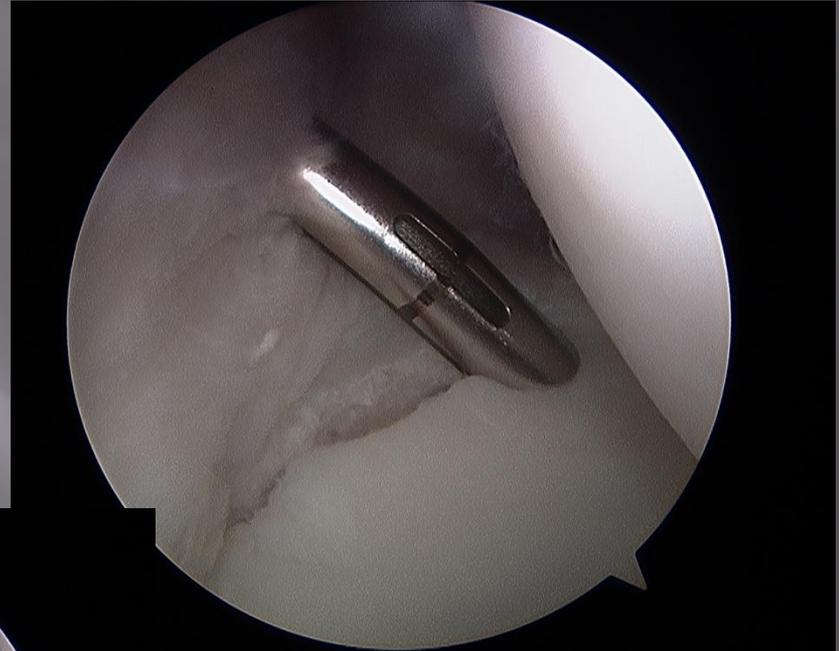
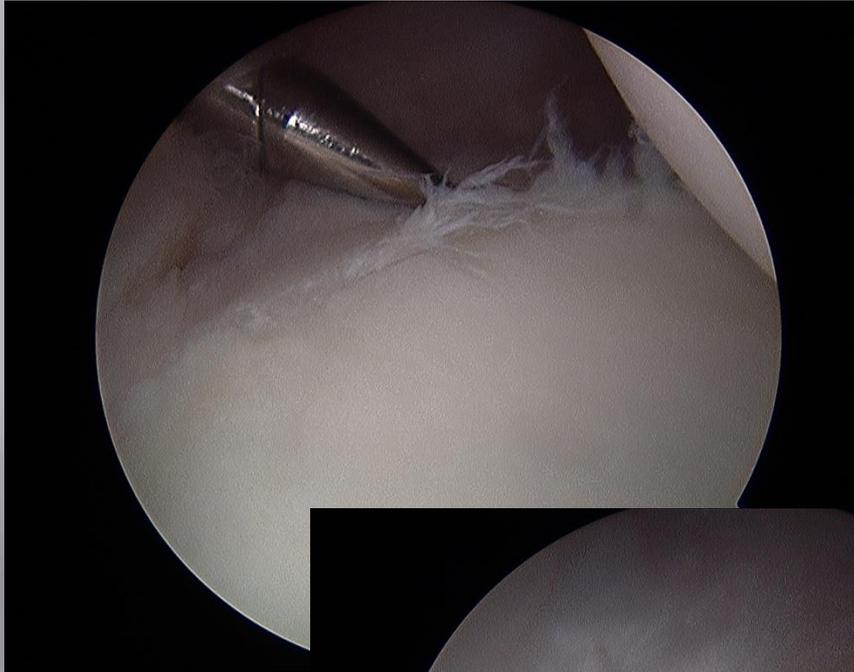
# Intro of Anchor



# Final Repair



# Posterior Labrum - New Technology



**Posterior  
Glenoid Exostosis**  
(Meister & Andrews)

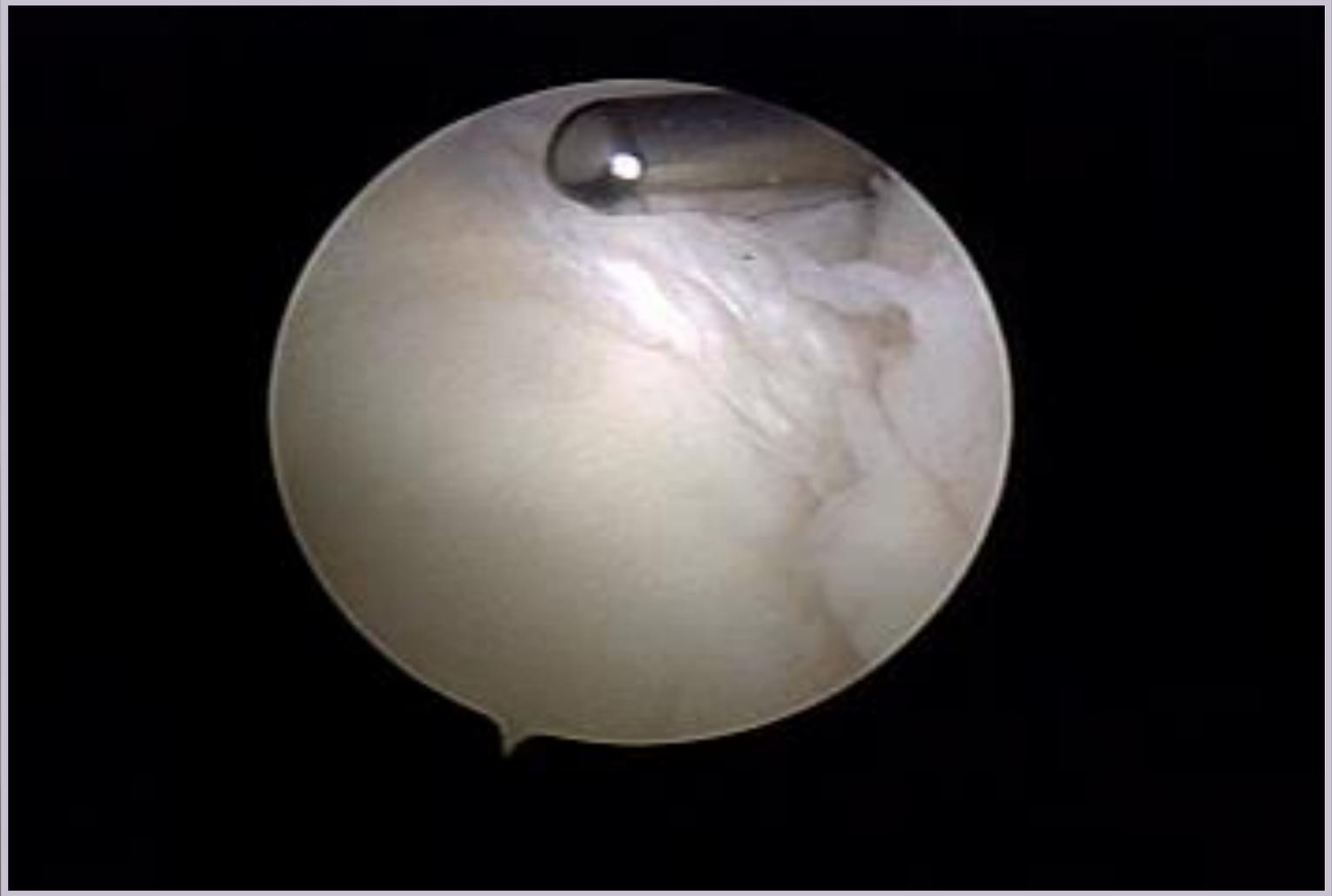
***“Throwers Exostosis”***  
***(Bennett’s Lesion)***

# Pathophysiology of “Throwers Exostosis”

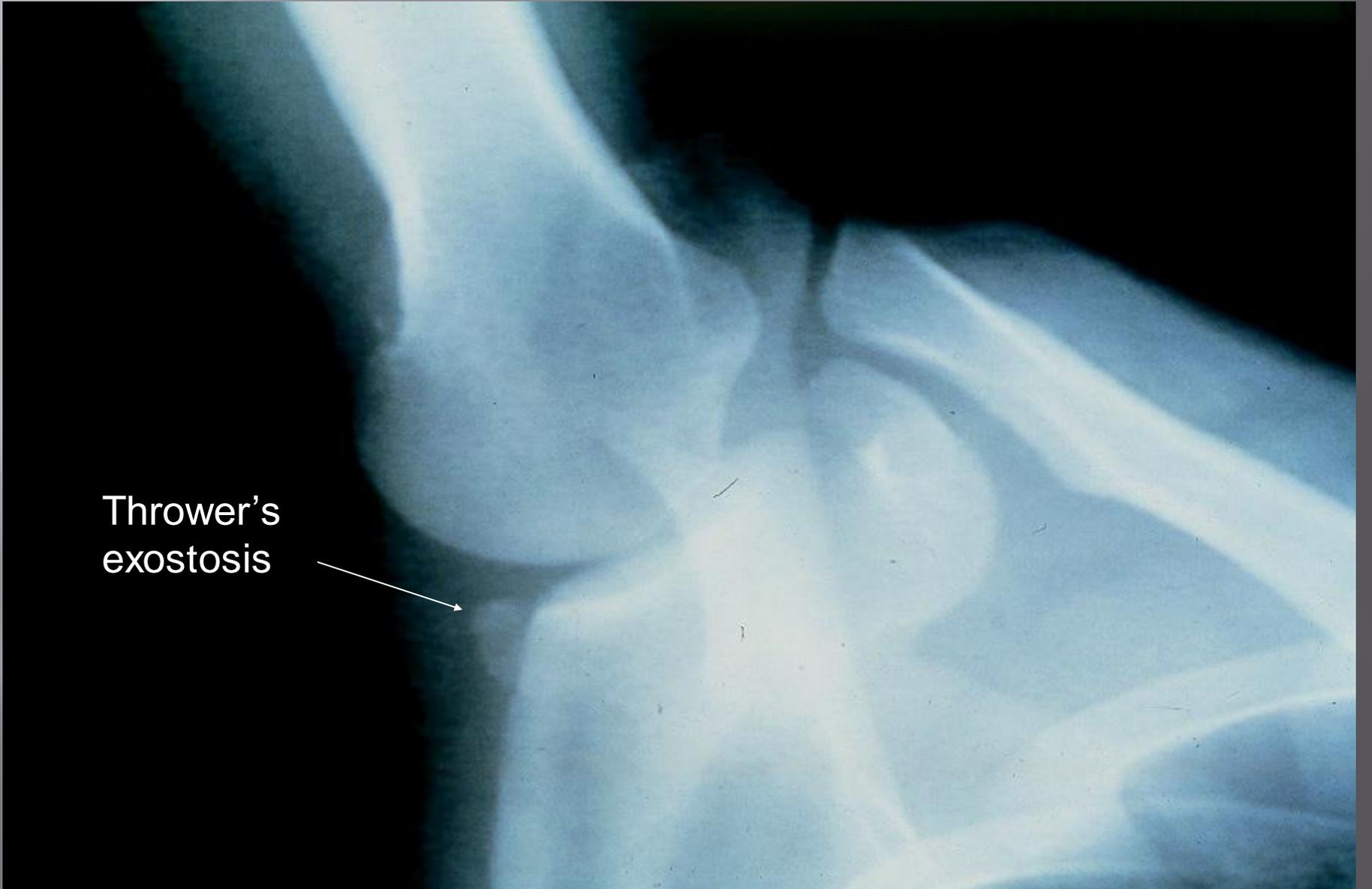
- ❑ Traction spur on posterior-inferior glenoid
- ❑ Associated with pull of posterior band of the inferior glenoid ligament
- ❑ During the deceleration phase of throwing
- ❑ May or may not be symptomatic



# Arthroscopic Excision



Thrower's  
exostosis



# Post-Op X-Ray



# Diagnostic Test

X-Ray

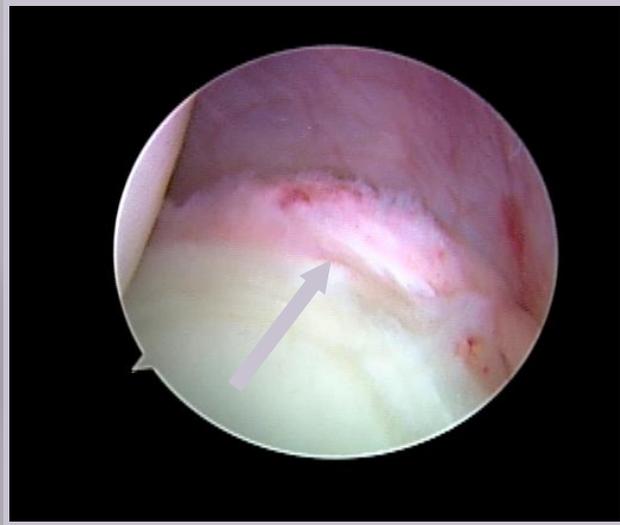
Thrower's Exostosis on Stryker



MRI

Thick P-L labrum & post. band attachment with bony exostosis





Posterior inf view of the exostosis



Erosive contact area on PI humeral head during cocking



Excise the lesion



Release the posterior band of the inf. GH lig

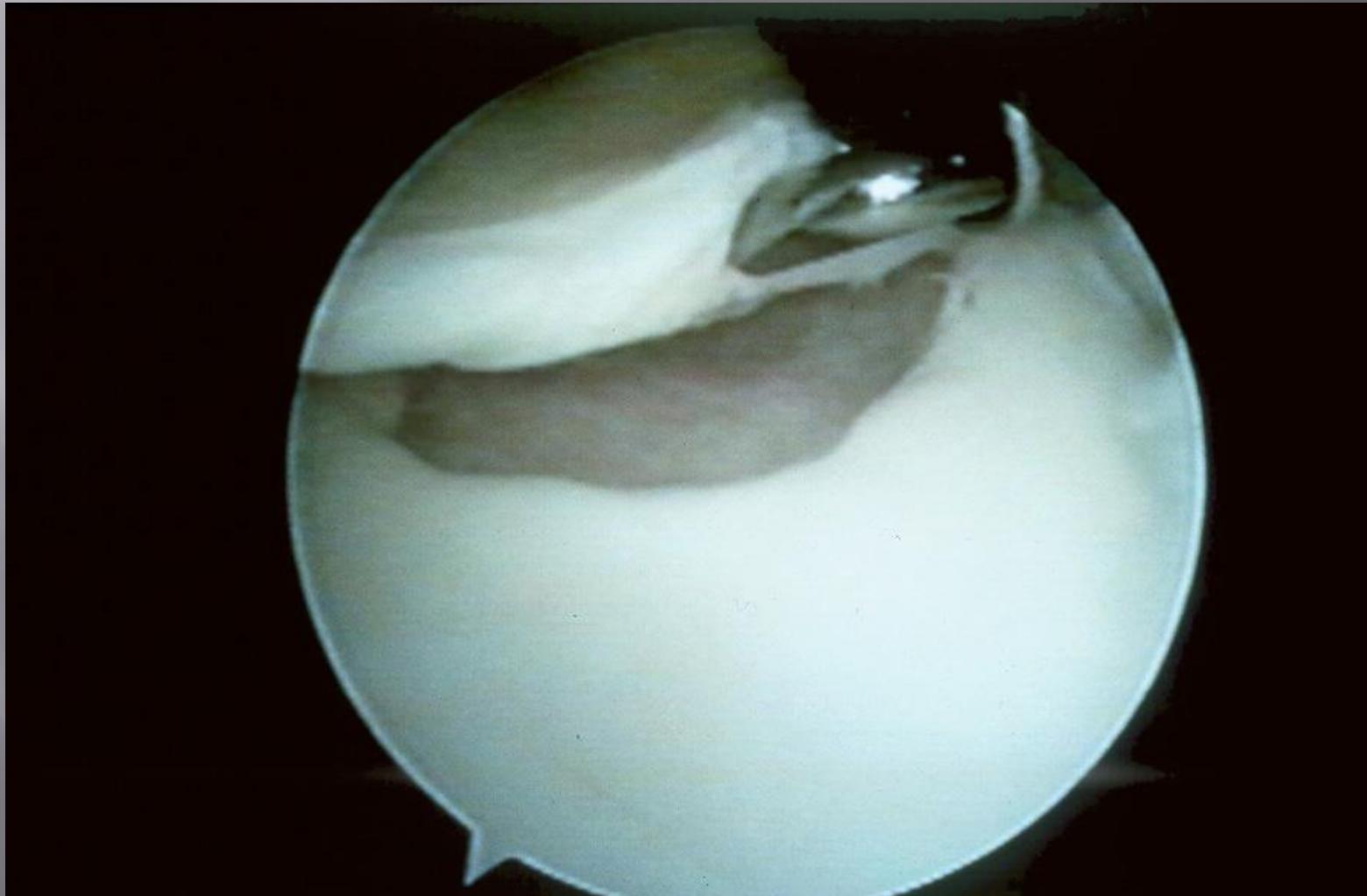
# “OCD of the Shoulder”

Osteochondritis Dissecans  
of the Glenoid

# Operative Technique



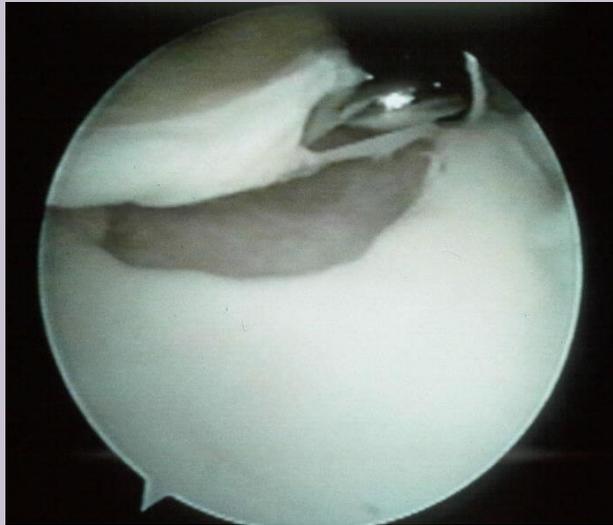
# Glenoid OCD



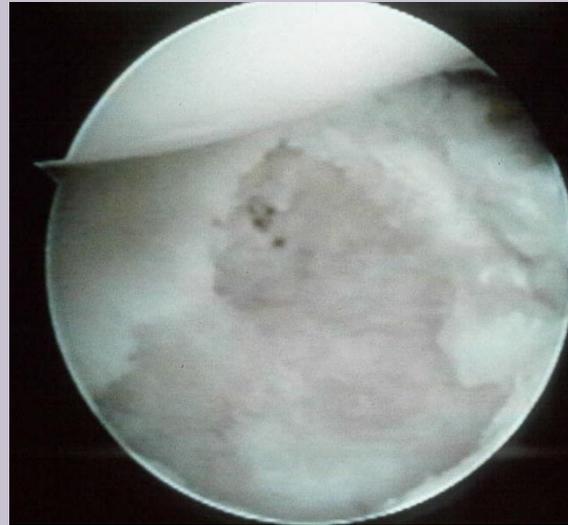




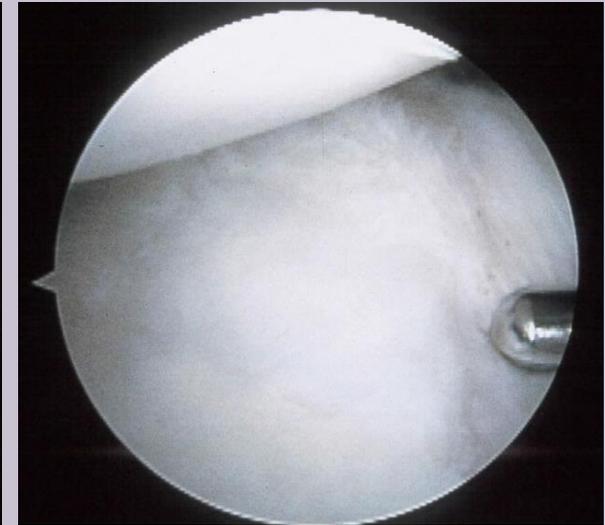
# Operative Technique



Excision



Abrasion



2nd look  
Arthroscopy  
12 mo.

SPINOGLYNOID  
NOTCH PARALABRAL  
CYST



# Spinoglenoid cyst.

One month  
after  
aspiration  
and  
cortisone  
injection



# Other Shoulder Pathology

- ▣ Batter's Shoulder
- ▣ AC joint pathology
- ▣ Deltoid strains
- ▣ Coracoid Impingement
- ▣ Suprascapular nerve entrapment
- ▣ DVT of upper extremity
- ▣ Thoracic outlet syndrome
- ▣ Cervical pathology

# CONCLUSIONS

- ▣ Surgical treatment in the thrower's shoulder is focused on the rotator cuff, labrum, and capsular laxity
- ▣ Be aware of some less common causes of shoulder pain in the thrower (exostosis, spinoglenoid cyst, OCD)

# The Throwing Shoulder – What Have We Learned?

- ▣ Its amazing that the shoulder can survive even a short course of baseball throwing!
- ▣ The pathophysiology of the throwing shoulder is controversial
- ▣ “Over rotation” repetitively will certainly eventually tear up the soft tissues about the throwing shoulder
- ▣ If you want an excuse to operate on a throwing shoulder obtain an **MRI!!**

# The Throwing Shoulder – What Have We Learned?

- ▣ Surgical options for injuries of the throwing shoulder continue to be refined and more sophisticated
- ▣ Minimally invasive procedures continue to evolve
- ▣ Some open procedures are still the “Gold standard”
- ▣ There’s always a role for *extensive conservative treatment*
- ▣ Rehabilitation is frequently *more important* than the surgical procedure