Pediatric Elbow and Shoulder Injuries

ACSM TEAM PHYSICIAN COURSE Part I
AMERICAN COLLEGE of SPORTS MEDICINE

Jacksonville, FL
February 3-7 2016

Mary Lloyd Ireland, M.D.

www.MaryLloydIreland.com
www.youtube.com/ukyortho

Menu

Participation:
Numbers in Organized Sports

- **Overall:** (Hogan KA, "Overuse Injuries in Pediatric and Adolescent Athletes," Orthop Clin North Am, 2003 Jul; 34(3):405-15.)
  - 30 million adolescents & preadolescents
- **Little League 2007:** (www.littleleague.org)
  - 2,227,505 baseball participants
  - 366,780 softball participants
  - 2,640,285 total Little League participants
- **USA Baseball:** (www.mlb.mlb.com/usa_baseball)
  - 9 million participants aged 9 to 17

Introduction

- Children participating in sports each year: 30 million
- 3.5 million children < age 12 treated for sports injuries
  - 50% of injuries are overuse

Epidemic injury patterns in youth sports – elbow injuries in pitchers

Injury Risks

- 11,840 athletes, 5-17 years old
- 4,379,000 injuries annually
- 1,363,000 serious
  (missed school, surgery)
- Sport injuries:
  36% of all injuries for this age group
- Survey included playground equipment and skateboards

Hogan KA, "Overuse Injuries in Pediatric and Adolescent Athletes," *Orthop Clin North Am*, 2003 Jul;34(3):405-15.

Survey 7-13 Years Old Children

- Two playing seasons
- Community organized
- Injury rates per 1000 athlete-exposures:

Soccer	2.1
Baseball	1.7
Football	1.5
Softball	1.0

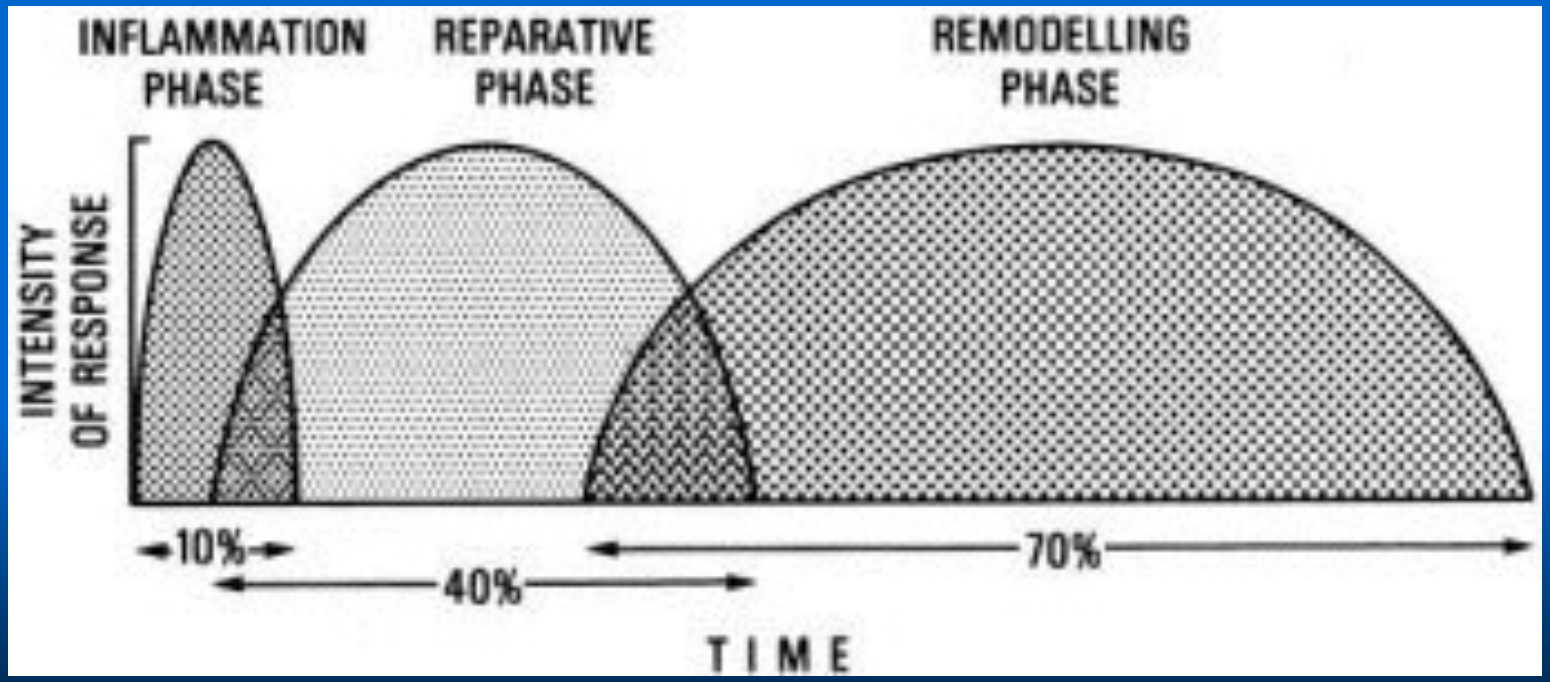
Radelet MA, Lephart SM, Rubinstein EN, Myers JB,
"Survey of the injury rate for children in community sports,"
Pediatrics 2002;110:E28.

Unique Properties of Growing Skeleton

- Periosteum thicker
- Cartilage thicker, more vascular

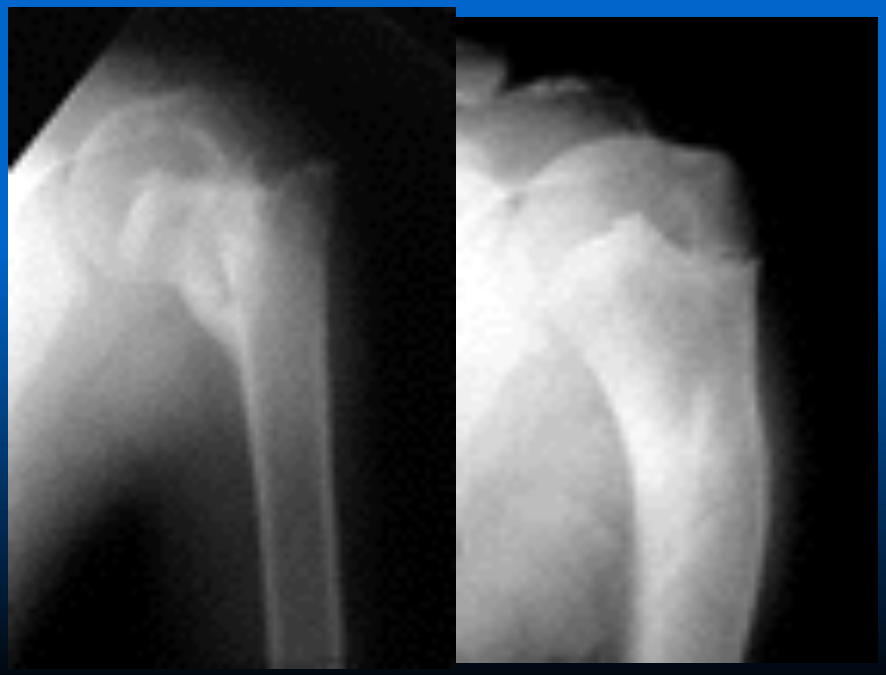
Fracture Healing

- Three stages



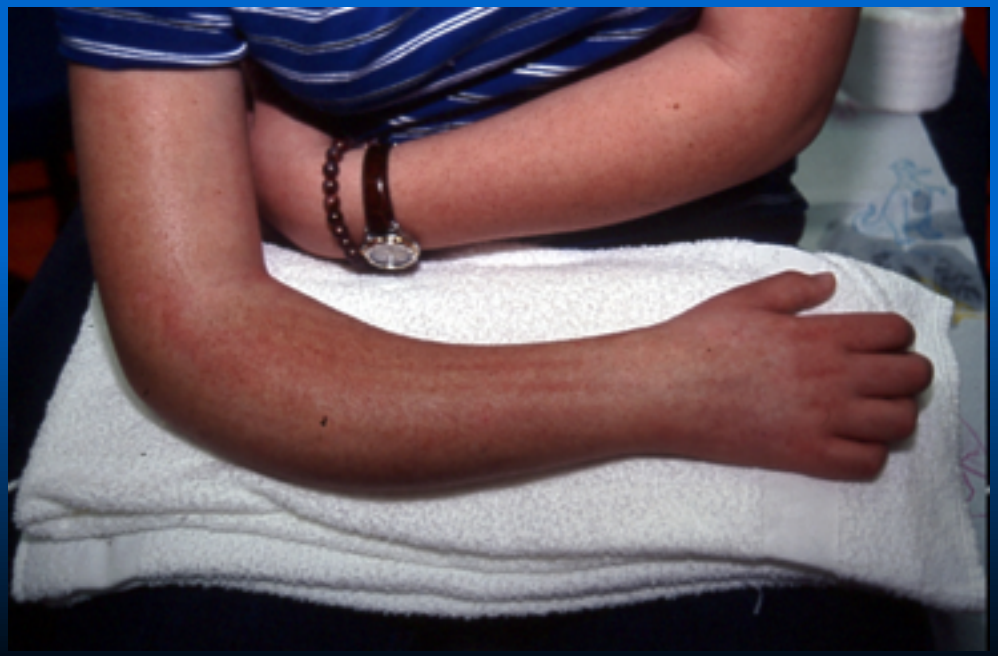
Remodeling

- Amount of growth
  - Patient age
  - Bone / physis involved
  - Location in bone – ie: proximity to physis
- Deformity in plane of motion



Both Bone Forearm Fractures

- Limits of acceptable reduction?
- Functional complaints rare



Displaced fractures

- Splint them as they lie
- Can apply axial traction as assistant applies splint

Stress Fractures in Adolescent Competitive Athletes with Open Physis

- Stress Fractures, 21 Athletes
  - 7 cases not satisfactory outcome
    - 4 tibial diaphysis
    - 6 athletes burst of speed
  - Early and thorough investigation
- Diagnosis Made
  - Routine x-rays + MRI scan
- 1 Surgery Olecranon

Niemeyer P, et. al., "Stress Fractures in Adolescent Competitive Athletes with Open Physis," *Knee Surg Sports Traumatol Arthrosc* (2006) 14: 771-777.

Imaging Studies

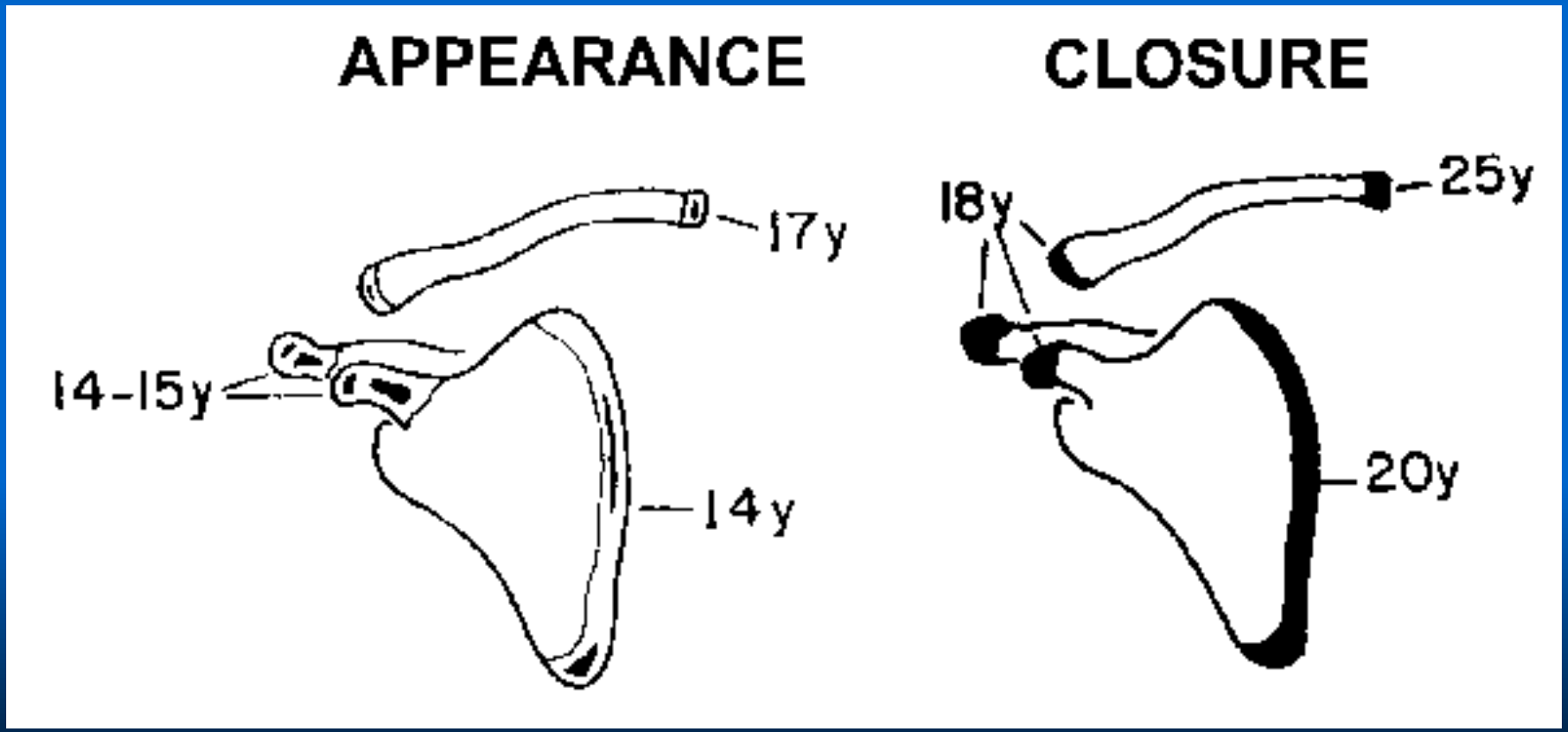
- Radiographs
  - Plain
  - Stress Views
- MRI Scan
- CT Scan with 3-D reconstruction
- Bone Scan

Comparison Views and Cone Views of Suspected Area Are Helpful

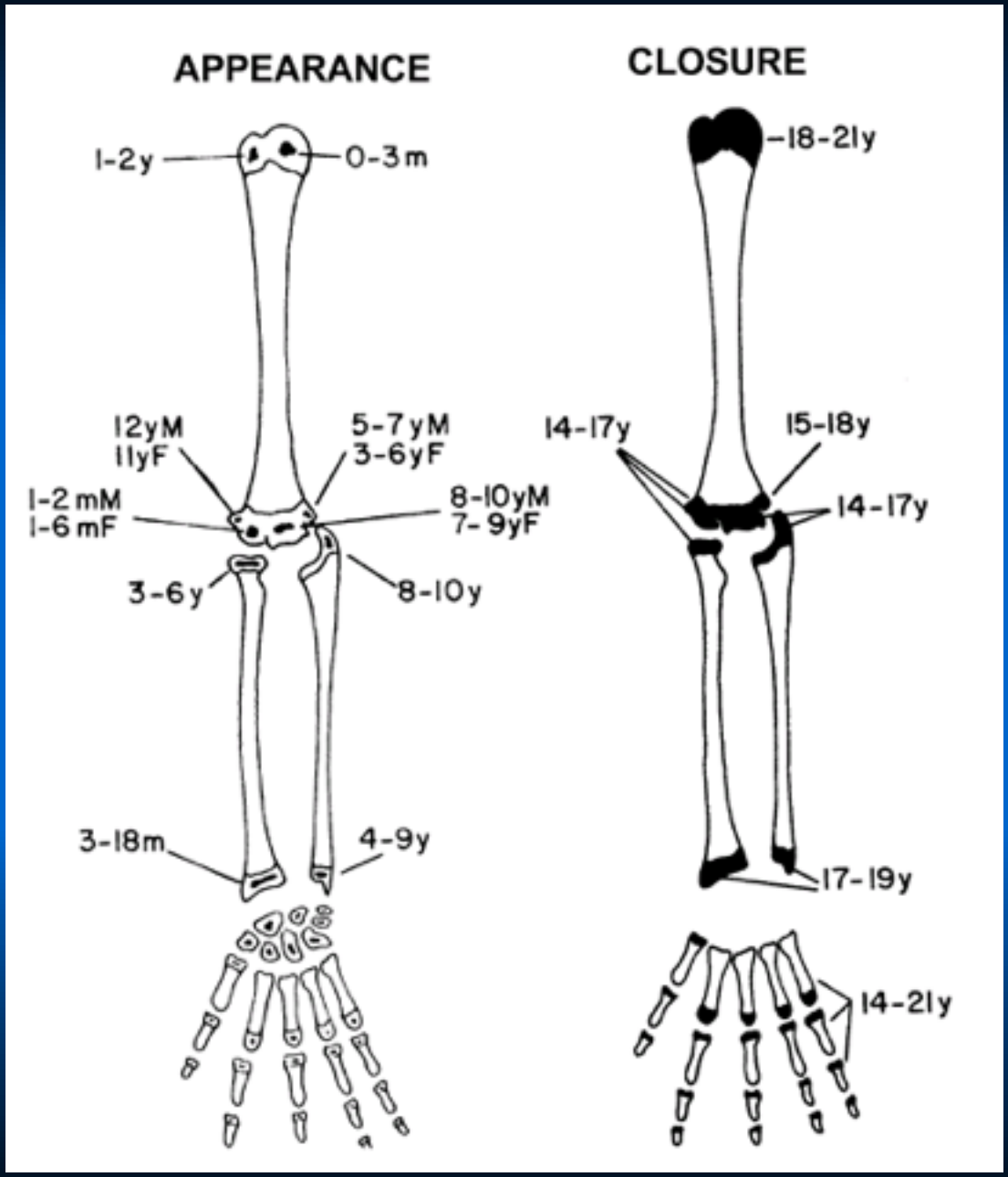
Unique Aspects

- Growth Plate
  - First line of failures due to stress or falls
  - Abnormal growth
  - Rotational adaptation
  - Physis / Epiphysis / Apophysis
  - Articular cartilage
    - Development
    - Softness

Appearance and Closure of Secondary Ossification Centers - UPPER EXTREMITY

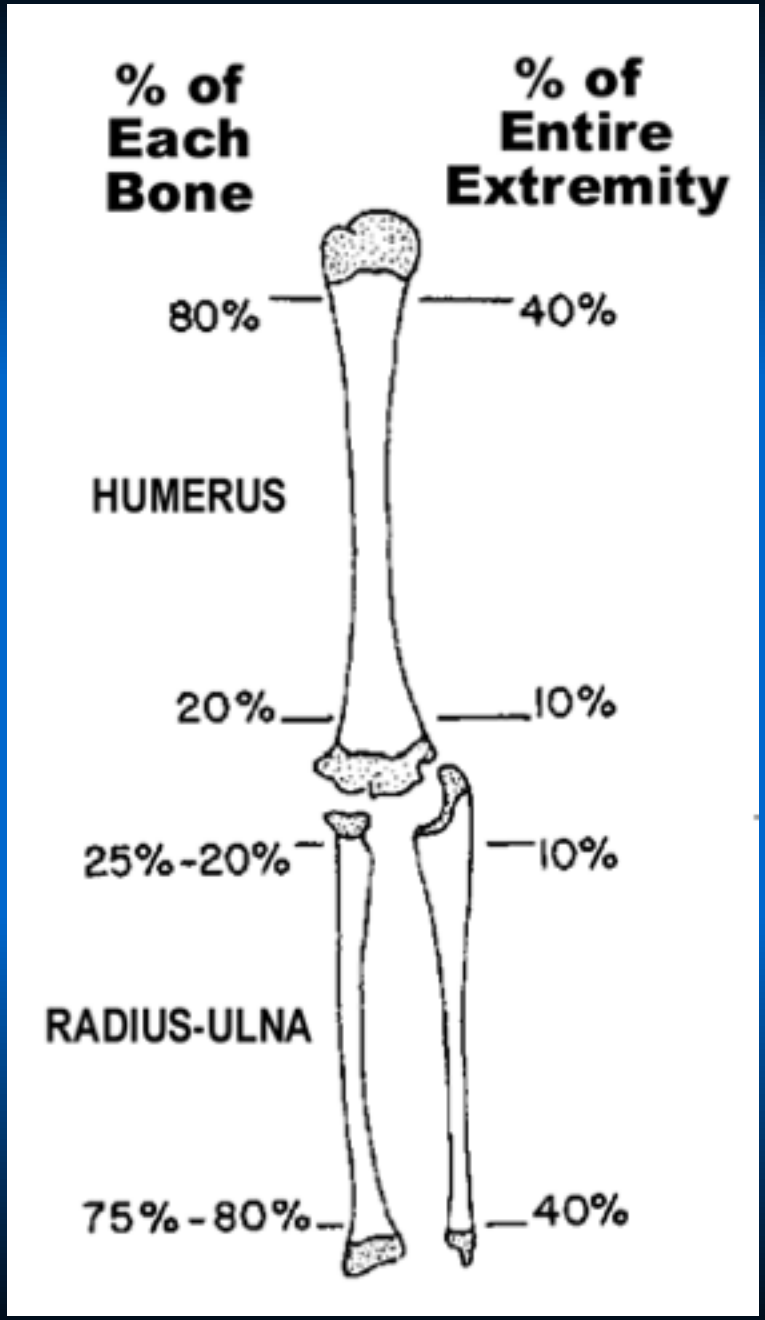


Appearance and Closure of Secondary Ossification Centers - UPPER EXTREMITY



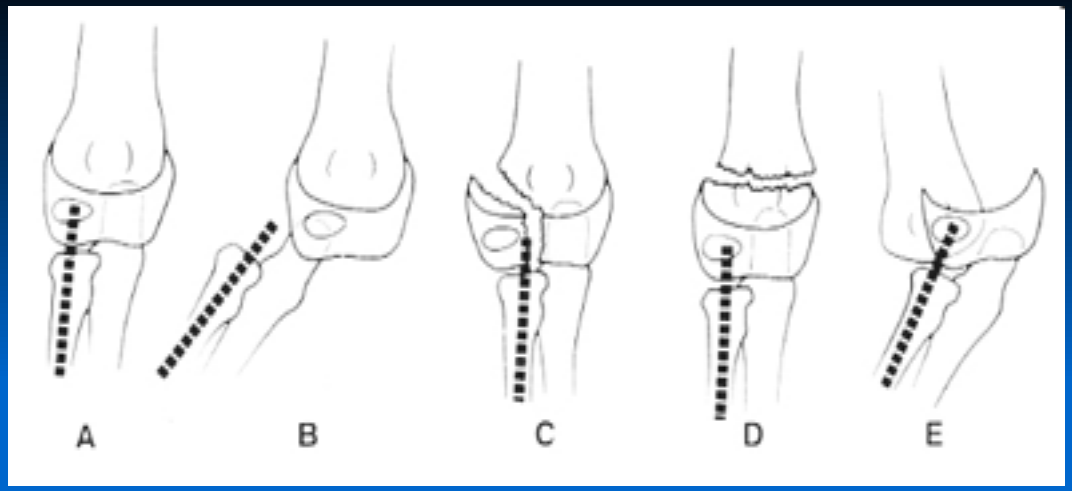
Contributions of individual growth regions to overall limb length.

from Ogden JA. Skeletal Injury in the Child. Philadelphia: W.B. Saunders, 1990.



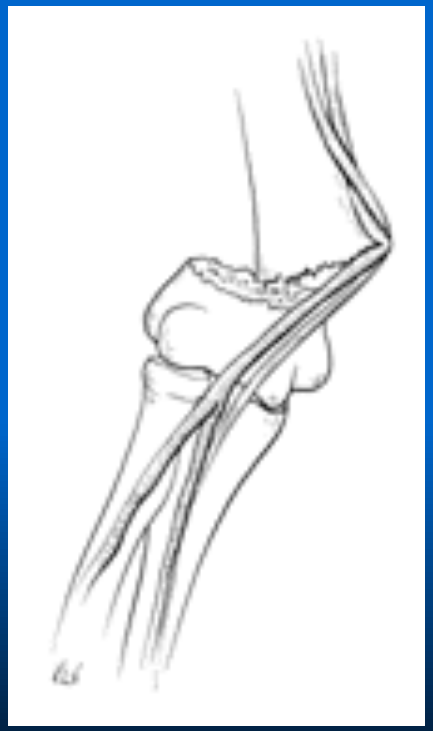
Elbow Injuries

- Supracondylar
- Lateral condyle
- Transphyseal
- Elbow dislocation
- Medial epicondyle
- Radial neck
- Olecranon



Hyperextension injury

Supracondylar Fractures
Classification Gartland



Type I

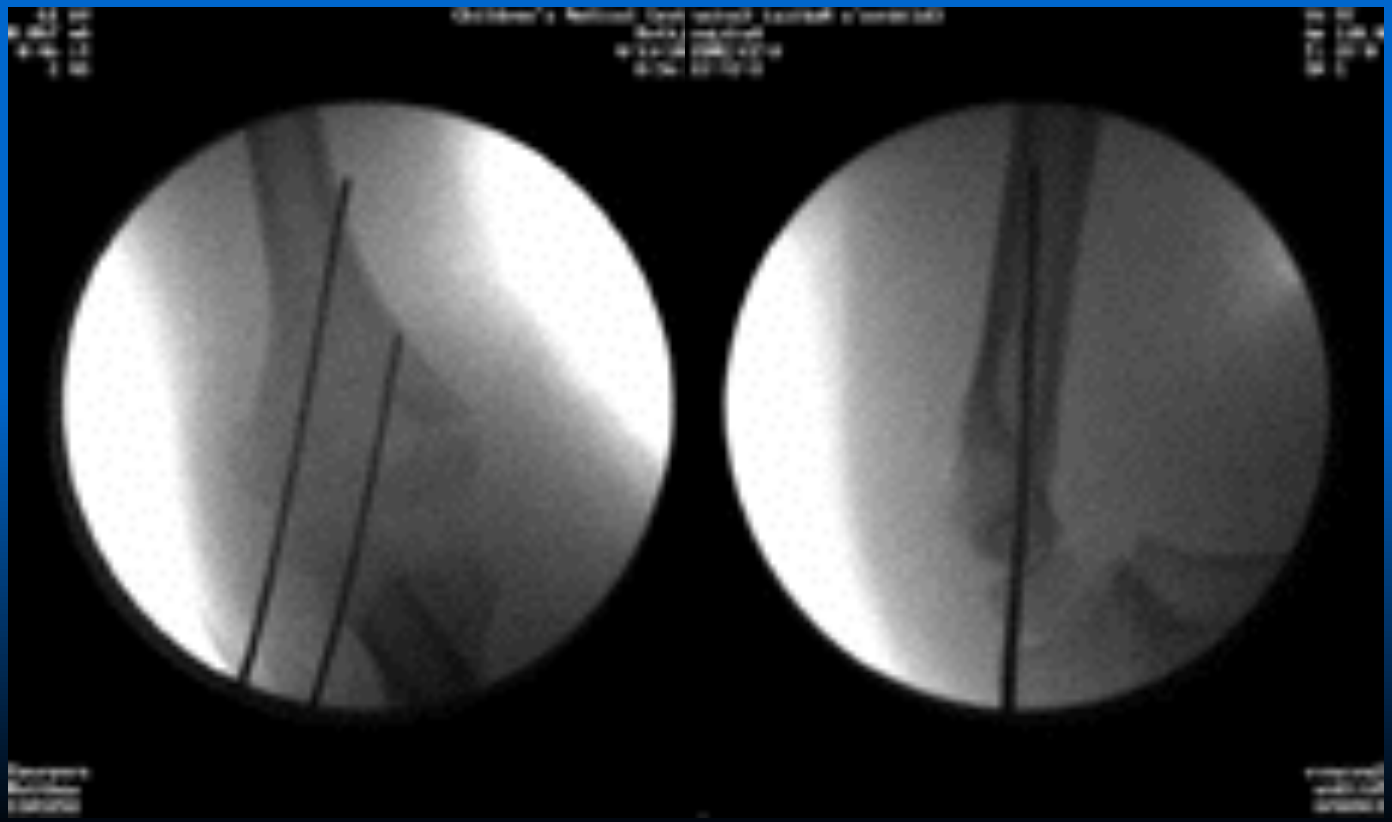
Type III

Supracondylar Fractures

Treatment

Types II and III

- Closed Reduction and Pinning
- Cast / Pins 3 weeks



Displaced supracondylar humerus fracture

Refer to appropriate center for emergency manageme

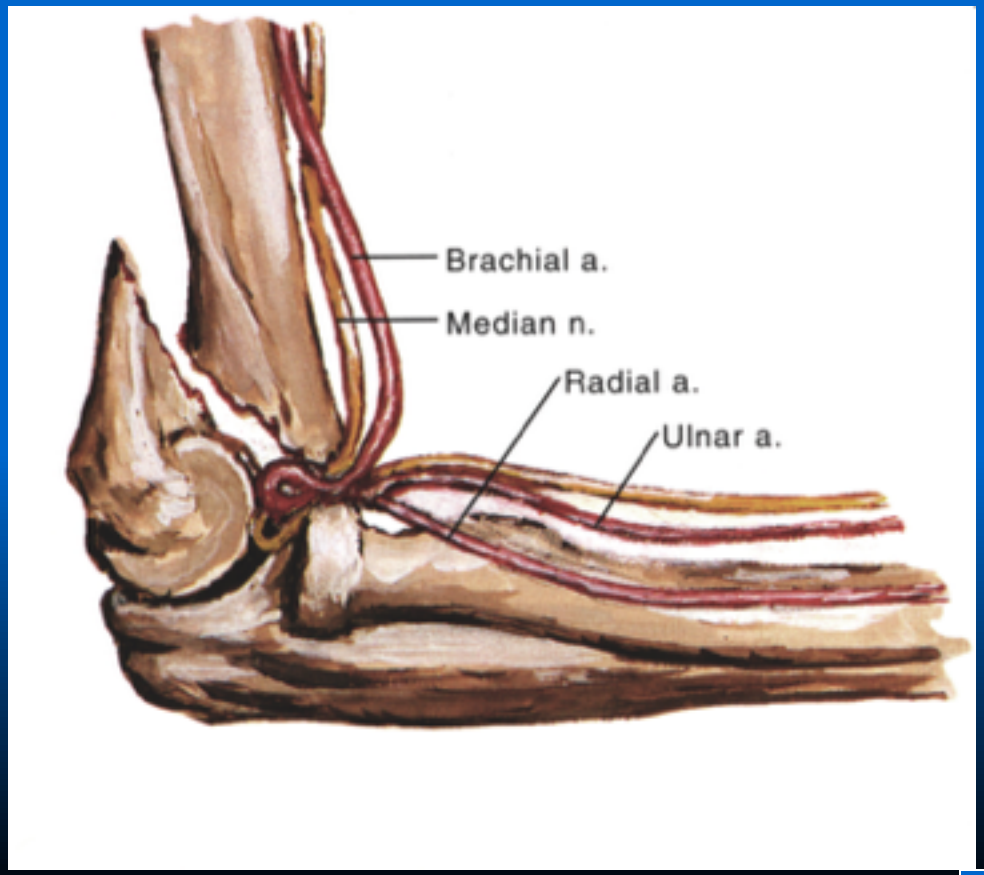
. . .

Supracondylar Fractures

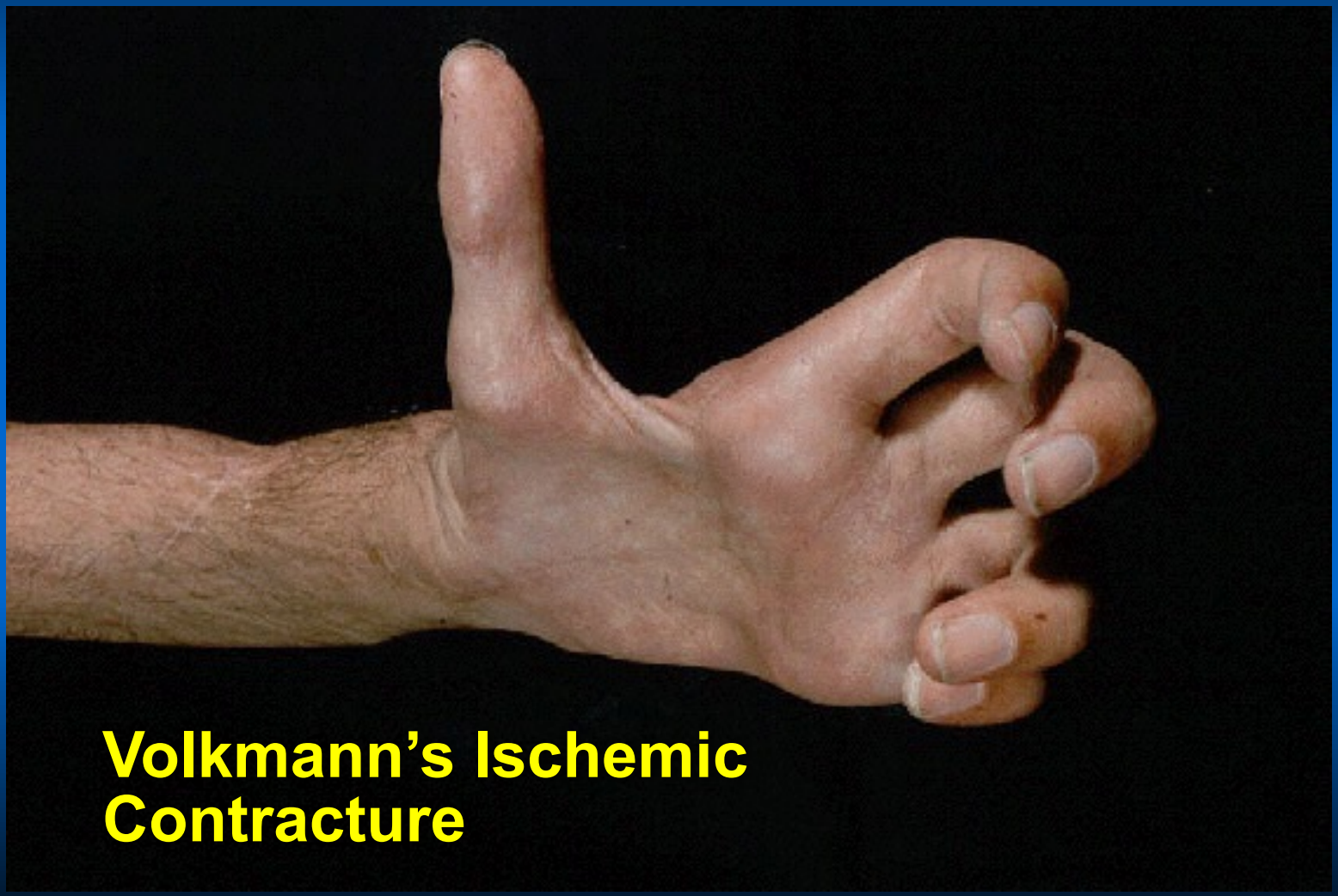
Catastrophic Results

Neurovascular injury

- Compartment syndrome



What you never want to see, but if you see it you'll never forget it:

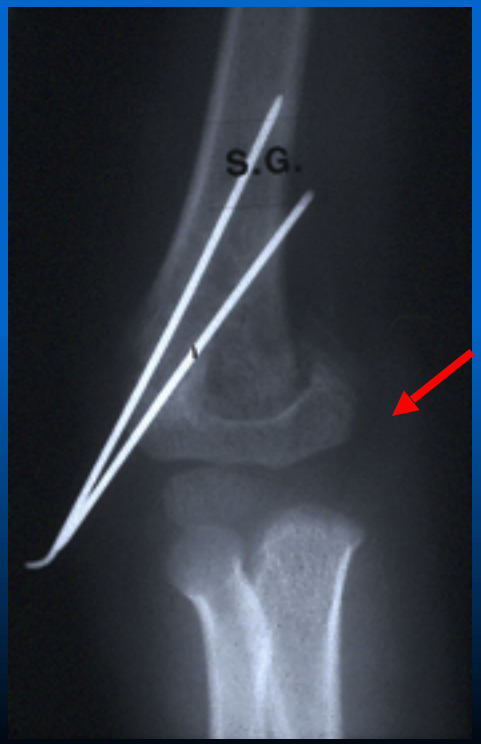


Supracondylar Fractures

Complications

Cubitus Varus

- Malunuion
- Cosmetic not functional
- Corrective osteotomies = loss of fixation



Supracondylar Fractures

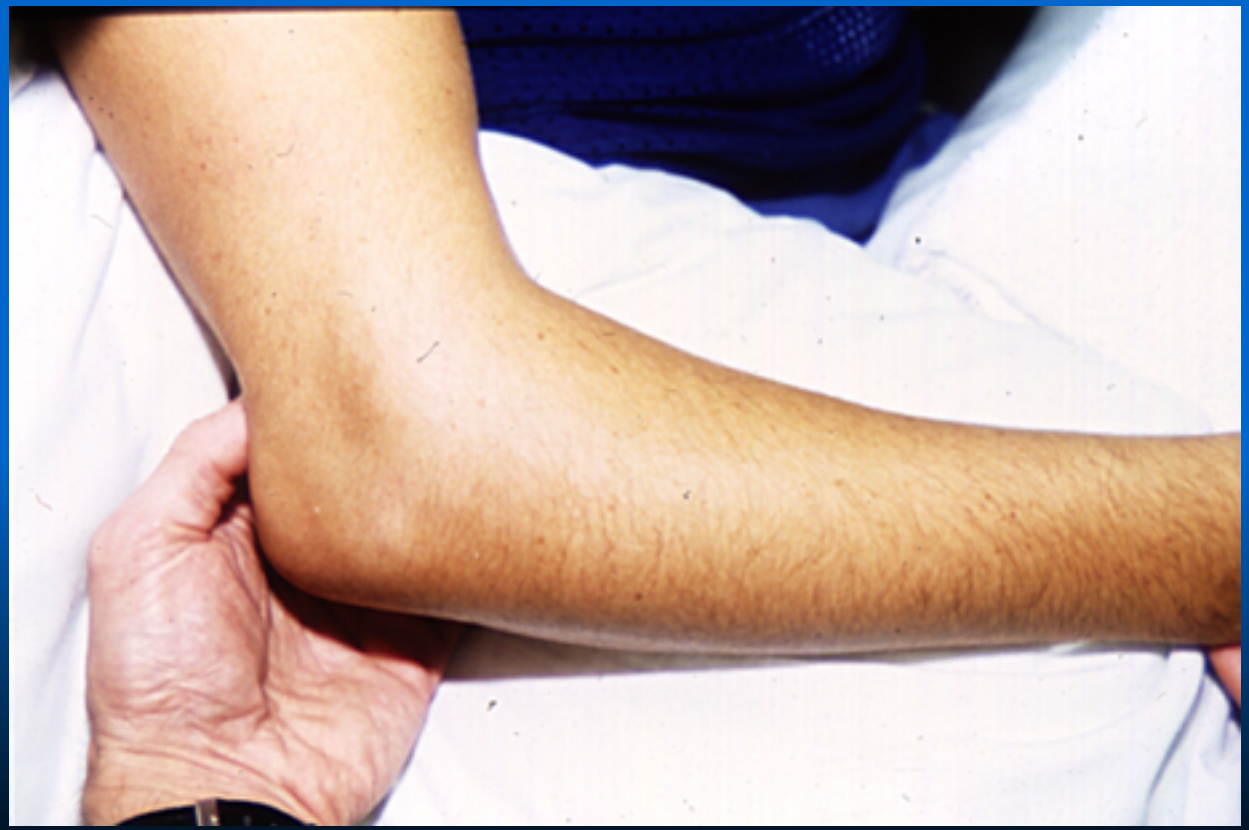
- Missed injury
- Cubitus varus

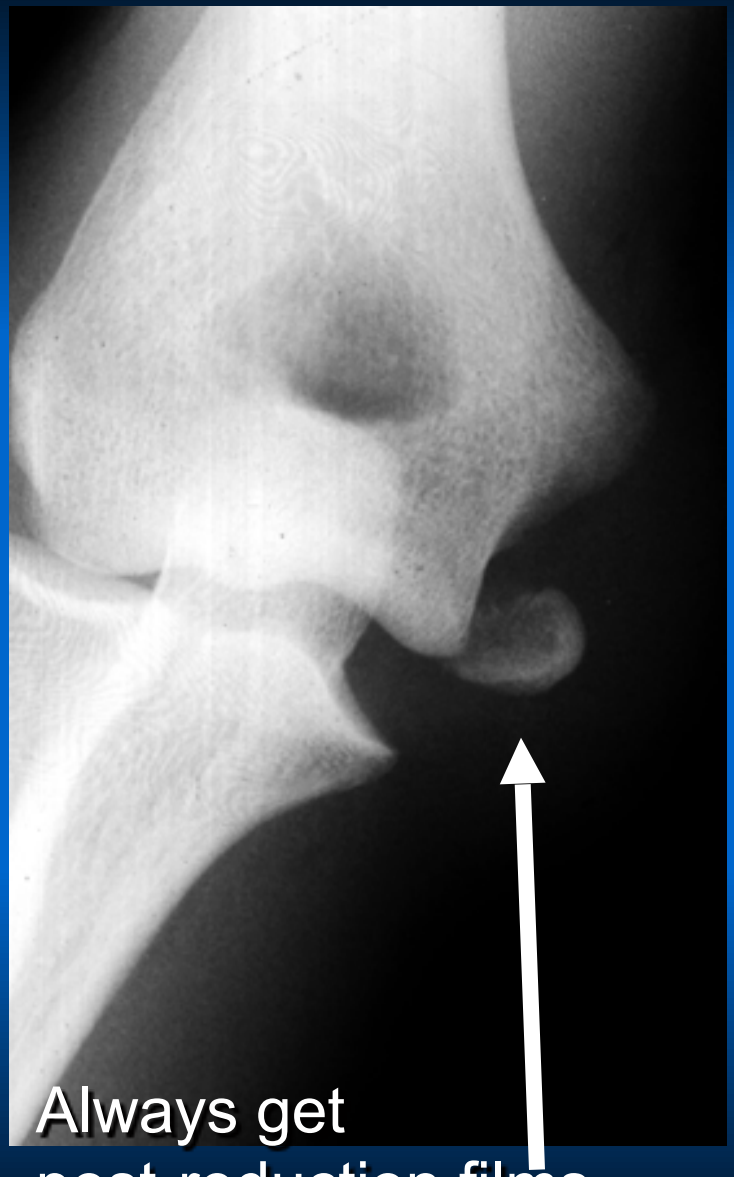
Elbow Dislocation

- Older Child and adolescent
- Think transphyseal, if young
- Medial epicondyle fracture?

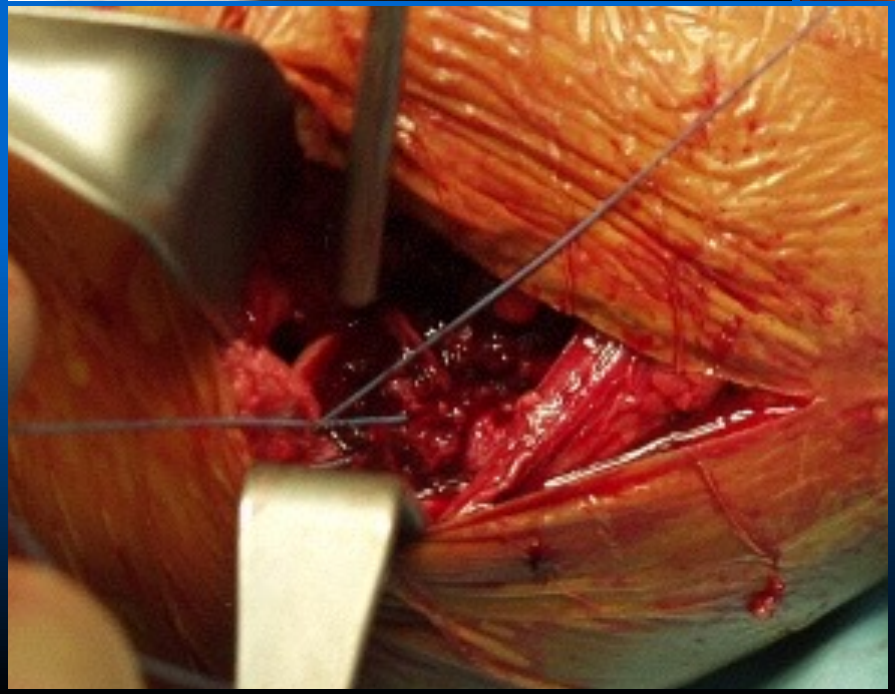
14 YO Football Athlete

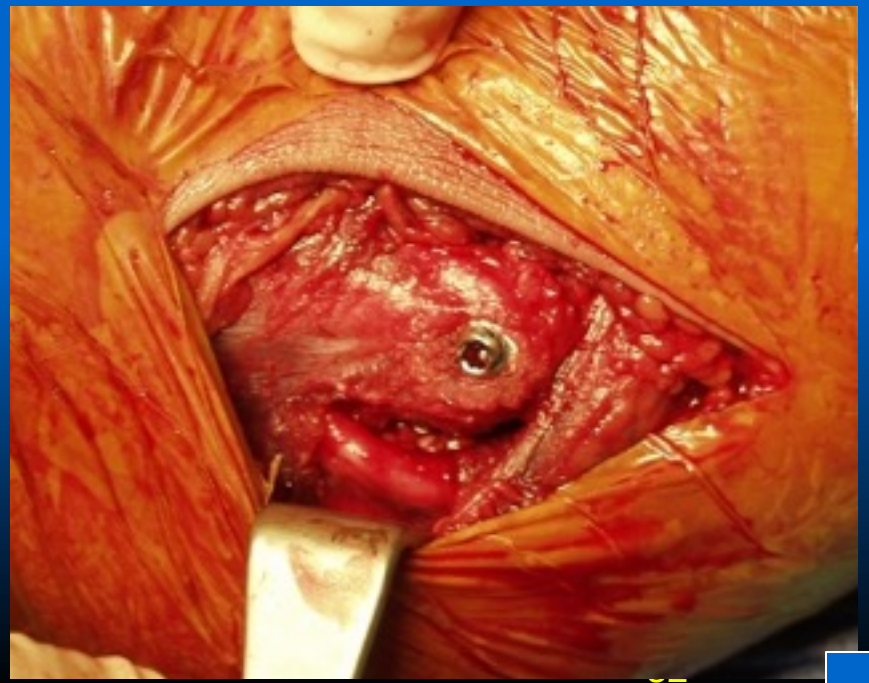
- Back of arm hit during practice
- Elbow posterior dislocation

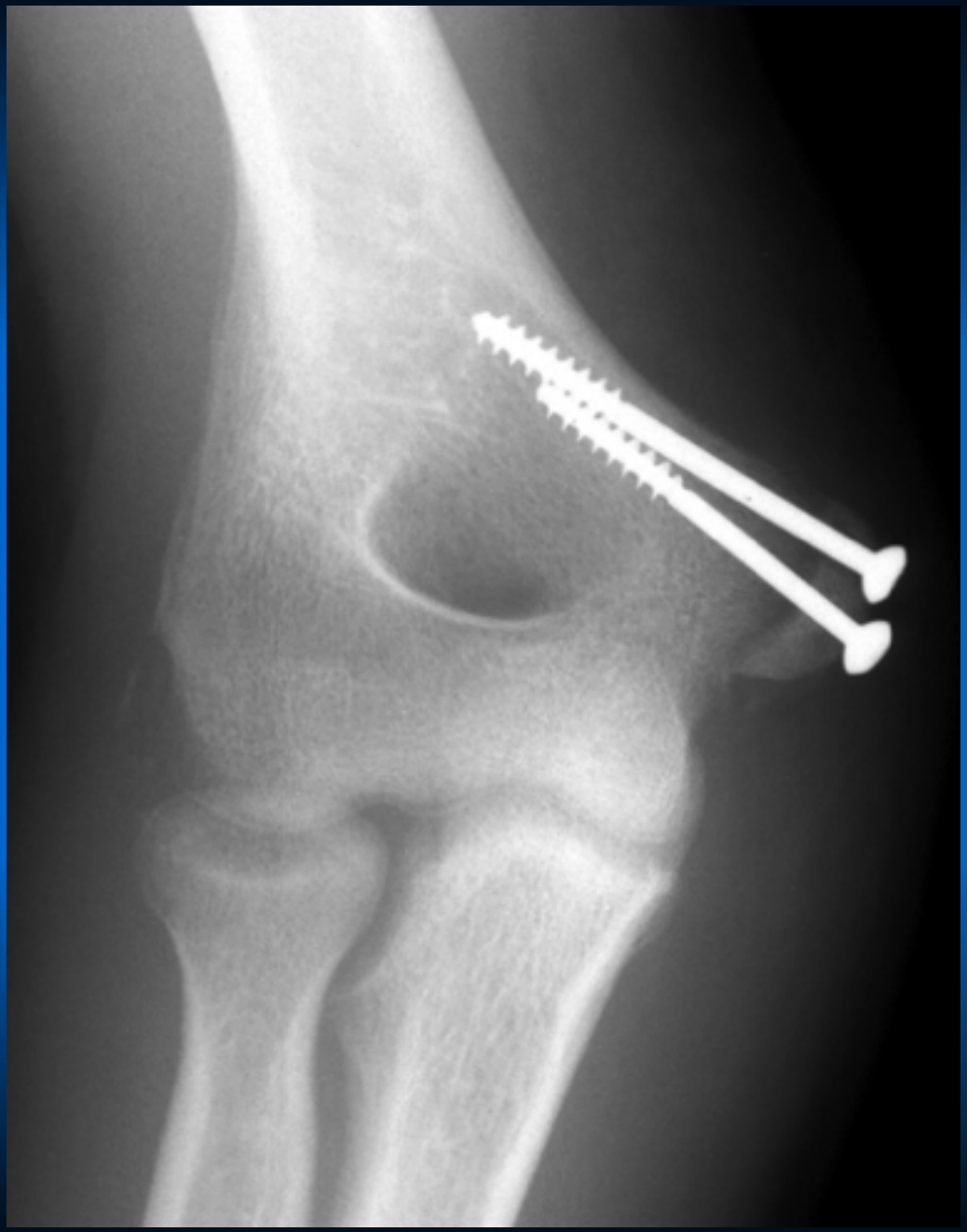




Always get
post-reduction films

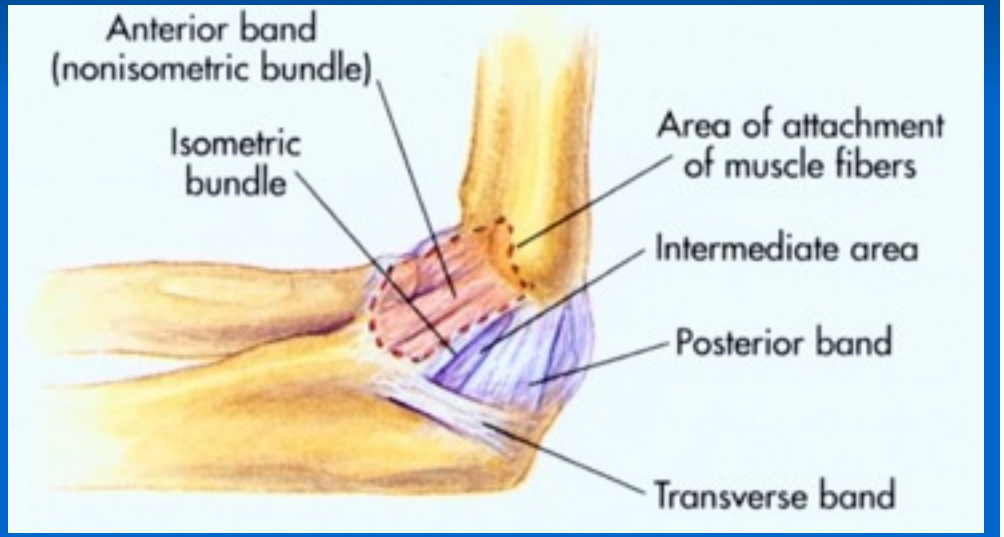


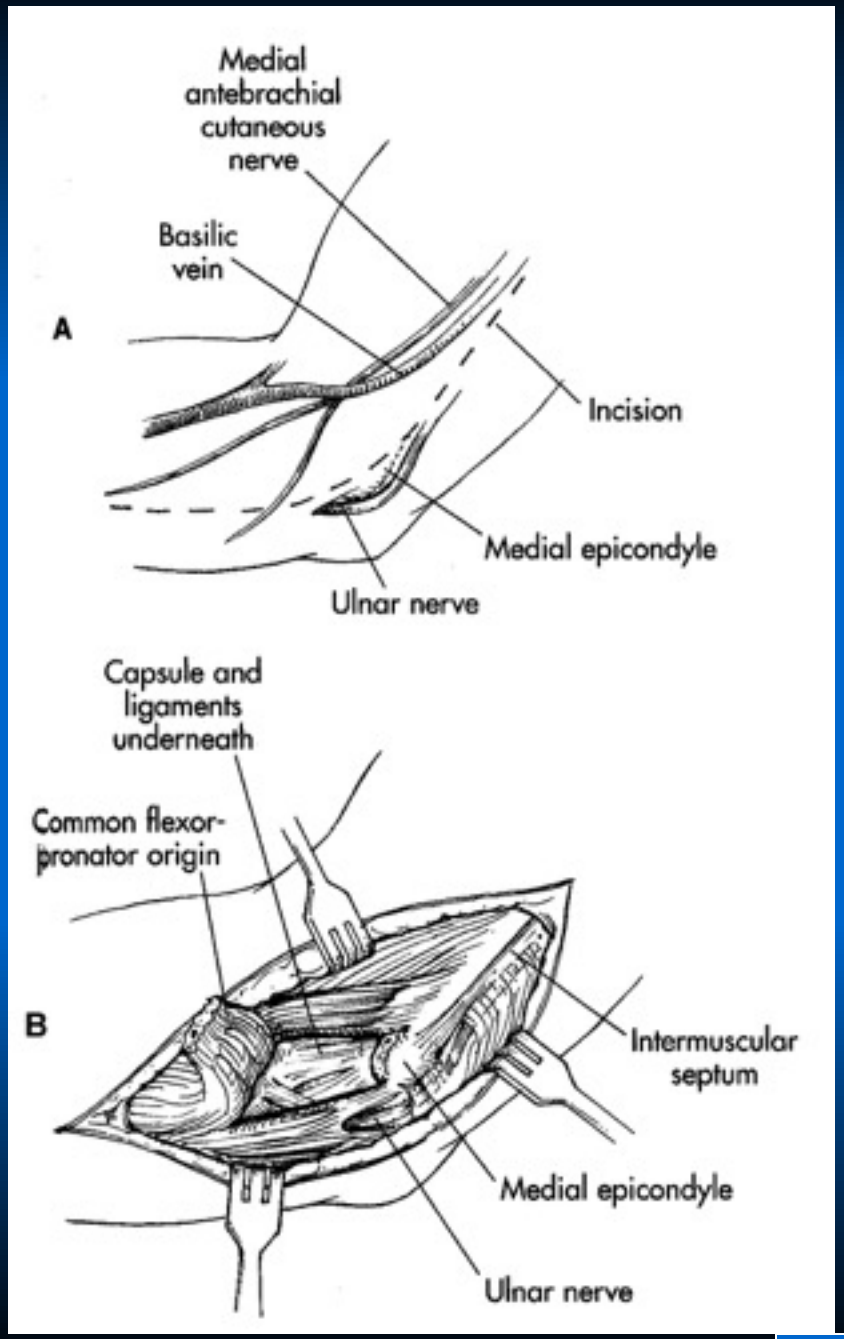




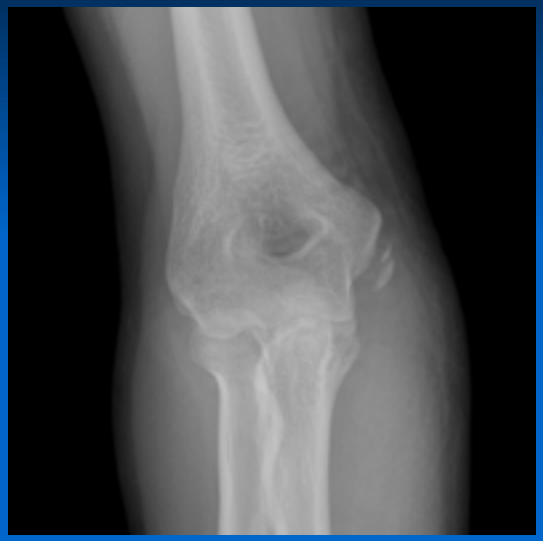
17 YO Female

- RHD Catcher
- Junior high school
- Dived back into base sustaining elbow valgus loading force to outstretched hand
- Immediate swelling/pain, medial elbow

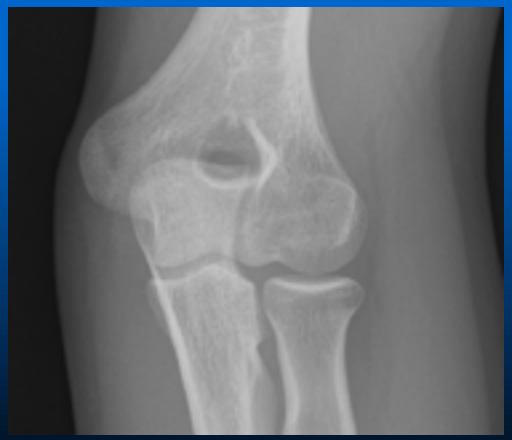

Anterior band
(nonisometric bundle)
Isometric
bundle
Area of attachment
of muscle fibers
Intermediate area
Posterior band
Transverse band


Medial
antebrachial
cutaneous
nerve
Basilic
vein
A
Incision
Medial epicondyle
Ulnar nerve
Capsule and
ligaments
underneath
Common flexor-
pronator origin
B
Intermuscular
septum
Medial epicondyle
Ulnar nerve

Xrays: Right elbow

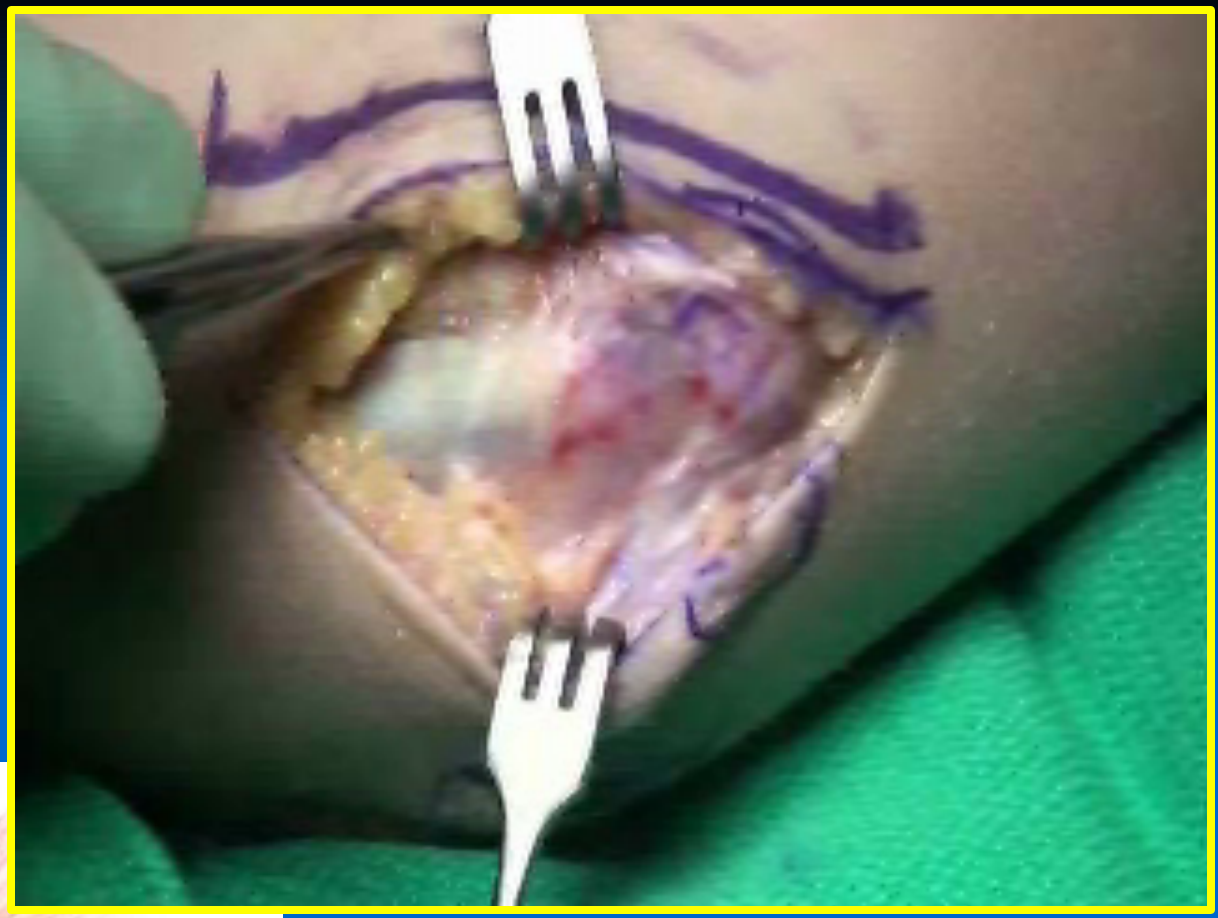


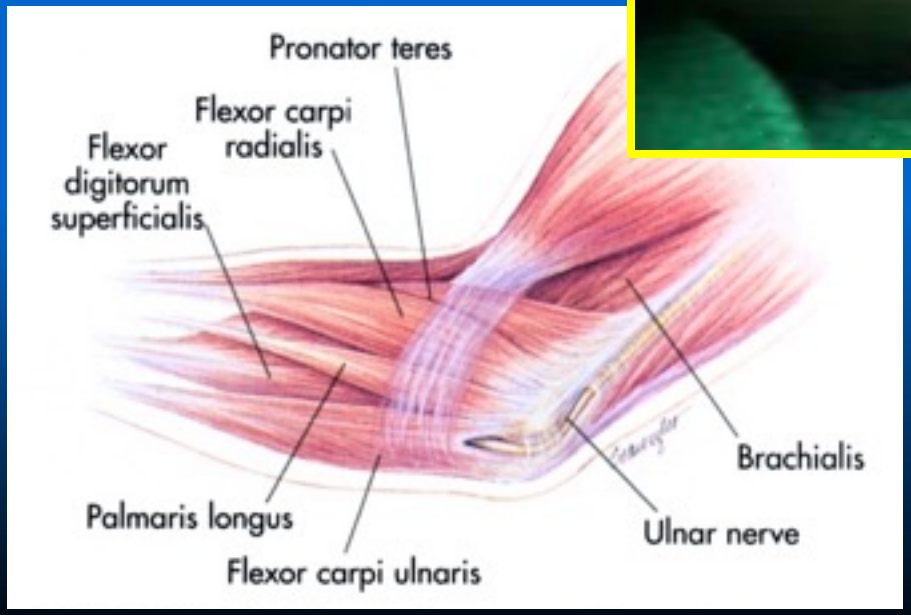
Left elbow



MRI scan

Medial Approach





ELBOW Differential Diagnosis

MEDIAL

Skeletally Immature

Acute	Chronic
• Avulsion Fracture Medial Humeral Epicondyle • Ulnar Collateral Ligament Sprain (rare) • Ulnar Nerve Subluxation (rare) • Fracture	• Medial Humeral Epicondyle Overgrowth • Stress Reaction • Nerve Instability

UCL Tear and Instability

Previously rare, now common in younger pitchers

ELBOW Differential Diagnosis

LATERAL

Skeletally Immature

Acute	Chronic
• Osteochondritis Dissecans Capitellum • Osteochondral Fracture Capitellum • Avulsion Fracture Lateral Humeral Epicondyle • Anterior Subluxation Radial Head • Fracture Capitellum Radial Head	• Lateral Humeral Epicondylitis • Radial Head hypertrophy/ overdevelopment • Loose Bodies • Osteochondritis dissecans Capitellum • Ostechondritis Radial Head

- OCD incidence appears to be decreasing, but no good epidemiologic studies in Little League
- Very common in Japan

ELBOW Differential Diagnosis

POSTERIOR

Skeletally Immature

Acute	Chronic
• Olecranon Fracture • Olecranon Apophysitis • Olecranon Bursal Contusion	• Olecranon Traction Apophysitis • Olecranon Spurs • Loose Bodies • Posteromedial Spurs

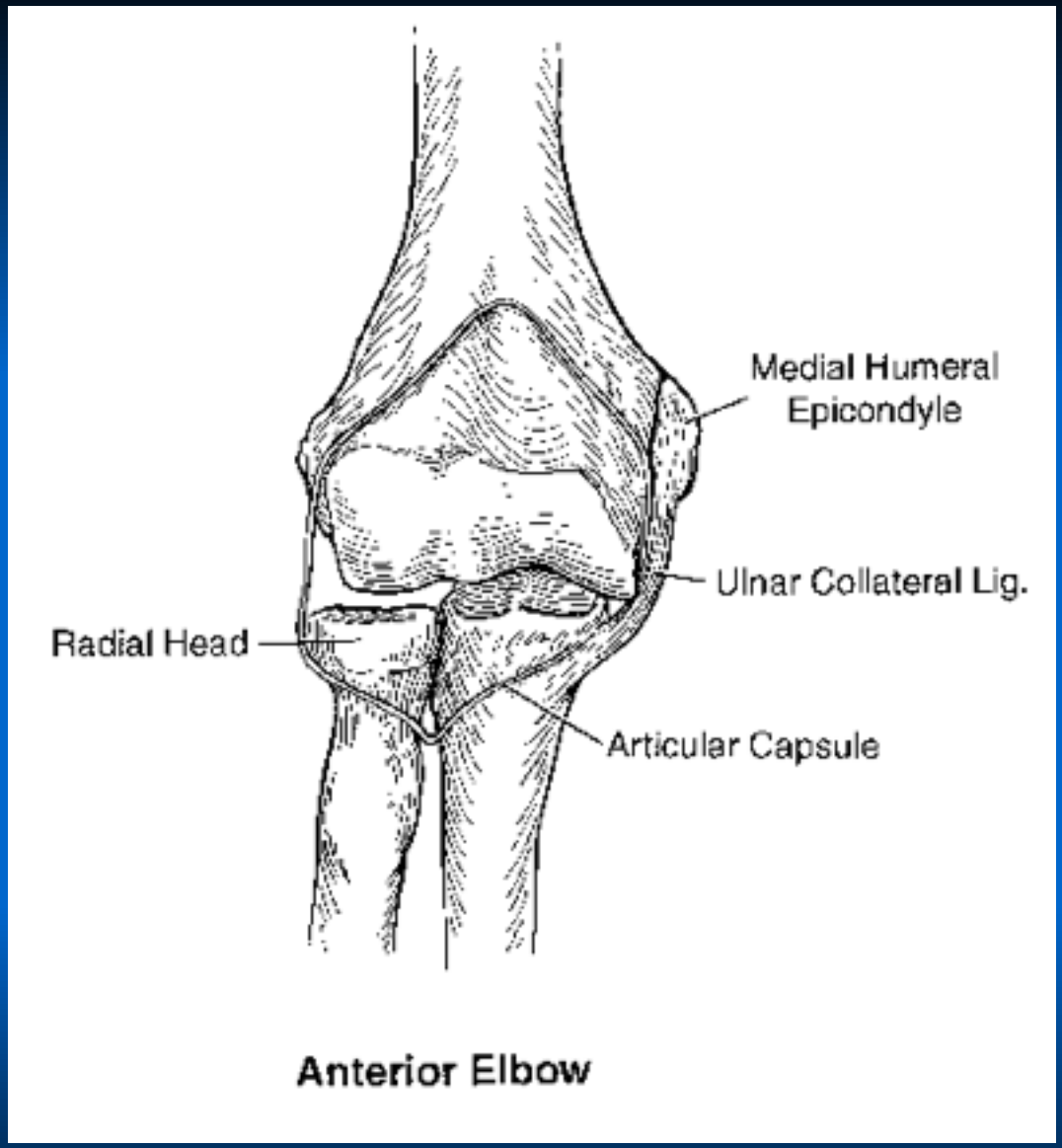
Olecranon apophysitis = Osgood Schlatter's disease of the elbow

ELBOW Differential Diagnosis

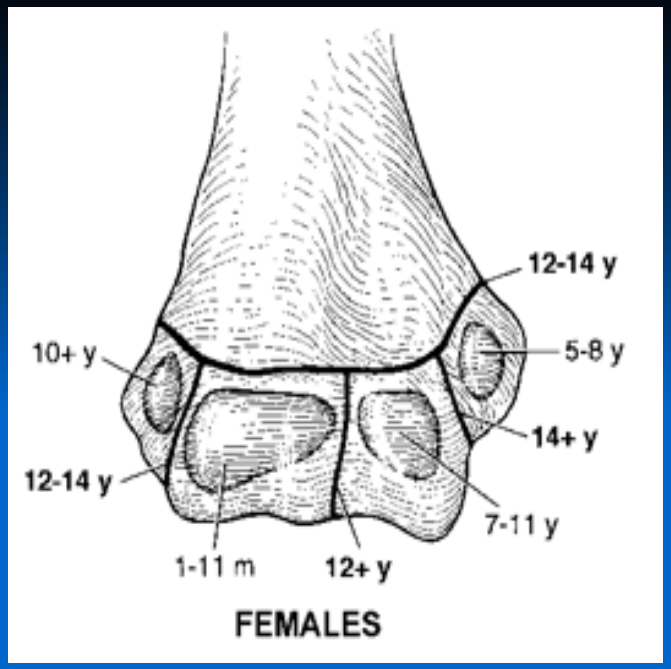
ANTERIOR

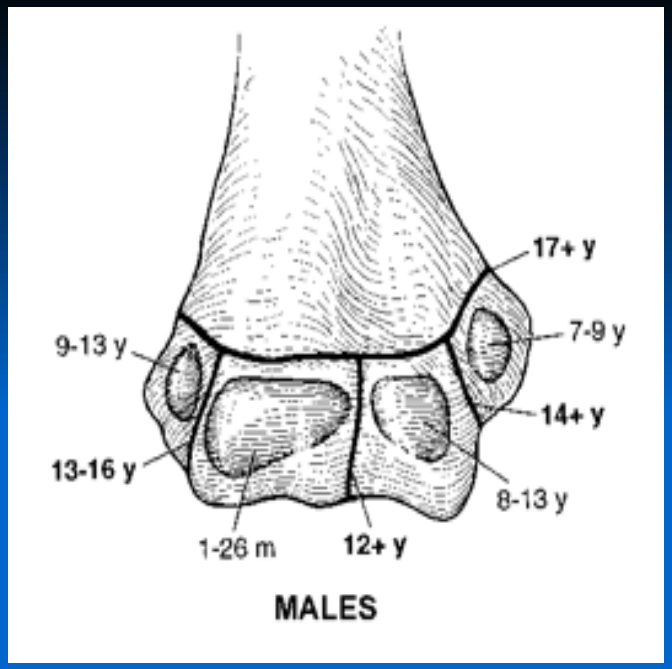
Skeletally Immature

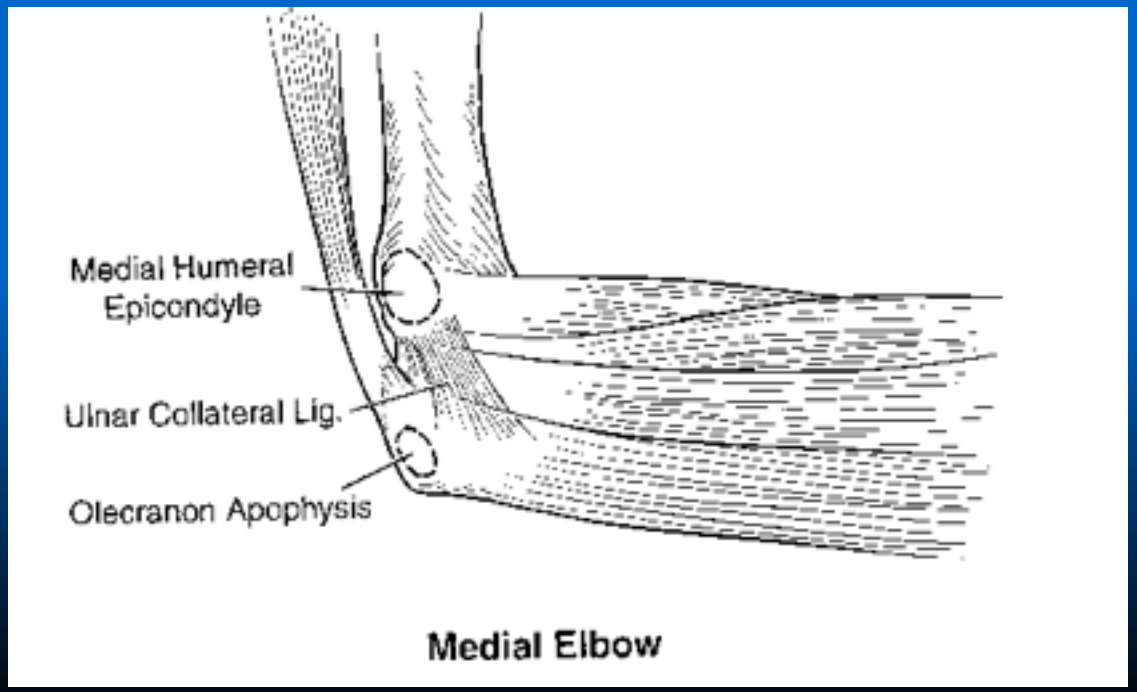
Acute	Chronic
• Distal Physeal Humerus Fracture • Capsular Sprain • Hyperextended Elbow	• Loose Bodies



from Andrews JA, et. al.,
Injuries in Baseball, Lippincott-Raven, 1998.







UCL Attachment not on Medial Epicondyle

Medial Humeral Epicondyle

- Origin of flexor pronator group (FCR, FCU, FDS, PL, PT Part)
- UCL attaches
  - Anterior oblique band
  - Medial epicondyle/coronoid ant inf

Medial Humeral Epicondyle

- Truly an apophysis
- Ossification center
  - Appears 5 years
  - Unites 15-16 years

Medial elbow pain diagnoses in throwers

- Medial epicondyle stress fracture
- UCL tear
- Ulnar neuritis/hypermobility
- Flexor-pronator strain much less common
- Subluxating medial triceps
- Valgus extension overload
  - (elbow impingement)
- Sublime tubercle fracture proximal ulna

Elbow

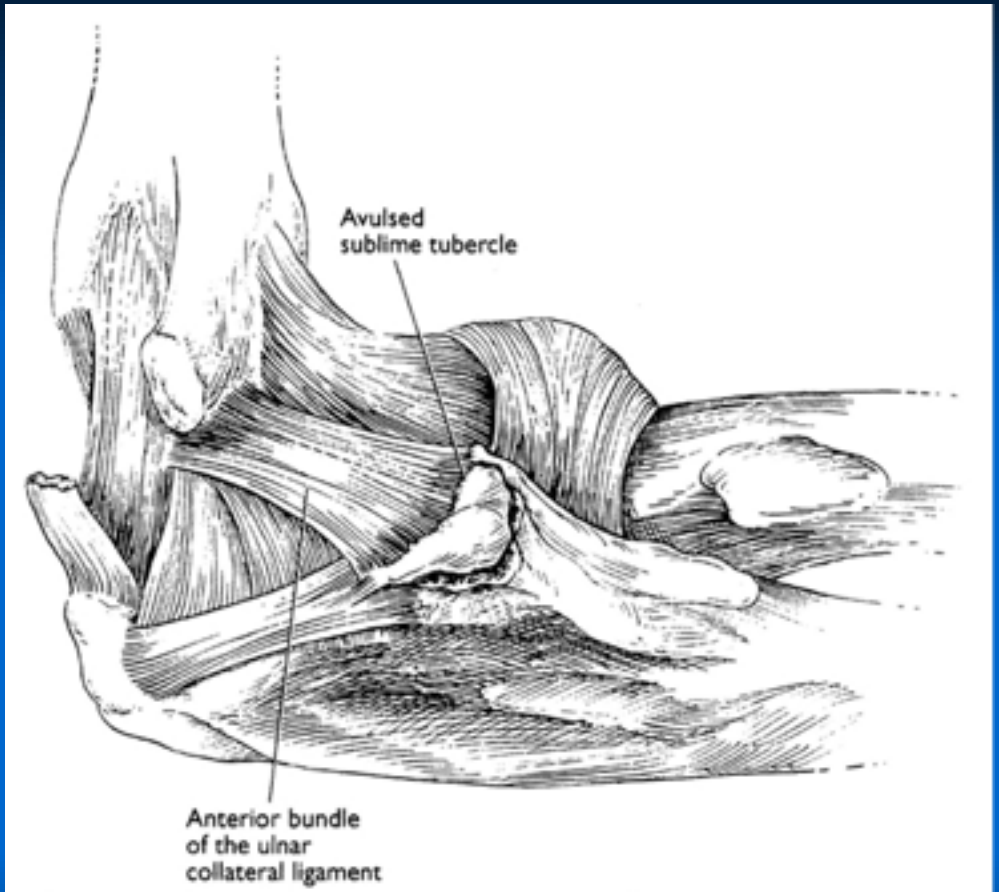
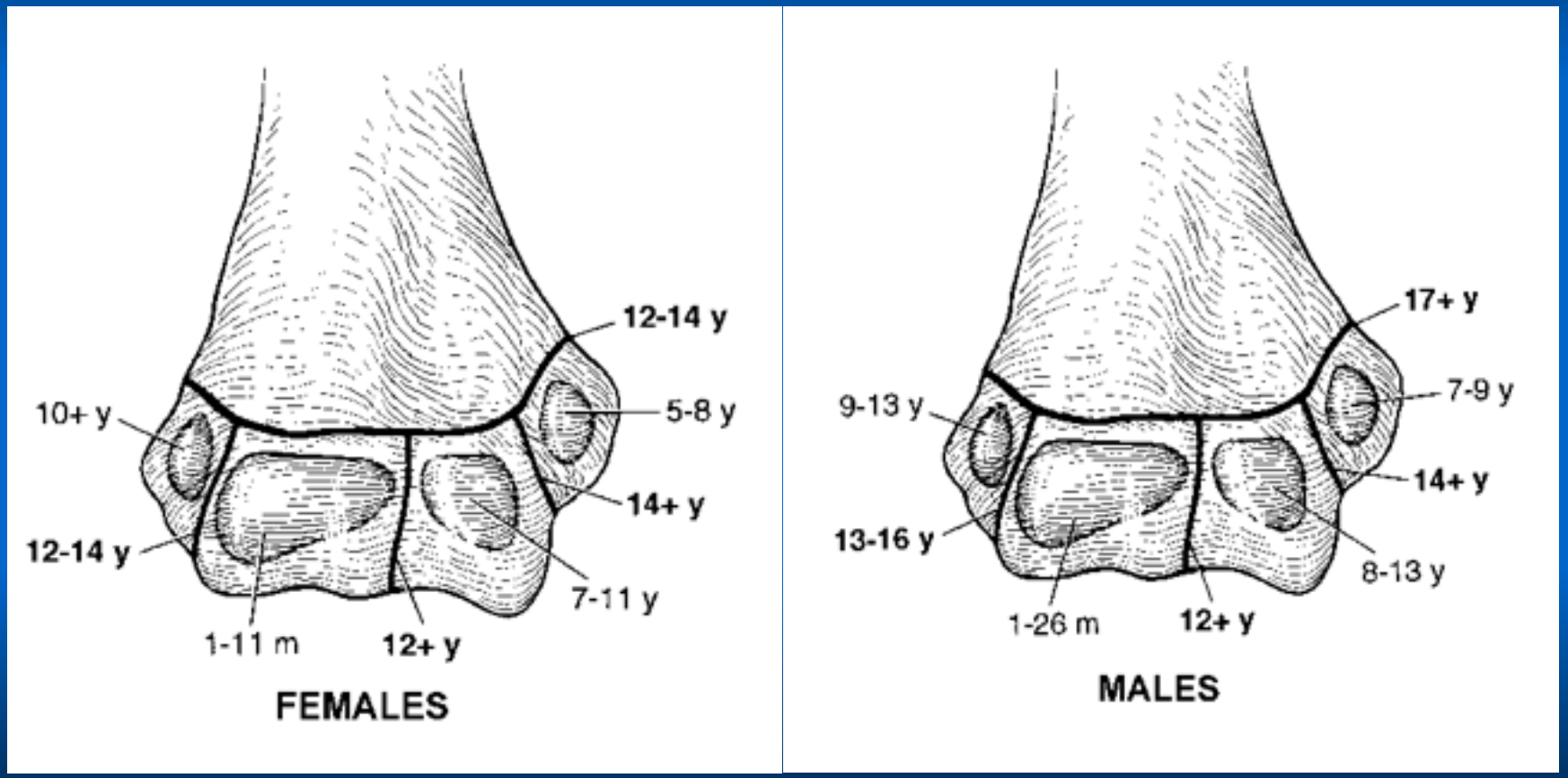


Figure 1. Medial view of the elbow showing the anterior bundle of the ulnar collateral ligament.

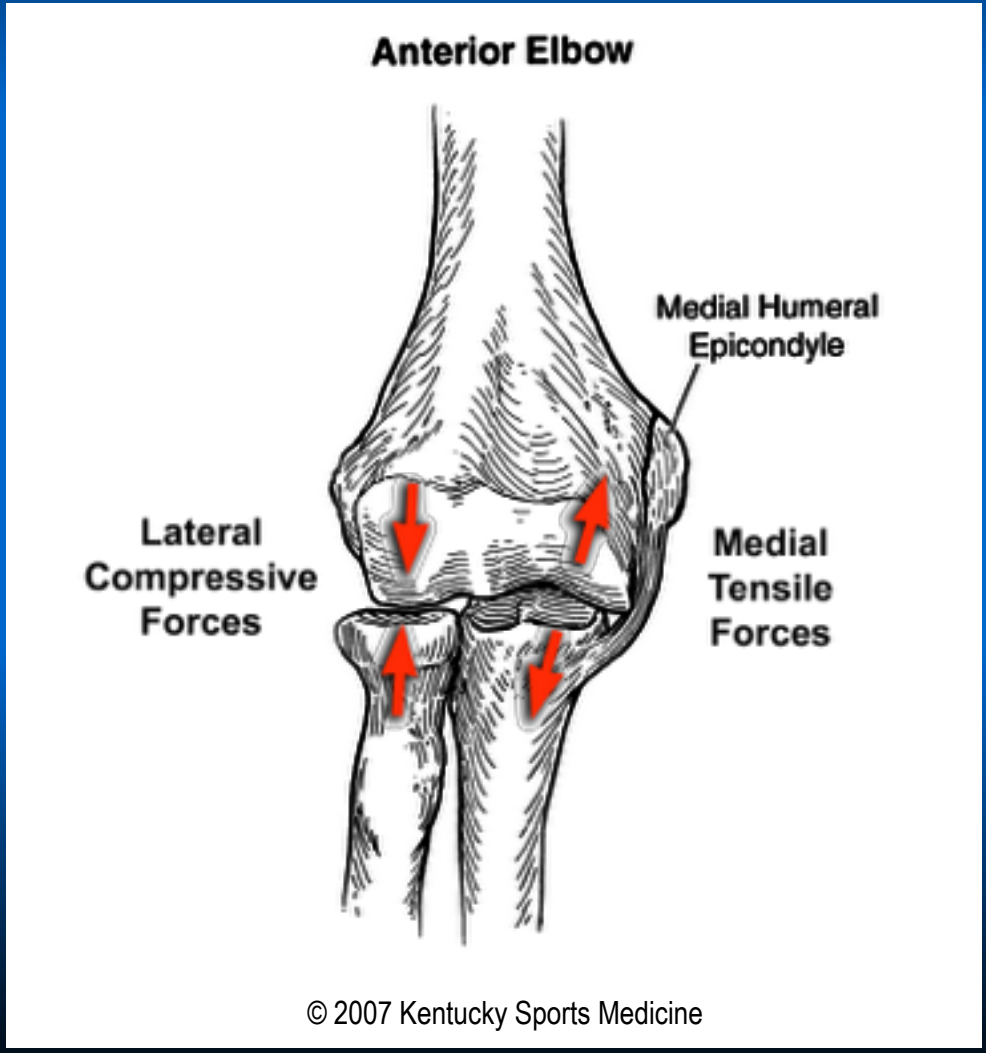
Salvo JP et. al, "Avulsion Fracture of the Ulnar Sublime Tubercle in Overhead Throwing Athletes," Am J Sports Med 30(3), 2002, 426-431.

Appearance and fusion of secondary ossification centers of the elbow in females and males



from Andrews JA, et. al., Injuries in Baseball, Lippincott-Raven, 1998.

Lateral Forces = Compression
Medial Forces = Tension



Elbow

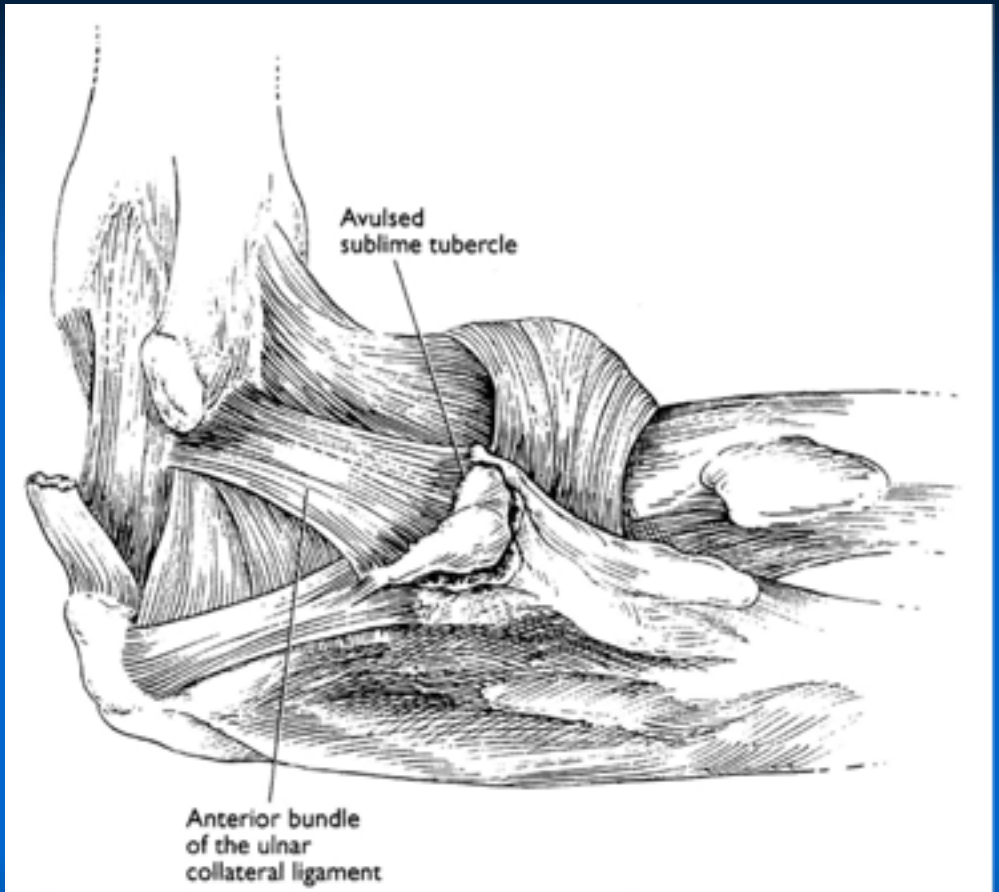
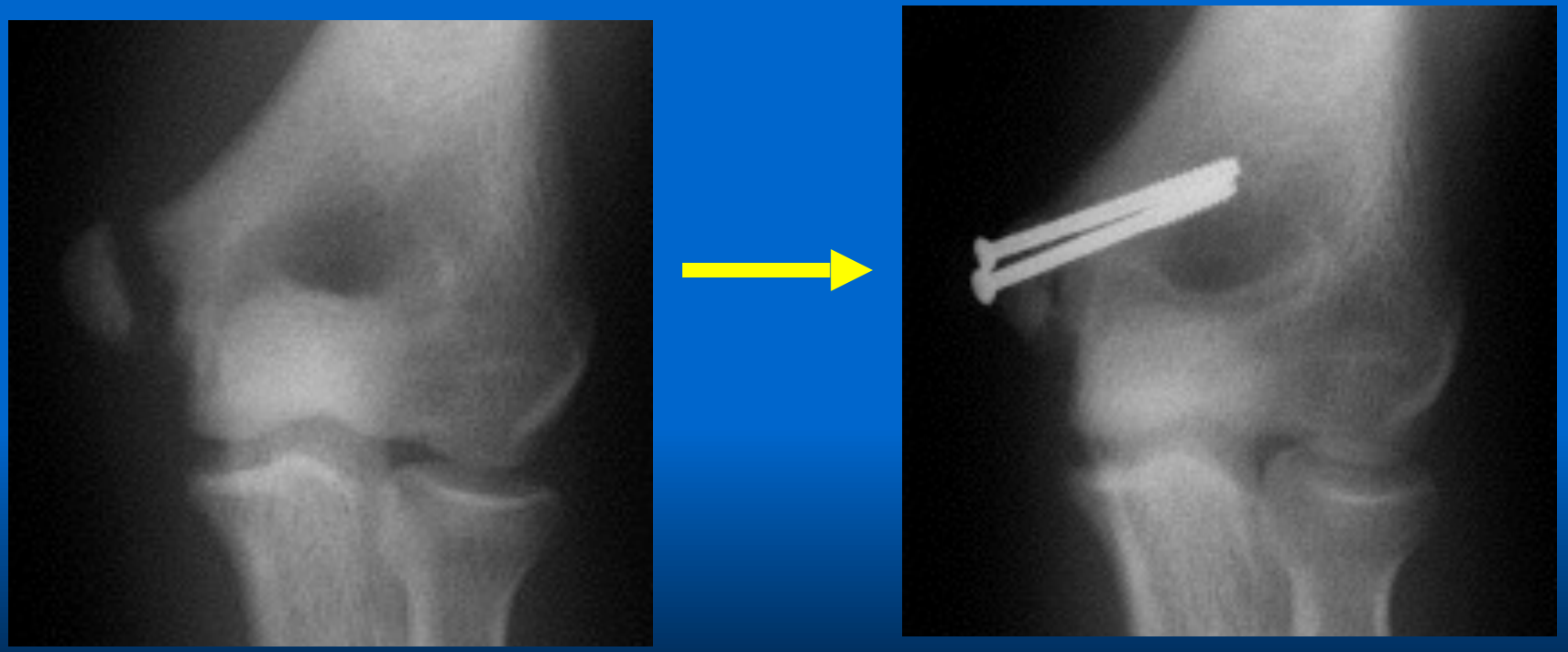


Figure 1. Medial view of the elbow showing the anterior bundle of the ulnar collateral ligament.

Salvo JP et. al, "Avulsion Fracture of the Ulnar Sublime Tubercle in Overhead Throwing Athletes," Am J Sports Med 30(3), 2002, 426-431.

Medial epicondyle fracture

- Controversial
  - Displaced extra-articular fractures



To Fix, or Not to Fix?

12 year old medial elbow pain for 4 months
Pitcher and Quarterback

1 mo.

3 mos. healed

12 year, 11-mo. Old RHD Pitcher

- 3 week history, medial elbow pain
- Kept throwing
- Little League, now in All-Stars
- PE:
  - Height 6’2”, Weight 190 lbs.
  - Medial elbow pain
  - No instability

Case courtesy of Dr. Adam Smith

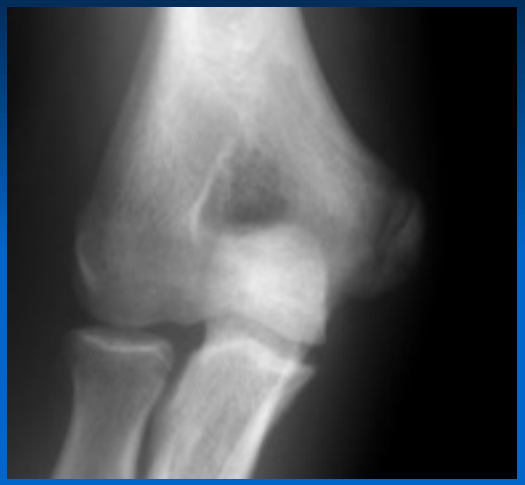
Elbow initial xrays

Medial epicondyle displaced fracture
UCL tear complete vs. partial

Follow up:

2 week:

6-week:



4-week:

4 month:

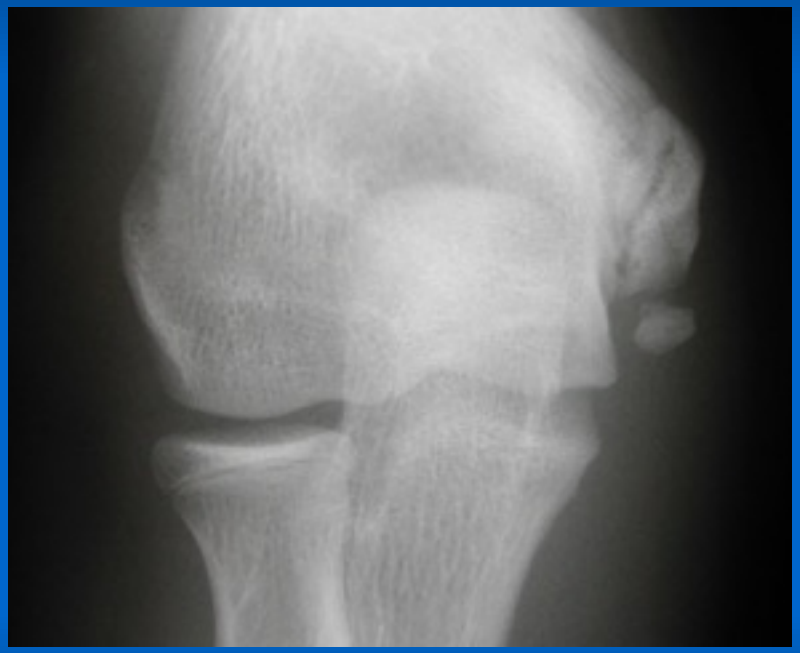
BB Bullet Appearance to medial epicondyle fracture

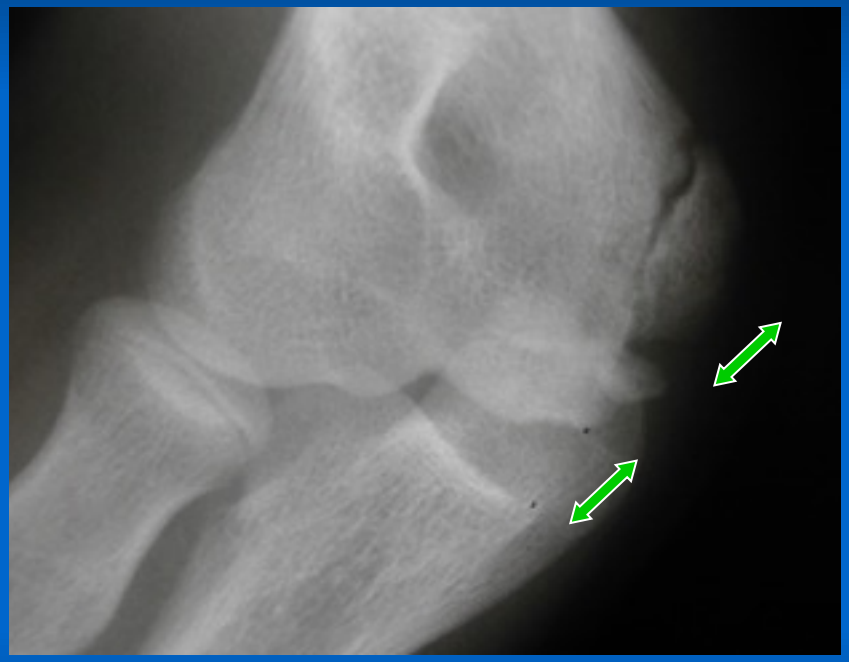
- May heal if you don't allow pitching too early
- May take long time to heal, but UCL is intact

BB Gun

- Don’t allow to fire too soon

14 YO Pitcher, medial elbow pain for a year, open medial humeral epiphysis torn UCL





Stress Views

UCL reconstruction performed, baseball career ended

Risk Factors

- Overuse
- Fatigue
- High Pitch Velocity
- Showcase Participation
- Age Groups – Age Matched Case Control Study
  - 95 pitchers surgery / 45 adolescent no surgery
  - Multivariant Analysis, Injury Risk Pitching:
    - >8 months/year5-fold
    - >80 pitches/game 4-fold
    - >85 mph 2.6X
    - Arm fatigue 36X

Dr. Andrews:
". . . the speed gun is the worst invention in the history of Little League baseball."

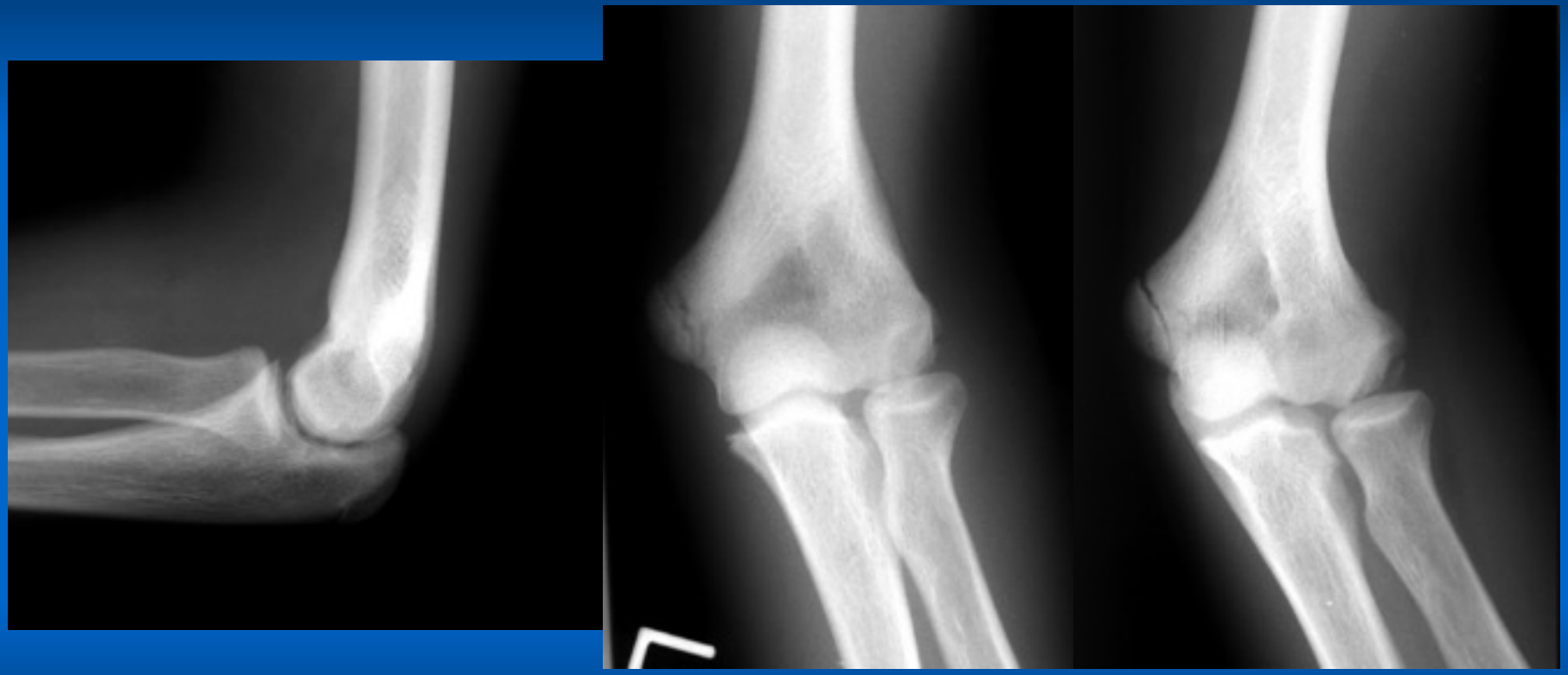
Olsen II SJ, Fleisig GS, Dun S, Loftice J, Andrews JR, "Risk Factors for Shoulder and Elbow Injuries in Adolescent Baseball Pitchers," Am J Sports Med 34(6); 2006,905-912.

UCL Reconstruction

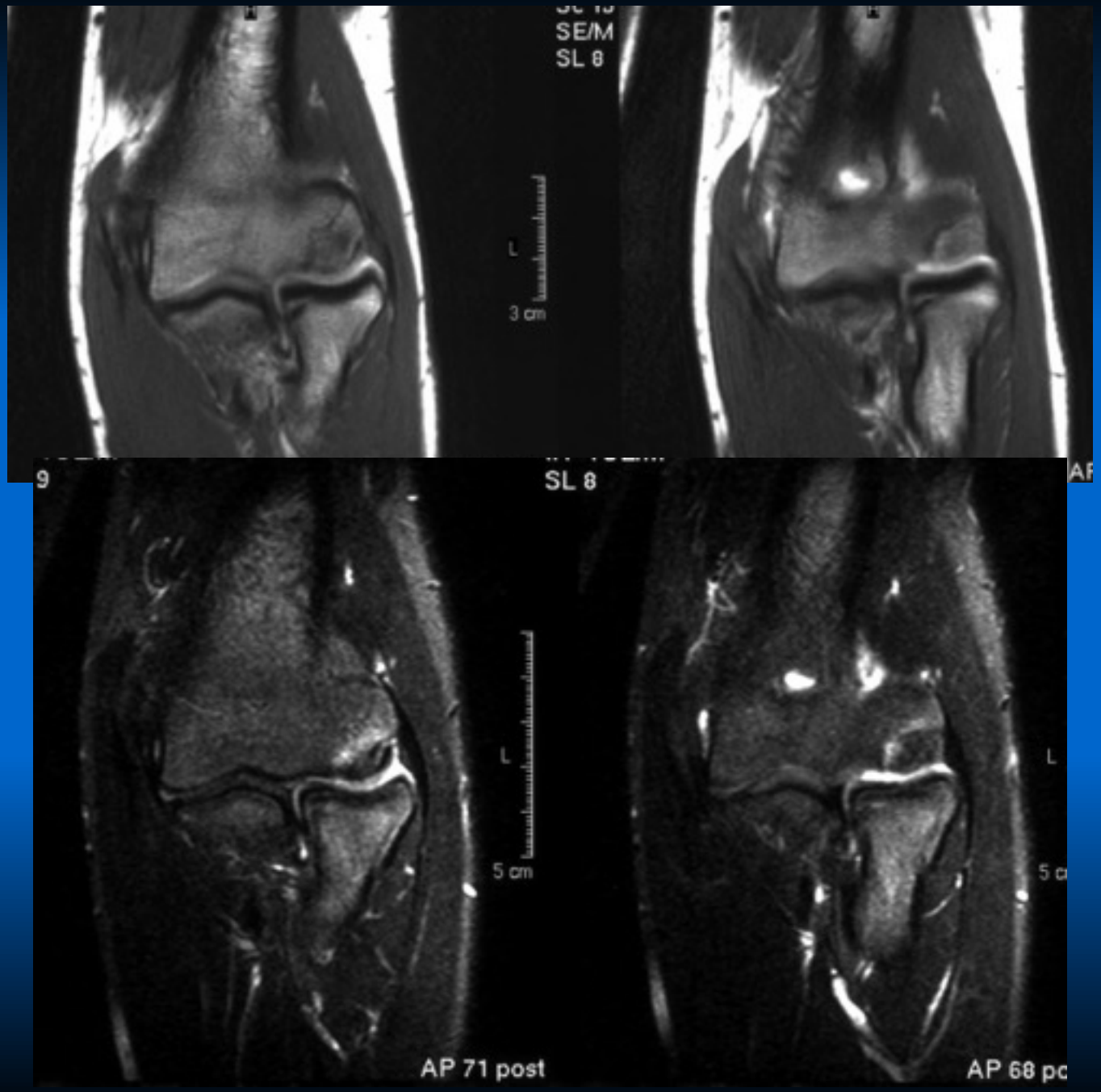
- 27 Patients, with avg. 35 month followup
- Risk factors (6)
- Patient results:
    - Avg. 3 risk factors
    - Fastball velocity 83 mph
    - 67% threw breaking pitchs < age 14
- 50% increase in UCL reconstructions in high school players
    - J.R. Andrews UCL reconstructions
      1988-1994: 8% high school (7 / 85)
      1995-2003: 13% high school (77 / 609)

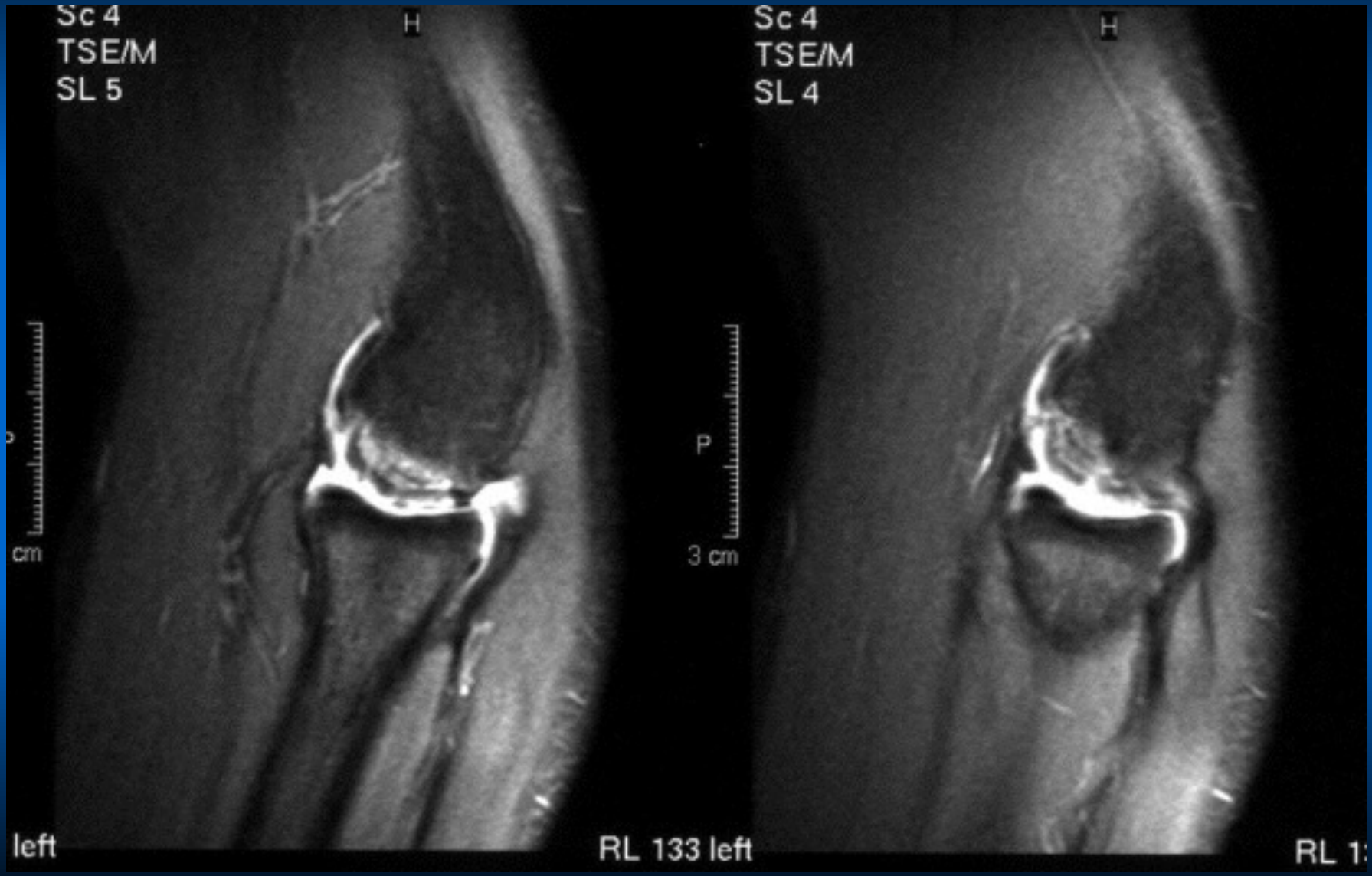
Petty DH, Andrews JR, Fleisig GS, Cain EL, "Ulnar Collateral Ligament Reconstruction in High School Baseball Players: Clinical Results and Injury Risk Factors," Am J Sports Med 32(5), 2004;1158-1164.

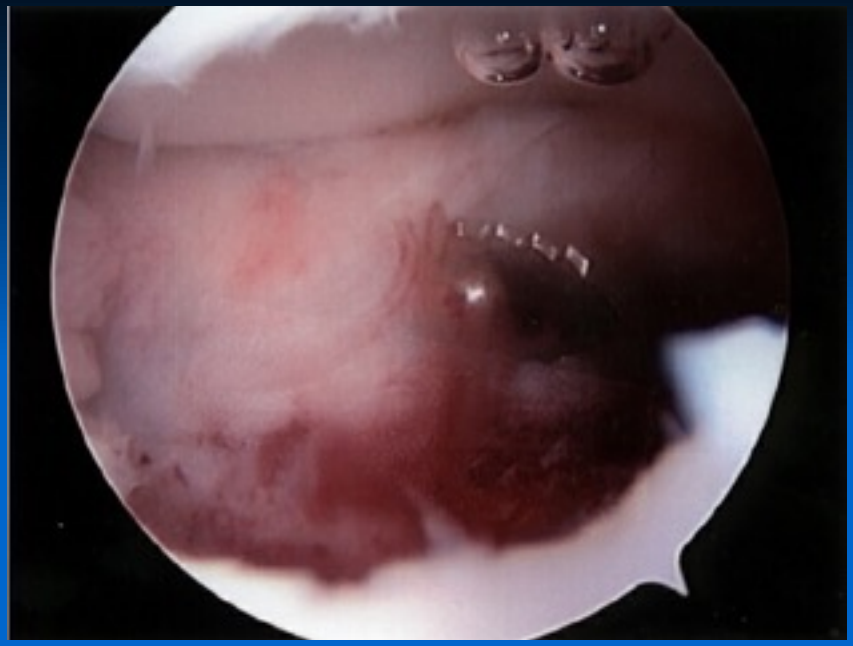
14 YO LHD Pitcher

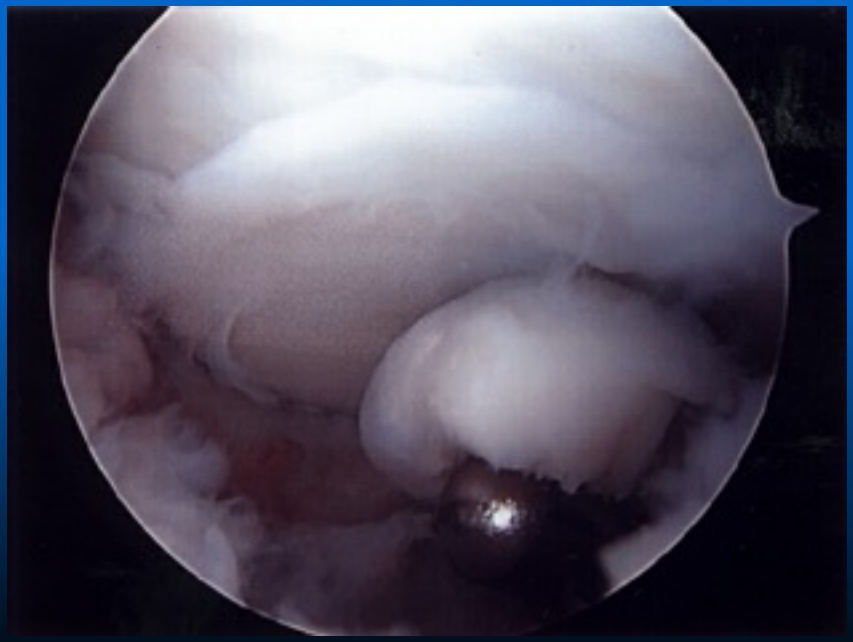


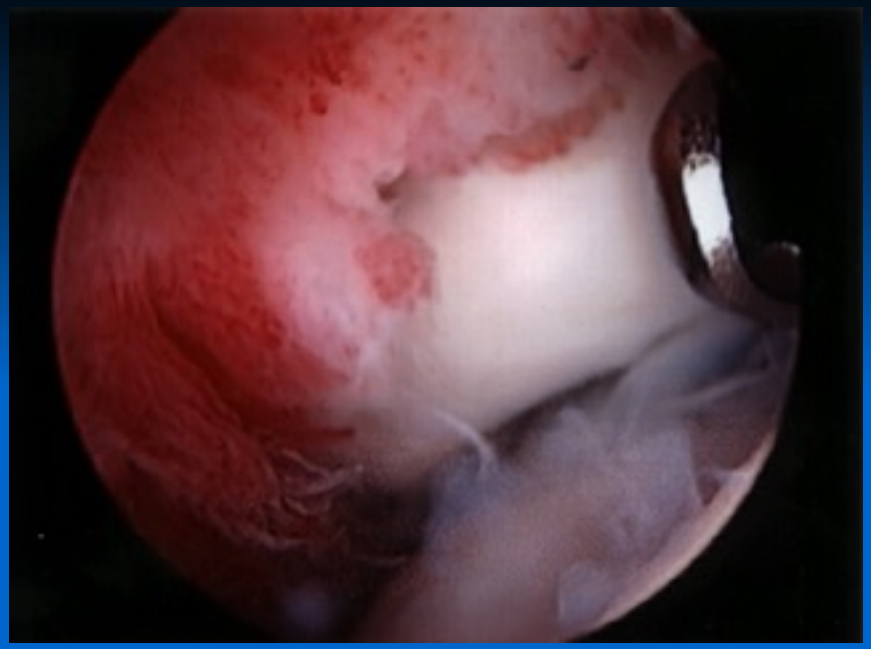
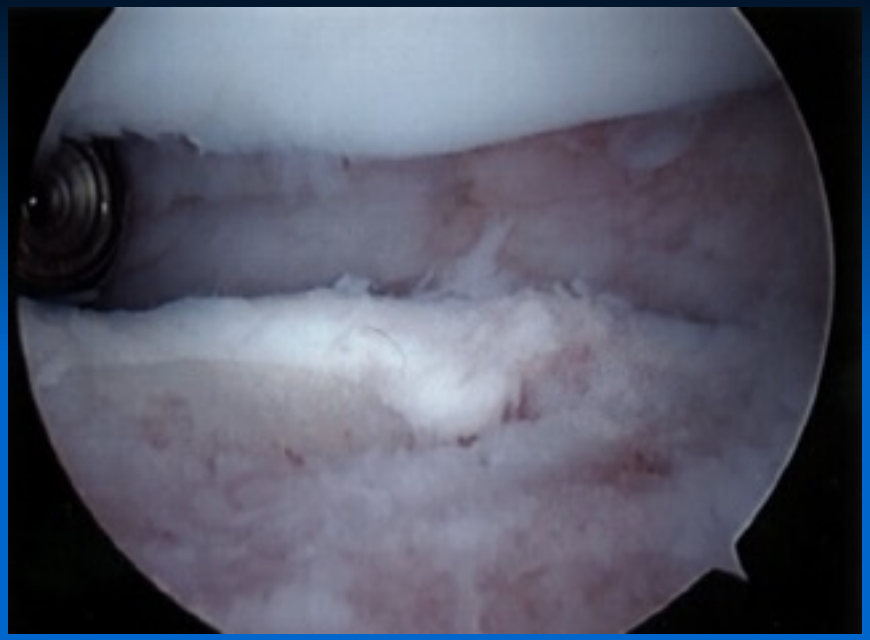
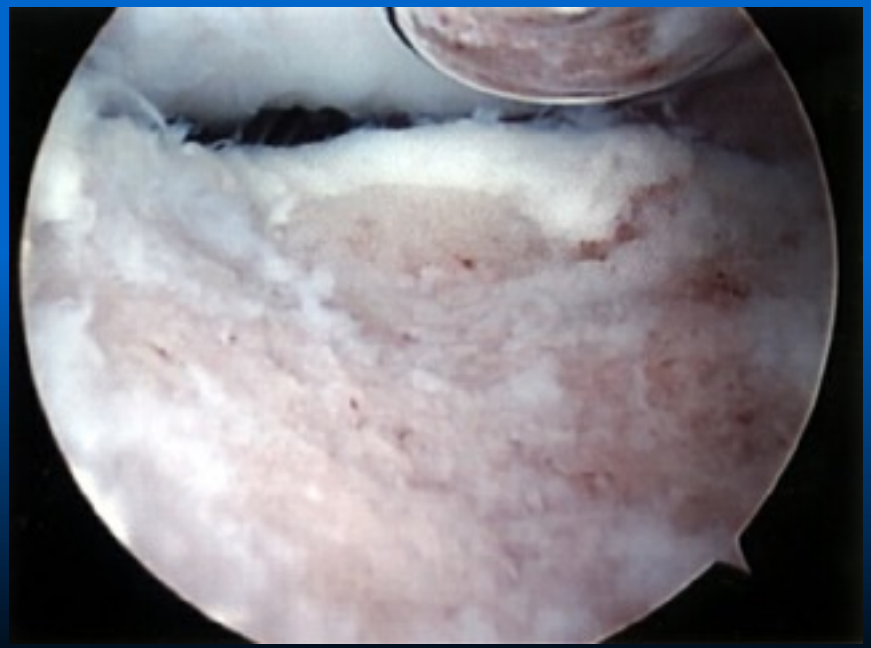
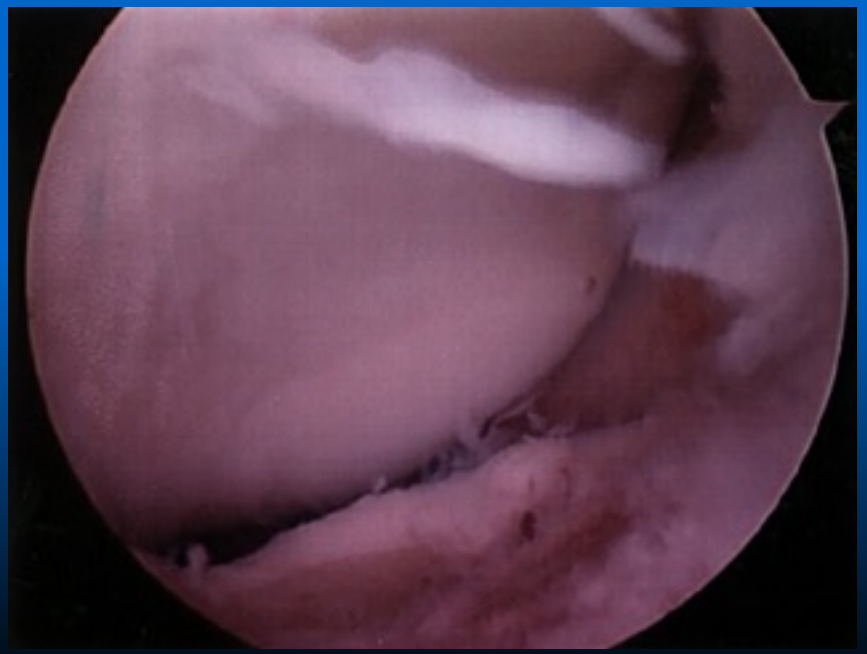
Unable to straighten elbow out for 2 months
Referred for UCL sprain


SE/M
SL 8
L
3 cm
9
SL 8
L
5 cm
AP 71 post
AP 68 pc

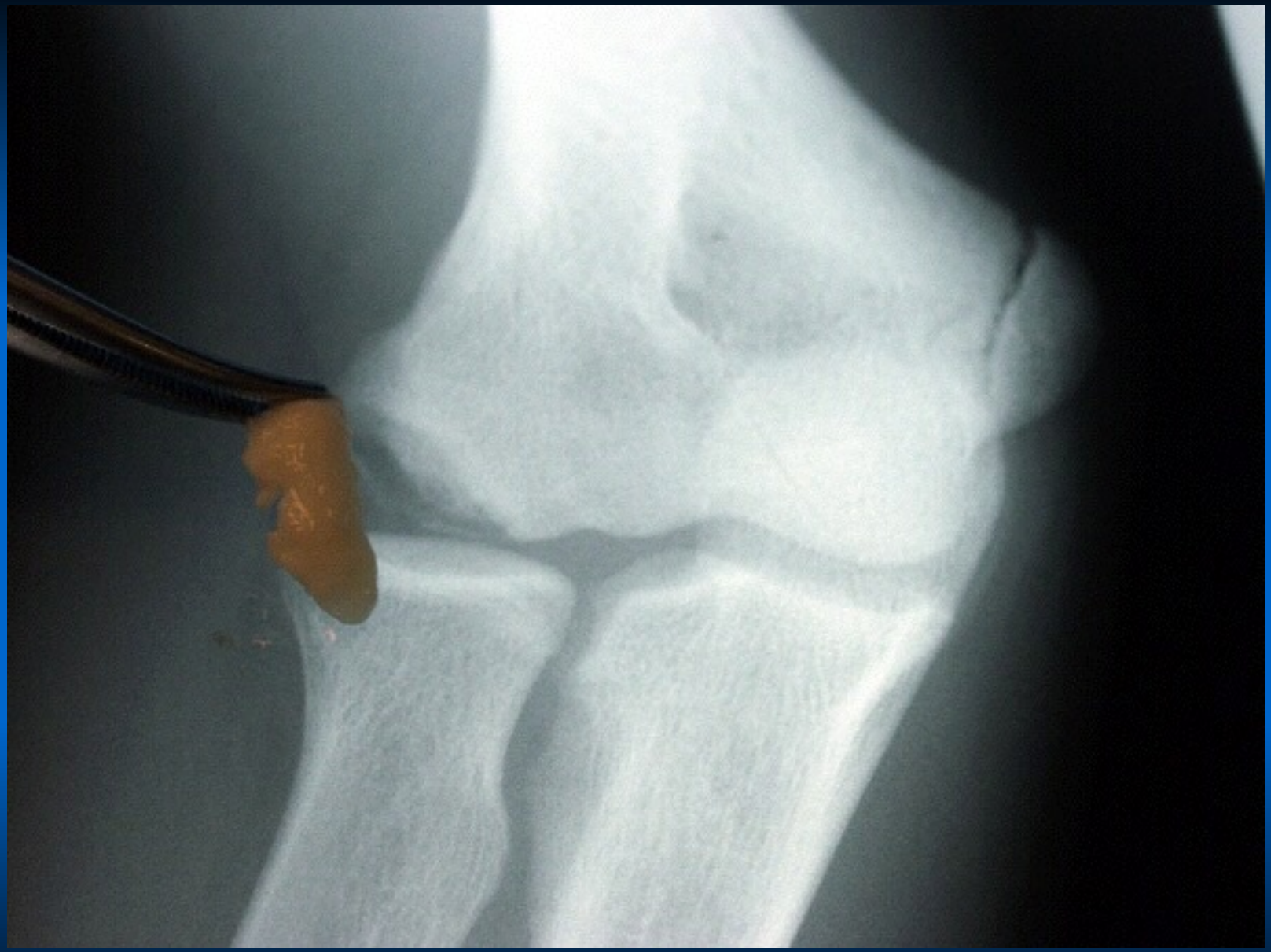

Sc 4
TSE/M
SL 5
H
cm
left
RL 133 left
Sc 4
TSE/M
SL 4
H
P
3 cm





Loose Bodies



Olecranon stress fracture

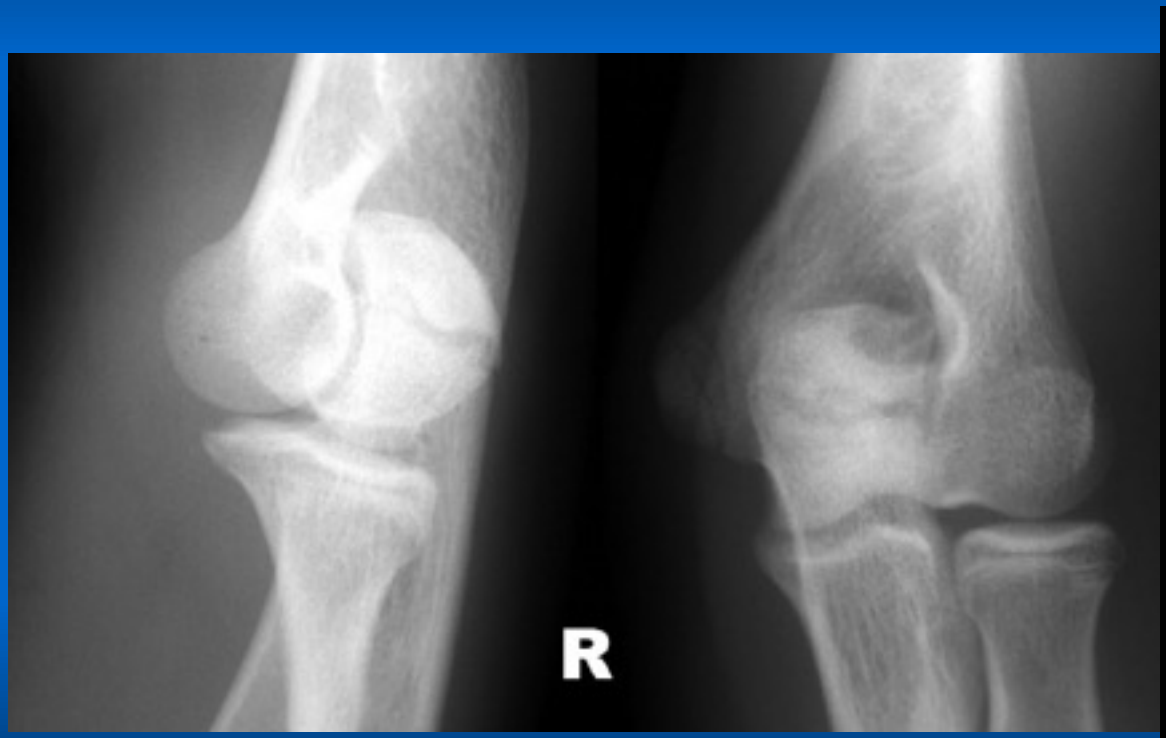
- 5 baseball players
  - Persistent olecranon physis
  - Underwent ORIF bone graft
- Mechanism
  - Extension forces – triceps
    - Gymnasts, divers
  - Combined – valgus extension overload
    - Overhead throwing athletes

Charlton J Shoulder Elbow Surg 2003

14 YO WM

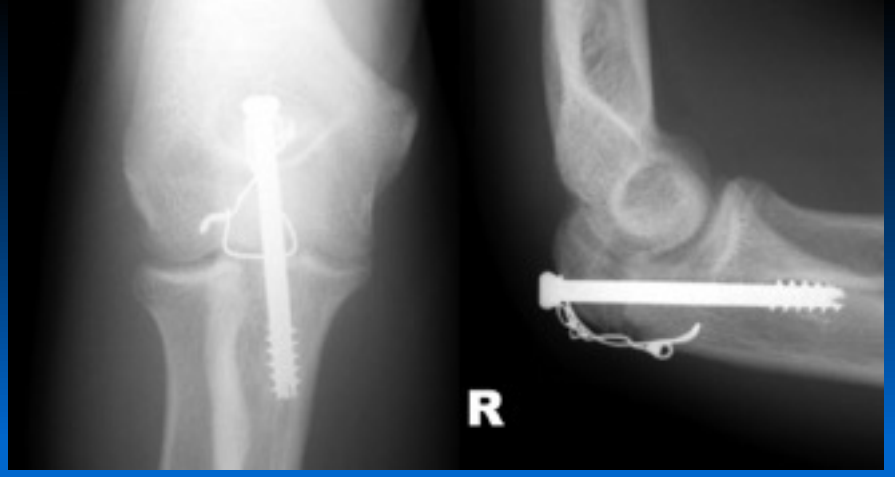
- RHD baseball player, wrestler, and football player
- Right elbow hyperextension sprain with impingement of the lateral synovial band

Initial presentation

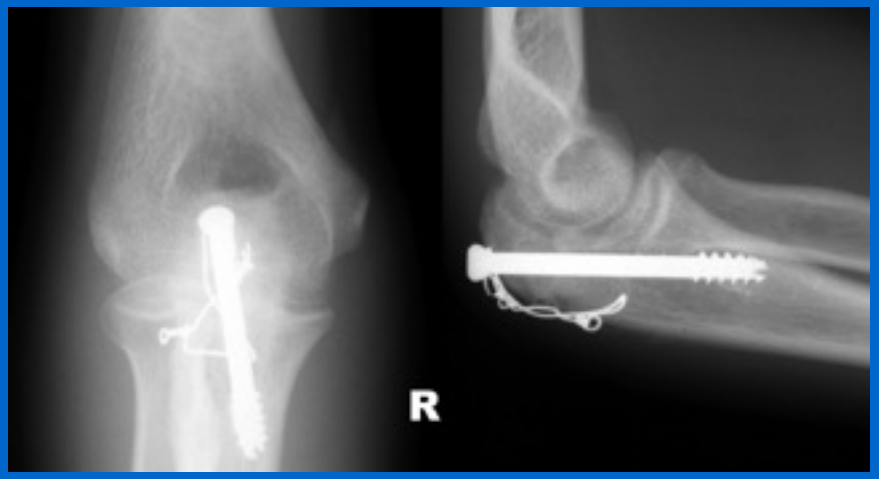


Post op

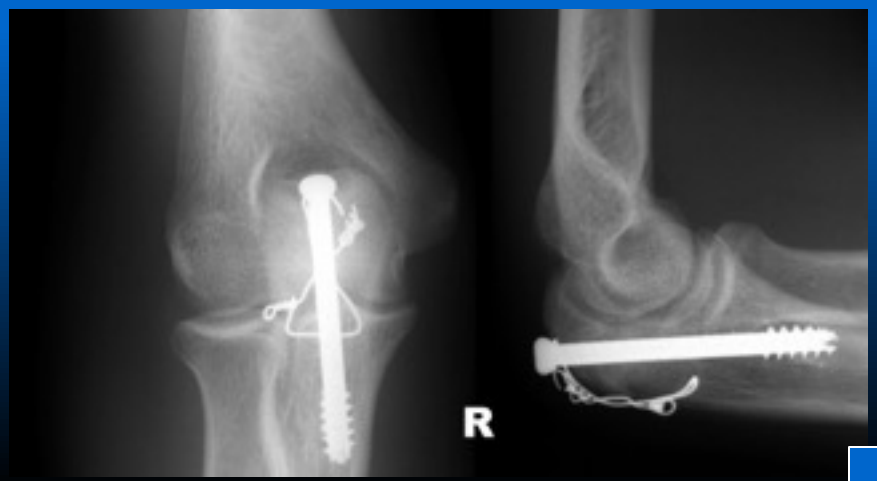
2 weeks



4 weeks



3 months



Shoulder Injuries
Adolescent (< Age 16)

- No epidemiological Studies
  Trends:
  - Acute
    - Football Defensive
    - Extreme Sports
      - Skateboarding
      - Diving - Sky

Shoulder Injury Sports Epidemiology

1978 Older study

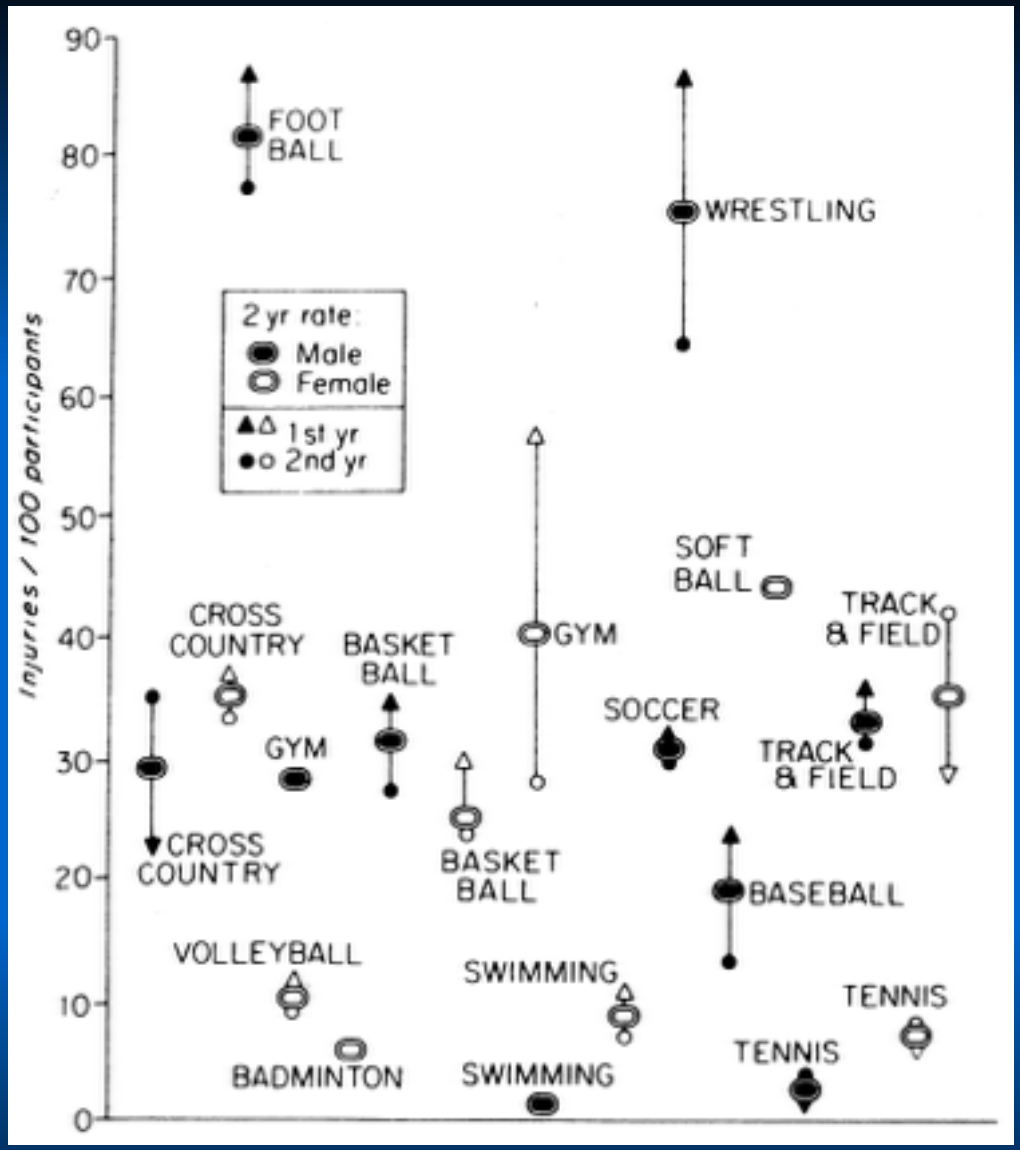


Fig. 14-3 in Wilkins KE, “Shoulder Injuries,” Chapter 14 in Stanitski, DeLee & Drez, eds., Pediatric and Adolescent Sports Medicine, Vol. 3 (W. B. Saunders Co., 1994), p. 177.

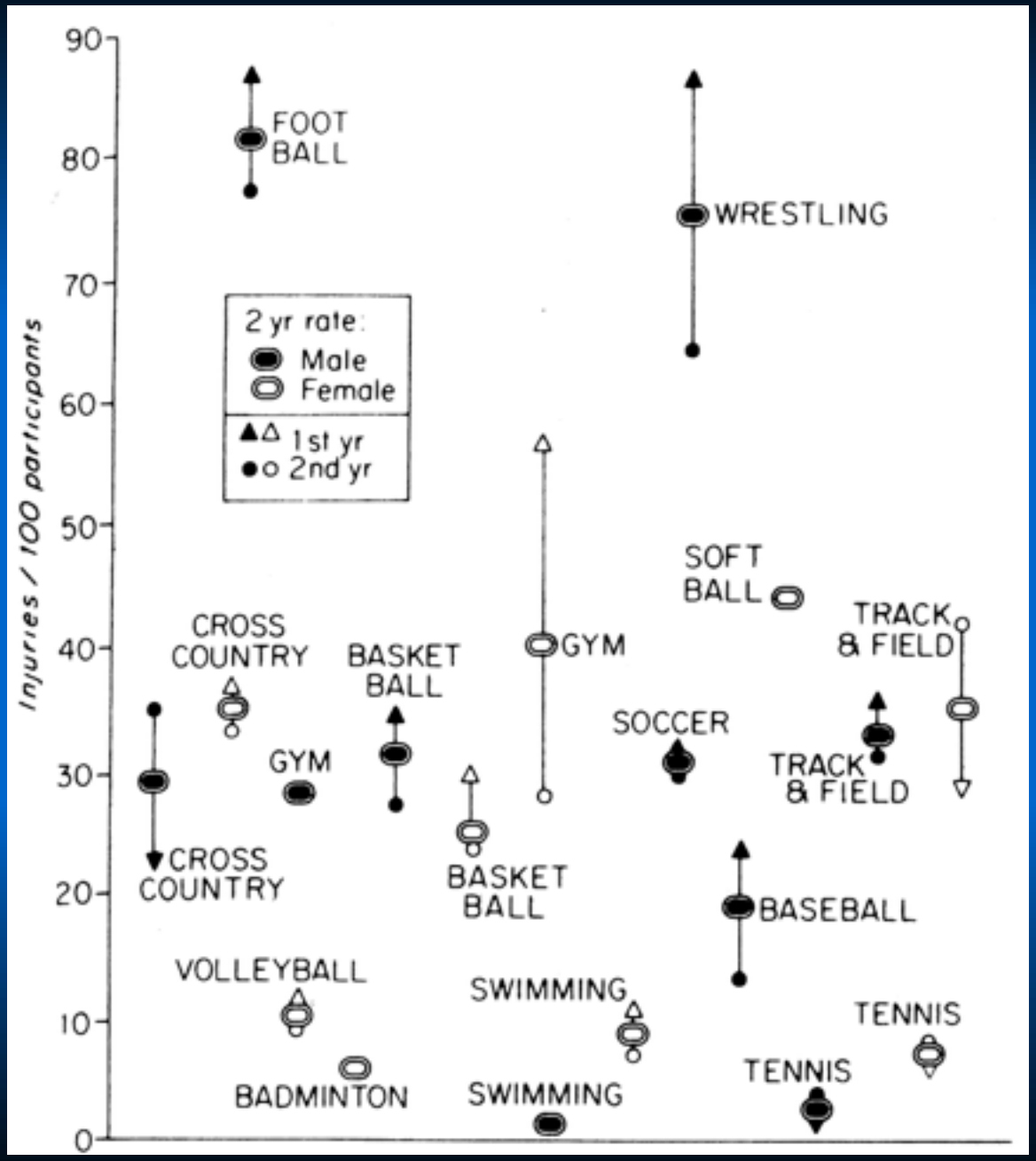
2 Year Rate:
Top 3 Sports
Injuries per 100 participants

Males

Football 82
Wrestling 75
Basketball 32

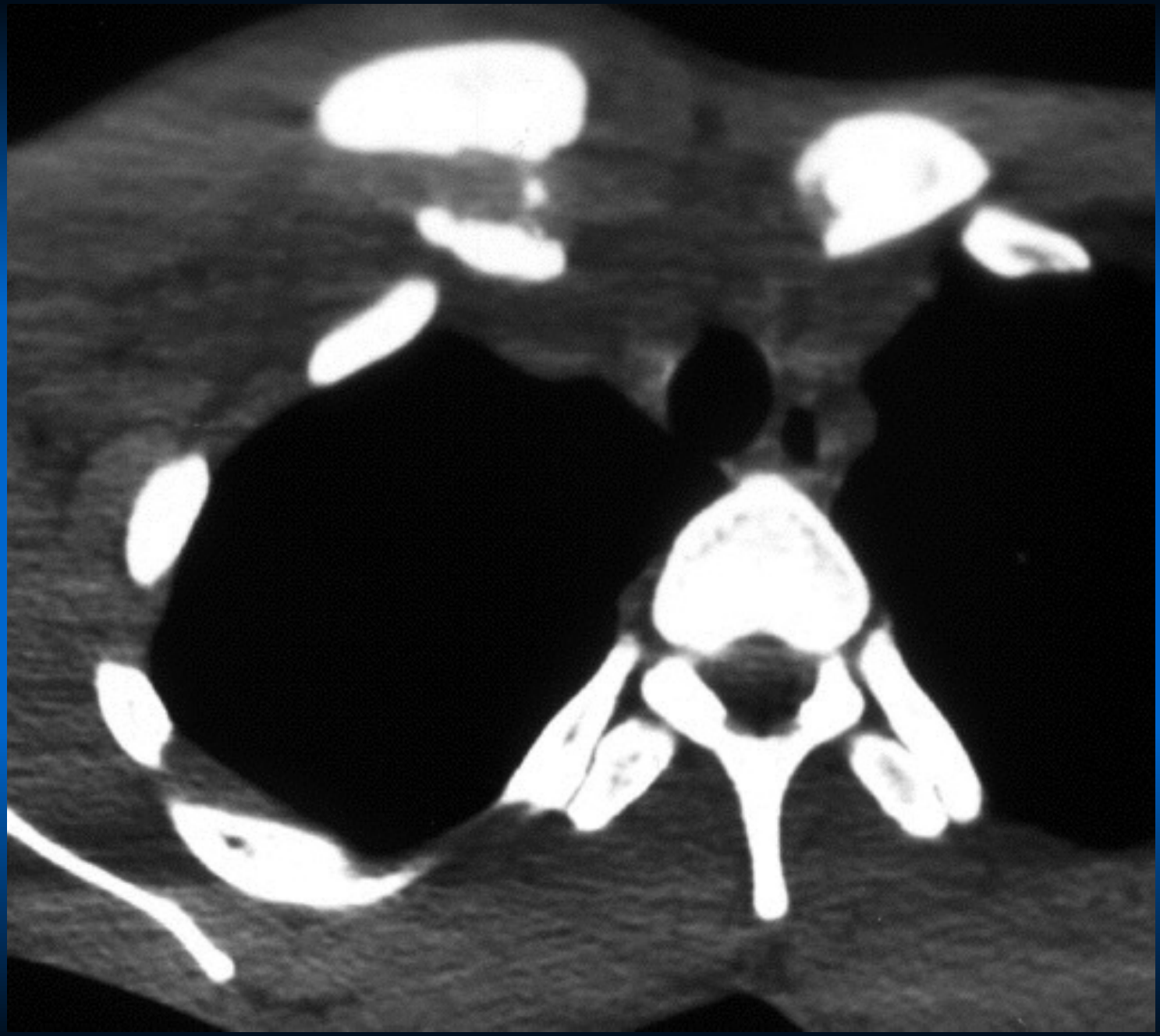
Females

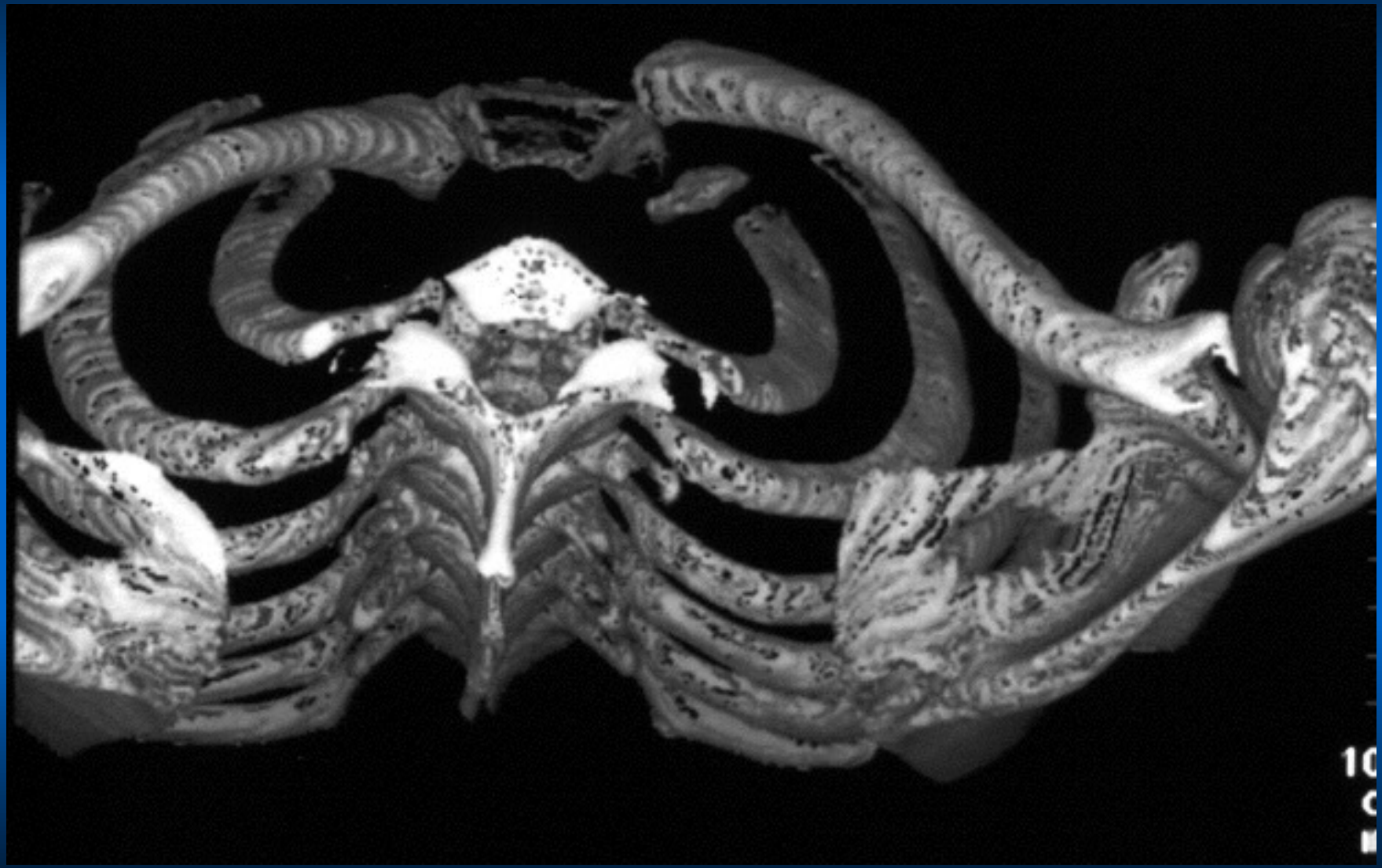
Softball 43
Gymnastics 40
X-Country 35



16 YO WM

Epiphyseal displaced fracture of the medial clavicle at the level of the sternoclavicular joint



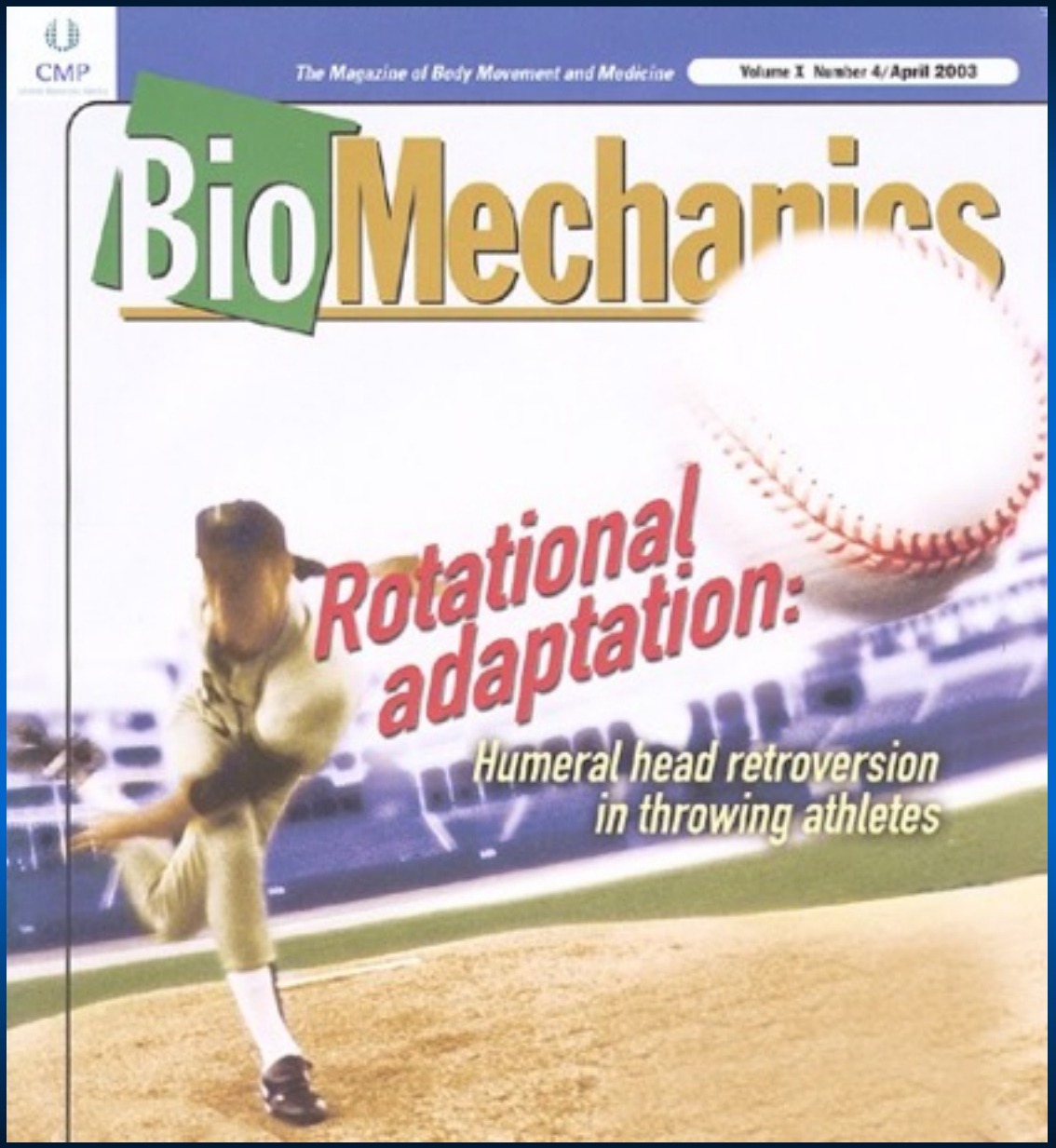


1 year post injury

Must Rule Out Fractures

Nolan Ryan didn't start pitching until he was in high school

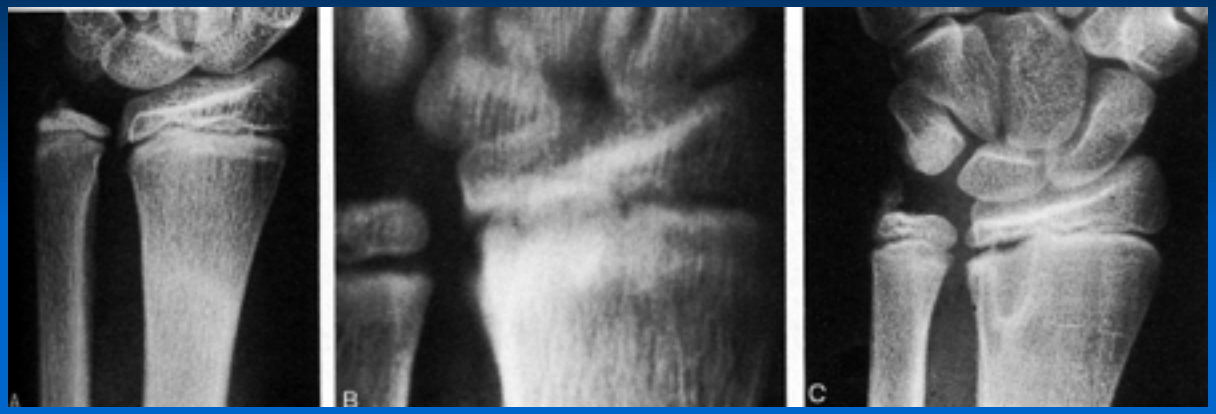
BioMechanics:
The Magazine of Body Movement and Medicine



Shoulder

- Little Leaguer's Shoulder
- Definition: proximal humerus stress fracture
- Symptoms: Diffuse shoulder pain, reproducible while throwing
- Signs: pain proximal humerus, posterolatersal and with ER
- Radiographs: 4 views
  - Comparison Stryker views

Distal radial growth arrest



Little Leaguer's Shoulder

Little Leaguer's Shoulder

- 23 patients
  - Age: average 14 years
    - 19 of 23 were pitchers
  - Pain while throwing
  - Symptoms: average duration 7.7 months
  - Treatment: rest for average 3 months
  - Follow up: average 9.6 months
  - 21/23 (91%) returned to baseball

Carson WGJ, Gasser SI, "Little Leaguer's Shoulder: A Report of 23 Cases," *Am J Sports Med* 1998;26:575-580.

Physeal and ROM Changes

- 79 youth baseball players
  - Age 8 – 15 years
- Increased physeal width on dominant side
- Increased ER dominant side

Mair SD, Uhl TL, Robbe RG, Brindle KA, "Physeal changes and range-of-motion differences in the dominant shoulders of skeletally immature baseball players," *J Shoulder Elbow Surg* 2004 Sep-Oct;13(5):487-91.

Little Leaguer's Shoulder

Diaphyseal Humerus Fracture in a Thrower
Think pathologic fracture – simple bone cyst

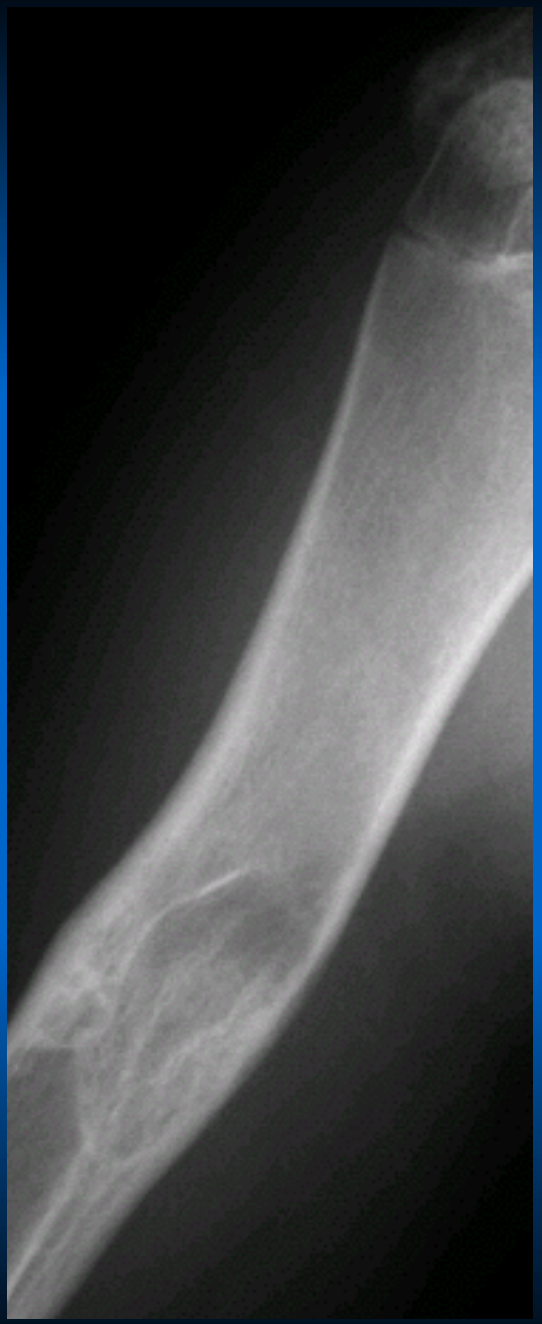
15 YO Baseball Outfielder

12 Y, 6 mo. old, broke left wrist. One week later, fell onto R upper extremity

Humerus Fracture Through Simple Cyst
Pathologic – Abnormal Bone


6 weeks
5 months
18 months

~ 3 years after fracture Complete filling in of cyst



Prevention is Key

- Pitchers are at high risk
  - No speed guns
  - Less showcases
  - Do training other than baseball
  - Little League pitchers do not become big league pitchers

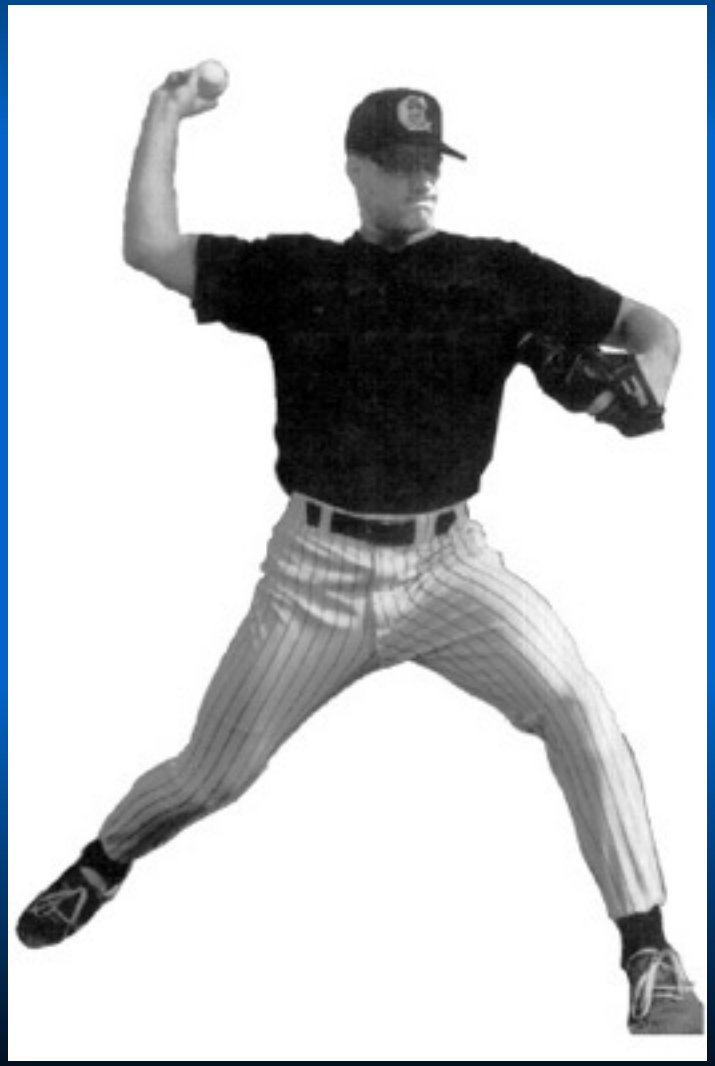
Conclusion:
13 YO "Big Pitcher" Syndrome

- Skeletally and mentally immature
- Fast growth phase
- Poor pitching mechanics
- Hip weakness
  = UE overuse injury

Protect our young athletes

- Reduce rate of Rotator Cuff and UCL tears in young pitchers

Little League pitchers do NOT become Big League pitchers



STOP Elbow Injuries in Youth Baseball: Youth Sports Injury Prevention

Sports
Trauma and
Overuse
Prevention

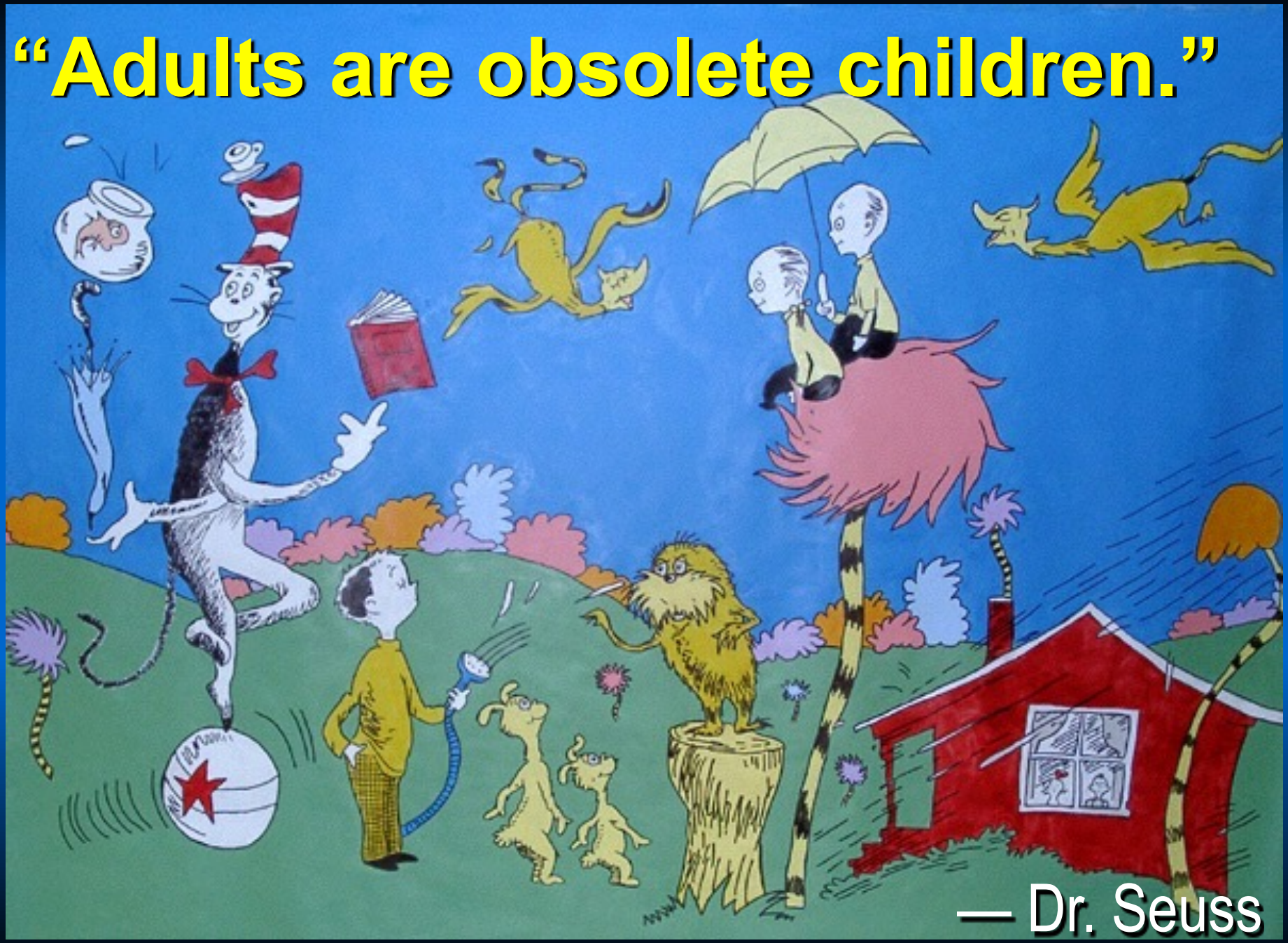
www.stopsportsinjuries.org

CONCLUSION

- Protect our young athletes from harm
- UCL tears in young baseball pitchers occur too often
- Educate athletes, parents, and coaches in injury patterns and prevention

Which is Safer?

Organized Sports
or
Free Play?


“Adults are obsolete children.”
— Dr. Seuss

I Am Invincible!