

Evaluation of the Pediatric Upper Extremity: A Case-Based Review of Shoulder and Elbow Injuries, Including Fractures

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DISCLOSURES

I have nothing to disclose

Objectives

- Describe history and findings for pediatric elbow exam for sports-related injuries
- Describe history and findings for pediatric shoulder exam for sports-related injuries.
- Present case examples to emphasize unique features of upper extremity conditions in active pediatric population.
- Review recommendations for sport specialization and care for overuse injuries.

The Shoulder and Elbow Exam

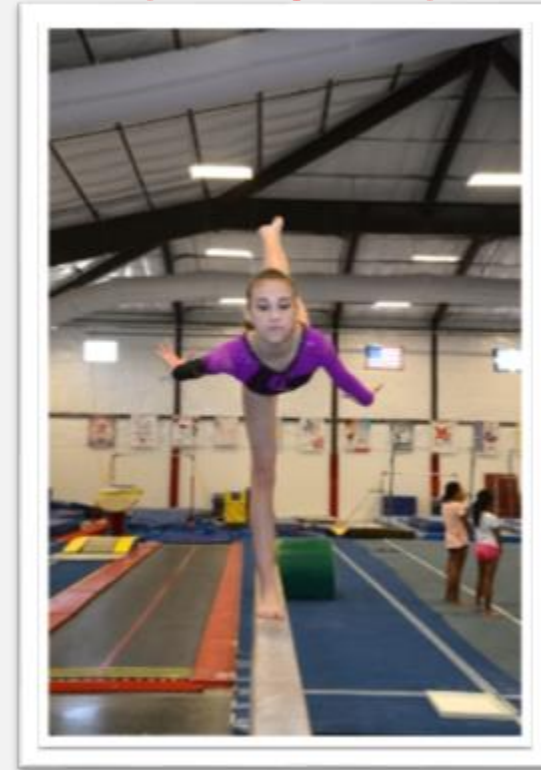
2 Athletes with shoulder or elbow pain

ACUTE



17 year old with a loud pop while falling to the ground

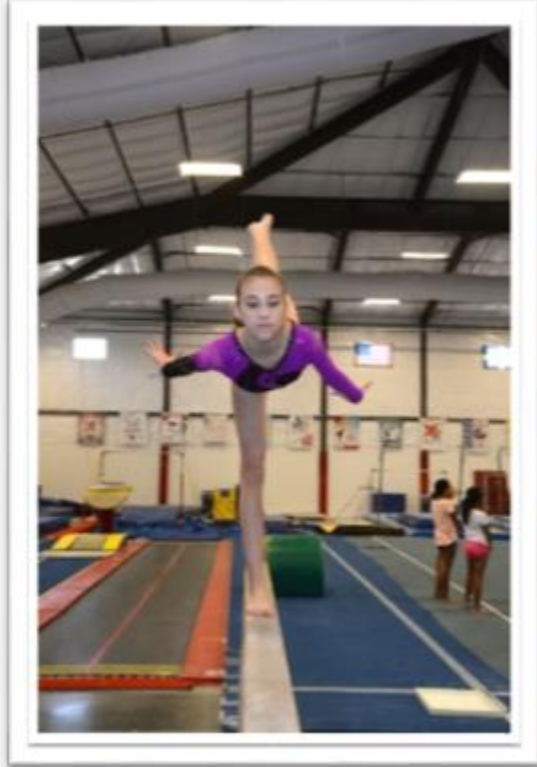
CHRONIC



12 year old with 6 months of shoulder pain

2 Athletes with shoulder or elbow pain

ACUTE



12 year old who heard a loud pop to her elbow

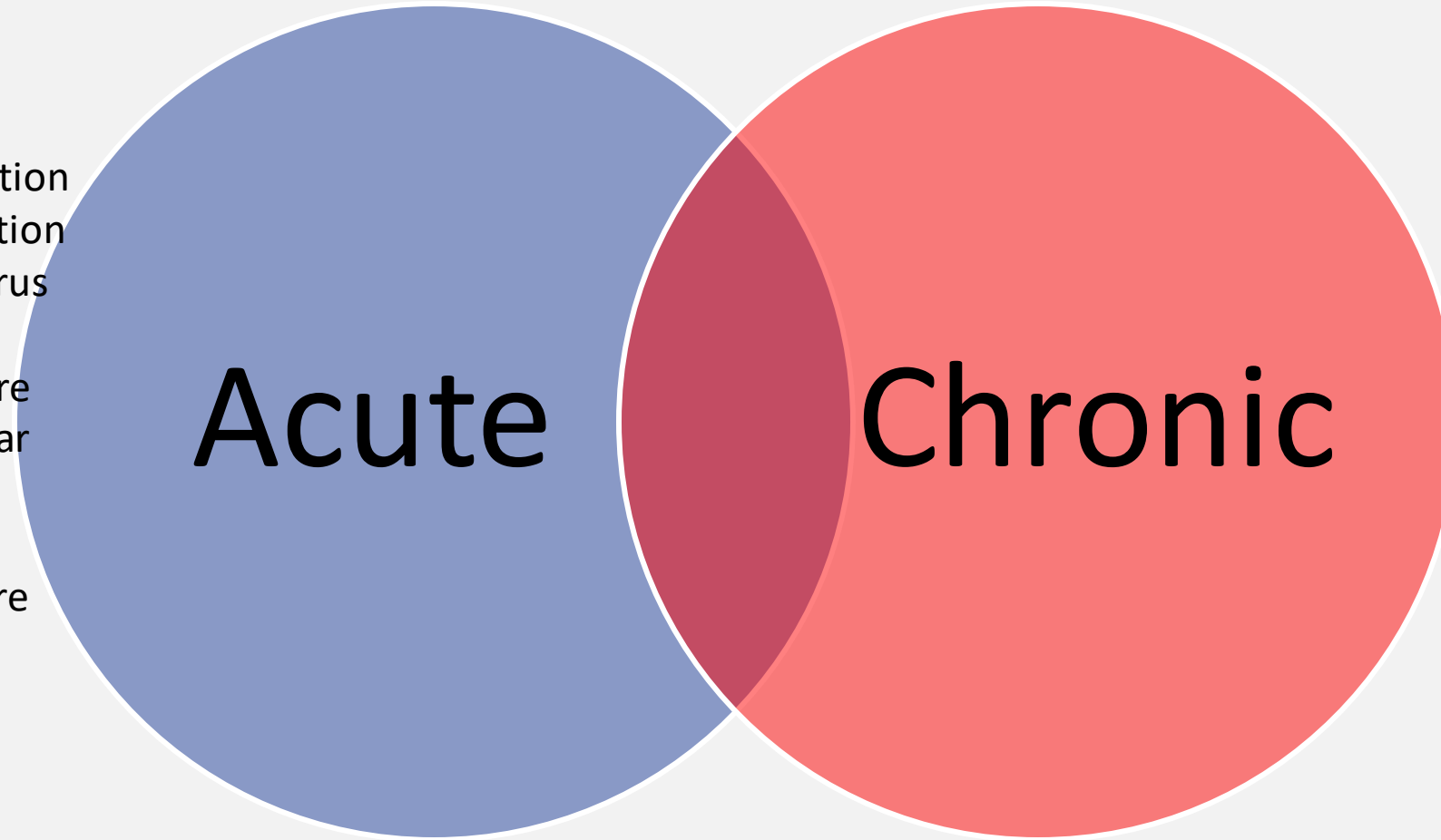
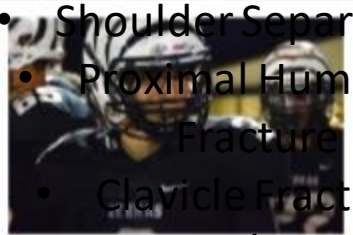
CHRONIC



17 year old
quarterback with 3
months of elbow pain

Shoulder Pain

- Shoulder Dislocation
- Shoulder Separation
- Proximal Humerus Fracture
- Clavicle Fracture
- Sternoclavicular Dislocation
- Labral tear
- Tendon Rupture



- Scapular Dyskinesia
- Shoulder Instability
- Proximal Humerus Epiphyseolysis
 - Labral Tear
- Snapping Scapula
- Impingement
 - Tendonitis



The Shoulder and Elbow Exam in 6 minutes.....

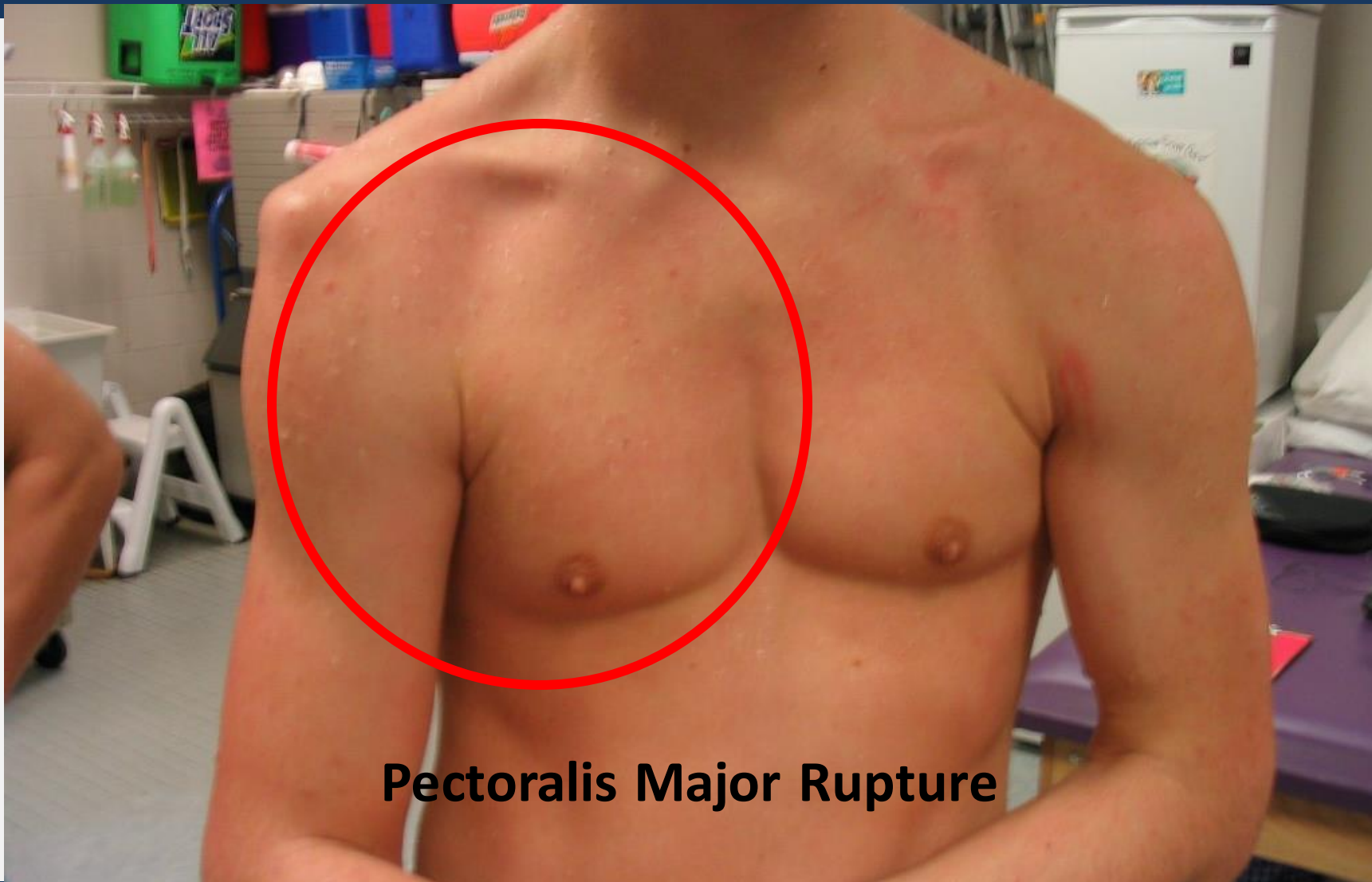
- Must always include
 - Neurovascular Exam
 - Vascular Exam
 - Radial Pulse
 - Capillary Refill
 - Neurologic Exam
 - Axillary/C5 Nerve Root
 - Musculocutaneous
 - Median/Anterior Interosseous Nerve (AIN)
 - Radius/Posterior Interosseous Nerve (PIN)
 - Ulnar
 - Cervical Spine Exam
 - Hyperlaxity Exam
- If a fracture is suspected, joint above and below deformity should be evaluated and imaged

The Shoulder and Elbow Exam in 6 minutes.....



Sternoclavicular Injury: evaluate for dysphagia/difficulty breathing, CT scan

The Shoulder and Elbow Exam in 6 minutes.....



Pectoralis Major Rupture

The Shoulder and Elbow Exam in 6 minutes.....



Type 3 Supracondylar Elbow Fracture

6 month old with a transphyseal fracture with possible non-accidental trauma



The Shoulder and Elbow Exam in 6 minutes.....

Clavicle Fracture



The Shoulder and Elbow Exam in 6 minutes.....



The Shoulder and Elbow Exam in 6 minutes.....

Labral Cyst (Spinoglenoid Cyst)



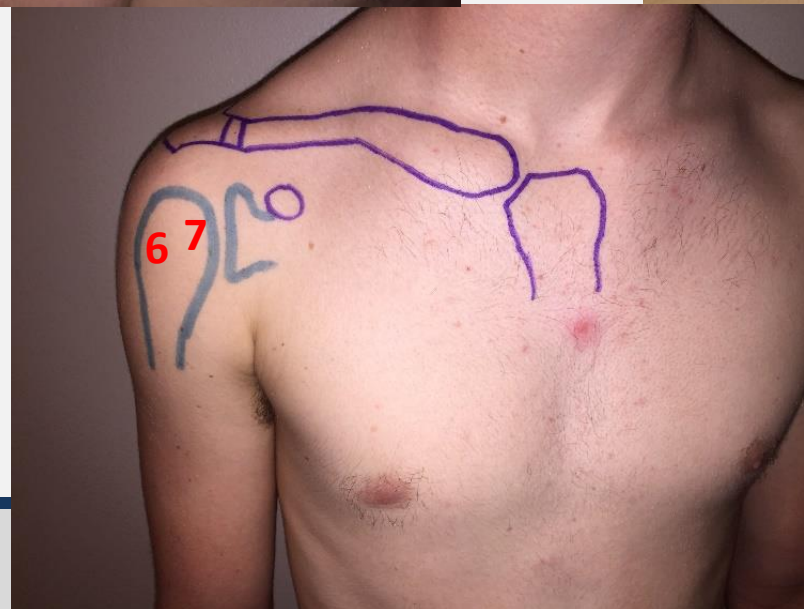
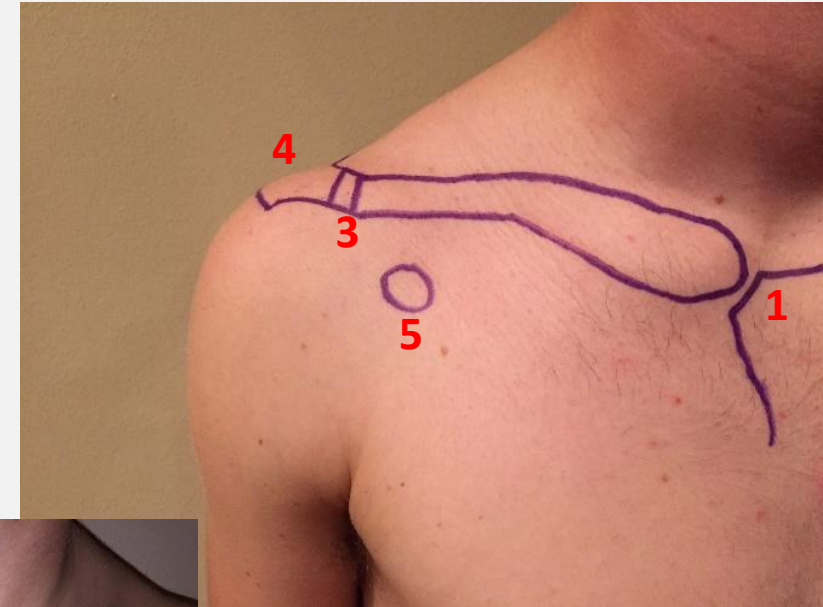
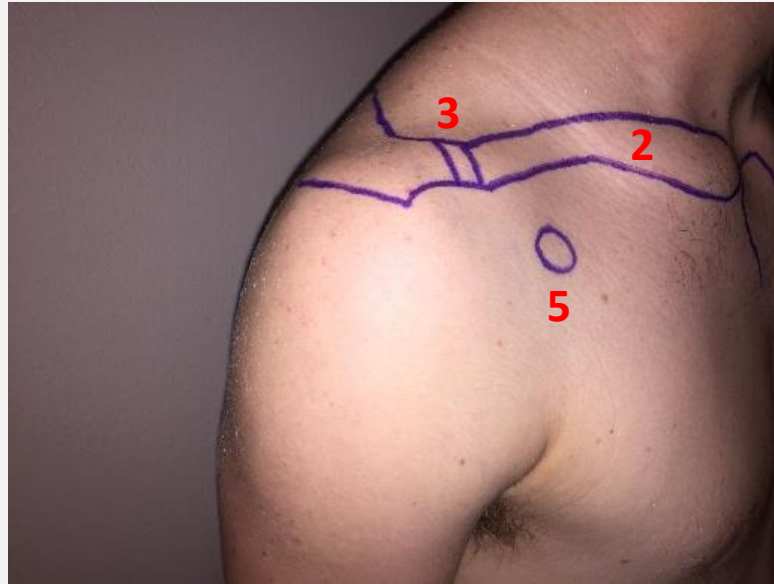
The Shoulder and Elbow Exam in 6 minutes.....

Scapular Winging



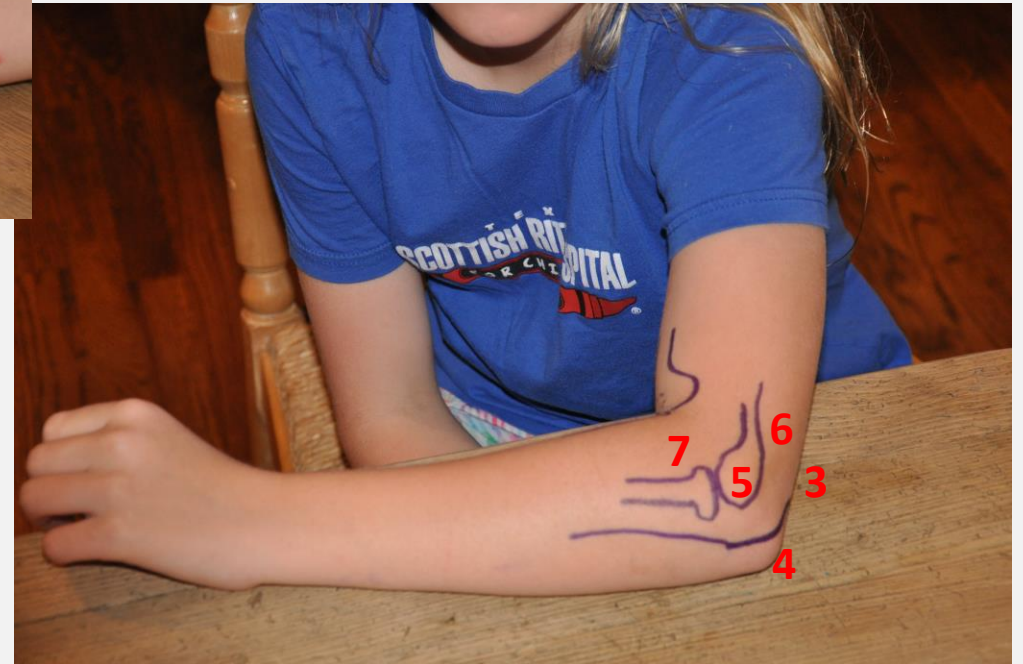
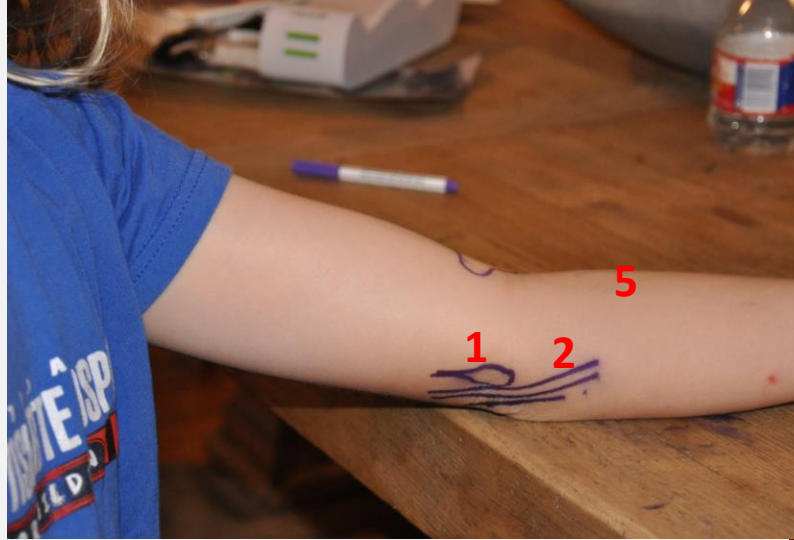
The Shoulder and Elbow Exam in 6 minutes.....

1. Sternoclavicular Joint
Proximal Clavicle Fracture
SC Joint Separation
2. Clavicle
Clavicle Fracture
3. Acromioclavicular Joint
AC or Shoulder Separation
4. Acromion
5. Corocoid
Scapular Dyskinesis
6. Humeral Head
Little Leaguer's Shoulder
7. Biceps Tendon
SLAP Tear
Tendinitis
Snapping Biceps



The Shoulder and Elbow Exam in 6 minutes.....

1. Medial Epicondyle
2. Ulnar Nerve
3. Triceps
4. Olecranon
5. Capitellum
6. Lateral Condyle
7. Radial Head



The Shoulder and Elbow Exam in 6 minutes.....

SHOULDER

- Forward flexion: 160 - 180°
- Extension: 40 - 60°
- Abduction: 180°
- Adduction: 45 °
- Internal rotation: GT/SI/L12/T12/T5
- External rotation: 80 - 90 °



The Shoulder and Elbow Exam in 6 minutes.....

SHOULDER

- Forward flexion: 160 - 180°
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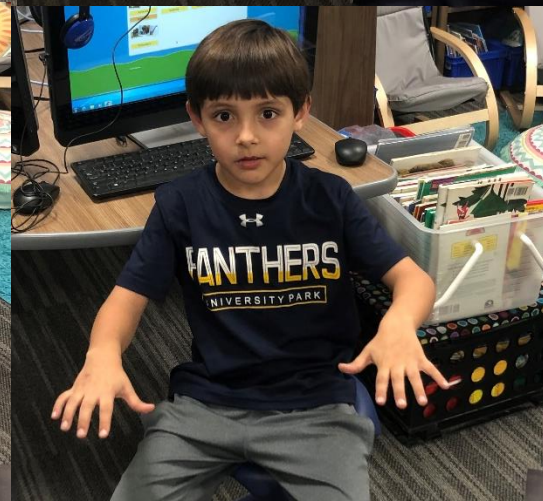
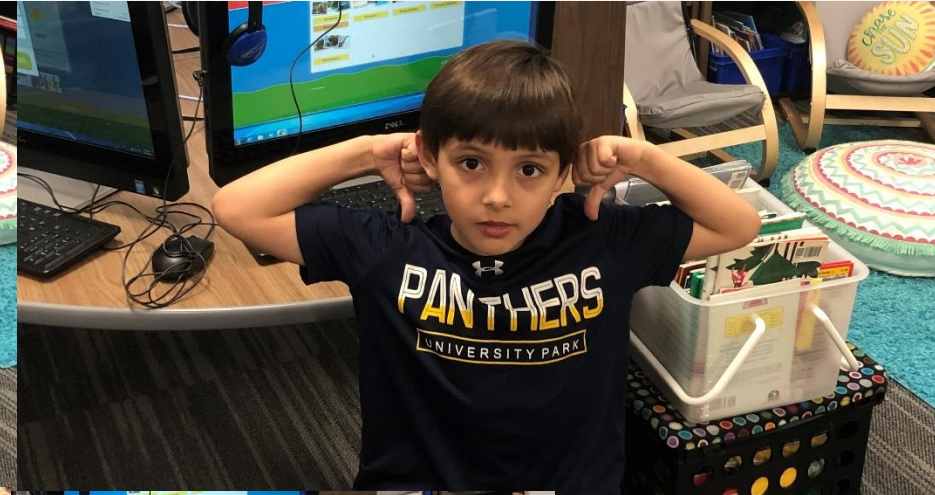
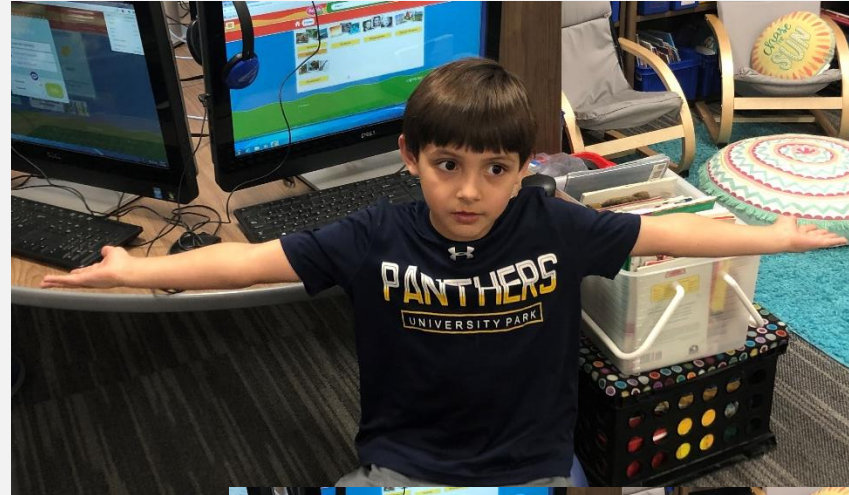


Video courtesy of Philip Wilson, MD

The Shoulder and Elbow Exam in 6 minutes.....

ELBOW

- Extension – Flexion
0 – 140°
- Supination – Pronation
90° – 90°



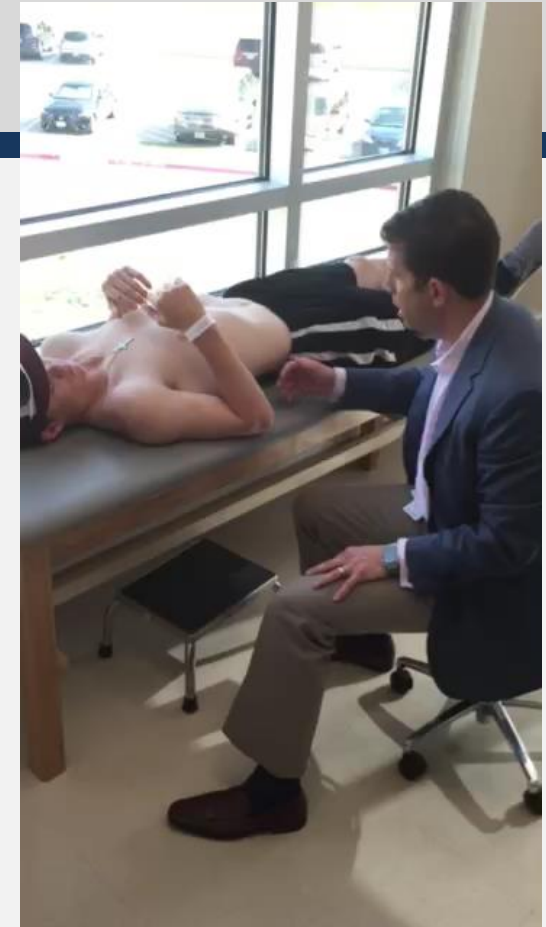
The Shoulder and Elbow Exam in 6 minutes.....

- Deltoid
 - Axillary Nerve
- Empty Can Sign
 - Rotator Cuff/Supraspinatus
- Forward Flexion
 - Biceps Tendon
- Internal Rotation
- External Rotation
- Elbow Flexion/Extension
 - Brachialis/Biceps
 - Triceps
- Supination
 - Biceps
 - Musculocutaneous Nerve
- Wrist Extension and Flexion
 - Radial Nerve
 - Forearm Flexor/Extensor Overuse
- Thumb Flexion/Extension
 - AIN/PIN
- Wide Fingers
 - Ulnar Nerve



The Shoulder and Elbow Exam in 6 minutes.....

- Shoulder Instability
 - Sulcus Sign
 - Apprehension/Relocation Sign
- Labral Tear
 - O'Brien SLAP Test
- Ulnar Collateral Ligament Instability
 - Milking Maneuver
 - Dynamic Milking Maneuver



Shoulder Instability
Apprehension/Relocation Sign



O'Brien SLAP Test

The Shoulder and Elbow Exam in 6 minutes.....



Positive Sulcus Sign

Live Shoulder/Elbow Exam



SPORTS
MEDICINE

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Case Example

Thrower's Overuse Shoulder Injury

Dave, 13 year old male

- Shoulder pain while pitching x 6 weeks
- Coach/Dad said my rotator cuff was inflamed



Dave, 10 year old male

- Shoulder pain while pitching x 6 weeks
- Coach/Dad said my rotator cuff was inflamed

1
Pain

2
Sports



Evaluation of a Youth Athlete

- History
 - Acute vs. Chronic
 - Time Management
 - Sports = Complaints
 - Parents Influence
 - Pain
 - Activity Related
 - Mechanical Symptoms
- Exam
 - Inspection
 - Palpation
 - ROM
 - Strength



SHOULDER

Common Problems in Active Youth

	Mechanism of Injury	History / Exam	Imaging	Treatment	When to Refer
Little Leaguer's Shoulder (Humeral Epiphysiolysis)	OVERUSE – repetitive injury; typically seen when pitching guidelines are not followed	Progressively worsening upper arm pain and pitching form with throwing laxity	XR: AP Grashey view with IR and ER; contralateral imaging for comparison Finding: physis widening, compare with contralateral	Rest until pain free, pitch training, physical therapy, reinforce pitching guidelines and overuse education	Persistent pain after forced rest
Multidirectional Instability	OVERUSE – sometimes presents with a single acute occurrence	Generalized ligamentous laxity (Beighton Criteria), activity-related pain, instability on exam, but not reported as symptom	XR: AP Grashey view, axillary view, and scapular Y-view Finding: normal	Physical Therapy: shoulder/scapular stabilization, progress to rotator cuff training, core and postural training Psychological Counseling: may be indicated with volitional dislocations	Recurrent instability or persistent pain
Scapular Dyskinesia	OVERUSE – poor mechanics	Generalized ligamentous laxity (Beighton Criteria), activity-related pain, pain with overhead activities, peri-scapular atrophy	XR: AP Grashey view, axillary view, and scapular Y-view Finding: normal	Physical Therapy: shoulder/scapular stabilization, core and postural training	Recurrent or persistent pain
Internal Impingement	OVERUSE – chronic rotator cuff and labral compression with repetitive motions	Activity related posterior shoulder pain, internal rotation deficit compared to contralateral side	XR: AP Grashey view, axillary view, and scapular Y-view Finding: normal	Rest, pitch training, scapular stabilization/sleeper stretch and overuse education	Recurrent or persistent pain
Shoulder Dislocation	ACUTE or RECURRENT - Fall on outstretched hand is most common	Focal sharp pain – anterior shoulder, empty lateral arm, anterior prominent mass.	XR: AP Grashey view, axillary view, and scapular Y-view Finding: glenoid margin loss, humeral head Hill Sachs Depression	Urgent closed reduction, immobilization	Any patient with suspected or confirmed shoulder dislocation
Clavicle Fracture	ACUTE – sudden injury; often a direct hit or fall on shoulder	Pain with palpation – clavicle with soft tissue swelling; prominent clavicle	XR: AP and 15 degrees Cranial View Finding: fracture or displacement	Depends on shortening, displacement, hand dominance, and activity restrictions	Any patient with suspected or confirmed clavicle fracture
Shoulder Separation – Acromioclavicular (AC) Injury	Fall onto shoulder with arm to the side	Pain with palpation distal clavicle, acromioclavicular (AC) joint and acromion	XR: AP Grashey view, axillary view, and scapular Y-view Finding: asymmetry in AC alignment	Little to no displacement – sling and early range of motion. Displaced lesion may require surgical management.	Visible displacement
Sternoclavicular (SC) Injury	Direct blow to chest	Pain and deformity over sternoclavicular joint. Evaluate for dysphagia and shortness of breath	XR: Serendipity view, typically requires CT Finding: subtle clavicle height asymmetry; CT scan axial diagnostic	May require surgical management	All injuries to sternoclavicular (SC) joint

Legend: XR - X-ray; MRI - Magnetic Resonance Imaging; AP - Anterior-Posterior view; Lat - Lateral view

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Imaging

XR: AP Grashey view, axillary view, and scapular Y-view

Imaging
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al view

IMAGING - KEY

- Anteroposterior



- Scapular – Y or Axillary



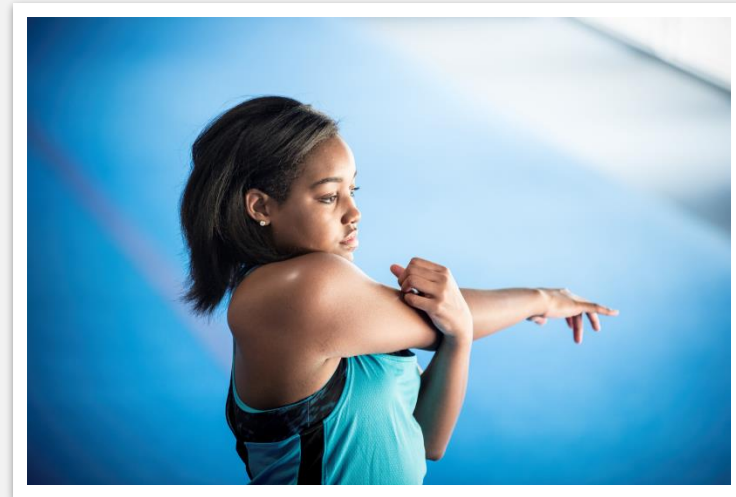
Dave, 10 yo male

- Shoulder pain while pitching x 6 weeks
- Coach/Dad said my rotator cuff was inflamed
 - No injury/event
 - Lateral shoulder soreness
 - Activity-related
 - Improves with rest
 - All-star pitcher
 - Play in 3 leagues
 - Played for the last 12 months
 - Dad is my pitching coach



Shoulder - Overuse

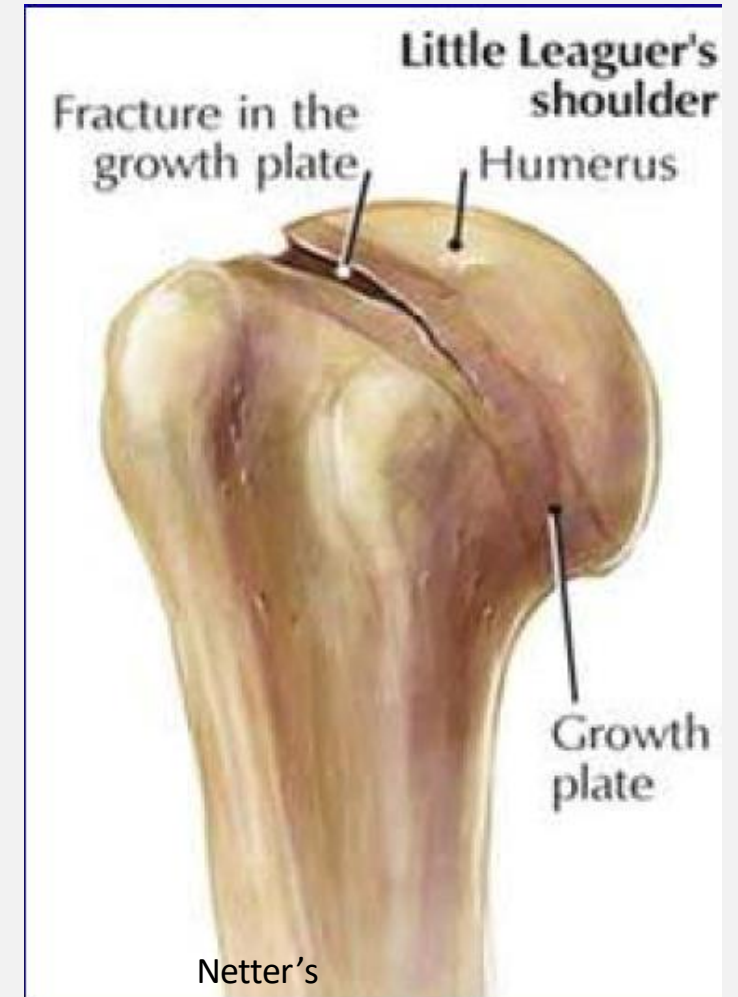
- Humeral Epiphysiolysis (Little League Shoulder)
- Multidirectional Instability
- Scapular Dyskinesia
- Internal Impingement



Humeral Epiphysiolysis

AKA: Little League Shoulder (LLS)

- An injury to the proximal humeral growth plate
- Male baseball pitchers ages 11-14 have the highest incidence of LLS



Humeral Epiphysiolysis

AKA: Little League Shoulder

- **Signs**
Poor form, especially when fatigued
- **Symptoms**
Progressively worsening upper arm pain with throwing
- **Diagnosis**
Radiology – plain films show widening proximal physis



Humeral Epiphysiolysis

AKA: Little League Shoulder



RECOMMEND CONTRALATERAL IMAGING

Humeral Epiphysiolysis

AKA: Little League Shoulder

- **Signs**
Poor form, especially when fatigued
- **Symptoms**
Progressively worsening upper arm pain with throwing
- **Diagnosis**
Radiology – plain films show widening proximal physis
- **Treatment**
 - **REST**
 - **PITCH TRAINING**
 - **SCAPULAR STABILIZATION**
 - **EDUCATION**

50% of middle school and high school sports injuries are overuse injuries



What is the big deal??

- Less free play
- More competition
- Single sport play
- Poor mechanics
- Year-round play



Pressure, Media, Means to an End

- Less free play
- More competition
- Single sport play
- Poor mechanics
- Year-round play

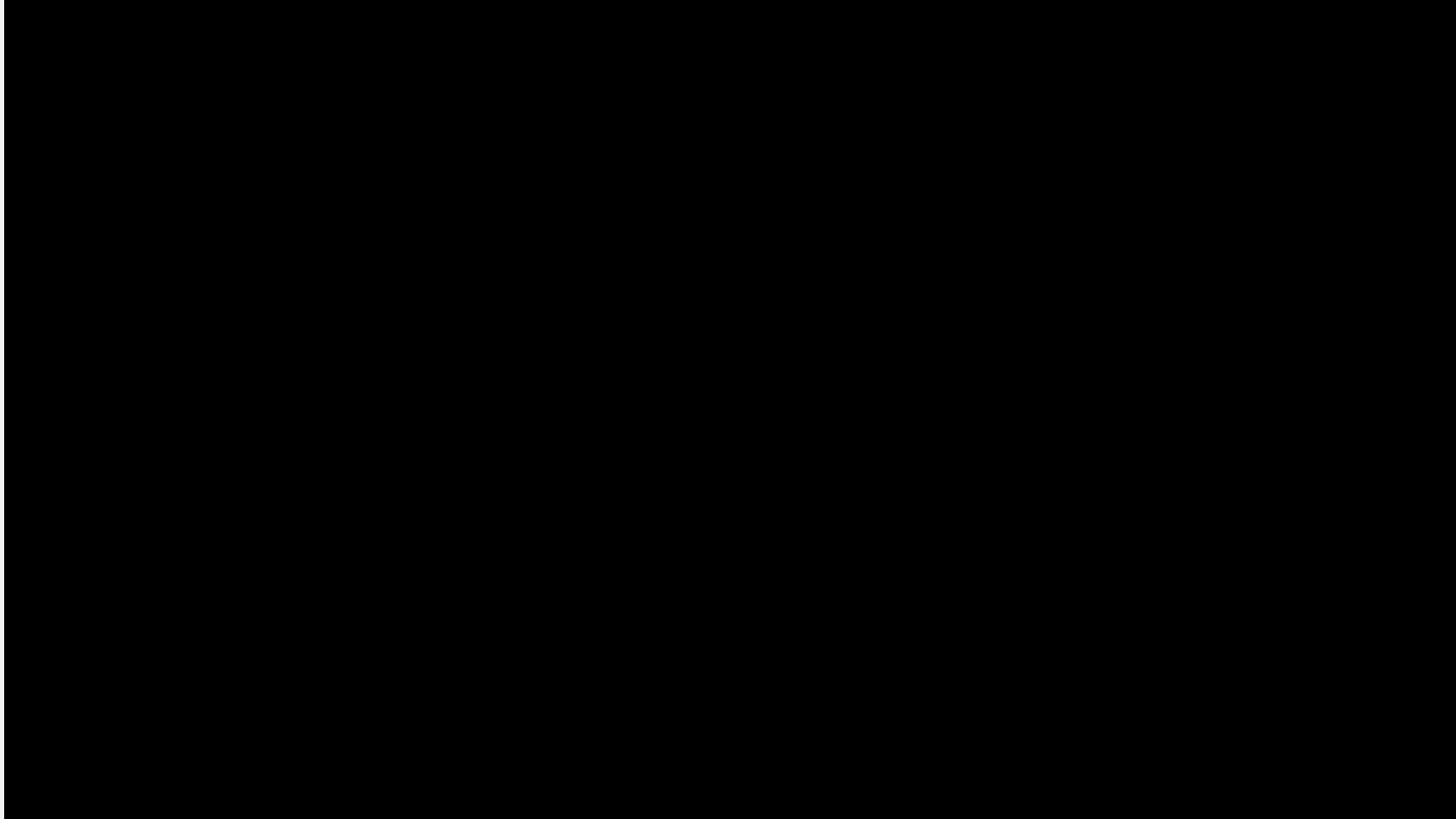
2000

Average Little Leaguer took 3.4 months off per year

2011

Average Little Leaguer took one week off per year

Top 10 Articles for Parents of Youth Athletes.....

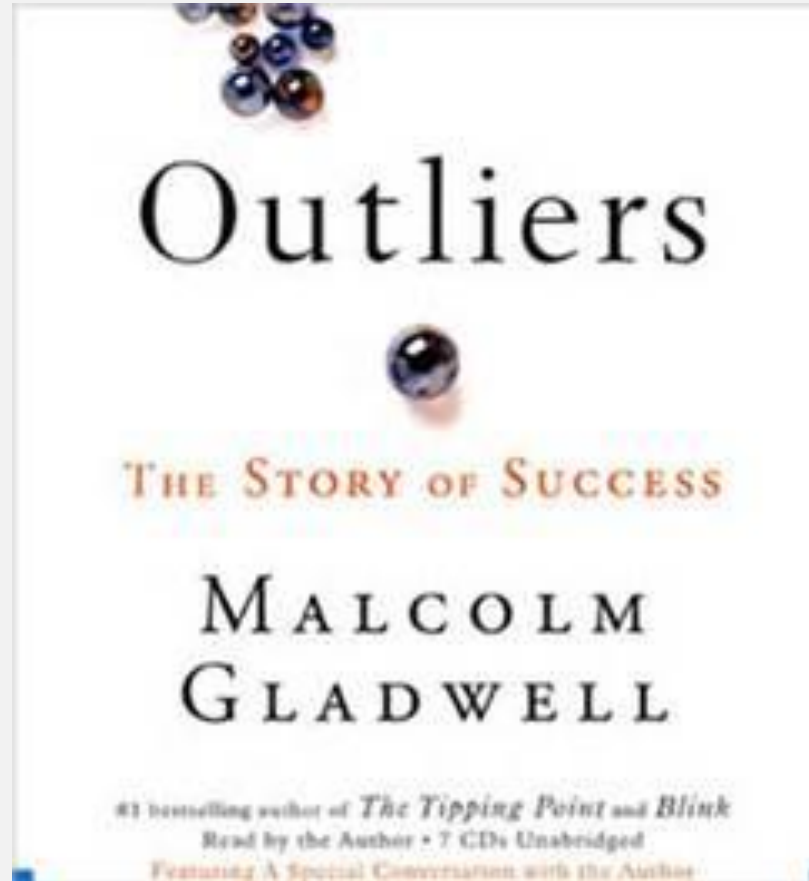


Resources

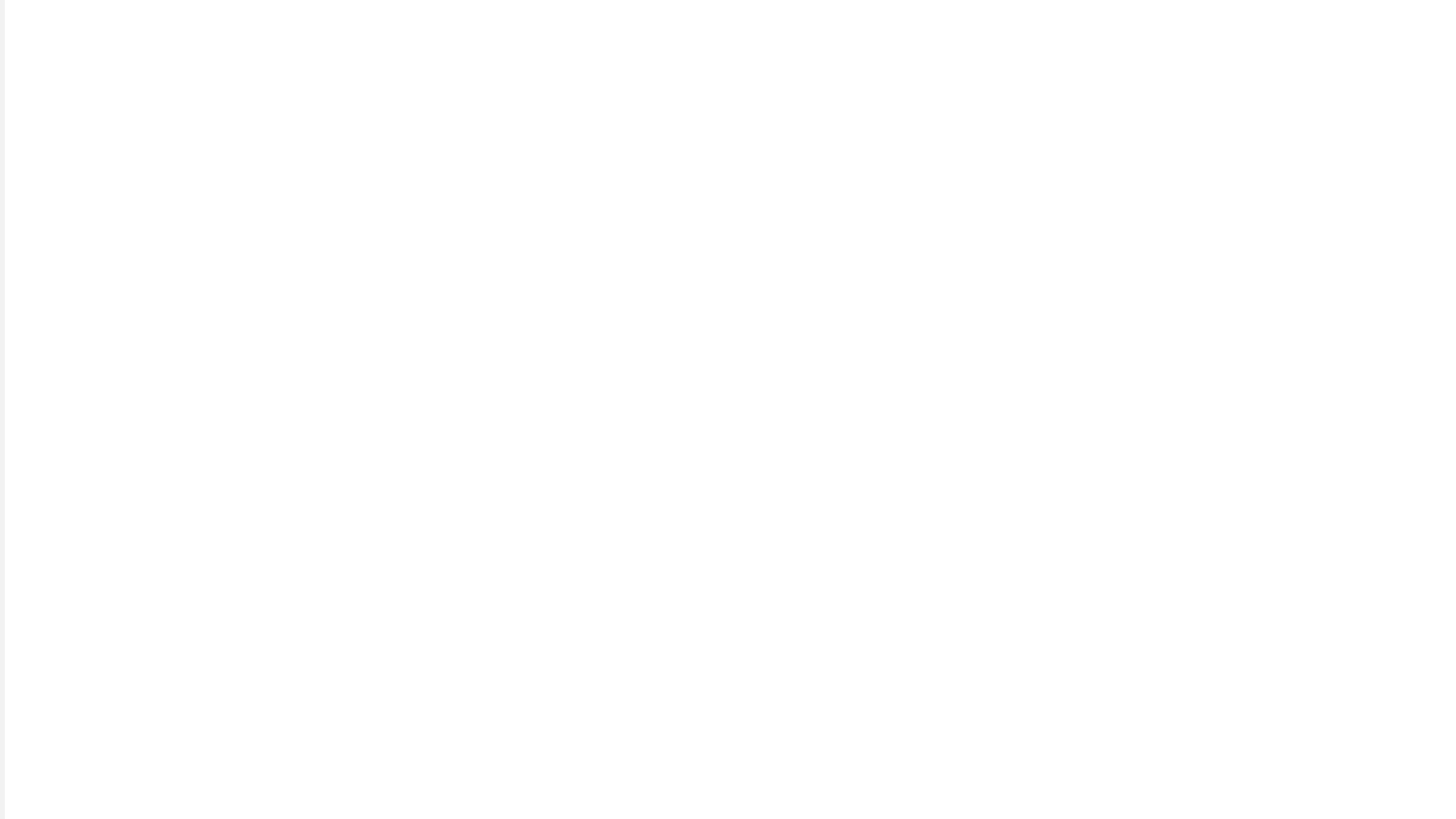
- stopsportsinjuries.com
- scottishritehospital.org/sports
- <https://www.mlb.com/pitch-smart/pitching-guidelines>
- <https://www.positivecoach.org/>
- <http://orthokids.org/>



SPORTS SPECIALIZATION



Top 10 Articles for Parents of Youth Athletes.....



Youth Athletic Conditions of the Shoulder

- Physical Exam – stick with the basics
- Imaging – consider contralateral imaging and ALWAYS request 2 views with either **scapular-Y** or **axillary views**
- Overuse Injuries – **REST**, Prevention, Physical Therapy/Proper Mechanics
- Educate athletes/parents on injury prevention strategies
- No more hours of organized sports than age of your child

Case Example

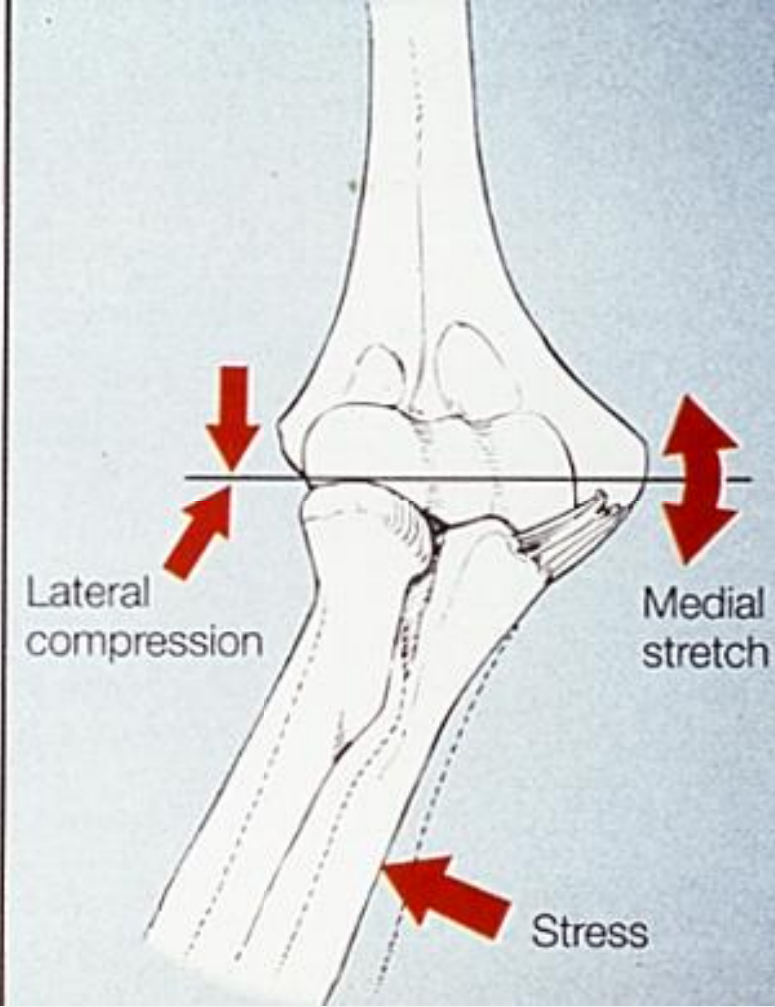
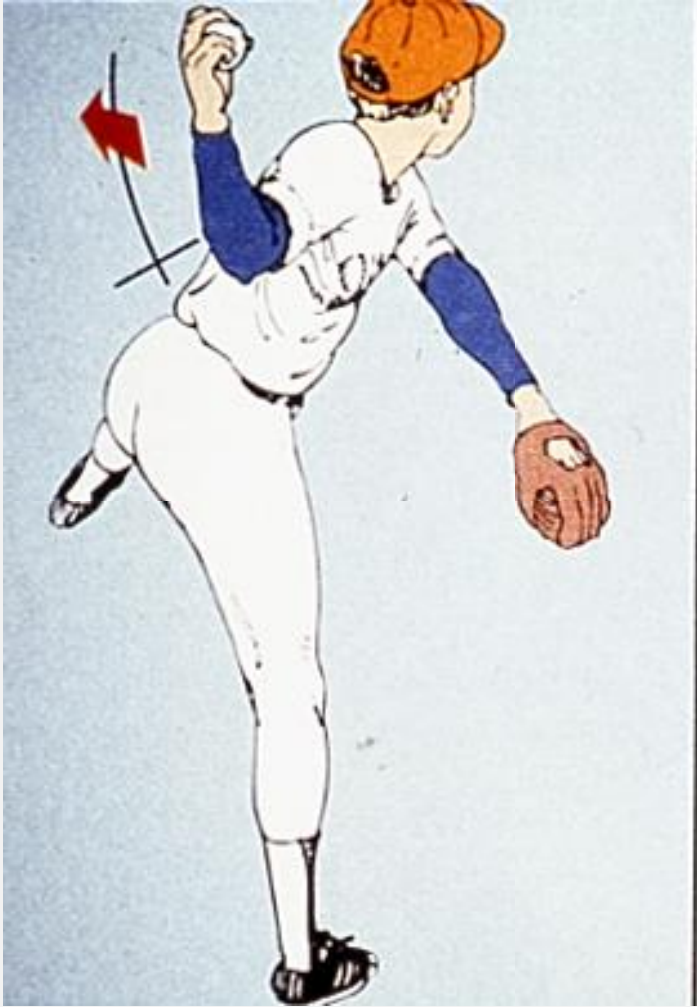
Overuse Elbow Injury: Osteochondritis Dissecans

Lexie, 11 yo Female

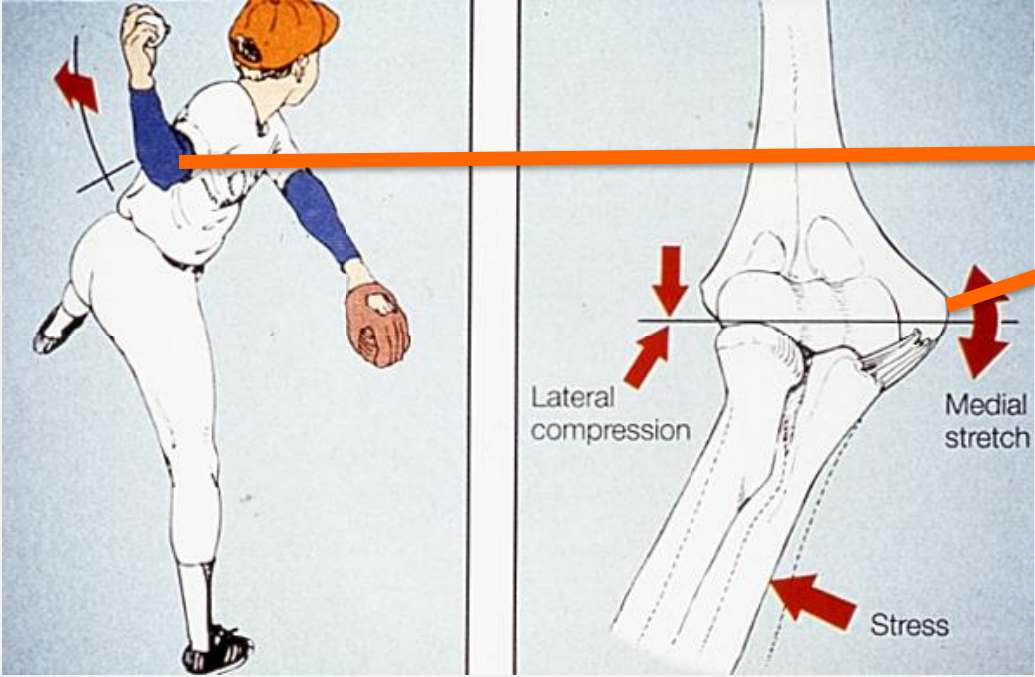
- 11+2 yo F – Level 9 gymnast
- Several month history of right elbow pain



Elbow Exam in a Throwing Athlete



Elbow Exam in a Throwing Athlete

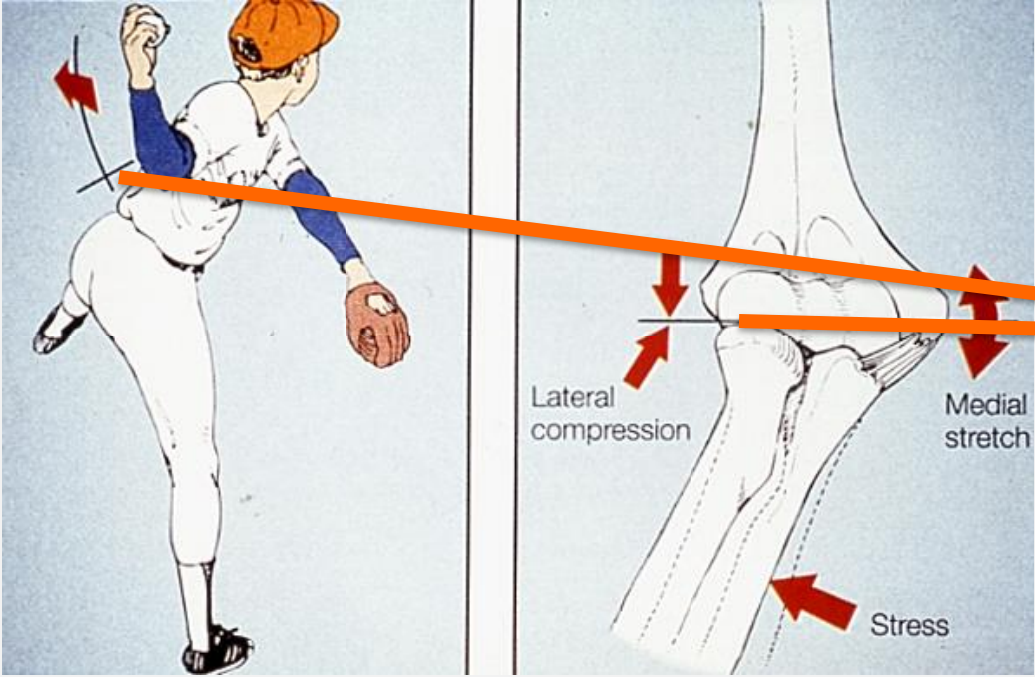


Medial Epicondylitis

Capitellar OCD

Olecranon Osteophyte

Elbow Exam in a Throwing Athlete

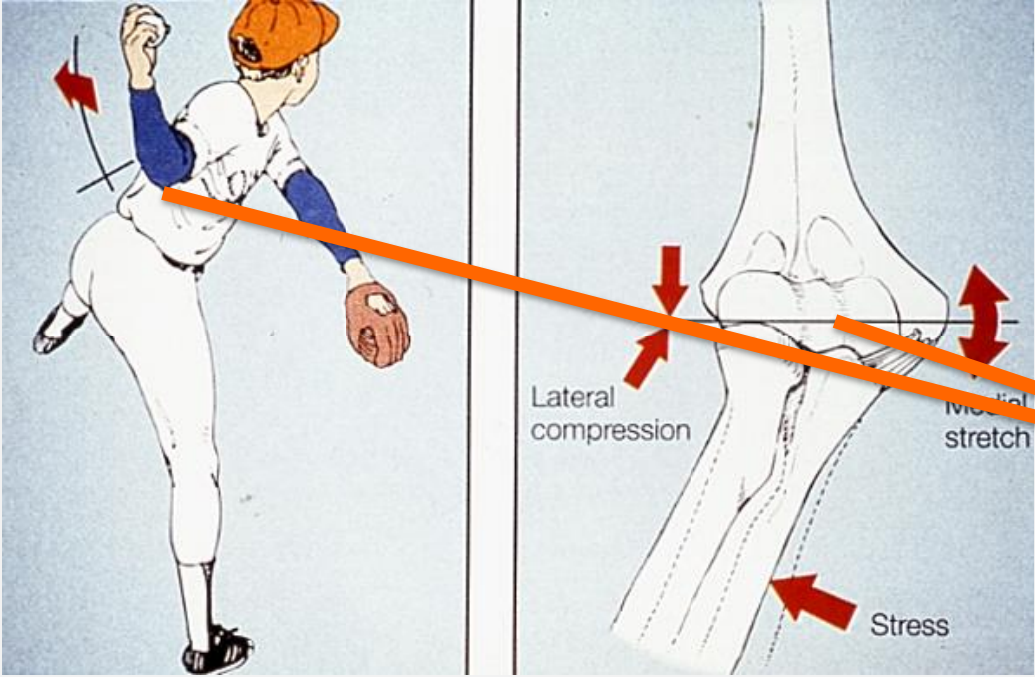


Medial
Epicondylitis

Capitellar OCD

Olecranon
Osteophyte

Elbow Exam in a Throwing Athlete



Medial Epicondylitis

Capitellar OCD

Olecranon Osteophyte

ELBOW | Common Problems in Active Youth

	Mechanism of Injury	History / Exam	Imaging	Treatment	When to Refer
Fracture/Dislocation	ACUTE – sudden injury, three mechanisms: direct trauma, avulsion, or dislocation; fall on outstretched hand	Reports elbow “popped” or buckled during a single event; restricted ROM and valgus laxity on exam; focal pain, with or without deformity; patient describes single event, swelling	XR –AP and Lat	Splint to stabilize for definitive treatment;	Refer any fracture, suspected fracture or dislocation Open fractures or visible deformity may require urgent referral to pediatric orthopedic surgeon or emergency room
Medial Epicondyle Apophysitis	OVERUSE – pain with repetitive throwing activity	Focal pain with palpation at medial epicondyle and medial flexor, loss of elbow extension. Pain with resisted wrist flexion	XR –AP, Lat, and internal oblique	Forced rest; physical therapy to focus on shoulder and elbow, pitcher require a pitch progression program prior to returning to throwing	Recurrent or persistent pain, change in appearance of medial compared to contralateral side, or any displacement
Capitellar Osteochondritis Dissecans	OVERUSE – pain with repetitive throwing or impact activity, e.g. pitching, gymnastics, throwing	Lateral mechanical symptoms, lateral dull pain that worsens with activity, popping, locking; posterior-lateral pain with palpation	XR –AP and Lat; MRI may be ordered by specialist to assist with definitive care	Forced rest in early stages, surgery often required	Any suspected
Ulnar Collateral Ligament Tear	OVERUSE or ACUTE – underlying history of overuse common, though sudden, forceful injury can occur, throwing	Medial elbow activity related pain with tenderness over medial elbow distal to medial epicondyle.	XR –AP and Lat	Majority treated with rest, activity modification, and physical therapy. Bone avulsions, acute injuries, or continued pain may require surgical treatment	Any suspected
Panner’s Disease	NOT overuse	< 10 years of age; self-limiting	XR –AP and Lat	Rest, do not immobilize	Persistent pain with rest
Olecranon Osteophytes / Impingement	OVERUSE	Posteromedial or posterolateral elbow pain with extension	XR –AP and Lat Finding: small radiographic appearance and similar to OCD of capitellum	Rest, physical therapy, may require arthroscopy	Persistent pain with rest
Olecranon Stress Fracture	OVERUSE	Vague pain moves from medial to lateral to posterior	XR – AP and Lat	Rest, pitch training, pitch counts and overuse education; may need surgical intervention	Persistent pain with rest
Synovial Impingement of the posterolateral elbow	ACUTE	Often recall a specific injury, tenderness over posterolateral elbow	XR – AP and Lat	Forced rest, mechanics training for form; physical therapy; occasional surgical resection	Refer all
Nursemaid’s Elbow	ACUTE – longitudinal distraction injury, typically in ages 2-3 y/o, not older than 7 y/o; recurrence is common	Initial pain that subsides quickly, residual pseudoparalysis, presents with forearm pronated, pain with palpation at radial head and with resistance to supination	XR – typically not needed	Non-operative reduction maneuver by trained personnel	Recurrence or assistance needed for definitive treatment

Legend: XR - X-ray; MRI - Magnetic Resonance Imaging; AP - Anterior-Posterior view; Lat - Lateral view

Note: This guide was created as a reference for primary care providers to evaluate a young athlete’s joint pain. The list is NOT inclusive. Other diagnosis including infection, neoplasia, or fractures/dislocation may also be considered.

- Imaging:
 - X-ray Elbow
 - AP and Lateral



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Differential Diagnosis

- Osteochondritis dissecans
- Medial epicondylitis
- Olecranon stress fracture
- Subluxating ulnar nerve
- Snapping triceps
- Ulnar collateral ligament tear
- Flexor-pronator tendonitis
- Little League Elbow
- Panner's Disease
- Posterolateral synovial impingement
- Fracture
 - Medial epicondyle, radial head, SCH, lateral condyle

Overuse – Elbow

Medial Epicondylitis

- AKA Little League Elbow
- Signs
 - History of repetitive throwing or tumbling
- Symptoms
 - Medial pain and loss of extension
- Diagnosis
 - Focal epicondyle and medial flexor pain
- Treatment
 - Forced rest



Overuse – Elbow

Medial Epicondylitis

- AKA Little League Elbow
- Signs
 - History of repetitive throwing
- Symptoms
 - Medial pain and loss of extension
- Diagnosis
 - Focal epicondyle and medial elbow swelling
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Differential Diagnosis

- Osteochondritis Dissecans
- Medial Epicondylitis
- **Olecranon stress fracture**
- Subluxating ulnar nerve
- Snapping triceps
- Ulnar collateral ligament tear
- Flexor-Pronator tendonitis
- Little League Elbow
- Panner's Disease
- Posterolateral Synovial Impingement
- Fracture
 - Medial epicondyle, radial head, SCH, lateral condyle



Posterolateral Synovial Impingement

- Rest, rest, rest
- Rehab & Mechanics

- Occasionally arthroscopic resection



Lexie

- 11+2 yo F – Level 9 gymnast
- Several month history of right elbow pain
- ROM: 10-135
- Tender to palpation over lateral elbow



Osteochondritis Dissecans of the Capitellum

- Commonly occurs in:
 - Pitchers
 - Gymnasts
- Presents primarily with:
 - Lateral elbow pain
 - Loss of motion
 - Occasionally mechanical symptoms



Osteochondritis Dissecans of

- Commonly occurs in:
 - Pitchers
 - Gymnasts
- Presents primarily with:
 - Lateral elbow pain
 - Loss of motion
 - Occasionally mechanical symptoms
- MRI is commonly used for treatment



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Classification



MRI

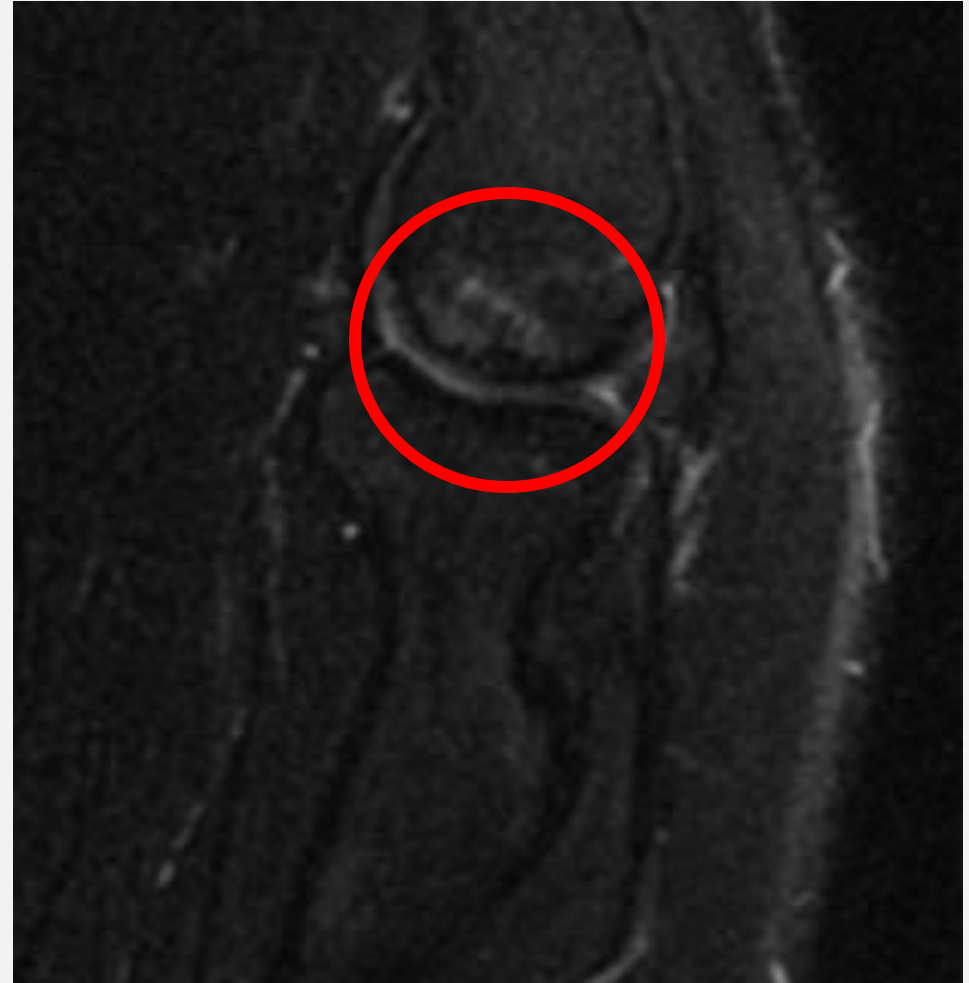
- Grade 0 – Normal
- Grade 1 – Intact cartilage with signal changes
- Grade 2 – High signal breach of cartilage
- Grade 3 – Thin rim of high signal intensity behind osteochondral fragment
- Grade 4 – Loose body

Treatment Outcomes

- Osteochondritis Dissecans of the Capitellum

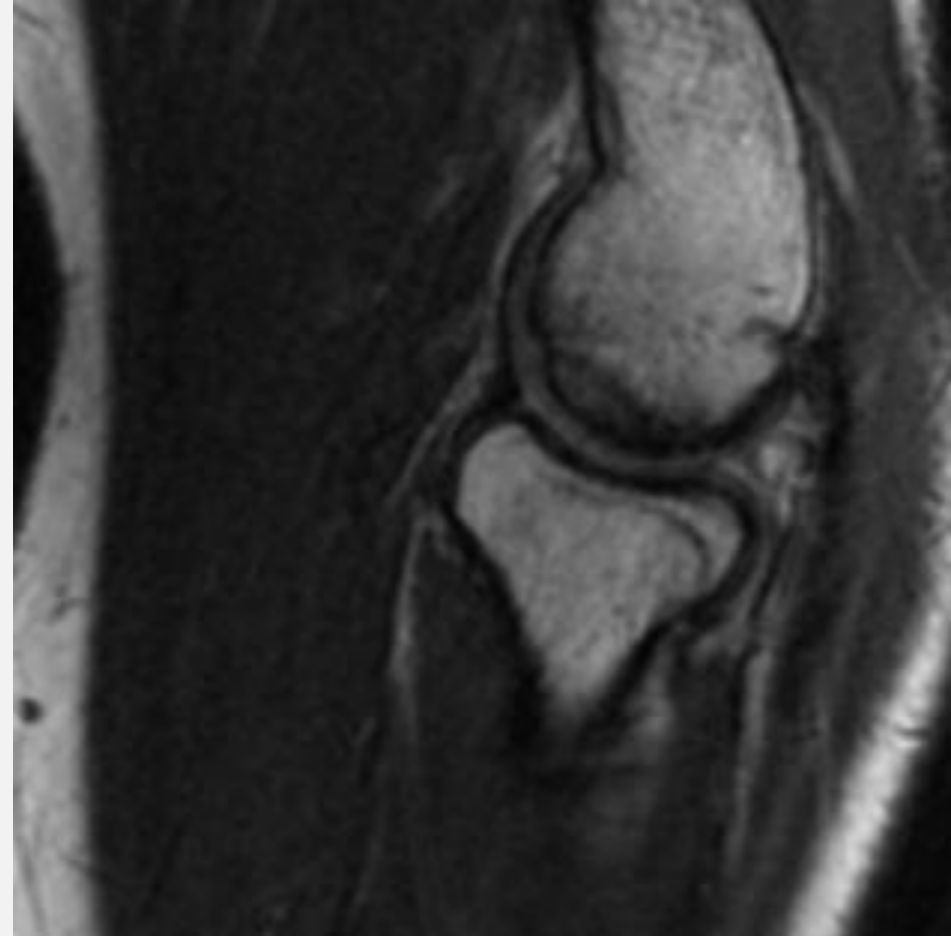
Treatment Options – Non-Operative

- Non-operative
 - Early grade, stable lesion
 - Cessation of sports for 3-6 weeks, return to sport in 3-6 months
 - Once pain subsided, strengthen and stretching exercises
- Monitored Interval Throwing Rehabilitation Program



Treatment Outcomes – Non-Operative

- Mitsunaga et al – J Trauma 1982
 - 84 patients seen during a 43 year period
 - >50% of patients had mild discomfort at 13.6 years
- Takahara – CORR 1999
 - 53 patients – average follow up of 12.6 years
 - 50% had poor outcome
 - No patient returned to previous sport
- Mihara et al – AJSM 2009
 - 39 baseball players (Mean 12.8 years)
 - 16/17 patients with open physes healed, compared to 11/22 with closed physes
 - 27/39 returned to sport

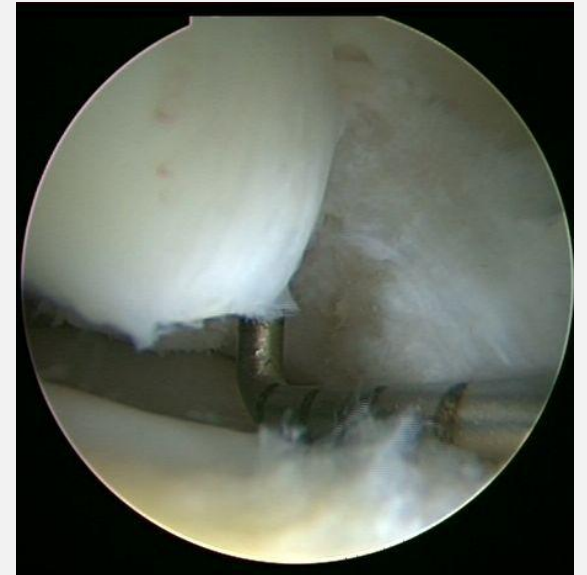
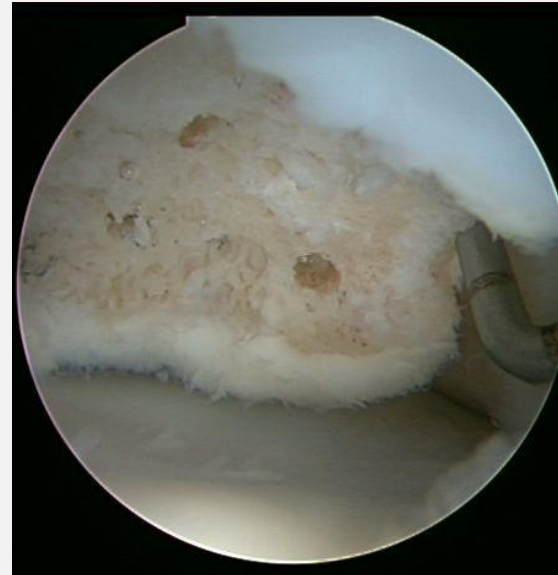
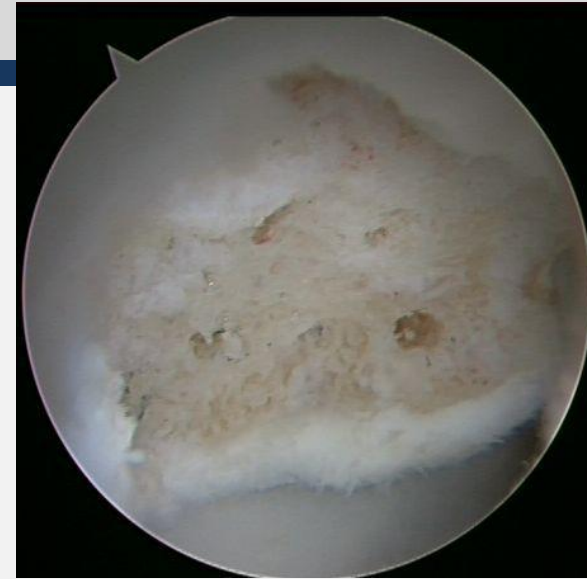
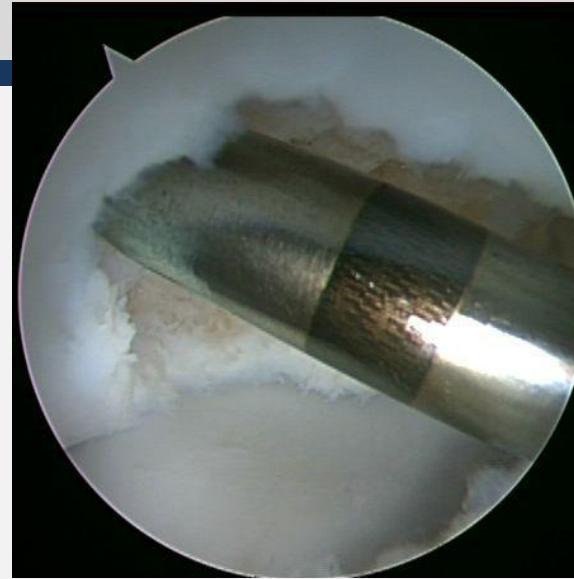


Surgical Treatment Indications

- Indications
 - Presence of loose bodies
 - Mechanical symptoms
 - Unstable lesions
 - Stable lesions that have failed 6 months of nonsurgical management

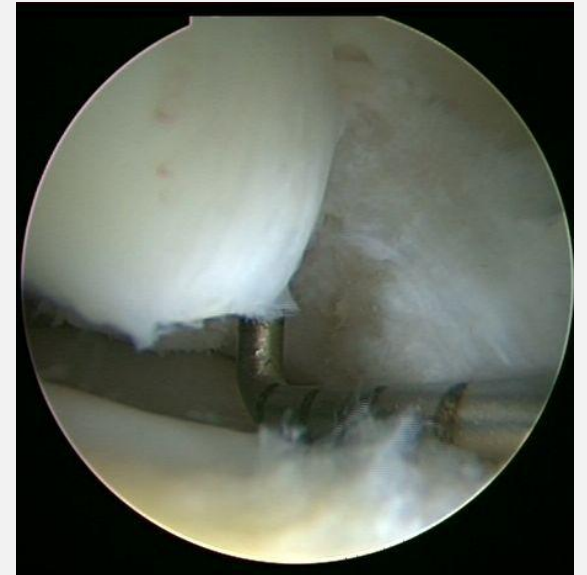
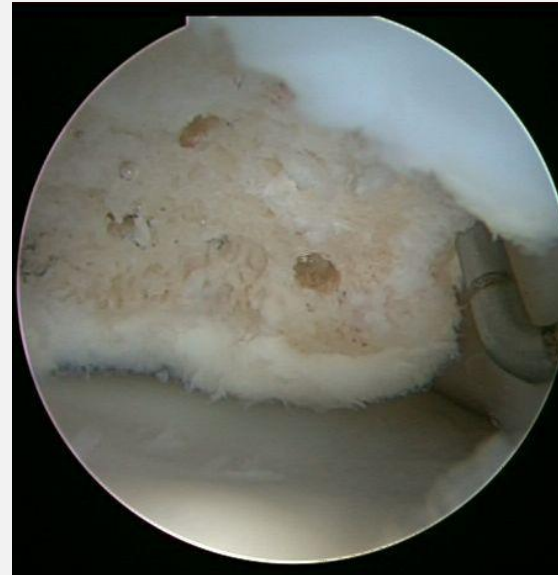
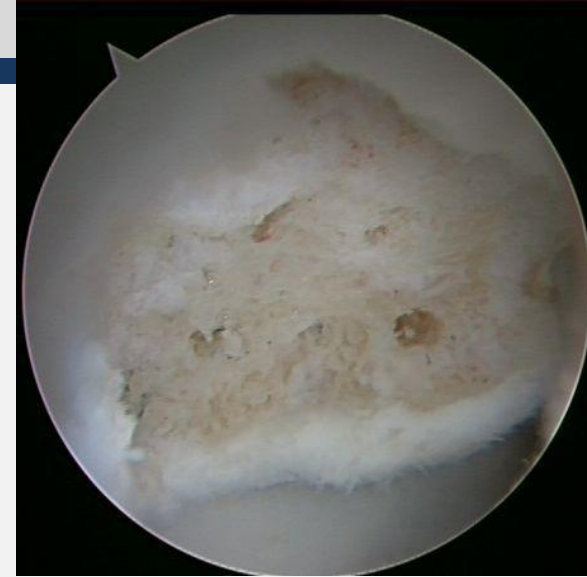
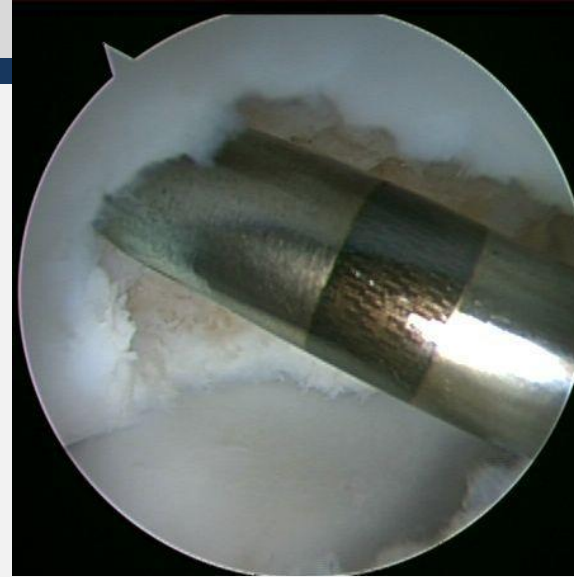
Open Debridement and Fragment Excision

- Bauer et al – CORR 1992
 - 31 patients with 23 year outcomes
 - 40% recurrence of symptoms and loss of elbow extension
 - 60% with degenerative joint disease
- Takahara et al – JBJS 2007
 - 55 patients with 9.6 year follow up
 - 35% reported moderate or severe pain, 35% reported no pain, and 30% reported mild pain
 - 50% returned to competitive sport



Open Debridement and Marrow Stimulation

- Jones, Weisel, Sankar & Ganley JPO 2012
 - N=25, average age 13.1
 - 12 require mini-arthrotomies
 - Improvement of 17 degrees of extension and 10 degrees of flexion
 - 86% Returned to participate at same level of sports
- Lewine et al JPO 2015
 - N=21
 - Nine with resolution on MRI
 - 4 Revision surgery
 - Timmerman improved 30 points
 - 57% Baseball Players & 67% of gymnast returned to their primary sports



Fragment Fixation

- Harada et al – JSES 2002
 - Staples and ICBG in 4 patients over 7.5 years
 - 100% union, full ROM and painless ADL's
 - 3 out of 4 returned to sport
- Takada et al – AJSM 2002
 - 10/11 returned to competitive pitching (treated with pullout wires)
- Kuwahata and Inoue – Orthopedics 1998
 - 7 patients treated with Herbert screws and bone graft
 - At 32 mo f/u - pain resolved in all 7, all returned to sports, and 18 degree ROM increase



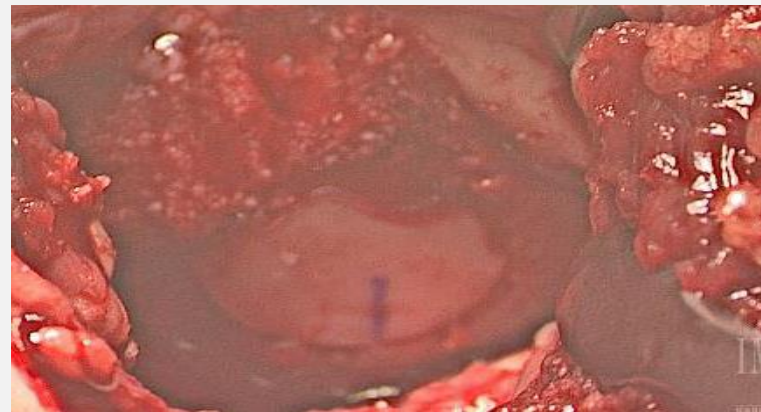
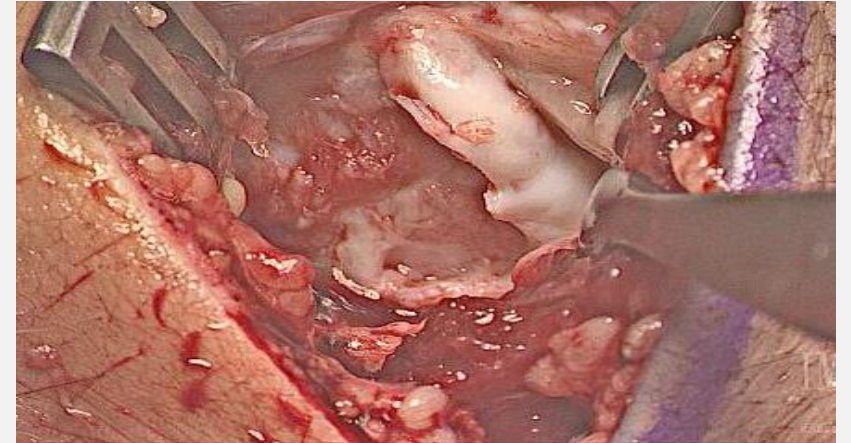
Internal Fixation of Unstable In Situ Osteochondritis Dissecans Lesions of the Capitellum

*William P. Hennrikus, BA, Patricia E. Miller, MS, Lyle J. Micheli, MD,
Peter M. Waters, MD, and Donald S. Bae, MD*

- JPO 2015
- 26 elbows – In-situ fixation of OCD of Capitellum
- 20/26 healed
 - Younger healed better (<15)
 - Smaller sagittal plane widths healed better (<13 mm)
- 66% returned to sport at prior level without elbow complaint

Surgical Treatment Options

- Osteochondral Autograft / Allograft Transplantation
 - Indications
 - ICRS grade IV
 - >50% articular surface area
 - Disruption of lateral buttress
 - Radial head engagement



Osteochondral Autograft Transplantation

- Yamamoto et al – AJSM 2006
 - 16/18 returned to sport with 3.5 year follow up
 - All patients with good to excellent outcome
- Iwasaki et al – JBJS 2009
 - 18/19 male athletes reported good to excellent results at 3.75 yr follow up
 - 17/19 returned to previous competitive level of sport
- Shimada et al – CORR 2005
 - 10 patients with 2 year follow up
 - 8/10 excellent clinical and radiologic results, 2/10 poor



Return to Sport After Operative Management of Osteochondritis Dissecans of the Capitellum

A Systematic Review and Meta-analysis

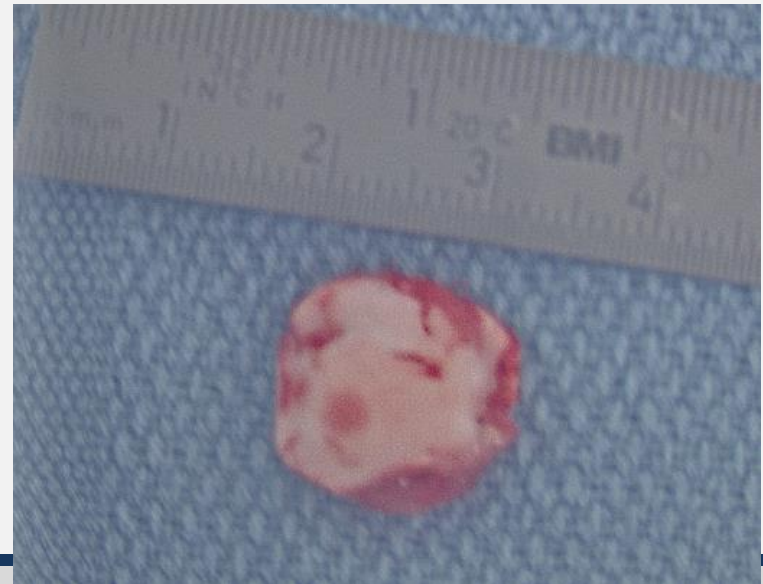
Robert W. Westermann,^{*†} MD, Kyle J. Hancock,[†] MD, Joseph A. Buckwalter,[†] MD, PhD, Benjamin Kopp,[†] BS, Natalie Glass,[†] PhD, and Brian R. Wolf,[†] MD, MS

Investigation performed at the University of Iowa, Iowa City, Iowa, USA

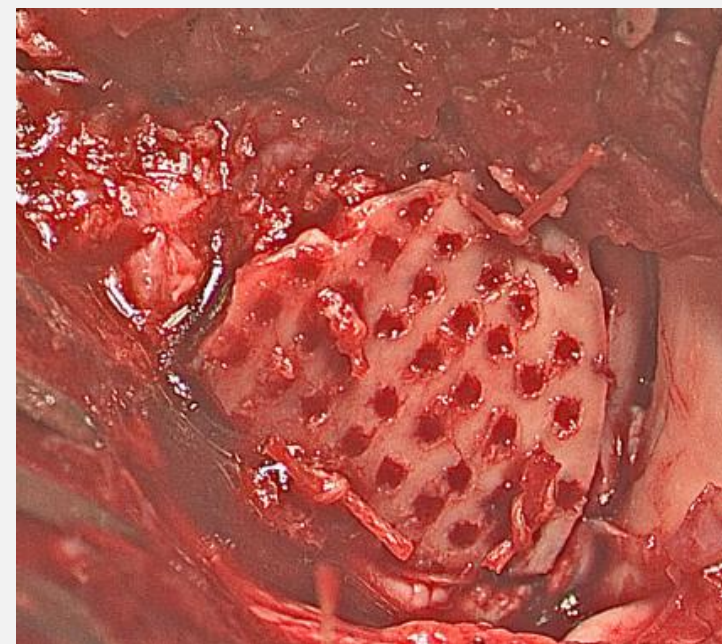
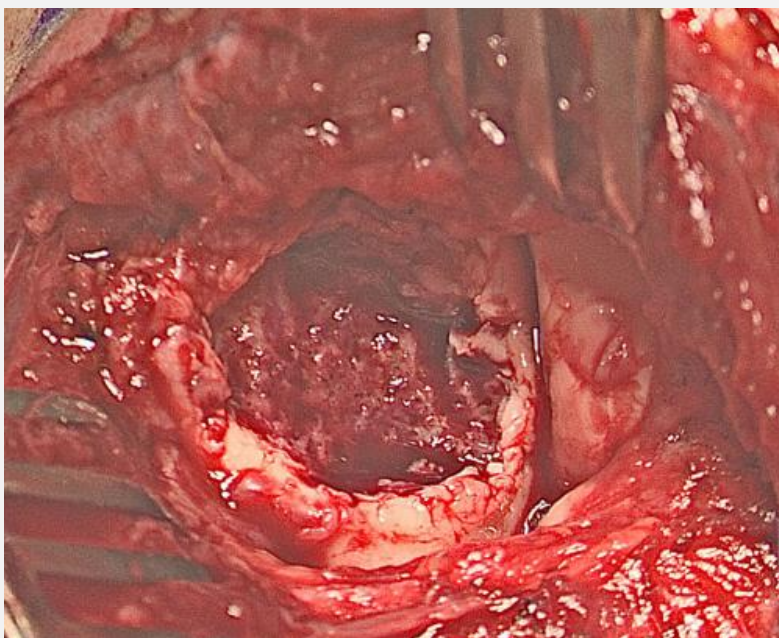
- OJSM 2016
- 24 studies – 492 patients
- 86% return to sport at 5.6 months
 - OATS was highest return to sport (94%)
 - Significantly better when compared to debridement/microfracture (71%)
 - Fracture fixation (64%)
- 15.9 degree improvement in range of motion

...now with Lexie

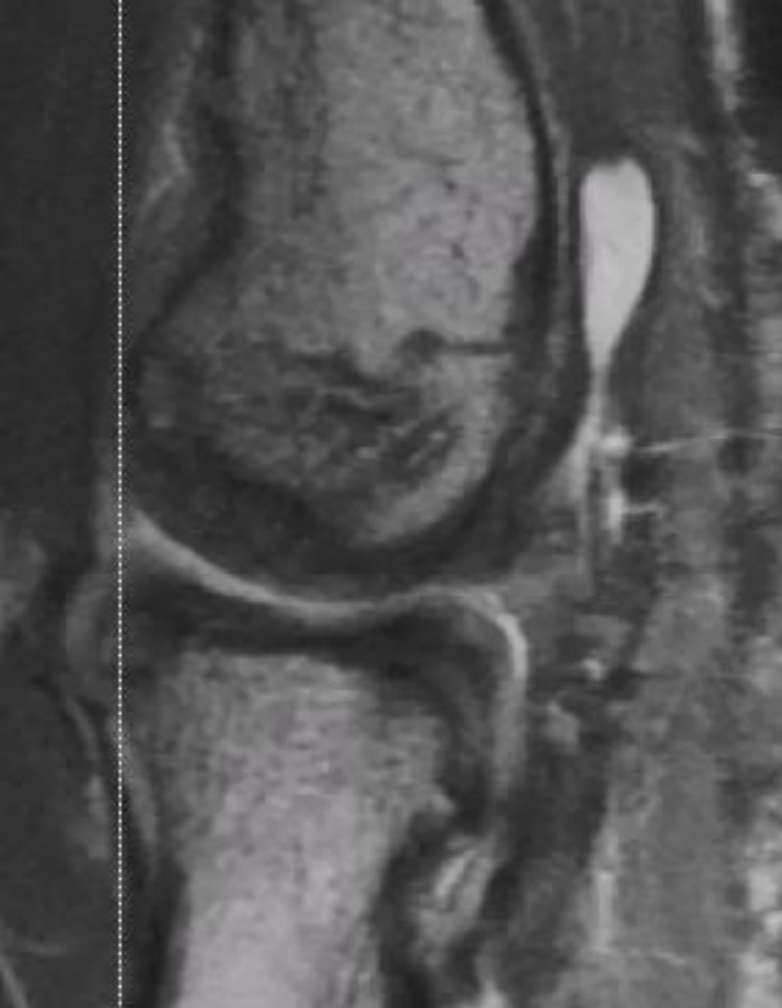
- Diagnostic scope
- OCD – undersurface was primarily cartilage with non-viable bone
 - Resection instead of fixation
- Debride to healthy bone



Lexie.....



Lexie - 1 year post-op



Elbow Summary

- Physical exam can often be the **key** to diagnosis in elbow injuries in the young athlete
- Overuse conditions can present in **multiple conditions** in the elbow
- Initial imaging of the elbow consists of an **AP and Lateral elbow**
 - Consider contralateral imaging if needed
- Treatment often times is **REST**, but may be require surgery for some conditions.



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Thank You

