

## Pediatric Musculoskeletal Development & Sports Issues

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## Objectives

- Describe conditions that predispose children and adolescents to sports injury
- Identify common injuries in the pediatric population
- Discuss risk factors and prevention strategies for sports injuries in the pediatric population.

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## Overuse Injuries

- Microtrauma to bone, muscle or tendon from repetitive stress without time to heal
  - Pain after activity
  - Pain during activity without change in performance
  - Pain with activity that restricts performance
  - Chronic pain at rest
- Year round sports participation
  - 50% of pediatric sports injuries associated with overuse
- Overtraining leads to burnout

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### Overuse Injuries

- Injuries more common during peak growth velocity
  - More likely if underlying biomechanical problem
- Sound training regimen
  - Maximum of 5 days a week
  - At least 1 day off from organized activity
  - 2-3 months off per year
  - Cross-training in off season and with overuse injury

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### Overuse Injuries

- Preventing burnout
  - Age-appropriate games- should be fun
  - 1-2 days off from organized sports each week
  - Longer breaks every 2-3 months
    - Cross-train to maintain conditioning
  - Focus on wellness
    - Listen to body for cues to slow down or alter training

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### Overuse Injuries

- Endurance events
  - Shorter in duration/length
  - Careful attention to safety and environmental conditions
    - Hypothermia
    - Hyperthermia
      - Child less able to handle heat stress
  - Gradual increase in time/mileage
    - 10% weekly

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### Overuse Injuries

- Year-round training and multiple teams
  - Focus on one sport or early specialization
    - Becoming more common
  - One or more teams simultaneously
- Motivation for over involvement
  - Meeting needs of child or parent?
    - College scholarship or Olympic team
  - Less than 0.5% of high school athletes make it to professional level
- Athletes who participate in a variety of sports
  - Have fewer injuries
  - Play sports longer than those who specialize before puberty

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### Overuse Injuries

- Guidance
  - Assess and identify child's motivation
  - 1-2 days off per week
  - 2-3 months off per year
  - Emphasize fun, skill acquisition and safety
  - One team per season
    - If two, keep training with guidelines above
  - Be alert for symptoms of burnout
    - Nonspecific complaints, fatigue, poor academic performance

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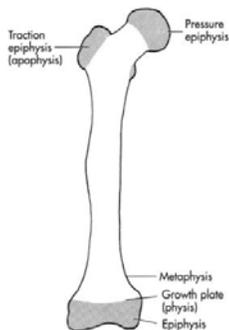
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### Growing Bone

- May be tremendous ally in treatment.
  - Splinting dysplastic hip in newborn will result in normal joint that functions for a lifetime.
  - Angular deformities from fracture completely remodel allowing for nonoperative treatment.
- May also exacerbate deformity.
  - Damage to physis may lead to progressive angulation or shortening of limb.




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## Sports Injuries

- Traction apophysitis
  - Overuse injury that occurs in growing child
    - Tendon pulls on area of growing bone
    - Children and teens seldom get tendonitis
  - Repetitive stress and microtrauma
    - Elbow- little leaguer elbow
    - Proximal tibia- Osgood-Schlatter disease
    - Calcaneous- sever disease
  - Pelvis



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## Little Leaguer Elbow

- Traction apophysitis of the medial epicondyle or olecranon
  - Skeletally immature throwing athlete
- Medial epicondyle or olecranon avulsion
  - Older child closer to maturity (12-14)
- Ulnar collateral ligament sprain or tear
- Compression injuries
  - Osteochondritis dissecans
    - 12 and older after capitellum has ossified



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## Little Leaguer Elbow

- History
  - History of overuse
    - Number of pitches, innings, year round participation
    - Premature use of curveball
    - Mechanical symptoms if loose body
- Pain is most common symptom and may be loss of extension in later stages of OCD
  - Medial in apophysitis, avulsion & UCL injury
  - Lateral in OCD and Panner disease
  - Posterior in olecranon apophysitis/avulsion

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### Little Leaguer Elbow

- Radiographs help establish diagnosis
  - Contralateral views helpful
- MRI may be needed
  - OCD, Panner disease, UCL injuries
- Treatment
  - Rest from throwing for 3-6 months or longer
  - PT to maintain strength and restore motion
  - Avoid immobilization beyond acute phase
  - Surgery for fixation, microfracture or excision of loose body

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### Cuff & Deltoid Strength

- Patient holds arms out from sides horizontally and tries to lift them
- Normal findings
  - Strength should be equal in both arms, and deltoid muscles should be equal in size
- Common abnormalities
  - Loss of strength and wasting of the deltoid muscle

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### Shoulder Range of Motion

- Arms out from sides with elbows bent at 90 degrees; Patient raises hands vertically
- Normal findings
  - Hands go back equally and at least to vertical position
- Common abnormalities
  - Loss of external rotation, which may indicate shoulder problem or history of dislocation

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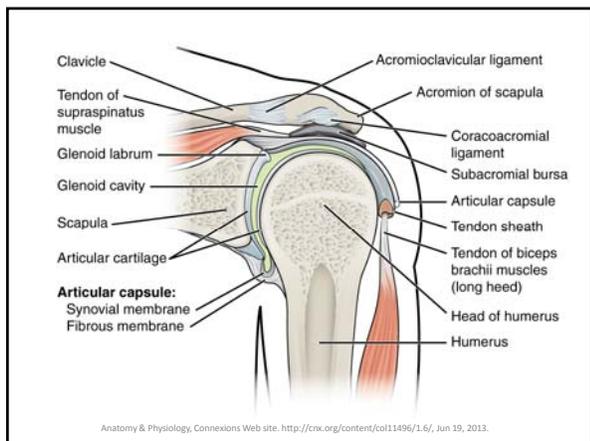
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### Age Is Key Variable

- Younger than 30 likely to report symptoms of instability from dislocation/subluxation of glenohumeral joint or AC joint
- Middle-aged (30-50) more commonly report impingement. Frozen shoulder may occur in diabetics and thin females in this age group
- Older than 50 more likely to have RCT, DJD or frozen shoulder

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### Glenohumeral Instability

- 50% of all major dislocations
  - Anterior 95%
    - Direct blow to externally rotated, abducted humerus
    - Fall on outstretched arm
  - Posterior 2-4%
  - Inferior (luxatio erecta) 0.5%
- Age at initial dislocation is prognostic
  - Recurrence of 55% in those 12-22 years
  - 37% in those 23-39 years
  - 12% at 30-40 years

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### Glenohumeral Instability

- Physical exam
  - Apprehension test
    - Anterior instability
  - Reduction sign
  - Sulcus sign
    - Inferior instability
  - Sensorimotor
    - Sensation over deltoid/fire deltoid
  - Generalized ligamentous laxity
    - “Double jointed”

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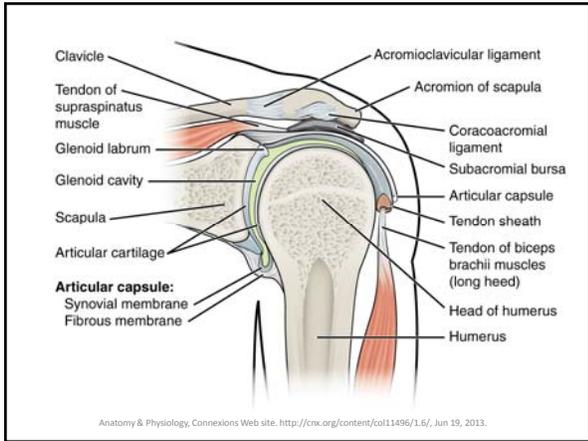
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### Throwing Athlete

- Tremendous kinetic energy through shoulder
  - Proper wind up and follow through is critical
- Anterior shoulder pain
  - Impingement
  - Subtle instability
    - May be primary instability with secondary impingement
- Aggressive rehab
  - Relative rest, selective stretching, strengthening of cuff and scapular stabilizers

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### Glenohumeral Instability

- Most commonly dislocated joint
- Age at initial dislocation is prognostic
  - Recurrence rates of 55% in 12-22 years
  - 37% in those 23-29 years
  - 12% at 30-40 years
- Fall on flexed elbow with adducted arm or by direct axial load to externally rotated humerus
- Traumatic dislocation more common in adolescent than in pediatric population
  - Consider ligamentous laxity if unstable in peds patient

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### Acromioclavicular Injuries

- AC separation
  - Fall onto tip of shoulder (acromion)
  - Classified as to degree of separation I-VI
    - Low grade treated with sling
    - High grade dislocations may need repair
      - Obvious deformity and instability
  - Tender over AC joint and pain with adduction

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### Acromioclavicular Injuries

- Radiographs
  - AP views of both shoulders
    - Stress views *may* be helpful to differentiate incomplete vs complete disruption
  - Low grade separation (subluxation) show little or no displacement
  - Grade III and higher injuries show increased distance between acromion and clavicle and between clavicle and coracoid

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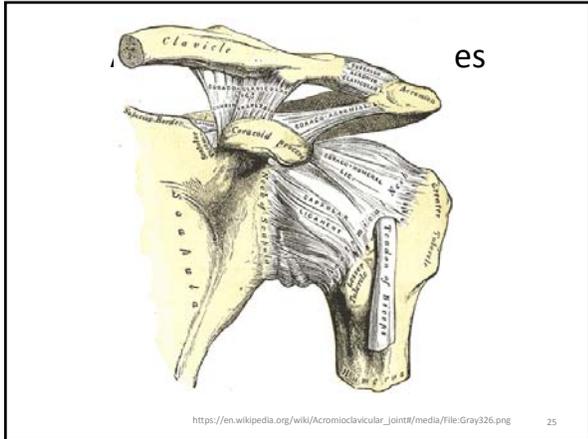
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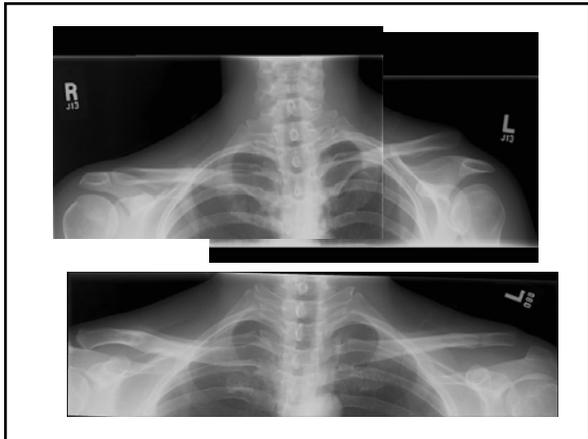
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**Acromioclavicular Injuries**

- Treatment
  - Low grade injury
    - Sling for few days only
  - High grade injury
    - Require surgical repair
    - Grade III injury may be treated conservatively in the low demand individual

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### Scoliosis

- Lateral curvature of the spine of  $> 10^\circ$ 
  - Small curves are not scoliosis
- Thoracic or lumbar spine (occasionally both)
  - Associated vertebral rotation with kyphosis or lordosis
- May be congenital
  - Vertebral anomalies
- Commonly idiopathic
- May be secondary to other disorder
  - Cerebral palsy
  - Muscular dystrophy
  - Myelomeningocele

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### Idiopathic Scoliosis

- Develops in early adolescence
  - Male = female in curves  $< 10^\circ$
  - Female 7X more likely to have significant, progressive curve requiring treatment
  - Progression typically girls at age 10-16 years
  - Not associated with pain
    - Pain suggests primary condition and requires further evaluation

Curve size	Girls:Boys
6-10°	1:1
11-20°	1.4:1
>21°	5.4:1

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### Scoliosis

- Physical exam
  - Forward bending test
    - Observe from behind
    - Elevation of rib cage, scapula or paravertebral muscle mass positive finding
  - Also assess
    - Skin
    - Leg length
    - Feet alignment
    - Neuromuscular status
  - Beware
    - Left side thoracic curves have high incidence of spinal cord abnormalities

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## Scoliosis



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## Is there a curve?



Dr. Richard Henderson, Chapel Hill, NC, 2010

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Dr. Richard Henderson, Chapel Hill, NC, 2010

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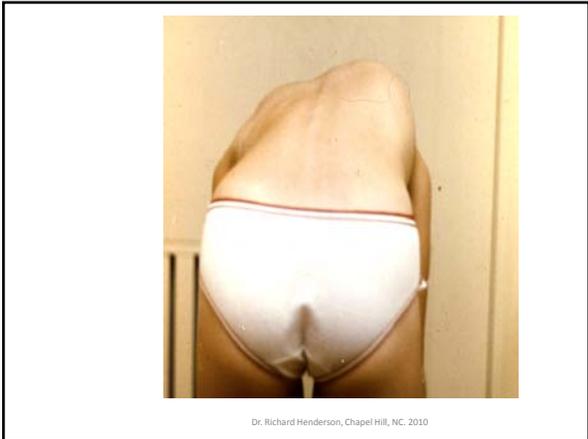
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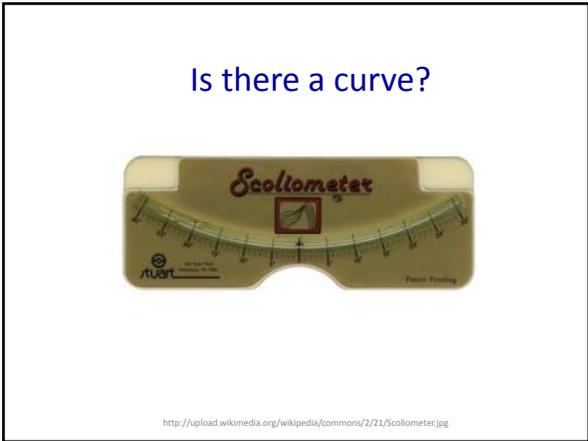
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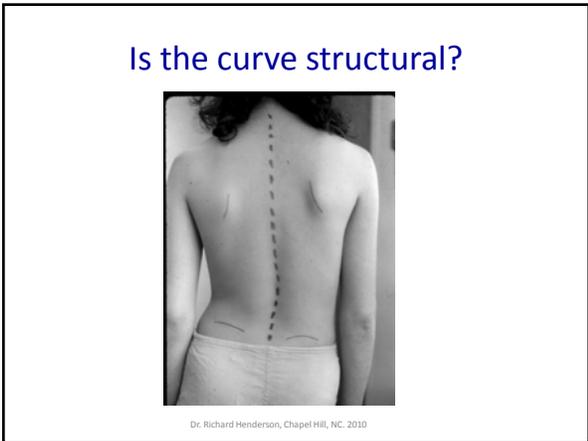
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### Is the curve structural?



- Postural curves
  - Pain
  - Leg length inequality
  - Behavioral

Dr. Richard Henderson, Chapel Hill, NC. 2010

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### Is the Curve Idiopathic?

- Congenital
  - Vertebral anomalies
- Neuromuscular
  - Cerebral palsy
  - Myelomeningocele
  - Muscular dystrophy
  - Polio
- Miscellaneous
  - Post surgical
  - Marfan syndrome
  - Trauma

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### Beware!

- Unusual curves
  - Left thoracic curves
- Unusual symptoms
  - Significant pain
  - Radiculopathy
- Unusual findings
  - Neurologic deficit
  - Skin changes
  - Hair patches
  - Asymmetry of lower extremities

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## Slipped Capital Femoral Epiphysis

- SCFE
  - Sudden or gradual displacement of femoral head through physis.
  - Typically during adolescent growth spurt.
- Predisposing factors
  - Obesity
  - Male gender
  - Sports
  - Femoral retroversion
  - Hypothyroidism and growth hormone deficiency



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## Slipped Capital Femoral Epiphysis

- Mean age at presentation
  - 12 years for girls (range:10-14 years)
  - 13 years for boys (range: 11-16 years)
  - Onset before or after typical range is associated with endocrinopathy.
- Bilateral involvement seen in 40-50%
  - Not always affected simultaneously
- May be acute or chronic
  - Early detection and treatment imperative

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## Slipped Capital Femoral Epiphysis

- Symptoms
  - Pain worse with activity
    - Localized to anterior thigh or knee.
  - May be unable to bear weight
- Exam
  - Loss of hip internal rotation
    - Further reduction of internal rotation with hip flexion.
      - Loss of internal rotation when hip is flexed to 90°
        - » Slip is always posterior and often medial
  - Loss of abduction and extension
  - Affected extremity usually shorter by 1-3 cm

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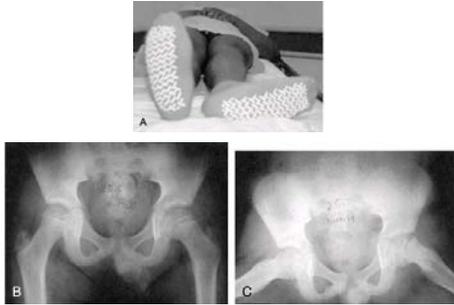
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### Slipped Capital Femoral Epiphysis



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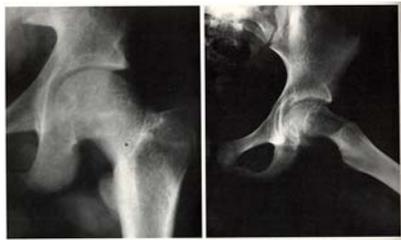
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### Slipped Capital Femoral Epiphysis



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### Slipped Capital Femoral Epiphysis

- Diagnostic tests
  - AP and frog-leg lateral radiographs of pelvis
  - AP view may appear normal
- Severity important in treatment and prognosis
- Severity is estimated by the percentage of femoral neck left exposed:
  - Mild- less than 25%
  - Moderate- 25-50% is moderate
  - Severe- more than 50%

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### Slipped Capital Femoral Epiphysis

- Treatment
  - In situ stabilization
    - Pin in current position to prevent progression.
  - If unstable may require urgent ORIF
  - Severe deformity may require realignment osteotomy.
    - Chronic painful limp despite treatment

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### Female Athletes

- Desire to change weight
- Menarche, menstrual regularity and LMP
  - Eating disorders and amenorrhea
    - Osteopenia and osteoporosis
- Sudden cardiac death less likely in females
- Females more likely
  - Patellofemoral syndrome, foot disorders, stress fractures, ACL rupture

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### Case #1

- 16 year old female with acute onset knee pain while playing basketball today
- Pain and immediate swelling after coming down from rebound
- Unable to bear weight
- Felt a pop at the time of injury

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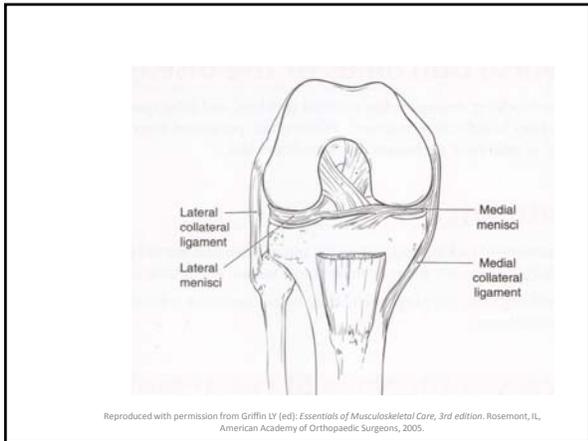
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### Case #1

- Exam
  - Large effusion
  - Anterior drawer (knee flexed at 90°) negative
  - Anterior translation of tibia in relation to femur

[https://en.wikipedia.org/wiki/Lachman\\_test#/media/File:ACL\\_17.jpg](https://en.wikipedia.org/wiki/Lachman_test#/media/File:ACL_17.jpg)

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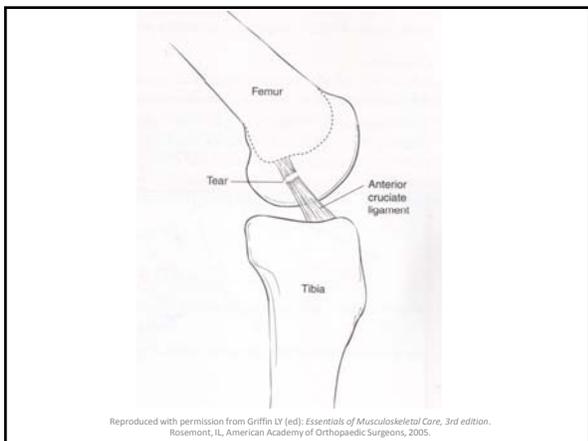
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Anterior Cruciate Ligament Tear

- Primary anterior and rotational stabilizer
- May be other associated injuries
- Typically non-contact deceleration injury
- One third to 1/2 report a “pop” & immediate effusion
- Painful ROM and inability to bear weight

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Anterior Cruciate Ligament Tear

- Diagnostic tests
  - Plain films may show avulsion of tibial insertion but usually normal
  - MRI shows discontinuity of ligament
  - Arthrocentesis
    - Can be performed to relieve pain and assess hemarthrosis
    - Fat globules in aspirate suggest fracture
    - Blood may clot after 24 hours making aspiration difficult

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Anterior Cruciate Ligament Tear

- Treatment
  - Varies according to age, activity level and associated injuries
  - Initial TX should include PRICE followed by WBAT, ROM and isometric quad exercises
  - Re-examination 10-14 days post injury
  - Rehab and functional bracing less favorable in young, active patient
  - ACL reconstruction
- Prevention with proper training

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### Case #2

- 15 year old male with medial knee pain and occasional clicking
- Most often with “plant and pivot” activity
- Symptoms are intermittent
- Knee “gives out”
- Knee swells after clicking or buckling
- Effusion improves with NSAIDs

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### Case #2

- Clinical symptoms
  - Minimal or no trauma
  - Gradual onset of effusion and stiffness
  - Mechanical symptoms
  - Reports of instability
- Exam
  - Small to moderate effusion
  - Medial joint line tenderness
  - Pain with full flexion and extension
  - Pain and popping on McMurray test

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### Meniscal Tear

- Treatment
  - PRICE
  - Course of NSAIDs at anti-inflammatory dose
  - Gradual return to activity
  - Recurrent catching, popping, locking will likely require surgical debriement
    - May consider injection in older patient
- Imaging
  - Wt bearing films with notch and sunrise views
  - MRI
- Arthroscopy for partial menisectomy vs repair

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### Case #3

- 12 year old male with knee pain after collision on soccer field
- Knee forced into valgus
- Edema over several hours after the injury
- Pain with weight bearing
- Unable to fully flex knee

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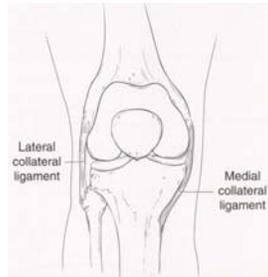
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### Collateral Ligament Tear

- Traumatic partial or complete tear
- May occur with meniscal, ACL, PCL tears



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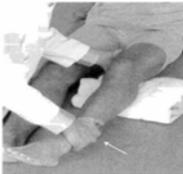
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### Collateral Ligament Tear

Tendon may be tender along entire course

- Apply varus stress
- Apply valgus stress
- Classification based on amount of joint space opening under stress



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### Collateral Ligament Tear

- Treatment
  - Typically conservative for isolated tears
    - Must rule out ACL, PCL and meniscal tears
  - PRICE
    - Hinged brace in higher grade tears
      - Weight bearing as tolerated with crutches
  - Analgesia with acetaminophen or tramadol
    - NSAIDS probably OK
  - PT includes early ROM, quad strength and gait training
  - Surgical repair if other ligaments torn

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### Patella/quadriceps tendonopathy

- Common in adolescent athlete
  - Sinding-Larsen-Johansson Disease in preadolescents
- Overuse or overload syndrome
- Associated with jumping sports
- May occur with erratic exercise habits
- Weight gain may play role
- Anterior knee pain
- Pain with sitting, squatting or kneeling
- Climbing stairs often increases pain

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### Patella/quadriceps tendonopathy

- Exam
  - Tender at inferior or superior patella pole
  - May be mild edema
    - No joint effusion
  - Fullness of infrapatellar bursa
  - AROM is normal but painful
  - Quadriceps atrophy if longstanding condition
  - Rule out other soft tissue conditions

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### Patella/quadriceps tendonopathy

- Treatment is primarily symptomatic
  - Period of rest
    - Few days to a few weeks
    - Consider brief immobilization
  - Analgesia with acetaminophen or tramadol
  - PT with focus on ROM, extensor stretching and quadriceps strength
    - Ultrasound or iontophoresis may help
  - Knee sleeve with patella cutout or patella tendon strap

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### Sever Disease/Calcaneal Apophysitis

- Repetitive stress and micro trauma
- Posterior heel pain and may have limp
- Apophysis closes
  - 9 years in female
  - 11 years in male
- Tenderness on heel squeeze
- Radiographs not diagnostic
  - Irregularity and sclerosis are normal



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### Sever Disease/Calcaneal Apophysitis

- Differential Diagnoses
  - Achilles tendinopathy
    - Can be associated with reactive arthritis or seronegative spondyloarthropathies
  - Infection
    - Likely unilateral, local swelling, elevated ESR
  - Tumor
    - Likely unilateral, local swelling, night pain

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### Sever Disease/Calcaneal Apophysitis

- Treatment
  - Activity modification
  - Heel lift (short term)
  - Achilles stretching
  - Ice after activity
  - Casting if severe
  - Consider infection or neoplastic disease if recalcitrant

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### Ankle Sprain

- More than 25,000 sprains daily
- Residual symptoms in nearly 40%
- Lateral ligaments most often affected
  - Inversion injury
  - Tibiofibular syndesmosis injury in “high” ankle sprain
- Subtalar joint may also be injured
  - Interosseous ligament tear
- Medial deltoid injury may also occur
  - Less common
  - Typically associated with eversion injury

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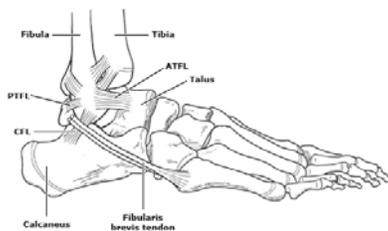
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### Ankle Ligaments



Maughan, M. Ankle sprain. In: UpToDate, Patrice, E. (Ed). UpToDate, Waltham, MA, 2015

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### Ankle Sprain

- Clinical symptoms
  - Pain over injured structures
  - Swelling
  - Loss of function
  - May report a “pop” in severe sprain
    - Followed by immediate swelling and inability to bear weight
  - May report history of previous sprain

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### Ankle Sprain

- Exam
  - Circumferential ecchymosis and swelling
  - Tenderness of affected structures
    - Palpate medial and lateral malleoli, base of 5<sup>th</sup> metatarsal and navicular
  - Special tests
    - Anterior drawer

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### Ankle Sprain

- Special tests
  - Squeeze test
    - Compress tibia and fibula at midcalf
  - External rotation test
    - Dorsiflex ankle and externally rotate foot
  - Positive test results in pain at distal tibiofibular syndesmosis
- Subtalar joint injury may show tenderness and ecchymosis of medial hindfoot

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### Ottawa Rules

- Tenderness at distal fibula or tibia
- Tenderness at 5<sup>th</sup> MT base or navicular
- Inability to bear wt. immediately and in clinic

Maughan, M. Ankle sprain. In: UpToDate, Patrice, E. (Ed), UpToDate, Waltham, MA, 2015

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### Ankle Sprain

- Differential Diagnosis
  - Fracture of distal fibula, base of 5<sup>th</sup> metatarsal, medial malleolus, calcaneus, talus (tender over structure, apparent on radiograph)
  - Proximal fibula fracture (Maisonneuve- proximal fibula, deltoid TTP and positive squeeze test)
  - Peroneal tendon tear or subluxation (muscle weakness on eversion, may report repeated popping)
  - Osteochondral fracture of talar dome (evident on radiographs, MRI or bone scan)

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### Ankle Sprain

- Treatment
  - Analgesia with acetaminophen or tramadol
  - PRICE with vigorous elevation (toes above nose)
  - Consider cast or cast boot for 2 weeks if severe
  - WBAT (crutches as needed for a few days)
  - Home therapy program
    - Range of motion
    - Stretching exercises after 2 weeks
    - Strengthening and proprioception exercises
  - Stirrup splint for 6 weeks or more
  - Formal physical therapy!
    - Chronic instability common after incomplete rehab

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## References/Resources

- American Academy of Family Physicians, American Academy of Pediatrics, American College of Sports Medicine. Preparticipation Physical Evaluation, 4th ed, Bernhardt D, Roberts W (Eds), American Academy of Pediatrics, Elk Grove Village, IL 2010.
- Standardized preparticipation athletic evaluation form can be downloaded from the American Academy of Pediatrics <http://www.aap.org/en-us/professional-resources/practice-support/Pages/Preparticipation-Physical-Evaluation-Forms.aspx>
- Gomez JE, Landry GL, Bernhardt DT. Critical evaluation of the 2-minute orthopedic screening examination. *Am J Dis Child* 1993; 147:1109.
- Goldberg, C. (2009). A practical guide to clinical medicine. University of California San Diego. Retrieved from <http://meded.ucsd.edu/clinicalmed/joints.htm#MCL>
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