OBJECTIVES

- Review the most common and life threatening challenges in pediatric orthopedics.
- Discuss the assessment and diagnostic approach for challenging cases.
- Describe case examples of things not to miss.
Overall incidence of fractures is increasing

50% of children will break at least one bone during childhood

Most common diagnosis involved in malpractice claims in ages 3-17
WHO's GETTING HURT?

- Boys
- Aged 12-15 years
- Overweight children
- Daredevils
- Milk avoiders
- Medications
- Genetics
Children are not little adults
.. Or are they ??
Pediatrics / Adults

- Thicker periosteum
- More vascularized periosteum
- Greater ability for remodeling
- More pliable
- Presence of physes and ossification centers
Comparative views
Fractures of Childhood
Greenstick Fractures

- Most common fracture pattern
  - Up to 50% of fractures before age 12 years
  - Incomplete fracture at metaphyseal-diaphyseal junction
    - Cortex remains intact on one side
    - May require completing the fracture to obtain closed reduction
  - Angulation and rotation are common
Bowing Fracture

- Occurs in young children
- Microfractures not visible except with bowing deformity
- Comparison views helpful
- Consult ortho for operative reduction
Torus Fracture,, Buckling

- Occur in metaphyseal region from compressive load
- As child grows metaphysis strengthens
Classic Greenstick Fracture of Ulna

Management:
Closed reduction - complete the fracture and immobilize

http://www.medcyclopaedia.com/
 PHYSEAL INJURIES, SALTER Fractures

- Fracture through the physis

- 5 Types:
  - I Split
  - II Above
  - III Lower
  - IV Through
  - V Ruin/crush
Salter I

- **SPLIT**
  - Fracture through the physis
  - No growth arrest
**Salter II**

- **ABOVE**
- Most common of Salter type fractures
- Fracture through the physis which extends into the metaphysis
- Growth arrest unlikely
Salter III

- **BELOW**
- Fracture through the physis and epiphysis
- Growth arrest unlikely
Salter IV

- THROUGH
- Fracture through the metaphysis and epiphysis
- May result in deformity
- Growth arrest +/-
Salter V

- **CRUSH/RUIN**
  - Least common of all Salter fractures
  - Crush injury to physis
  - +Growth arrest
  - Poor functional prognosis
PHYSEAL INJURIES, SALTER Fractures

- History and physical very important
  - FOOSH, ab/adduction
  - Repetitive stress injuries
- Point tenderness over a physis is all you need
- Type I and V may not have any appreciable x-ray changes
<table>
<thead>
<tr>
<th>Type of Physeal Fracture</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salter Harris I</td>
<td>Splint immobilization Orthopedic follow-up</td>
</tr>
<tr>
<td>Salter Harris II</td>
<td>Splint if no reduction needed Orthopedic follow-up</td>
</tr>
<tr>
<td>Salter Harris III</td>
<td>Anatomic alignment critical May need ORIF</td>
</tr>
<tr>
<td>Salter Harris IV</td>
<td>Usually needs ORIF</td>
</tr>
<tr>
<td>Salter Harris V</td>
<td>Casting Non weight-bearing</td>
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</tbody>
</table>
PEDIATRIC ELBOW INJURIES

- **Supracondylar fractures**
  - Most common elbow fracture
  - FOOSH

- **Radial head subluxation (Nursemaid’s Elbow)**
  - Usually in children <6 years of age
  - Classically pulling type of injury
# Elbow Ossification Centres

<table>
<thead>
<tr>
<th>Ossification Center</th>
<th>Age of Appearance</th>
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<tbody>
<tr>
<td>L</td>
<td>Capitellum</td>
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<tr>
<td>R</td>
<td>Radial head</td>
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<tr>
<td>I</td>
<td>Internal (medial) epicondyle</td>
</tr>
<tr>
<td>T</td>
<td>Trochlea</td>
</tr>
<tr>
<td>O</td>
<td>Olecranon</td>
</tr>
<tr>
<td>E</td>
<td>External (lateral) epicondyle</td>
</tr>
</tbody>
</table>

1 year
3 years
5 years
7 years
9 years
11 years

Elbow ossification centres

http://www.hawaii.edu/medicine/pediatrics/pemxray/pemxray.html
CASE

- 5yo fall from horizontal ladder
- Unwitnessed by parent
- c/o right elbow pain
SUPRACONDYLAR FRACTURE

- Fracture of the distal humeral metaphysis just above the condyles
- 60% of elbow fractures in pediatrics
- At risk for neurovascular compromise
- Nerve injuries occur in 7% of displaced supracondylar fractures
SUPRACONDYLAR FRACTURE, TYPE 1

- Minimal or no displacement
- May just see posterior fat pad
SUPRACONDYLAR FRACTURE, TYPE 2

- Partially intact posterior cortex with some angulation without complete dislocation
SUPRACONDYLAR FRACTURE, TYPE 3

- Complete displacement
Name the Gartland Classification
MANAGEMENT

- Perform history and exam of the effected extremity with neurovascular evaluation and documentation of function
- Obtain radiographs – AP and lateral views
- Immobilize (long arm volar splint) at 90 degrees
- Administer pain control
MANAGEMENT

- **Gartland 1** - Splint and refer
- **Gartland 2** - Orthopedic consultation and closed reduction
- **Gartland 3** - Admit and operative repair
- Admission for displaced fractures or those with significant swelling
- Observation (elevation, ice and analgesics)
- If neurovascular exam changes after reduction, exploration is warranted
CASE ,, 2 Y.O GIRL

- Frantic mother brings her 2 year-old girl to ED with complaint of not moving her right arm after swinging him in a circle.
- Exam shows quiet child with her arm held next to his side in flexion and pronation.
- Hand and shoulder are non tender if patient is distracted. Distal NV intact. No erythema or swelling is noted.
Nursemaid's Elbow

- Occurs between ages 1 and 5 years (2-3 years peak incidence)
- Precipitated by traction on arm
  - Swinging by wrists
  - Pulling by arms
  - Struggling into a coat
- History: child had sudden onset of not moving arm - often history of traction to arm or swinging of child by arms
- Transverse tear in annular ligament with entrapment of annular ligament between radial head and capitellum
MANAGEMENT

- Diagnostic studies:
  - None needed if diagnosis is evident
  - Classic history
  - No focal tenderness, bruising, or edema
  - Radiographs of elbow in equivocal cases
- Two methods for “reduction”
  - **Supination and flexion** (84%)
  - **Hyperpronation** (shown in small randomized trial to be the better method – 93% effective with one try!)
  - A click or pop may be felt or heard - within 30 min child moving arm freely
CASE

- 3 year-old male BIB mom for limp on the left leg
- No history of trauma - no systemic signs and symptoms
- No PMH or comorbid disease
- Physical exam except limp is normal without joint irritability
- Radiographs of left LE normal
Studies: Choban S, Killian JT; *JPO*

- **Causes of limp in 60 children**

<table>
<thead>
<tr>
<th>Causes of limp in children</th>
<th>Numbers of children</th>
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</thead>
<tbody>
<tr>
<td>Toxic synovitis</td>
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<tr>
<td>Septic arthritis</td>
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<tr>
<td>Trauma</td>
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<tr>
<td>Osteomyelitis</td>
<td></td>
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<tr>
<td>Viral syndrome</td>
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<tr>
<td>Perthes disease</td>
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<tr>
<td>Fracture</td>
<td></td>
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<tr>
<td>JRA</td>
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<td>Soft tissue infection</td>
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<tr>
<td>Sickle cell crisis</td>
<td></td>
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<tr>
<td>Schönlein–Henoch purpura</td>
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<tr>
<td>Discitis</td>
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</table>

**Site of origin of limp in children**

- Hip
- Thigh
- Knee
- Leg
- Foot
Transient (Toxic) Synovitis of the Hip

- Short-lived inflammation of synovium
- Males > females
  - Ages 4-10 years
  - Usually unilateral
- Clinical: Pain in hip that radiates to thigh and knee
- Physical Exam: Hip held in flexion, adduction and internal/external rotation. Temperature normal or slightly elevated.
- Consider hip aspiration if ? diagnosis
Transient (Toxic) Synovitis of the Hip

- **Radiography:**
  - AP Pelvis may show effusion
- **Ultrasound:**
  - Shows effusion in 95% of cases
- **Laboratory:**
  - CBC and sedimentation rate are normal or slightly elevate
- **Management:**
  - Bed rest, NSAIDs, and close follow-up
Management of Limp

- Complete history and physical exam
- Administer pain control (NSAID my first choice)
- Radiographs
- Consider CBC and ESR/CRP
- Admit if CBC or ESR/CRP elevated or evidence for infection or tumour (consult orthopaedist)
- Close follow-up for re-examination

Refusal to walk necessitates laboratory and radiographic evaluation
CASE

- 4 year-old girl
- Presents with fever and pain with walking for one day
- Girl fell playing 3 days ago but mom states she seemed fine afterwards
- Vital signs: T 39.5°C, HR 130, RR 24, BP 100/70 mmHg, Pulse ox 99%
- She refuses to walk and exam of hip shows irritability

Is this a trauma history? Or... a red herring
CASE ......

- Administer pain medication
- Send labs CBC, sedimentation rate (CRP if available) [Consider send blood culture]
- Obtain radiographs
- Empiric antibiotic therapy
CASE .....
Pathophysiology:

- Hematogenous spread most common
  - Bacteremia from soft tissue or other infection
  - Spread from osteomyelitis (10%)
- Trauma or surgery may predispose
- Consider disseminated gonorrhea in adolescents

What are 3 causes of periosteal elevation?
Osteomyelitis, bone cancer and child abuse
Septic Arthritis Etiology

**Neonate**
- *S. aureus*
- Group B strep gram (-) bacilli

**2 mo - 5 yrs**
- *K. kingae*
- *S. aureus*
- *S. pneumoniae*
- *H. influenzae*

**5 - 12 yrs**
- *S. aureus*
- *K. kingae*
- *S. pneumoniae*
- *N. gonorrhoeae*

Incidence of MRSA on the rise!
SEPTIC ARTHRITIS

Clinical:
- Neonate may only show nonspecific signs
- Fever common (75%)
- Erythema, swelling, pain on passive motion
- If in the hip: tenderness in groin and over hip joint and hip is held flexed, externally rotated and abducted position
Distinguishing Septic Arthritis from Transient Synovitis of the Hip (Caird, et al, JBJS 2006)

Prospective evaluation of 53 children who underwent hip aspiration for suspected septic arthritis

- T > 38.5°C*  
- Elevated CRP (>2.0 mg/dL)  
- Elevated ESR (>40 mm/hr)*  
- Refusal to bear weight*  
- Elevated WBC (>12,000/mm³)*

* Factors shown to be predictive by Kocher, et al

5 factors = 98%  
4 factors = 93%  
3 factors = 83%
**Radiography:**
- May show widening of the joint
- Soft tissue swelling
- Signs of adjacent osteomyelitis

**Ultrasound:**
- Used to determine if an effusion is present

*Ultrasonography cannot be used alone to distinguish septic arthritis from transient synovitis—use also clinical and laboratory evaluation*
SEPTIC ARTHRITIS: Radiography
SEPTIC ARTHRITIS: Radiography

>2 mm difference is significant
SEPTIC ARTHRITIS: Management

- Call peds ortho/ortho consultants early

- Aspiration of the joint or arthrotomy / arthroscopy

- IV antibiotics by age - coverage including MRSA in communities where prevalent

- Cover also for GC with adolescents
8 year-old boy

Brought to ED with limp for months to ED by mother.

Been to several doctors

Patient complains of groin and thigh pain, otherwise well.

Exam reveals a well appearing male who walks with a slight limp on the left; limited in abduction on the left.

Mom was told to go see a psychiatrist by PMD
CASE ....

- Patient given ibuprofen PO
- Radiographs are ordered
Legg-Calve-Perthes Disease (Coxa Plana)

- Discovered by 3 investigators simultaneously (1908-1910)
  - Arthur Legg (U.S.); Jacques Calve (France); George Perthes (Germany)
- Self limited disorder of aseptic necrosis of femoral head with replacement resulting in flattening of the femoral head
- Males > females
  - Age between 4 and 12 years
  - Unilateral 85%; bilateral 15%
- Unclear etiology, but result is ischemia and necrosis of femoral head
- May have abnormal blood viscosity and clotting
  - Reports of low Protein C and Protein S levels, factor V Leiden mutations
Legg-Calve-Perthes Disease (Coxa Planæ)

**Clinical:**
- Onset insidious, onset over years.
- Early sign is invariably a limp. Patient with pain in medial thigh, groin and knee.
- Muscle spasms are often present and patient is limited in activity.

**Physical exam:**
- Motion limited in all directions especially abduction. Leg length discrepancy.
Legg-Calve-Perthes Disease

- **Radiography:**
  - Early-joint space widening; Crescent sign
  - Later-femoral head appears more dense, fragmentation
  - Late-collapse and regeneration, signs of OA

- **CT/ MRI**

Stage 1: Avascular necrosis
Stage 2: Fragmentation/Resorption
Stage 3: Re-ossification
Legg-Calvé-Perthes Disease: Management

- Reduce pain with NSAIDs and reduce activity
- NWB, stretching exercises, braces, and/or casting
- Refer to pediatric orthopaedist
  - Observation in young patients or those with minimal disease
  - Containment to maintain sphericity of femoral head
    - Maintaining hips in abduction and internal rotation
  - Traction early on for relief of spasm
  - Femoral and pelvic osteotomies may be required
CASE; 14 year-old male

What is the problem here?
CASE; 14 year-old male

Always get two views
Slipped Capital Femoral Epiphysis (SCFE)

- Occurs in children between 10-16 years:
  - Males ages 12-15 years, females 10-13 years
  - Males > females
  - 73% of males had weights greater than 90th percentile
  - 25% bilateral
  - 70% with skeletal ages below chronological age
- Clinical:
  - "Silent slips" (without pain) can occur in up to 20% of patients.
  - May give history of minor trauma - onset is insidious.
  - Discomfort in groin, stiffness of the hip or with knee pain
Classification of SCFE

- Generally accepted that classification based on stability
  - Stability has been defined as ability to walk without crutches (95% of cases) – prognosis is great
  - Unstable - child unable to bear weight without crutches (5% of cases)
    - Increased risk of avascular necrosis (3-84%)
    - History of trauma often present; hip and thigh pain
    - Physical exam with hip irritability; limitation in internal rotation; hip held externally rotated
Pitfalls in Diagnosis of SCFE

- Misdiagnosis - 30% of patients are misdiagnosed
  - Knee pain
  - Thigh pain
  - Other diagnoses: muscle strain, flat feet, Osgood Schlatter’s disease
  - Growing pains
- Failure to recognize referred pain
- Failure to interpret plain films
- Caution, patients with high BMI >30 may have increased risk of bilateral SCFE
Widening or irregularity of physis may be subtle
SCFE: Radiography, Klein’s line
Klein Line on the Anteroposterior Radiograph Is Not a Sensitive Diagnostic Radiologic Test for Slipped Capital Femoral Epiphysis

Dorothy J. Pinheiro, MD, and William L. Hambrick, MD

Objectives: To assess whether the anteroposterior (AP) radiographic view is sensitive, specific, and reliable in detecting and diagnosing the presence of a slipped capital femoral epiphysis (SCFE). A prospective study of 15 patients with SCFE was performed from January 1991 to March 1993. The AP radiographs were retrospectively reviewed for 1 year, and the presence or absence of a slip was recorded.

Methods: A prospective study of 15 patients with SCFE was performed from January 1991 to March 1993. The AP radiographs were retrospectively reviewed for 1 year, and the presence or absence of a slip was recorded.

Results: Of the 15 patients, 14 (93%) were male, 11 (73%) were white, and 4 (27%) were African American. The AP radiographs were reviewed by three radiologists, and the presence or absence of a slip was recorded.

Conclusion: The AP radiograph is not a sensitive diagnostic radiologic test for SCFE. A true anteroposterior (AP) radiograph should be performed in all patients with suspected SCFE in order to accurately diagnose the disorder and prevent delays in diagnosis.

Surgical capital femoral epiphysseal injury (SCFE) is a common hip disorder in children characterized by a separation of the capital femoral epiphysis from the femoral head through the physis. The occurrence of SCFE has been reported to be 10-15 per 100,000 children aged 10-16 years. The diagnosis of SCFE is based on clinical examination and plain radiographs and is confirmed with an MRI. Therefore, a slipped capital femoral epiphysis should be a clinical entity characterized by a separation of the physis and the capital femoral epiphysis from the femoral head. The incidence of SCFE is 10-15 per 100,000 children aged 10-16 years. The diagnosis of SCFE is based on clinical examination and plain radiographs and is confirmed with an MRI.
SCFE: Radiography

Important to x-ray both hips because...60% are bilateral

- **CT:**
  - Sensitive method of measuring the degree of tilt - detects early disease (rarely needed)

- **MRI:**
  - May be most sensitive for early slips...marrow edema and slippage
  - MRI may be used to follow contralateral hip for slippage
SCFE: Management and Complications

**Management:**
- Immediate immobilization, non-wt bearing to prevent worsening of SCFE
- Stable - admit - consult ortho for internal fixation
- Unstable - consult ortho for internal fixation/with open reduction???

**Complications:**
- Avascular necrosis of femoral head and degenerative joint disease associated with unstable SCFE
CASE

- 14 year-old male BIB ambulance from school for right leg pain. Patient was kicking a football when he heard a crack.

- RLE is normal except for marked tenderness to thigh and hip and pain when moving the hip in flexion or internal/external rotation.

- You order ibuprofen PO and radiographs of the pelvis, hip and femur.
Radiographs show avulsion of a pophysis (may need oblique views)
Avulsion Fractures

- Avulsion fractures of the pelvis occur in children and adolescents involved in sport activities.
- Age 14-25 years
Location: Avulsion fractures
Avulsion Fractures,, Management

- Pain control
- Bed rest X 1 week (pm) - weight bear as tolerated X 6 weeks
- Return to sports in 6-10 weeks (key pain free with running)
THANKS