

26th Annual General Pediatric Review & Self-Assessment

**ORTHOPEDECS/ SPORTS
MEDICINE**

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26th Annual General Pediatric Review & Self-Assessment

Disclosure of Relevant Relationship

Dr. Wright has not had (in the past 24 months) any relevant conflicts of interest or relevant financial relationship with the manufacturers of products or services that will be discussed in this CME activity or in his presentation.

Dr. Wright will support this presentation and clinical recommendations with the “best available evidence” from medical literature.

Dr. Wright does not intend to discuss an unapproved/investigative use of a commercial product/device in this presentation.



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“Suggested Topics To Be Covered in the Orthopaedic Section:”

- Sprains/Strains (Sports Injuries)
- Fractures (Greenstick, Clavicle, Spiral, Distal Humerus) & Fracture Complications
- Radial Head Subluxation
- Developmental Dysplasia of the Hips
- SCFE, Legg-Calve-Perthes, Osteo Dessicans
- Scoliosis, Back Pain

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Orthopaedic Problems

- 20 % pediatric visits for musculoskeletal complaints
- PCP participates in management
 - Know pitfalls
 - Avoid over/under referral
 - Avoid unnecessary tests/treatments

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Diagnosis

- History – Mom knows (best)
- Physical examination
 - Think of existing normal anatomy
 - Normal – Wide range, age related
 - Signs of disease
 - Swelling vs effusion
 - Tenderness – local/diffuse
 - Errythema
 - Heat

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Diagnosis

- Lab – Simple tests (CBC, ESR, CRP)
- X-ray
 - Before “high tech”
 - Two orthogonal views
 - Growing bones have “extra” bones

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Diagnosis

- Bone scan
 - Non-specific – bone turn over
 - Increase blood flow
 - Inflammation
 - Fracture, infection, growth

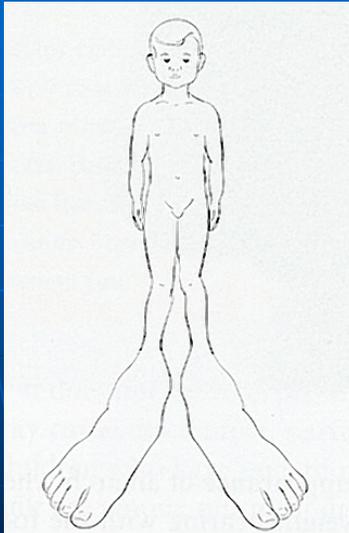
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Diagnosis

- | | |
|--|---|
| <ul style="list-style-type: none">■ Ultrasound<ul style="list-style-type: none">• Shows interfaces• Fluid• Cartilage surfaces• Bone hides all below | <ul style="list-style-type: none">■ MRI<ul style="list-style-type: none">• Can <u>imply</u> inflammation/tumor• Soft tissue definition/bone marrow edema• Is predictive• Interpreter prejudice |
|--|---|

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How some parents seem to see their children



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Intoeing

- Foot: Metatarsus adductus, clubfoot
- Leg: Internal tibial Torsion
- Hip: Femoral anteversion/external rotation contracture of hip

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Assessing Intoeing

- Constant or intermittent
- Improving or remaining same
- Family history of same
- Foot Progression Angle
 - Angle foot makes w/ line of progression
 - Normal about 0 to 30° external rotation

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Intoeing by age

- Metatarsus Adductus
- INTERNAL Tibial Torsion
- Femoral ANTEversion



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Metatarsus Adductus (MTA)

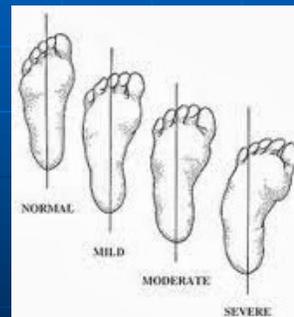
- Medial deviation of the forefoot
- Measure "heel bisector line (HBL)"
 - Normal = 2nd toe
- Begin Serial casting before 9 months
- Surgery rarely necessary



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Classification of MTA

- Rigid Vs Flexible
 - HBL
 - Normal
 - Mild
 - Moderate
 - Severe
- Web Space
 - 2-3
 - 3-4
 - 4-5
 - >5



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Treatment of MTA

- Treat rigid, \geq moderate
- Beware heel valgus!
- Serial casting prior to age 9 months
- Maintain w/ straight-last shoes
 - Avoid
 - Denis-Browne bars
 - Reverse-last shoes

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MTA Surgery

- | ■ <u>Age</u> | <u>Procedure</u> |
|------------------|----------------------------|
| ■ 1-3 | Medial soft-tissue release |
| ■ 4-6 | Cuboid osteotomy |
| ■ >7 | Medial cuneiform osteotomy |
| ■ Not me! | MT base osteotomies |
| ■ | MT base capsulotomies |

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Internal Tibial Torsion (ITT)

- Common before age 3
- May walk w/ knees externally rotated
- Diagnose by Thigh-foot-angle
 - Normal 0 to 30° external
- X-rays not helpful unless Blount's disease suspected



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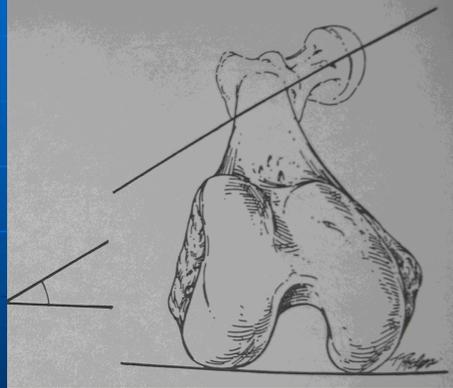
Treatment of ITT

- **>90%** spontaneously correct by age 5 yrs
- Braces are unproven-expensive
 - Internal tibial torsion brace
 - Dennis-Browne Bar
 - Occasionally used for TFA >- 20°
- Surgical intervention (tibial osteotomy)
 - >-15° TFA after age 5 and symptomatic

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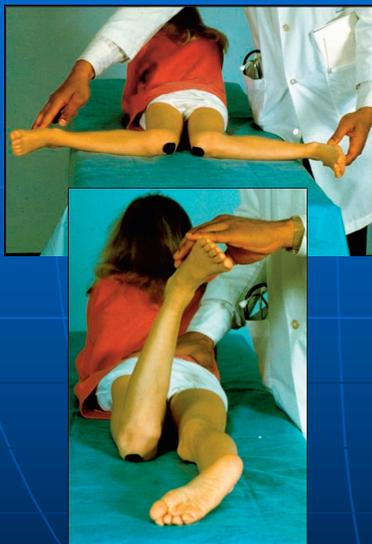
Femoral Anteversion

- Normal anatomical development
- Axis of head and neck of femur compared to transverse axis of femoral condyles
 - 40° at birth
 - 15° at maturity
- Radiographs not helpful



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Excessive Femoral Anteversion



- Intermittent intoeing
 - Fatigue
 - Running
- W-sitting common
- Diagnosed clinically
 - Hip internal rotation > 70°
 - Hip external rotation < 30°

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Excessive Femoral Anteversion

- Intoeing resolves in **90%** by age 8
- No brace or shoe modifications changes spontaneous resolution
 - Twister cables prevent tripping ?
 - Expensive
 - Ugly
 - Tear up clothing

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Excessive Femoral Anteversion

- Surgery intervention
 - Proximal femoral osteotomy
 - Indications: **Severe persistent intoeing w/ frequent tripping**
 - Patello-femoral malalignment/tracking
 - Acetabular dysplasia

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Intoeing – Bottom Line

- Observation
- Observation
- Observation

- Bracing is RARELY necessary



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Clubfoot

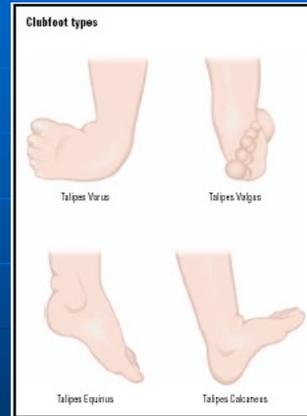
- Congenital talipes equinovarus
- "CAVE"
 - Cavus
 - Adductus
 - Varus Heel
 - Equinus



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Clubfoot - Treatment

- Serial casting up to 3 months
- Surgical release commonly
- Multiple operations later possible



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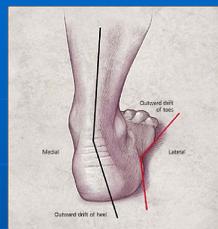
Pes Planus



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Flat Feet

- Flexible Vs Rigid
- Asymptomatic Vs Painful
- Heelcord contracture
- Neurologic abnormality



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Flatfoot - orthotics



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Flat Feet - Asymptomatic

- “Orthopaedic shoes” do not create arches
- Arch supports do not support the arch
- Reassurance/education is helpful
- Growth is facilitated with activity
- “Support” induces weakness/alters mechanics



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Flat Feet - Symptomatic

- Tight heelcord: Stretching exercises
- Look for signs of rigid flatfoot
- Prominent navicular bone
- Peroneal spasm
- Plantar fascia
- Sever’s disease
- Stress fractures

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Rigid Flatfoot

- Not passively correctable
- Often unilateral
- Stiff subtalar joint
- Painful by adolescence
- Refer to Pedi Ortho specialist
- Usually require surgical treatment



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Rigid Flatfoot - Causes

- Congenital vertical talus
- **Tarsal coalition**
- Fibular hemimelia
- Spastic peroneals
 - Subtalar arthritis
 - Neurological condition



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Developmental Dysplasia of Hip

- Nomenclature
 - DDH vs CDH
 - Dislocated (+Ortoloni, Allis)
 - Dislocatable (+Barlow)
 - Subluxated/Subluxable (Ultrasound)
- Etiology: Intra-uterine positioning (?)
- Incidence: 2 per 1000 live births

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Developmental Dysplasia of the Hip

- Occurs in neonatal period
- More common in first-borns and breech position deliveries
- Association with **congenital muscular torticollis and metatarsus adductus**

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DDH – Risk Factors

- Family history (10% unstable)
- Breech presentation 3rd trimester (5%)
- Large birth weight
- Torticollis or metatarsus adductus
- 1st born, female

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DDH

- Detection
 - At birth: Ortoloni/Barlow tests
 - **After 6 wks:** Limited Abduction
 - After 3 months: Allis (Galeazzi), LLD
- Left hip 60%, Bilateral 20%

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Clinical Features: Your First Clue

- Asymmetric hip creases
- Positive Barlow and/or Ortolani maneuver
- Limited abduction of hip



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DDH

- X-rays in first 6 weeks unreliable
- Ultrasound - reliable, assess suspect hip
- Pavlik harness successful 95%
- Surgical treatment of failed Pavlik/late Dx
- Reduction prior to 1st birthday critical

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Ortolani and Barlow Maneuvers

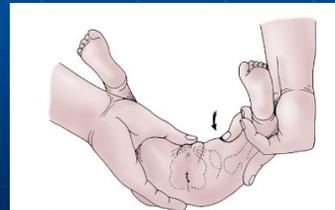
TABLE 12-1 Ortolani and Barlow Maneuvers

Ortolani (Reduction) Maneuver

- Stabilize the pelvis with one hand.
- With the other hand, slightly abduct the infant's hip.
- With the index and long fingers over the greater trochanter, pull the thigh up to gently reduce the hip.

Barlow (Provocative) Test

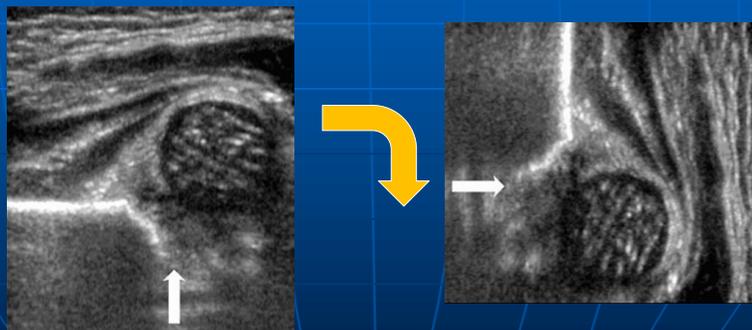
- Stabilize the pelvis with one hand.
- Place the thumb on the inner aspect of the thigh near the lesser trochanter.
- Adduct the hip.
- Exert downward pressure on the thigh with the thumb, pushing it into the table.



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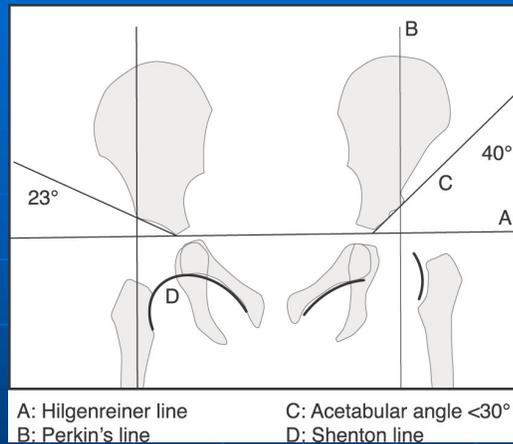
Diagnostic Studies

- Dynamic ultrasonography in neonates and young infants
- Plain AP pelvis and frog-leg views in older infants and children



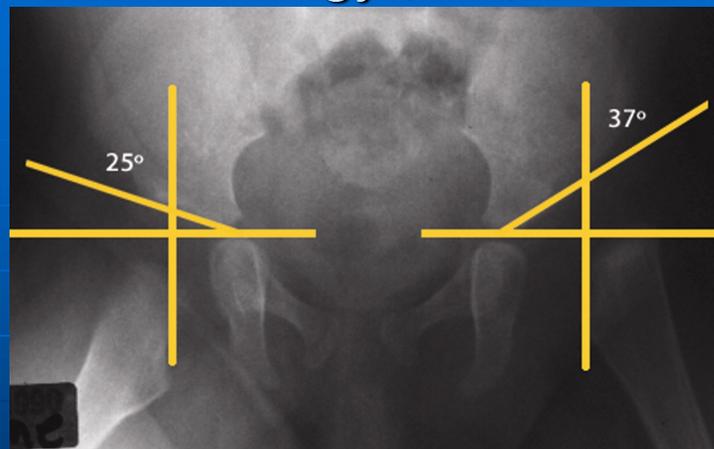
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Radiology (1 of 2)



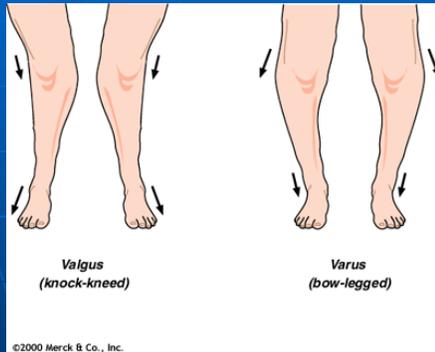
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Radiology (2 of 2)



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Bowlegs (Genu Varum)



- Physiologic genu varum
- Infantile tibia vara (Blount's Disease)
- Bone dystrophy (Rickets)
- Bone dysplasia (achondroplasia)
- Physeal abnormality (trauma)

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Physiologic Genu Varum

- Usually corrects by 20 - 24 months
- Treatment: Reassurance only
- Worrisome: Progressive or unilateral
 - Blount's disease most likely
- X-ray: Measure metaphyseal-diaphyseal angle (MDA) - 11° or more

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MDA parameters



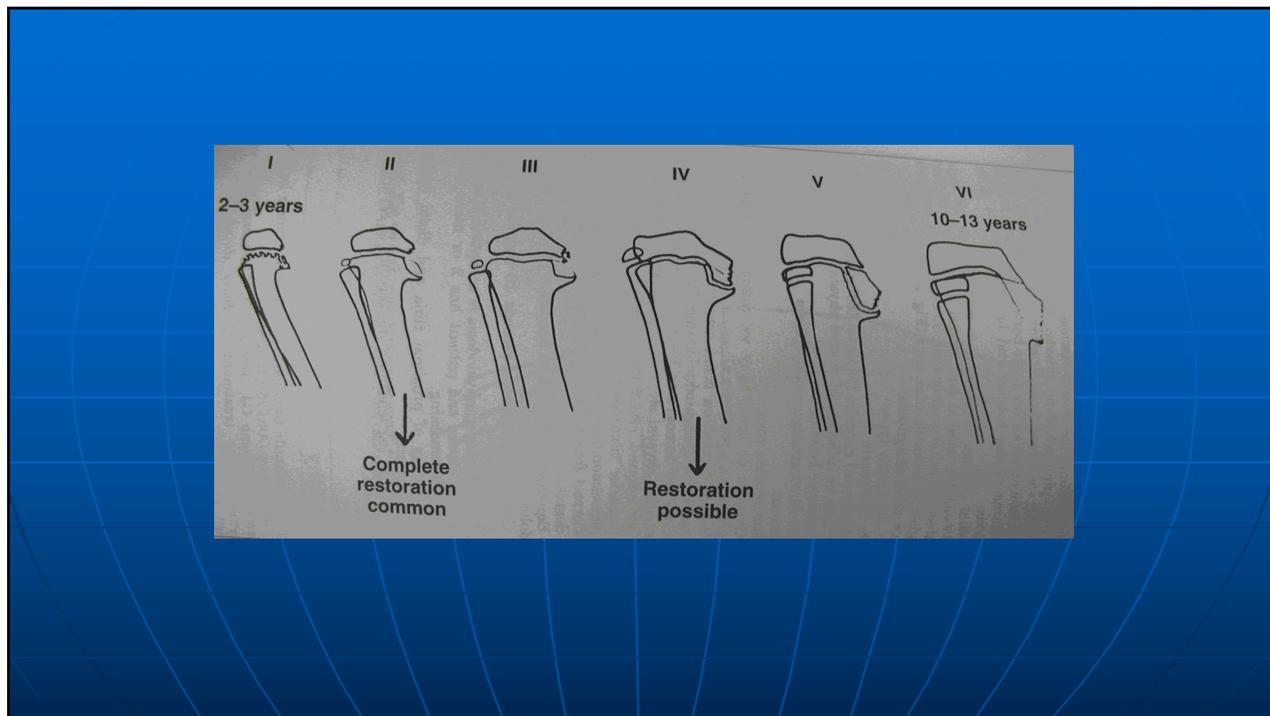
- | <u>MDA</u> | <u>Probable etiology</u> |
|-------------------|-----------------------------|
| ▪ $\leq 9^\circ$ | Physiologic genu varum |
| ▪ 10-15° | Gray zone-close observation |
| ▪ $\geq 16^\circ$ | Blount's disease |

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Infantile Tibia Vara (Blount's)

- Usually bilateral and progressive
- Obesity and ITT common
- Early bracing may help
- Surgical treatment often required
- Morbidity fairly common
 - Recurrence, joint incongruity, arthritis
- Pedi Ortho referral always indicated

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Perthe's Disease

- Idiopathic osteonecrosis femoral head
- Etiology unknown
 - Old theories
 - Trauma
 - Transient synovitis
 - New theories:
 - Abnormal clotting factors
 - Second hand cigarette smoke

An X-ray image of a knee joint showing Perthe's Disease, characterized by a fragmented and irregular femoral head.

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Perthe's Disease

- Typical age 4-8 years
- Limping +/- Pain
- Limited hip abduction/IR
- 12% bilateral
- Onset after age 6 = worse prognosis
- Femoral head small, flattened

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Perthe's Pitfalls

- Referred pain to knees
- Early x-rays may be normal
- Radiographic appearance variable
- Include frog lateral views both hips
- Epiphyseal dysplasia may mimic AVN
- **MRI unnecessary**

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Perthe's Charades

- Epiphyseal dysplasia
- Spondyloepiphyseal dysplasia
- Hypothyroidism
- Sickle cell disease
- TB of hip

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Perthe's Treatment

- Not an emergency
- 2 to 4 year process
- Activity reduction
- NSAID's
- Gentle hip ROM exercises

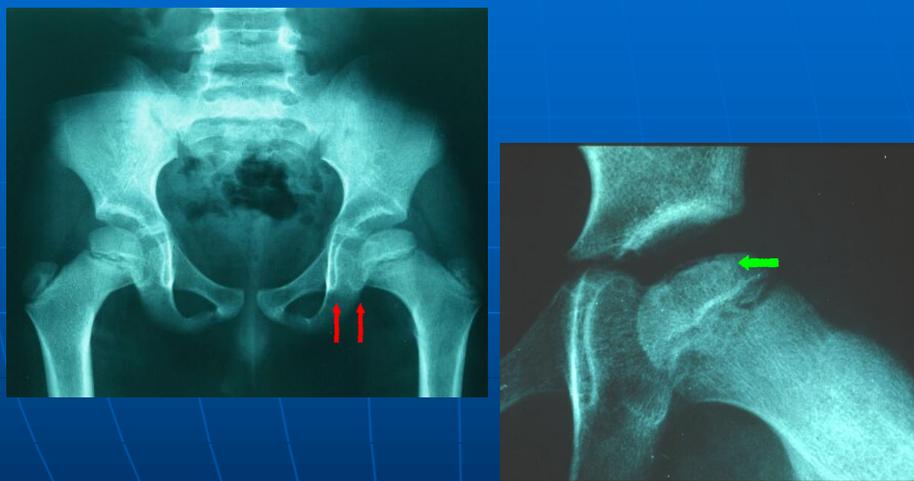
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Perthe's Treatment

- Older age (>7-8 yrs)
- Total head involvement
- Prolonged regeneration stage
- Hip containment
 - Abduction traction or Petrie casting
 - Ambulator abduction bracing
 - Proximal femoral osteotomy
 - Salter pelvic osteotomy

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Radiograph: LCP



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Legg-Calvé-Perthes Disease

- Avascular necrosis leading to collapse, fragmentation, and then reossification
- Most frequent between 4 and 9 years
- Boys more often than girls
- Bilateral in 10% of cases

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Clinical Features: Your First Clue

- Knee or hip pain
- Limp
- Shortened limb
- Limited range of motion of hip

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Diagnostic Studies

- Radiology
 - AP and frog-leg pelvis radiographs
- Findings
 - Femoral head smaller and cartilage space appears wider
 - Crescent sign
 - Fragmented femoral head—less radiopaque
- MRI

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Management

- Disease is self-limited – limp can last 2 to 4 years
- Nonsteroidal anti-inflammatory agents
- Limit activities
- Crutches/braces occasionally needed
 - May help maintain spherical femoral head
- Better outcomes in younger children

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Slipped Capital Femoral Epiphysis (SCFE)

- 65% obese males
- Peak adolescent growth spurt
- Limping with external rotation LE
- X-rays diagnostic
- Urgent surgical treatment required
- High morbidity

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SCFE Classification

- Stable
 - Able to bear weight on limb
 - Good prognosis
- Unstable
 - Unable to bear weight
 - Poor prognosis
- "Head-Shaft angle" measures deformity

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SCFE Treatment

- Percutaneous pinning of hip
 - Stabilization of epiphysis
 - Closure of physis
- Prophylactic pinning opposite hip?
 - 40% bilateral occurrence
- Spica cast immobilization x 3 months

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SCFE Pitfalls

- Referred pain to the knee
- Bedrest/crutches not protective
- Slip more visible on lateral hip x-ray
- Endocrinopathy-early, bilateral SCFE
- 40-50% develop SCFE other hip
- No sports until both hip physis fused

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SCFE Pitfalls

- Osteonecrosis femoral head
- Chondrolysis
- Restricted hip motion
- Leg length discrepancy
- Premature hip arthrosis

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SCFE: Background

- Incidence: 1-3/100,000
- Occurs during early adolescence
- Increased forces during growth spurt
- Males 2 times as frequent as females
- Obese in 2/3 of cases
- *Can* become bilateral in up to 40% of children

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Clinical Features: Your First Clue

- Obese preadolescent or adolescent
- Often weeks to months of discomfort
 - Acute visit precipitated by trauma
- Limp
- Hip, thigh, groin, or knee pain
- Decreased range of motion of hip

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Diagnostic Studies

- Radiology
 - AP pelvis and frog-leg of hips
- Signs
 - Physeal widening
 - Klein line
 - Epiphysis inferior and posterior
 - Disruption of Shenton line

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Klein Line



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Management

- Bed rest
- Pain management
- Relief of muscle spasms
- Definitive treatment is surgical.
 - Screw placed through femoral neck



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Hip Pain by Age

- Transient Synovitis
- Perthes Disease
- SCFE



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Infection

- Osteomyelitis
- Septic Arthritis
 - Hematogenous
 - Direct extension
 - Sub acute
 - Chronic
- Agents
 - Bacterial: Staph aureus
 - TB
 - Fungal

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Septic Arthritis: Background

- Occurs in all age groups
 - More common in younger children
- Majority of cases in lower extremity
- Mechanism of entry
 - Hematogenous seeding
 - Local spread
 - Traumatic or surgical introduction of bacteria

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Septic Arthritis

- History
 - Onset-rapid
 - Limp/refusal to walk
 - Fever (>102)
 - Swelling (knee/ankle)
- Physical
 - Pain w/ motion - Severe
 - Pseudoparalysis
 - Effusion
 - Increase warmth
 - Cellulitis confuses

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Septic Arthritis

- Prognosis
 - Early diagnosis: Good
 - Hip, late dx: ON
 - Serial aspiration: Usually adequate
 - Surgical drainage: Morbidity

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Clinical Features: Your First Clue

- Irritability
- Fever
- Erythema
- Limp/refusal to walk
- Decreased range of motion of limb

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Position of Comfort With Hip Effusion

Which hip is affected?

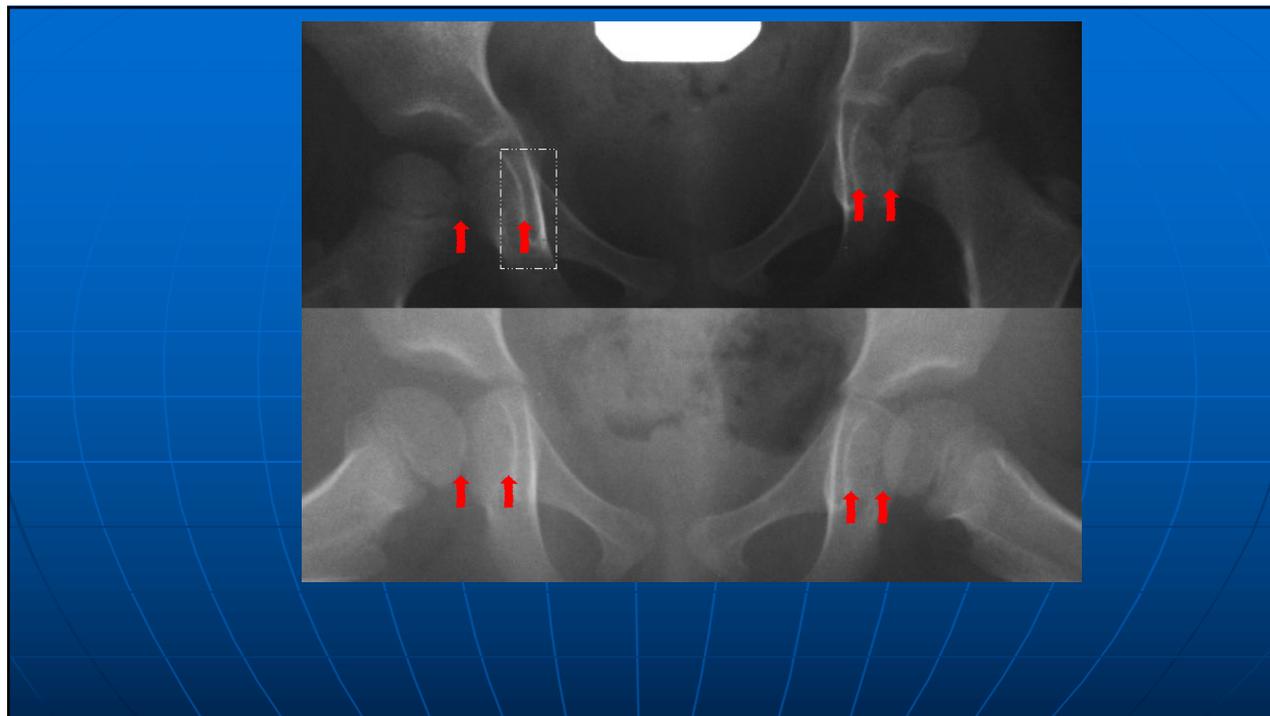


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Diagnostic Studies

- Radiology
 - Radiograph may be nondiagnostic
 - Ultrasonography helpful in detecting fluid
- Laboratory
 - CBC
 - CRP (more helpful than ESR)

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Management

- Once the diagnosis of septic joint is made, surgical intervention should proceed ASAP.
 - Needle aspiration or open surgical drainage required

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Synovial Fluid Findings

TABLE 12-4 Synovial Fluid Findings in Different Types of Arthritis.

	Character	WBC count (/uL)	PMNs (%)	Mucin clot	Other
Normal	Clear; yellow	<200	<10	Good	
Juvenile rheumatoid arthritis	Turbid	250–50,000	50–70	Fair to poor	50% with decreased complement
reactive arthritis	Cloudy to turbid; can be clear	1,000–150,000	50–70	Fair to poor	Increased complement
Lyme arthritis	Turbid	500–100,000	>50	Poor	
Septic arthritis	Turbid; white-grey	10,000–250,000	>75	Poor	Low glucose High lactate

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Septic Arthritis Treatment by Age

TABLE 12-3 Septic Arthritis Pathogens and Treatment

Age	Organism	Treatment
Birth to 2 months	Group B Streptococcus	Nafcillin 50 mg/kg and gentamicin 2.5 mg/kg
	<i>S aureus</i>	
	Gram-negative rods	
2 months to 3 yr	<i>S aureus</i>	Nafcillin 50 mg/kg and ceftriaxone 50 mg/kg (consider vancomycin 10 mg/kg)
	<i>H influenzae</i>	
	<i>S pneumoniae</i>	
3 years to 12 yr	<i>S aureus</i>	Nafcillin 50 mg/kg and ceftriaxone 50 mg/kg (consider vancomycin 10 mg/kg)
	<i>S pneumoniae</i>	
	<i>S pyogenes</i>	
> 12 yr	<i>S aureus</i>	Nafcillin 50 mg/kg and ceftriaxone 50 mg/kg (consider vancomycin 10 mg/kg)
	<i>S pneumoniae</i>	
	<i>N gonorrhoeae</i>	

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Bottom Line "Kocher Criteria"

1. Inability to bear weight
2. Fever
3. Elevated WBC (>12,000)
4. Elevated ESR (>40)

4/4 – 99% Septic Arthritis

3/4 – 93%

2/4 – 40%

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Transient Synovitis

- Common in 2-8 year group
 - Afebrile or low grade
 - Limp/gait ceases
 - Pain at extremes of motion
 - Small effusion
- Aspiration (if done)
 - Small amount
 - 5-15,000 WBC
 - 75% poly's
 - Glucose 60 or higher

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Osteomyelitis

- History
 - Rapid to insidious onset
 - Limp/refusal to walk
 - Fever (>102)
 - Swelling near joint
- Physical
 - Local tenderness
 - Swelling +/- effusion
 - Loss of motion not prominent
 - Erythema, heat common
- Sub-acute or chronic
 - Symptoms/signs subtle

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Osteomyelitis

- Lab
 - WBC, ESR, CRP inc. sig.
- Imaging
 - X-ray: normal early (< 10D)
 - US: Periosteal abscess
 - MRI: Bone and soft tissue edema
- Culture
 - Staph aureus
 - Neonate: Strep B, E. coli
 - Infant to 4: Pneumo, Strep A, H. flu
 - 4 and up: Staph aureus
- Sub-acute or chronic
 - Variable, often normal

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Osteomyelitis

- Treatment: Medical/Surgical
 - Neonate: Ox/Gent or Cefotaxime
 - Infant to age 4: Ox, Cef 1, Clinda
 - 4 and up: Ox, Cef 1, Clinda
 - 6 weeks IV, variable oral

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Osteomyelitis

- Prognosis
 - Low incidence of Chronic osteo
 - Growth arrest in late diagnosis
 - Overgrowth of extremity can occur
 - Medical complications not benign

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Subacute Osteomyelitis

- Subtle, chronic symptoms
- Muscular atrophy, limp
- No fever
- Radiograph: diaphyseal lesion
- Tumor must be ruled out

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Chronic Recurrent Multifocal Osteomyelitis

- Insidious onset
 - Localized bone pain
 - Palmoplantar pustulosis/psoriasis
 - Fever not common
 - Can be single or or multiple
 - Culture negative usually

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Chronic Recurrent Multifocal Osteomyelitis

- X-ray: suggestive of osteo
- Bone scan: other locations
- Biopsy: r/o tumor, histiocytosis

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Diskitis

- Inflammation of IVD
- Etiology uncertain
- Self limited?
- Bx/Asp only in resistant cases
- Staph aureus virtually all
- Antibiotic treatment generally recommended

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Diskitis

- Symptoms vary per age group
- < 3: Hip irritability in extension
- 3 to 9: Abdominal pain, some back
- > 9: Back pain, "walk on eggs"
- Fever uncommon
- WBC nl, ESR elevated
- X-ray: Narrow disc space
- Bone scan: sensitive, not infallable

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Sacroiliitis

- Back pain
- FABER +
- Same Labs as septic arthritis
- No aspiration
- Medically treated
- Prognosis good

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Tropical Myositis

- Staph aureus in muscle
 - Fever
 - WBC, ESR, CRP increased
 - Joint/Bone studies negative
 - MRI can be most helpful
- Prolonged illness
- Multiple abscesses common
- Surgical, medical treatment needed

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Appendicitis

- Can be mistaken for hip/SI infection
- Index of suspicion
- Sympathetic hip joint effusion
- Aspirate: Negative for infection
- Abdominal CT

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TB Spine

- Onset insidious
- Collapse of vertebral body first
- Multiple levels common
- Treatment usually medical
- Surgery for neurological symptoms

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TB Hip/Other joints

- Insidious onset
- Painless limp
- Fevers variable
- Destruction of both sides of joint

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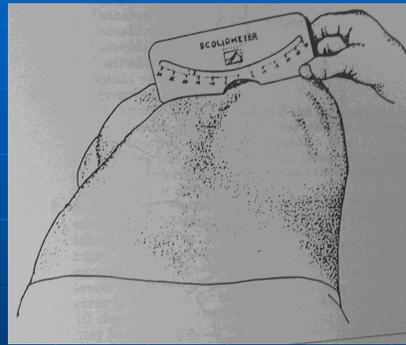
Scoliosis

- Idiopathic
- Congenital
- Paralytic
- Functional
- Hysterical
- Discogenic
- Traumatic
- Tumor

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Idiopathic Scoliosis

- Cause unknown
- Structural curve $> 10^\circ$
- Screening: Adam's forward bend test
- Scoliometer
- Common Curves: R thoracic/ L lumbar
- Not painful



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Scoliosis Progression

- Associated with:
 - Size of Curve
 - Rate of growth
 - Growth remaining (Risser Sign)

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Scoliosis Pitfalls

- Failure to examine back!
- Over-referral
 - Leg length discrepancy
 - Scoliometer $\geq 7^\circ$ suggests curve $> 20^\circ$
- Unusual curve pattern (left thoracic)
 - Refer to Pedi Ortho specialist
 - Neuro exam (abdominal reflex)
 - MRI spinal cord

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Scoliosis Surgery

- Curves **>40 degrees**
- Segmental fixation
- Autologous blood
- 5 to 6 days hospital
- Skeletally immature-Ant/Post
- Superior mesenteric syndrome
 - Early, day 3
 - Late (typical), day 5-7

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Congenital Scoliosis

- Errors in vertebral development during embryogenesis
 - Failure of Formation
 - Failure of Segmentation
- **Associated anomalies:**
 - 20% **urinary tract**
 - 25% **cardiac**

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Radial Head Dislocation

- Idiopathic vs Syndrome
- Prominence lateral elbow
- ROM restricted to some degree
- Observation +/- surgery at maturity

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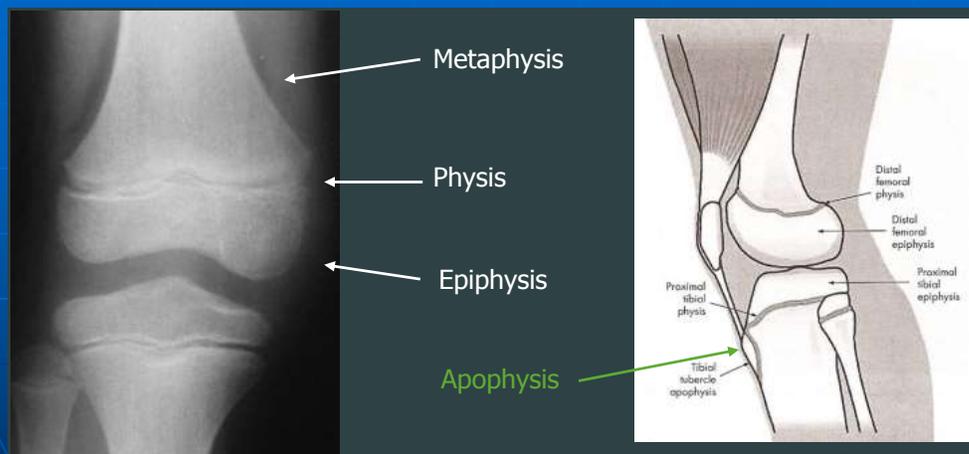
Tibial Bowing

- **Posteromedial** (wait till the PM)
 - Idiopathic
 - Limb Length Inequality
 - Observation
 - Equalization procedures
- **Anterolateral**
 - Congenital pseudoarthrosis
 - Neurofibromatosis
 - Protect
 - Multiple operations



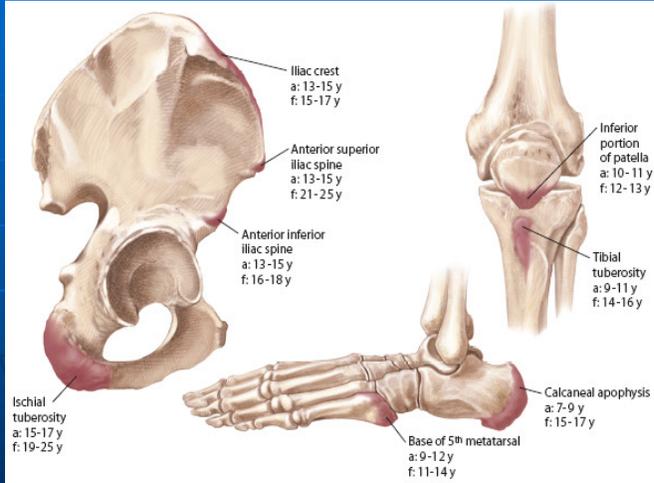
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Skeletally Immature



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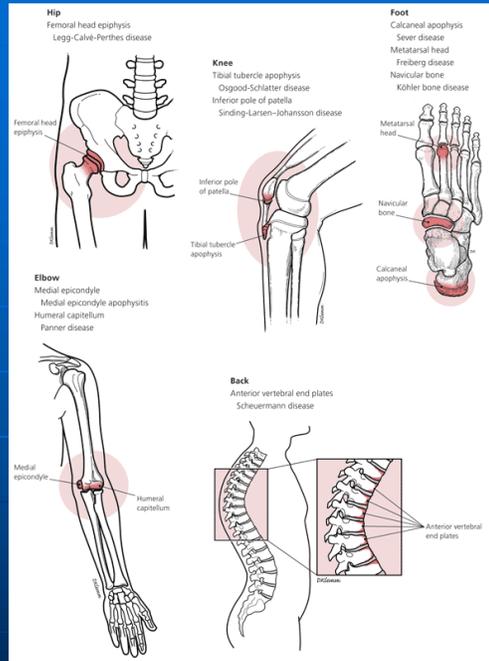
Apophysitis



- Sever's Disease
- Iselin's
- Sinding-Larsen-Johansson
- Osgood-Schlatter

107

"Osteochondrosis"



108



Fractures...

...or "children are NOT just small adults"

—Mercer Rang

109

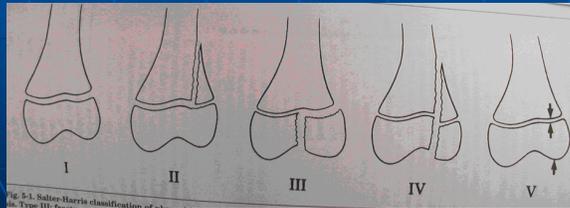
Fractures

- Stronger in tension
- Periosteum thick
- Elastic physiology
- Growth plates weak link
- Growth arrest
- Remodeling

110

Salter Harris Classification

- I Physis only
- II Physis + Metaphysis
- III Physis + Epiphysis
- IV Physis+Metaphysis+Epiphysis
- V Physis Crushed
- (VI) Peripheral physis



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“Trivial” Fractures

- Nurse Maid Elbow
- Clavicle
- Humerus
- Toddler fx: tibia
- Torus
 - Bone fails in compression
 - Deformity usually minimal
 - Heal in 3 to 4 weeks
 - Growth arrest very rare

113

Birth fractures

- Clavicle
- Humerus



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Dangerous Fractures

- Humeral supracondylar
- Lateral condyle fracture of elbow
- Peri-articular
- Femoral neck
- Knee
- Ankle



115

Compartment syndrome

How many "P's" ?

1. Pain
2. Pallor
3. Paresthesia
4. Paralysis
5. **Poikilothermia**
6. **Pulselessness**

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Compartment syndrome

- Elbow, knee, tibia, ankle
 - Pain out of proportion
 - Pain w/ passive motion
 - Motor loss
 - Sensory +/- loss
- Pulses - **often normal**
- Capillary refill - **often normal**
- Index of suspicion - **HIGH**

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Amputations

- Amniotic bands
- Failure of formation
 - Transverse (amputation)
 - Longitudinal (Hemimelia)
 - Intercalary (Phocomelia)

118

Systemic

- Bone dysplasias
 - Mucopolysaccharidosis
 - Achondroplasia
 - Diastrophic
 - MED
 - OI
 - Vitamin D dependent rickets
- Osteochondromatosis
- Enchondromatosis
 - Ollier's disease
 - Maffuci's disease

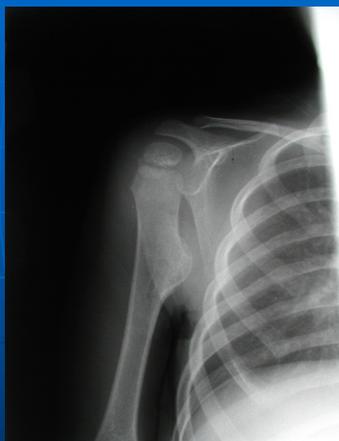
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Neoplasia

- Benign
 - Borders well defined
 - No periosteal reaction
 - No endosteal reaction
 - Deformity of bone sharp/defined
- Malignant
 - Vague borders
 - Periosteal reaction new
 - Endosteal destruction permeative
 - Matrix mottled, irregular

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Osteochondroma



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Neoplasia

- Caffey's
 - Onion skinning
 - Diaphyseal, total
 - Mimics infection/Ewings

122

Neoplasia

- Eosinophilic Granuloma
 - Sclerotic border
 - Lytic center
 - Faded border
 - Periosteal elevation possible
 - Vertebra Plana unique to this
- Mimics
 - Infection
 - Tumor (Ewings, neuroblastoma,
 - Ewings, neuroblast., lymphoma

123

Neoplasia

- Ewings
 - Diaphyseal
 - Permeative destruction
 - Periosteal elevation
- Mimics
 - Infection
 - Caffey's
 - EG

124

Neoplasia

- Osteoid osteoma
 - Sclerotic border
 - Lytic center (Target)
 - Faded border
 - Periosteal rxn rare
 - Mimics
 - infection
 - EG

125

Leukemia

- Periphyseal lysis
- Multiple bones
- Vertebral compression

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Neuromuscular

- Cerebral palsy
 - Quadriplegic
 - Hemiplegic
 - Diplegic
 - Spastic/Athetoid
- Myelomeningocele
- Tethered Cord

127

Neuromuscular

- Prader-Willi
- Down's

128

Neuromuscular

- Muscular dystrophy
- Charcot-Marie-Tooth
- Myotonic Dystrophy
- Arthrogryposis
- Benign congenital hypotonia
- Guillian-Barre Syndrome

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Nutritional

- Rickets
- Vitamin D Toxicity
- Scurvy
- Diffuse Periostitis
 - Prostaglandin E infusion
 - Syphilis
 - Vit D Toxicity
 - Caffey's

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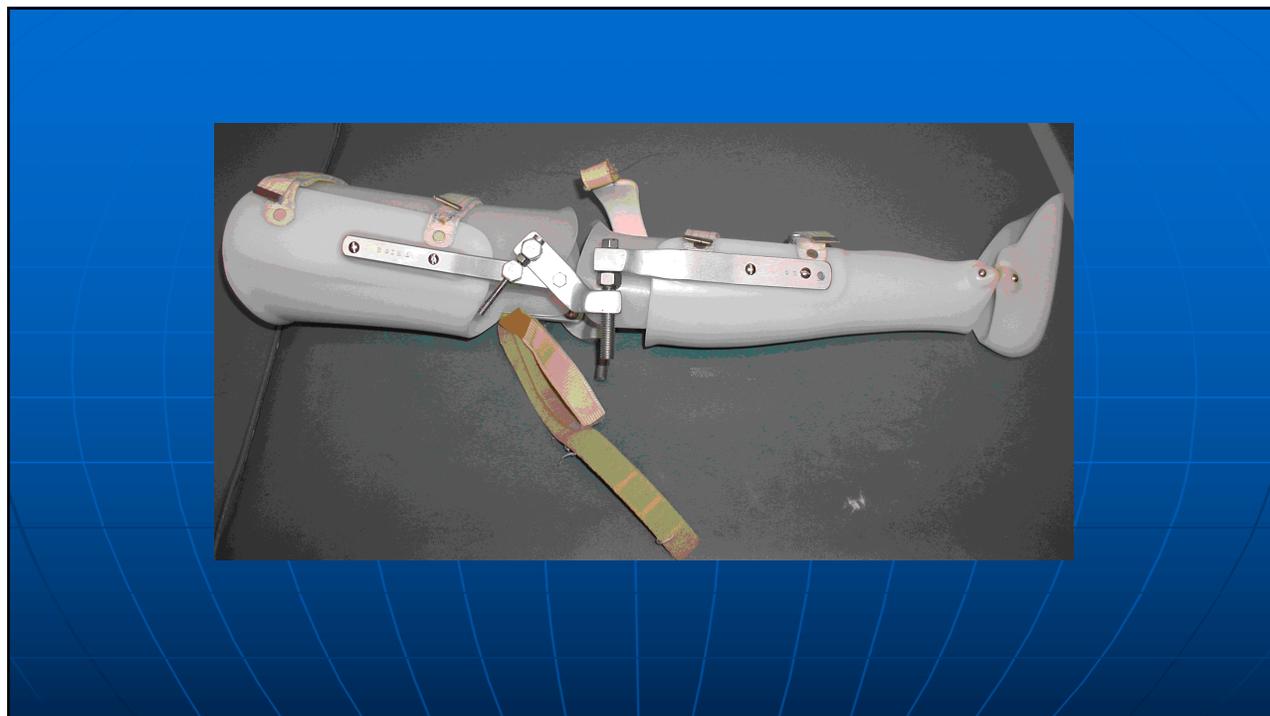
Shoes, Braces and Things

- AFO, KAFO, etc
 - Named for joint controlled
 - Custom or off "the shelf"
 - Solid or hinged, plastic or metal
 - Functional, retentive or corrective
- Twister cables
- Internal Tibial Torsion Brace
- Dennis - Browne Bar

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Thank You!

137

A word about NAT...

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Battered Child (NAT)

- History
 - Delay in eval
 - Vague, inconsistent history
 - Unobserved injury
 - Repeated visits
- Fracture: none pathognomonic
 - Humerus/tibia fx in < 1 year old
 - Femur fracture, transverse esp.
 - "Corner fracture"

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Myth

- Easy to recognize child with NAT



FIG. 3. Third most common type: femur, transverse, middle third.

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Recognition of NAT Important

- Unrecognized and return to home -
25% risk of serious injury, 5% risk of death
- Recognize and get child into safe environment
- Abuse second leading cause of mortality in infants and children

141

How Widespread a Problem?

- 1 - 1.5% of children are abused per year
- 70,000 - 2,000,000 children are abused annually in US.

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“Quoted” Risk Factors for NAT

- Young
- First born children
- Premature infants
- Disabled children
- Stepchildren
- Single-parent homes
- Drug - abusing parents
- Families with low income
- Children of parents who were abused

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Signs of NAT

- Inconsistent history of injury
- Delay in presentation
- Reported mechanism of injury insufficient to explain injury
- Parents/caregivers may be hostile or indifferent

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Evaluation

- Team approach helpful - pediatrician, medical social worker, subspecialties, law enforcement, government child protection agencies
- Orthopaedic surgeon may be alone in recognition and documentation

145

Risk Factors

- Children of all ages, socioeconomic backgrounds, family types may be subjects of abuse
- Up to 65% may have only isolated long bone fracture



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Child Abuse - Epidemiology

- >1 million children/year are victims of abuse and/or neglect
- >1,200 deaths/year
- Fractures are 2nd most common presentation of physical abuse
- 1/3 of abused children eventually seen by orthopaedic surgeon

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Fractures in Abused Children

- 25-50% of children with documented NAT will have fx's
- 31% of child NAT victims had fx's

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Isolated Long Bone Fracture

Loder, JPO 1991

- Most common orthopaedic presentation of children with NAT - 65% of children with fx's
- Only 13% of children with fractures presented with multiple fractures in different stages of healing

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NAT Fx Pattern

- Most are similar to accidental trauma fracture patterns
- Must rely on other factors, history, physical examination, etc...
- Age of child with specific fx's

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Associated Features of NAT

- Multiple fractures in different stages of healing
- Soft tissue injuries - bruising, burns
- Intraabdominal injuries
- Intracranial injuries

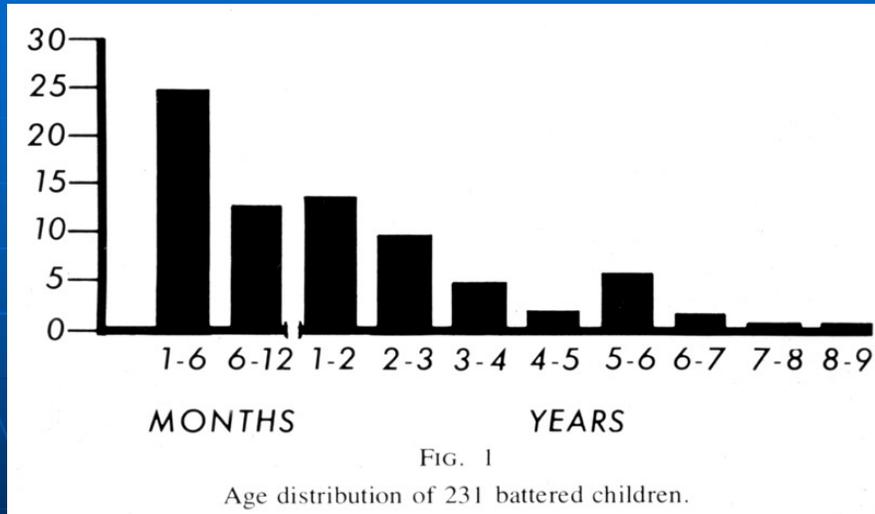
151

Flags for NAT

- AGE of Patient
- History
- Social Situation
- Other injuries (current and past)
- Specific injuries/ fractures

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Age of Battered Children



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Who is at Risk?

- Most children with NAT fractures - age of < 3 years

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Who's at Risk?

- Most femur fx's in children who are < 1 yo of age are from NAT (60-70%)
- Most femur fx's in children > 1 yo accidental



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Features that Increase Chance of NAT

- Inappropriate clinical hx
- Failure to seek medical attention
- Discovery of fx in healing state

156

History

- Is the injury consistent with the explanation given?
- Is the explanation consistent with the child's level of development?
- Does the story change between caregivers? between child and caregiver?

157

History

- Has there been a delay in seeking medical treatment?
- Is the parent reluctant to give an explanation?
- Drug or alcohol abuse?
- Parents in abusive relationships?

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History

- Is the affect inappropriate between the child and the parents? (lack of concern, overly concerned)
- Poor compliance with past medical treatment
- Adults were victims of child abuse
- Families under stress (loss of job, etc..)

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History - Associated Risks

- Children born to adolescent parents
- Children who suffer from colic
- The abused child may be overly compliant and passive or extremely aggressive
- Role reversal

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Physical Examination

- Undress the child
- Look for areas of bruising
 - Bruises at different stages of healing

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Physical Examination

- Careful search for signs of acute or chronic trauma
- Sign - bruises, abrasions, burns
- Head - examine for skull trauma, palpate fontanelles if open, consider funduscopic exam for retinal hemorrhage
- Trunk - palpate rib cage, abdomen
- Extremities - careful palpation
- Genitalia - consider exam for sexual abuse

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Fractures Commonly seen in NAT - High Specificity

- Femur fracture in child < 1 year old
- Humeral shaft fracture in < 3 year old
- Sternal fractures
- Metaphyseal corner (bucket-handle) fractures
- Posterior rib fxs
- Digit fractures in nonambulatory children



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Radiographic W/U

- Skeletal survey for children with suspicion of NAT
- "Babygram" not sufficient as does not provide necessary detail to identify fractures

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Myths

- Spiral Fractures have a high association with NAT
- Actually commonly seen accidental fx pattern



FIG. 4. Fourth most common type: femur, spiral, middle third. Considered by many authors to be the classic type.

165

Humerus Fx's

- Diaphyseal fx's in children < 3 yo are very suggestive of NAT!!!!!!



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Management - NAT Suspected

- Professional, tactful, nonjudgmental approach in initial encounter and workup
- Explain workup to parents as standard approach to specific ages/injury patterns
- Early involvement of child protection team if available
- Early contact/involvement of child's primary care physician

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Management - Documentation

- Many cases result in medical records becoming part of legal record
- Carefully document history, physical exam and radiographic findings
- Document evidence supporting physical abuse
- Document statement regarding level of certainty of abuse

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Legal Aspects of NAT

- All states require reporting of suspected cases of abuse by medical professionals
- Need only reasonable suspicion to report suspected maltreatment
- Law affords immunity from civil or criminal liability for reporting in good faith

169

Differential Diagnosis - NAT Fractures

- Accidental trauma
- Osteogenesis Imperfecta
- Metabolic Bone Disease (rickets, etc.)
- Birth trauma
- Physiologic periostitis



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Summary

- Isolated diaphyseal fx's common in NAT and accidental trauma
- Remember other factors, history, physical examination



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NAT Summary

- Humerus diaphyseal fx's < 3 yo are almost always associated with NAT
- Femur fx's < 1 yo are usually due to NAT

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The Bottom Line

- Causes of nontraumatic orthopedic emergencies vary with age.
- Always examine the hips in patients with knee pain.
- Radiographs are often needed to establish the diagnosis.
- Not all elbow fractures are the same
- Prompt orthopedic referral for specific conditions
- Always keep NAT in the back of your mind...

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Acknowledgments

- [www.](#) (almost anything you can imagine!)
- APLS Pediatric Emergency Medicine Resource
- OTA

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Thank You!

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