Diagnosing Child Abuse: the Role of the Radiologist

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Child Abuse: The Epidemic

- 2004: 152,250 children/adolescents confirmed victims of physical abuse in the United States
- Child abuse is a medical/public health issue: victims of child abuse more likely to develop long term mental, physical, emotional disabilities
- Mandated reporting of suspected child abuse
- Radiologists often the first to suspect/diagnose child abuse

Our Patient: AS

- 3 month old female brought to CHB from OSH for new onset seizures and lethargy
- Father’s story: AS left unrestrained in babychair on floor. Father returns after 2 minutes to find baby being dragged on the floor by 2-year-old brother. AS started seizing and was brought to ED.
- CT as part of seizure workup
Patient AS: Parietal Bone Fracture

Axial C- CT, Bone Window

Images courtesy of Dr. Paul Kleinman & Dr. Jay Pahade, Children’s Hospital Boston
Patient AS: Suture Diastasis

Axial C- CT, Bone Window

Images courtesy of Dr. Paul Kleinman & Dr. Jay Pahade, Children's Hospital Boston
Patient AS: Soft Tissue Hematoma

Axial C- CT, Bone Window

Images courtesy of Dr. Paul Kleinman & Dr. Jay Pahade, Children's Hospital Boston
Patient AS: Subdural Hematoma

Images courtesy of Dr. Paul Kleinman & Dr. Jay Pahade, Children's Hospital Boston

Axial C- CT, Brain Window
Patient AS: Left Temporoparietal Subdural Hematoma

Images courtesy of Dr. Paul Kleinman & Dr. Jay Pahade, Children's Hospital Boston
Patient AS: Loss of Gray/White Matter Differentiation

Images courtesy of Dr. Paul Kleinman & Dr. Jay Pahade, Children's Hospital Boston

Axial C-CT, Brain Window
Patient AS: Effacement of Left Lateral Ventricle

Images courtesy of Dr. Paul Kleinman & Dr. Jay Pahade, Children's Hospital Boston
Patient AS: Sulcal Effacement

Images courtesy of Dr. Paul Kleinman & Dr. Jay Pahade, Children's Hospital Boston

Axial C- CT, Brain Window
While C-CT is the test of choice for detecting acute intracranial hemorrhage, MRI is more sensitive for detecting subacute and chronic hemorrhage.
Patient AS: Petechial Hemorrhage

Images courtesy of Dr. Paul Kleinman & Dr. Jay Pahade, Children's Hospital Boston
Non-Accidental Head Injury (NAHI)

- Head trauma is the leading cause of child abuse fatalities
- Injury by direct contact and/or by indirect forces of acceleration/deceleration
- Constellation of injuries include: retinal hemorrhages, subdural hematoma (SDH), intracerebral contusions, diffuse cerebral edema
- Variety of presentations: vomiting, lethargy, seizures, respiratory distress, mild changes in mental status, asymptomatic
The Skeletal Survey Performed to Evaluate for Fractures in Suspected Child Abuse

- Skull: AP and lateral
- Spine: AP and lateral
- Chest: AP, right posterior oblique, left posterior oblique
- Pelvis and hips: AP
- Lower extremities: AP and frog lateral
- Upper extremities (shoulder through wrist): AP
- Hands: PA
- Feet: AP
- Sternum: lateral

Fractures Specific for Child Abuse: Low Specificity

- Subperiosteal new bone formation
- Clavicular fractures
- Long bone shaft fractures
- Linear skull fractures
Fractures Specific for Child Abuse: Moderate Specificity

- Multiple fractures, especially bilateral
- Fractures of different ages
- Epiphyseal separations
- Vertebral body fractures and subluxations
- Digital fractures
- Complex skull fractures
Fractures Specific for Child Abuse: High Specificity

- Classic metaphyseal lesions
- Rib fractures, especially posterior
- Scapular fractures (including acromion)
- Spinous process fractures
- Sternal fractures
The Classic Metaphyseal Lesion (CML)

- Most common in children less than 2 years of age
- Results from shaking of extremities or chest
- Most often in distal femur, proximal tibia, distal tibia, proximal humerus
- Reflects shearing injury extending through primary spongiosa of the metaphysis

The Classic Metaphyseal Fracture (CML): Corner Fracture

• Reflects shearing injury extending through primary spongiosa of the metaphysis
• Most often in distal femur, proximal tibia, distal tibia, proximal humerus
• Results from shaking of extremities or chest
• Most common in children less than 2 years of age

The Classic Metaphyseal Fracture (CML): Bucket Handle Fracture

Patient AS: Healing Corner CML of Proximal Tibia

Images courtesy of Dr. Paul Kleinman & Dr. Jay Pahade, Children’s Hospital Boston
Patient AS: Transverse Fracture of Left Acromion

Images courtesy of Dr. Paul Kleinman & Dr. Jay Pahade, Children's Hospital Boston
Patient AS: Callus Formation

Images courtesy of Dr. Paul Kleinman & Dr. Jay Pahade, Children's Hospital Boston
Patient AS: Healing Fractures of Posterior Ribs on CXR

Images courtesy of Dr. Paul Kleinman & Dr. Jay Pahade, Children’s Hospital Boston
Skeletal Survey vs. Scintigraphy

**Skeletal survey** is more sensitive for detection of...
- healed/healing injuries
- skull fractures, spinal fracture and scapular fracture
- Better able to evaluate type of lesion

**Scintigraphy** is more sensitive for detection of...
- Occult skeletal injuries in early stages
- Rib fractures, acute nondisplaced long bone fractures, subperiosteal hemorrhage
- Soft tissue injuries
- Will not pick up healed fractures
- More expensive and difficult to interpret
- Higher radiation exposure
- Often requires sedation of child patient

Recommendation: Bone Scintigraphy used as Adjunct to Skeletal Survey
Patient AS: Increased uptake on F-18 Bone Scintigraphy

Fractures detected on plain film and scintigraphy.

Additional fractures detected on scintigraphy but not on plain film.

Images courtesy of Dr. Paul Kleinman & Dr. Jay Pahade, Children's Hospital Boston
The previous slide illustrates the increased sensitivity of scintigraphy over plain film for new fractures.
Patient AS: Additional Fracture Detected at Two Week Follow-Up

Images courtesy of Dr. Celeste Wilson, Children's Hospital Boston
Two week follow-up skeletal survey can reveal additional fractures that may not have been apparent on prior plain film because of the young age of the fracture.
## Differential Diagnosis of Child Abuse

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<th>Subdural Hemorrhage or Fluid</th>
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Osteogenesis Imperfecta

- Rare: 1/20,000 births
- Generalized disorder of type I collagen affecting bone, ligaments, skin, sclera, dentin
- Consider OI if:
  - abnormal bone fragility with osteoporosis
  - Wormian bones
  - Joint laxity
  - Abnormal skin texture
  - Blue sclera
  - Defective dentition (dentinogenesis imperfecta)
  - Hearing loss
Companion Patient 1: Osteogenesis Imperfecta

- Osteopenia
- Multiple Fractures
- Soft bone leading to multiple bowing deformities

OI vs. Child Abuse

Companion Patient 1 with confirmed OI

Osteopenic bone with anterior bowing deformity

Patient AS

Normal bone with CML
Patient AS: Building a Case for Child Abuse

- High Index of Clinical Suspicion
  - Story of accidental injury inconsistent with type and pattern of injuries

- Gathering the Evidence
  - Rule out metabolic causes
  - Several radiographic findings highly specific for child abuse

- Protect the child
  - DSS involvement
  - Temporary custody till trial
Patient AS: Fractures Incurred

High Specificity

- Classic metaphyseal lesions
- Rib fractures, especially posterior
- Scapular fractures (including acromion)
- Spinous process fractures
- Sternal fractures

Moderate Specificity

- Multiple fractures, especially bilateral
- Fractures of different ages
- Epiphyseal separations
- Vertebral body fractures and subluxations
- Digital fractures
- Complex skull fractures

Common but Low Specificity

- Subperiosteal new bone formation
- Clavicular fractures
- Long bone shaft fractures
- Linear skull fractures
Acknowledgements

- Dr. Paul Kleinman
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- Dr. Jay Pahade
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References