Making a Difference by Protecting the Future: How to Diagnose Child Abuse Radiologically

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Definition & Epidemiology

- Includes physical, sexual, & psychological abuse; most common form: neglect

- Estimated 4 million cases/yr (probably <1/2 of all cases are reported, though)

- At least 2,000 child deaths annually in U.S.
Distribution of 165 inflicted fractures in 31 infant fatalities

What to Get

(i.e., the Abuse Skeletal Survey)

- Chest
- Skull (+laterals)
- Humeri
- Forearms
- Hand
- Pelvis
- Femurs
- Tibia/Fibula
- Ankles (+ laterals)
- Feet

_In children 1 year or younger, also get lateral thoracolumbar spine film..._
Four standard views

Two lateral

*Radiology in Ped Emer Med, Vol. 5, Case 9*
Suture Workshop

C = Coronal

S = Sagittal

L = Lamboidal

P = Parietomastoid

O = Occipitomastoid
Children’s Hospital Patient 1

- 3-month-old boy
- p/w apneic spells and bradycardia

Hx: per mother, pt fell from her arms ~2 ft to ground; no LOC or external bleeding
PE

- comatose child
- fixed & dilated left pupil
- b/l retinal hemorrhages
- rt. ankle clonus
Children’s Patient 1: Lateral Skull

*Widening of Parietomastoid sutures* ➔ *↑ICP*
Companion Patient A: 2 month-old who “fell off bed twice”

*Radiology in Ped Emerg Med, Vol. 5, Case 9*
Right Parietal Skull Fracture

Radiology in Ped Emerg Med, Vol. 5, Case 9
Companion Patient B: 2 mo
girl p/w “scalp swelling”

“Eggshell” multiple skull fx’s

highly suggestive of child abuse
Companion Patient C: 7-month-old boy brought to ED

- mother came home from work and found him seizing
Rt-sided Cerebral Edema +

Posterior Interhemispheric Subdural Hematoma

typically caused by shaking

most common CNS injury in child abuse

From the Child Abuse Referral and Education (CARE) Network
Subacute or chronic subdural hemorrhages (less dense than brain) & contusion along the falx anteriorly & posteriorly

From Children’s Hospital Radiology Teaching File
Companion Patient D: 1 yo brought in by ambulance comatose

From the Child Abuse Referral and Education (CARE) Network
Diffuse Cerebral Edema

Both hemispheres v. low in attenuation (dk gray). Cerebral hemispheres = darker than the cerebellum, thalami, and basal ganglia...

“Reversal sign” or “bright cerebellum sign”: severe anoxic brain injury w/ resultant swelling

From the Child Abuse Referral and Education (CARE) Network
Dx: Diffuse Cerebral Edema

This child was violently shaken, causing severe brain injury and permanent impairment. Prognosis = poor.

DDx: shaking alone and/or violent impact, strangulation, drowning, post-traumatic apnea

From the Child Abuse Referral and Education (CARE) Network
Companion Patient E: 4-month-old w/ shaken baby syndrome

Radiology in Ped Emer Med, Vol 5, Case 7
Frontal subacute (or chronic) subdural effusions

Acute Rt. Temporo-parietal subdural hematoma

Small am’t blood in interhemispheric fissure

Radiology in Ped Emer Med, Vol 5, Case 7
Companion Patient F: 3 yo boy poorly responsive

Paramedics note agonal respirations; Glasgow Coma Score = 3, pupils fixed & dilated

Radiology in Ped Emer Med, Vol 3, Case 14
Retinal Hemorrhages

Post Interhemispheric subdural hematoma
Companion Patient G: 15 mo-old child w/ sz d/o x 4 months, developmental delay

From the Child Abuse Referral and Education (CARE) Network
Repetitive Brain Injury

B/l subdural hematomas (or different ages)

Enlargement of ventricles (atrophy)

More recent hematoma (more gray)

From the Child Abuse Referral and Education (CARE) Network
Normal Chest Wall Anatomy

1 – Rib Head
2 - Tubercle
3 – Transverse Process

Darker areas = generous cartilaginous apophyses

*Courtesy of Paul Kleinman, M.D. (Diagnostic Imaging of Child Abuse, 2\textsuperscript{nd} Edition, 1998, p.111)*
Chest Wall Mechanism of Injury

“Excessive leverage of the posterior ribs over the fulcrum of the transverse processes” ➔ fractures at arrow sites

Companion Patient H:

Has this 3 month old been harmed?

From the Child Abuse Referral and Education (CARE) Network
Compression injury: body of L1

Angulation at T12-L1 due to tearing of posterior spinal ligaments

Injury to bony and ligamentous elements = permanent

Injuries at thoracolumbar junction relatively common in abuse—especially shaken infant syndrome!
Children’s Hospital Patient 2

- 3 mo girl w/ unknown PMH
- Presented to pediatrician w/ diarrhea
- As part of her w/u, a KUB was performed
Children’s Patient 2:

*Healing Anterior Rib Fx’s*

*Posterior Rib Fx’s*

Courtesy of Dr. Paul Kleinman, Children’s Hospital
Children’s Patient 1: AP film

From Children’s Hospital
Patient 1: AP film

Fx of left Clavicle (< 2 wks old)

Fx of Rt 1st Rib (but no callus has appeared yet)

From Children’s Hospital
Companion Patient I: 3-mo-old
p/w abdominal pain, emesis

From the Child Abuse Referral and Education (CARE) Network
Dx: Multiple Healing Fx’s

Rt post 5th-7th and 9th Rib Fx’s

Rt lateral rib Fx’s

From the Child Abuse Referral and Education (CARE) Network
Children’s Pt 3: 3 mo boy from Children’s s/p Rt mainstem intubation

Courtesy of Chad Brecher, M.D., BIDMC
Incidental finding: Posterior Rib Fx’s!

Courtesy of Chad Brecher, M.D., BIDMC
Companion Patient J: 4-mo-old p/w cough; chest X-ray request says “rule-out PNA”

Left 7th rib posterior Fx

From the Child Abuse Referral and Education (CARE) Network
4-mo-old w/ failure-to-thrive

Healing multiple left- and right-sided lateral rib fractures

From the Child Abuse Referral and Education (CARE) Network
Children’s Patient 2: RPO

Courtesy of Dr. Paul Kleinman, Children’s Hospital
Pelvic Fx

(very rare, but essentially pathognomonic)

Courtesy of Dr. Paul Kleinman, Children’s Hospital
**Patient 2: Femur films**

- Involves damage to the primary spongiosum across the metaphysis; **CML’s = Classic Metaphyseal Lesions**

- **“Corner Fx’s”**

*NB: “Bucket-handle Fx” would be seen with a caudally or cranially angulated projection*

_Courtesy of Dr. Paul Kleinman, Children’s Hospital_
Patient 2: Left Femur Film

Additional “corner fx’s” on distal femur

Courtesy of Dr. Paul Kleinman, Children’s Hospital
Patient 2: Lateral knee films

- Corner Fx of proximal Tibia
- “Bucket-handle” Fx of distal Femur

Courtesy of Dr. Paul Kleinman, Children’s Hospital
“Bucket-handle” Fracture

From the Child Abuse Referral and Education (CARE) Network
Companion Patient K: 4-mo-baby w/ brain injury suspicious for child abuse.

- Skeletal survey was performed to eval for other injuries of abuse

- Again, corner fx of distal femur

*From the Child Abuse Referral and Education (CARE) Network*
Companion Patient L: 3 mo sibling of an older abused child

From the Child Abuse Referral and Education (CARE) Network
Children’s Patient 1: Tibia films

Left Tibia w/ “corner Fx”
Pt 1: Femur Films

From Children’s Hospital
Pt. 1: Femur Films

Nl left femur

Rt femur w/ mature periosteal reaction

Indicates sub-periosteal bleeding ~4 wks earlier;
DDx includes Hypervitaminosis-A and Infantile Cortical Hyperostosis (Caffey’s Dz)

From Children’s Hospital
When Plain Films Just Aren’t Enough…

Companion

**Patient M:** 11-mo-girl w/ ?rt-sided posterior rib fx’s at a recent skeletal survey

*From the Child Abuse Referral and Education (CARE) Network*
Excellent for detecting difficult-to-see post rib Fx’s (as seen here)

Left humerus spiral fx

From the Child Abuse Referral and Education (CARE) Network
DDx for Multiple Fractures:

- Osteogenesis Imperfecta
- Congenital Indifference to Pain
- Menke’s Kinky-Hair Syndrome
- Metabolic Bone Disease
Companion Patient M: Another Case of Abuse?

- 2-mo-boy p/w CC of “crying and fussiness” x 1.5 hrs

- Brought in to ED by parents, who had just returned from shopping w/ baby and who deny any h/o trauma
FHx:

Multiple Fx’s, malformations, scoliosis, and “bow legs”
Add’l view demonstrating Oblique Spiral nature of the Fx

Dx: Osteogenesis Imperfecta Type IV

Type I = most common; 1/30,000; auto dom.

Type II = lethal; defective type I collagen synthesis.

Type III = auto rec; few survive past cardioresp complications.
Other radiographic evidence: Abd CT

**Companion Patient N:** 20-mo-girl admitted for eval of low hematocrit

From the Child Abuse Referral and Education (CARE) Network
Adrenal Hematoma

From the Child Abuse Referral and Education (CARE) Network
Add’l Abuse Imaging: Upper GI

Companion

Patient O: 3 ½ yo boy p/w 4-day h/o persistent post-prandial emesis and abd pain.

From the Child Abuse Referral and Education (CARE) Network
Duodenal Hematoma

- Relatively common injury of abuse
- Typically in older children kicked or punched in abd
- Unusual injury in children < 2 yo

From the Child Abuse Referral and Education (CARE) Network
Take-home Points

- **Look and Listen** for Inconsistent or suspicious hx

- **Skeletal**: Rib Fx’s, CML’s (“corner” & “bucket-handle”), spine; multiple fx’s; differing ages; any fx inconsistent w/ child’s developmental hx
Take-Home Points

**Head**: Subdural hemmorrhages, cerebral edema, multiple/”eggshell” fx’s

**Abd**: duodenal or jejunal hematoma, bowel lac
References

• Caffey J. Multiple fractures in the long bones of infants suffering from chronic subdural hematoma. AJR 1946, 56:163-173.
• Kleinman PK, Marks SC, Adams VI, Blackbourne BD. Factors affecting the visualization of posterior rib fractures in abused infants. AJR 1988; 150:635-638.
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