Trauma X in the Infant

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Infant Abuse

• In 2004, approximately 872,000 children were victims of child abuse or neglect.
• Children under 1 year of age accounted for 45% of these victims.
An Incidental Finding

- 2 month old boy with 2 days of bilious vomiting immediately after feedings
- KUB done at OSH to r/o SBO; possible dilated loop of small bowel and question of healing posterior R 6th rib fracture
- Transferred to CHB for further evaluation of emesis and possible nonaccidental trauma
Initial Evaluation at CHB

- Repeat KUB showed paucity of gas, but a normal UGI study ruled out volvulus
- However, KUB also demonstrated multiple rib fractures
Our pt: Multiple rib fractures on KUB

Healing fracture on lateral rib with soft tissue swelling

Image courtesy of Dr. Velez and Dr. Hines-Peralta, Children’s Hospital Boston
Our pt: Multiple rib fractures on KUB

Healing posterior rib fracture with large callus

Image courtesy of Dr. Velez and Dr. Hines-Peralta, Children’s Hospital Boston
Concern for Child Abuse

**High specificity:**
- Classic metaphyseal lesions
- Rib fractures, especially posterior
- Scapular fractures
- 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

Injuries Characteristic of Infant Abuse

- Rib fractures, especially posterior
- Classic metaphyseal lesions
- Subdural hemorrhage

- Any fracture in a non-ambulating infant is concerning to some degree
Full Trauma X Workup Begun

- Child Protection Services contacted
- Patient admitted overnight
- Guard stationed outside room to prevent flight
- Mother denies abuse; says no one else in house has abused the child
What tests to order?

• **Skeletal survey:**
  - ACR/AAP recommendations: 19 plain films covering entire body
  - all abnormal areas should be viewed in 2 projections
  - Oblique views of thorax if rib fractures suspected
  - Four views of skull if fractures suspected (frontal, 2 lateral, Towne’s for occipital injury)
  - Role of scintigraphy: not part of routine survey but helpful for identifying otherwise overlooked rib fractures

• **Neuroimaging:**
  - CT to evaluate acute hemorrhage
  - MRI if CT positive or if CT negative but strong suspicion of intracranial injury
Our pt: Formal Skeletal Survey

- Posterior fractures of ribs 5 and 6
- Lateral fracture of rib 5
- Right clavicular fracture

Image courtesy of Dr. Velez and Dr. Hines-Peralta, Children's Hospital Boston
Rib fractures in infant abuse

• Typically result from two hand anteroposterior compression of the rib cage

• Common fracture patterns:
  – Bilateral
  – Located at the same position on adjacent ribs
  – Multiple fractures in one rib
Rib fractures in infant abuse

- **Posterior**: lever effect, ventral surface first
- **Lateral**: buckling effect, medial to lateral
- **Anterior**: costochondral junction

Identifying rib fractures

- Acute rib fractures can be very difficult to see, especially if they are incomplete, nondisplaced, or oblique to the x-ray beam
  - Importance of oblique views and perhaps bone scintigraphy

- Role of callus formation
  - E.g. lateral rib fractures appearing outside pleural margin
  - Costochondral junction fractures are probably more common than we think because there is little new bone formation afterwards
Rib fractures and CPR

- Extremely rare in otherwise healthy babies
- Posterior rib fractures do not occur with CPR, making them pathognomonic for child abuse
The Classic Metaphyseal Lesion

- A classic injury in child abuse, especially in infants
- Occurs when the child is twisted or pulled by an extremity or shaken entirely, causing shearing injury
- A series of microfractures through the most immature part of the metaphysis, the primary spongiosa, curving upward at the end to undercut the subperiosteal bony collar

Corner or Bucket Handle Fracture?

How to spot a healing CML: Companion patient #1

- Most reliable sign: extension of physeal lucency into the metaphysis (hypertrophic chondrocyte activity due to vascular disruption at chondro-osseous junction)
- +/- fracture line, sclerosis

MedPix Medical Image Database, http://rad.usuhs.edu/medpix/medpix_home.html
The Great Imitators

- **Rickets**: metaphyseal fractures, subperiosteal new bone formation
- **Metabolic bone disease of prematurity**: ribs, long bones
- **Osteogenesis imperfecta**: diaphyseal fractures most common; metaphyseal fractures occur, but don’t look like CMLs
  - typically have diffuse osteopenia and bowing deformities; blue sclerae in type I
The Great Imitators

• **Congenital syphilis**: lesions may look identical to CMLs

• **Accidental trauma**: especially long bone fractures
  - Important to consider child’s age in the context of the history provided

• **Obstetric trauma**: most commonly clavicle fractures
  - Callus formation is rapid and extensive; if child is >11 days old without callus formation, injury is not birth-related
Intracranial injury

- The most common and specific form of intracranial injury in infant abuse is the subdural hematoma
- “Shaken baby” theory of shear injury
- Typically crescentic or parafalcine
Radiologic Imaging of SDHs

• **Acute** SDHs are best evaluated on **noncontrast CT**
  - Hyper→ hypoattenuated over weeks
  - For acute SDHs in the parafalcine area, coronal reformation CT images or ultrasound are often necessary

• **MRI** is excellent for **subacute or chronic** SDHs
  - Especially iso- or hypodense lesions
Head CT shows new and old hemorrhage

Acute focal parenchymal hemorrhages

Two old, layered subdural hemorrhages

Images courtesy of Dr. Velez and Dr. Hines-Peralta, Children’s Hospital Boston
Other Etiologies of Infant SDH

- Severe force from a household fall
- Vacuum assisted delivery
  - Symptoms usually apparent within 36 hours of life
What happened next?

- Foster care the next morning
- Grandmother’s care several months later
- Developing well
- Parents never admitted to intentionally harming him
References

http://www.childwelfare.gov/pubs/factsheets/fatality.cfm


Kemp, AM et al. Which radiological investigations should be performed to identify fractures in suspected child abuse? Clinical Radiology 2006; 61:723-736.


http://www.acf.hhs.gov/programs/cb/pubs/cm04/summary.htm
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