Fractures in Children: Accident or Abuse?

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Fractures

- 8% - 12% of all pediatric injuries.
- In infants and toddlers, physical abuse is the cause of 12% - 20% of fractures.
- ~80% of all fractures caused by child abuse occur in children younger than 18 months.

In children younger than 3 years, 20% of fractures caused by abuse are misdiagnosed initially as noninflicted or as attributable to other causes.
Of 258 patients with abusive fractures, 54 (20%) had at least one previous physician visit at which abuse was missed.

- Independent predictors of missed abuse:
  - male gender
  - extremity vs axially located fracture
  - presentation to a primary care setting/general emergency department vs pediatric emergency department
Details that can help the physician determine whether a fracture was caused by abuse rather than unintentional injury include:

- the history
- the child’s age and developmental stage
- the type and location of the fracture
- the age of the fracture
- an understanding of the mechanism that causes the particular type of fracture
Fractures With High Specificity for Abuse

- Classic Metaphyseal Lesions (CMLs)
- Rib fractures, especially posterior
- Scapular fractures (rare)
- Spinous process fractures (rare)
- Sternal fractures (rare)
Classic Metaphyseal Lesions (CMLs)

- Caused when torsional and tractional shearing forces are applied across the metaphysis

- May occur with vigorous pulling or twisting of an infant’s extremity
Most Common Locations of CMLs:
Classic Metaphyseal Lesions (CMLs)

- Commonly heal without subperiosteal new bone formation or marginal sclerosis
  - Heal quickly and can be undetectable on plain radiographs in 4 - 8 weeks

- Discovered in 39-50% of abused children less than 18 months of age.
Rib Fractures

- The positive predictive value of rib fractures for child abuse in children younger than 3 years was 95%.
  - Rib fracture(s) were the only skeletal manifestation of NAT in 29% of children.

- Most abusive rib fractures result from anterior-posterior compression of the chest.
  - Held around the chest, Squeezed, and/or Shaken
**Figure 1:** Mechanism of Injury in Rib Fractures. (From: Cooperman, D.R. and Merten, D.F. Skeletal Manifestations of Child Abuse. In Reece, R.M. and Ludwig, S. Child Abuse: Medical Diagnosis and Management. Baltimore. Lippincott, Williams and Wilkins. 141. 2001)
Of 446 Children who underwent CPR, 3 had CPR-related rib fractures.

- All of these involved the anterior ribs.

- Posterior rib fractures have never been definitively documented to result from CPR.
Common Fractures With Low Specificity for Child Abuse

- Clavicular fractures
- Long-bone shaft fractures (not CMLs)
- Linear skull fractures
Differential Diagnosis

- Osteogenesis Imperfecta
  - This diagnosis often suggested by:
    - a family history of fractures
    - short stature
    - blue sclera
    - poor dentition
    - radiographic evidence of low bone density or osteopenia.
    - The fractures are most commonly transverse in nature, occurring in the shafts of the long bones.
  - Genetics for definitive diagnosis
  - OI: 6-7 per 100,000
  - Child abuse: ~160 per 100,000
Differential Diagnosis

- Osteopenia of Prematurity
  - Preterm infants have decreased bone mineralization at birth.
  - Infants at risk if:
    - Born at < 28 WGA*
    - Weigh < 1500g at birth*
    - Received prolonged (> 4 weeks) TPN
    - Have BPD
    - Have received a prolonged course of diuretics or steroids
Differential Diagnosis

- Bone Demineralization from Disuse
  - Any child with a severe disability that limits or prevents ambulation can be at risk.
  - Fractures are usually diaphyseal (not CMLs)
Vitamin D Deficiency Rickets
- Vitamin D deficiency in otherwise healthy infants and toddlers is common.
  - ~40% of infants and toddlers
- Despite the high prevalence of vitamin D insufficiency in infants and toddlers, rickets is uncommon.
Differential Diagnosis

- **Copper Deficiency**
  - Rare condition that may be complicated by fractures.
  - May be observed in children with severe nutritional disorders (liver failure, short gut syndrome)

- **Menkes Disease**
  - Rare, X-linked recessive defect of copper metabolism
Case

- 4 month old female presents to the ER with bruising and swelling around her right elbow. Her caregiver cannot give an explanation for the injury.

- X-ray??
Imaging

- **Skeletal Survey**
  - Additional fractures are identified in ~10% of skeletal surveys, with higher yields in infants.

- A repeat skeletal survey should be performed 2 weeks after the initial skeletal survey if child abuse is strongly suspected!
Follow-up skeletal surveys reveal new information in 20% of cases.

Frequently affected the perceived likelihood of abuse
  - Even in cases where the initial level of concern for abuse was moderate
Imaging

- Head imaging should be considered for any child < 1 year with a fracture suspicious for abuse.
Case

- 4 month old female presents to the ER with swelling of her right upper extremity. Her caregiver cannot give an explanation for the injuries.

  - Labs??
Labs

- CMP (Calcium, AST, ALT, Alk phos)*
- CBC*
- Amylase and Lipase*
- Bag UA*
- PTH
- 25-OH Vit D
- Urinary Calcium excretion
- Serum copper and Ceruloplasmin
- Genetic Testing


• Ravichandiran, N., Schuh, S., Bejuk, M., Al-Harthy, N., Shouldice, M., Au, H., and Boutis, K. Delayed Identification of Pediatric Abuse-Related Fractures. Pediatrics 2010;125;60; originally published online November 30, 2009; DOI: 10.1542/ peds.2008-3794