Clinical Conundrums in Child Abuse

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Fractures: Bad Luck, Bad Bones, or Bad Environment?

• Fractures with High Specificity for Abuse
• Fractures with Low Specificity for Abuse
• Special Circumstances (i.e., weird stuff happens)
• Bruises and Fractures: More likely abuse?
• Skeletal Surveys
• Bone Fragility Disorders

High Specificity Fractures for Abuse

• Classic Metaphyseal Lesions
• Rib Fractures
• Scapular Fractures
• Sternal and Pelvic Fractures
• Hand and Foot Fractures in infants

Classic Metaphyseal Lesion

• Fractures with High Specificity for Abuse
• Fractures with Low Specificity for Abuse
• Special Circumstances (i.e., weird stuff happens)
• Bruises and Fractures: More likely abuse?
• Skeletal Surveys
• Bone Fragility Disorders
• 5 month old infant

The Clinical Conundrum: Fractures common in both abusive and accidental trauma
  - Femur fractures
  - Tibia/fibula fractures
  - Radius/ulna fractures
  - Skull fractures

Scapular Fractures

Acromial Fractures

Rib Fractures in Children

Low Specificity Fractures
• The Clinical Conundrum: Fractures common in both abusive and accidental trauma
  - Femur fractures
  - Tibia/fibula fractures
  - Radius/ulna fractures
  - Skull fractures

<table>
<thead>
<tr>
<th>Age (mo)</th>
<th>n</th>
<th>Abuse</th>
<th>Unknown</th>
<th>Accident</th>
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<tr>
<td>0-11</td>
<td>103</td>
<td>40 (39%)</td>
<td>12 (12%)</td>
<td>51 (50%)</td>
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<td>12-23</td>
<td>61</td>
<td>7 (14%)</td>
<td>1 (2%)</td>
<td>43 (84%)</td>
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<td>24-35</td>
<td>61</td>
<td>5 (8%)</td>
<td>5 (8%)</td>
<td>51 (85%)</td>
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<tr>
<td>Total</td>
<td>215</td>
<td>52 (24%)</td>
<td>18 (8%)</td>
<td>145 (67%)</td>
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Leventhal et al (cont).

- Among children with long bone fractures:
  - The majority of fractures were accidental, except in children < 1 yo (82% of distal long bone fractures were from abuse)
  - 85% of abused children with distal long bone fractures had positive skeletal surveys (skeletal surveys helpful in reassuring an injury is accidental)
  - Femur fractures: Age is important; 60% were from abuse in children <1 yo; 20% abuse in children >1 yo
  - Femur fractures in ambulatory children can occur from “low energy events”, eg, falls while running
  - Humeral fractures: location is important
    - Abuse: 13/14 were shaft or metaphyseal fractures
    - Accidental: 13/15 were supracondylar

- Humerus: 16
  - 13 (81%) Abuse
  - 0 Unknown
  - 3 (19%) Accident

- Tib/Fib: 35
  - 14 (40%) Abuse
  - 0 Unknown
  - 21 (60%) Accident

- Femur: 26
  - 9 (35%) Abuse
  - 4 (15%) Unknown
  - 13 (50%) Accident

- Rad/Uln: 17
  - 4 (23%) Abuse
  - 1 (6%) Unknown
  - 12 (71%) Accident

Femur Fractures

- Largest bone in the body
- Often thought that “high energy forces” required to cause a fracture
Femur Fractures

- 2 month old infant brought to ED refusing to move left leg.

2 month old with left femur fracture

Exersaucer related skeletal injury
Fracture Associated with Exersaucer


Femur Fractures in Infants

• Transverse Fracture of the Distal Femoral Metadiaphysis: A Plausible Accidental Mechanism.

• Haney, S. et al. Pediatric Emergency Care 25(12), 841-844
  o 18 cases of distal femoral metadiaphyseal fractures submitted by child abuse pediatrics from around the country.
  o Cases were classified as probable abuse if there was no reported trauma to explain the injury

TABLE 2

| Table 2: Demographic and Clinical Characteristics of Cases |

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<th>Variable</th>
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<th>v2</th>
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<td>Sex</td>
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<td>0.86</td>
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<td>0.00</td>
<td>0.86</td>
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<td>Fracture site</td>
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<td>4</td>
<td>0.00</td>
<td>0.86</td>
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<tr>
<td>Fracture severity</td>
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<td>Fracture displacement</td>
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<td>4</td>
<td>0.00</td>
<td>0.86</td>
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FIGURE 2

4 month old infant in bouncy seat on bed; bouncy seat with infant falls forward off bed. Infant found to have bruise on left kneecap.

Toddler’s Fracture

- Usually a subtle, spiral or oblique non-displaced fracture of the mid or distal tibia.
- Can occur from seemingly innocuous trauma
- May have a history of a limp with no witnessed trauma
- NOTE: you have to be toddling to have a “toddler’s” fracture.
9 month old cruiser presents with 2 weeks of reluctance to bear weight on left leg. Prior xray of leg 1 week ago reportedly normal.

He returns to ED 2 weeks later with sudden onset of lethargy.
**Femur Fractures**

  - 42 children 1-5 yo (avg. age 3.1 years)
  - History of a fall in 34; no witnessed event in 8
  - Fracture type
    - Spiral 28, Oblique 6, Transverse 8
  - History was considered suspicious in 14 children
  - Only one fracture felt to be definitely result of abuse

- **Femur Fractures**

- In young ambulatory children:
  - Can occur as a result of a low energy event; fall from a low height or fall while running.
  - Fracture pattern is not predictive of abuse.
  - Probability of intentionally inflicted isolated femur fracture in child > 1yo is low.
  - Concept of toddler's fracture can be expanded to include a spiral femur fracture.

  - 139 children < 4 yo with isolated femur fractures.
  - 13 (9%) were likely to have been abused.
    - Average age 1.1 years
  - 121 (91%) sustained fracture most likely as an accident
    - Average age 2.3 years
  - A child not yet walking was strongest predictor of likely abuse.
    - Only 3 of 115 walking children were felt to be likely abused.

  - Misperceptions regarding femur fractures.
    - Toddlers rarely break their femurs.
      - A peak age of femur fractures occurs between 2 and 3 yo
    - Lots of force is required to break the femur.
      - Simple falls with usual activities can fracture femur; simple falls or falls while running.
    - There is a high risk of abuse if a child has a femur fracture.
      - Typical young walking child who sustains isolated femur fracture with no other clinical indicators of abuse is unlikely to have been abused.
5/19/12

3 yo boy fell while rough housing with brothers

2 yo child stepped on a toy, slipped and fell; immediately cried and could not walk.

Bruising Associated with Fractures of Abuse

- Reviewed 170 children with acute fractures (not skull)
- 93 (55%) abusive; 20 (12%) indeterminate; 57 (33%) non-abusive
  - Most fractures, abusive or non-abusive, were not associated with bruising
  - Abusive fractures: 26% had associated bruising
  - Accidental fractures: 23% had associated bruising
  - No conclusions about force can be made based on lack of bruising
  - In the abused group:
    - < 1 yo: more infants had multiple fractures
    - > 1 yo: more children had multiple bruises

Bruising and fractures of abuse

- Study included 192 children (mean age 13 mo, median age 6 mo) with 626 fractures from abuse. The authors looked for bruising near the fracture site.
- Bruising was found near the site of fracture in 20% of fractures. If skull fractures are excluded, only 9% of fractures had bruising near the site of fracture.

Bruising near the site of fracture:
  - Skull - 42%
  - Ribs - 7%
  - Metaphyseal - 20%
  - Tibia - 3.8%
  - Fibula - 14.1%
Diagnostic Imaging of Child Abuse

- Skeletal Surveys
  - Skull: frontal and lateral
  - Cervical Spine AP and lateral
  - Lateral Spine: thoracic, lumbar, sacral
  - Pelvis: AP
  - Thorax: AP and Lateral
  - Humeri AP
  - Forearms AP
  - Hands PA
  - Femurs AP
  - Tibia/Fibula AP
  - Feet AP

Skeletal Surveys

- The importance of oblique chest x-rays
  - Reviewed 22 cases with rib fractures
  - Interpretation of four-view chest series (AP, lateral, L and R obliques) was different than interpretation of two-view chest series in 12 (54%) of the 22 cases.
  - The four-view series added 19 rib fractures not seen in the two-view series and excluded 6 rib fractures.

Skeletal Survey; Oblique Views

Initial Survey

Follow-up Survey

- 4 month old infant presents with acute transverse humeral fracture
Bone Disorders Confused with Abuse

- Disorders of Collagen Production
  - Osteogenesis Imperfecta
- Disorders of Mineralization
  - Rickets
  - Osteopenia of Prematurity

Osteopenia of Prematurity

- Birth weight < 1.500 gms
- Slow to start enteral feeds
- Prolonged parental nutrition
- Prolonged mechanical ventilation
- Diuretics

6 month old infant with RSV bronchiolitis; born at 26 weeks, RDS, Grade 2 IVH, prolonged stay in NICU

Chest xray 2 months later shows healing left posterior rib fractures at site of previous “popping”