Radiologic Diagnosis of Rickets

Vitamin D Deficiency or Abuse
Is There Reason for Confusion?

Jeannette M Perez-Rossello, MD

Children’s Hospital Boston
Harvard Medical School
Boston, Massachusetts
Rachitic Changes

- Loss of the zone of provisional calcification, apparent physeal widening
- Fraying, flared/cupped metaphysis
- Demineralization
- Findings most apparent in bones with rapid growth: distal radius and femur, costochondral junctions
Current controversy: Rickets vs. abuse

Vitamin D Deficiency

The prevalence of vitamin D deficiency (25OHD<20 ng/mL) in the USA is high, 22-58%, in otherwise healthy infants and young children

At what level... do we begin to see rickets? is there increase in fracture risk?
3 Rickets Scenarios

1. Metabolic Bone Disease of Prematurity
2. Nutritional Vitamin D deficiency Rickets
3. Congenital Rickets

But there are many more…
Metabolic Bone Disease of Prematurity

- Rachitic changes: 22-53%
- Fractures, with or without rachitic changes: 8-16%
  - Upper extremity > lower extremity: Transverse/greenstick metaphyseal or diaphyseal
  - No physeal fractures
  - Rib fractures: mid posterior arch and lateral

McIntosh. Arch Dis Child 1982;57:848-850
Lyon. Pediatr Radiol 1987;17:56-58
Nutritional Vitamin D Deficiency Rickets

- Seen as early as 3-6 mo.
- At risk:
  - Breast fed infant without supplements: breast milk is low in vitamin D
  - Dark skin
  - Limited sun light
Vitamin D Deficiency Rickets in Riyadh

• 500 infants and young children, less than 2 years old with clinical findings of rickets
  – **ONLY 1 FRACTURE**

• Control group: 1213 children from outpatient clinic screened with wrist x-rays and Alk Phos
  – 85 (7%) “subclinical” rickets= Alk Phos>400, early cupping and fraying of the metaphysis
Congenital Rickets

• India: 337.68 million surveyed
• 165 mothers, severe osteomalacia
  – 3 infants with neonatal hypocalcemic seizures
  – 3 infants with congenital rickets
    • Frontal and parietal bossing, swollen wrists and ankles, wide anterior fontanelle
    • Radiographic rachitic changes
    • \( \downarrow \) Vitamin D  \( \uparrow \) PTH  \( \downarrow \) Calcium

Pub Med: Congenital Rickets

- 12 papers (1968-present)
  - 10 cases reports = 23 patients
  - 2 series = 22 patients

- Infants: newborns - 2 months old
  - Biochem: \( \downarrow \) Vitamin D \( \uparrow \) PTH \( \downarrow \) Calcium
  - X-rays: all with rachitic changes
  - Fractures: *rare, all associated with rachitic changes*
Fractures in Infants

- Infants < 12 months: 0.14 – 1%
- Toddlers 1-2 years old: 0.06 – 3%

Fractures in infants are uncommon

Hall et al. Osteoporos Int 2009. 20:1873
Thandrayen et al. Osteoporos Int 2009. 20:47-52
100 x more common for a fracture to be abuse 12% vs. metabolic abnormality (rickets) 0.12%

<table>
<thead>
<tr>
<th>Cause</th>
<th>Proportion, %</th>
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<tbody>
<tr>
<td>Fall</td>
<td>50.42</td>
</tr>
<tr>
<td>Abuse</td>
<td>12.08</td>
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<tr>
<td>Other accident</td>
<td>11.60</td>
</tr>
<tr>
<td>Motor vehicle accident</td>
<td>11.40</td>
</tr>
<tr>
<td>Uncertain whether accidental or intentional</td>
<td>2.17</td>
</tr>
<tr>
<td>Bone abnormality</td>
<td>0.85</td>
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<tr>
<td>Metabolic abnormality</td>
<td>0.12</td>
</tr>
<tr>
<td>Birth trauma</td>
<td>0.05</td>
</tr>
<tr>
<td>No injury E-code</td>
<td>11.32</td>
</tr>
<tr>
<td>Total</td>
<td>100.01</td>
</tr>
</tbody>
</table>
Vitamin D deficiency is not associated with diagnosis of abuse or presence of multiple fractures, metaphyseal and rib fractures.
Vitamin D deficiency: Rachitic Changes

- 360 healthy infants and toddlers (8-24 mo.)
- 44 (12%) had Vitamin D deficiency (25 OHD<20 ng/mL)
- Mild rachitic changes in 5%
- Fracture prevalence = 0 (95% CI: 0-0.10)

• 45 children, 2-24 mo.
• Rickets varying causes: nutritional (71%)
• 17% had fractures not resembling abuse
  – 13% more than >1 fracture
Rachitic Changes in Deceased Infants: 
A Radiologic and Pathologic Study

- 26 deceased infants with inflicted skeletal injuries whose distal femurs were resected
- 14 (53%) infants had intracranial injuries
- All the patients had radiographs with skeletal injuries suspicious for abuse

NO radiologic or pathologic rachitic changes in 26 infant fatalities with multiple fractures

Perez-Rossello & Kleinman, unpublished data
Abstract presente IPR, London 2011
Take Home Points

• Vitamin D deficiency is common in infants but rachitic changes are not

• When rachitic changes are present in infants fractures are uncommon and do not resemble the abuse

• In infants, with or without vitamin D deficiency presenting with multiple fractures, the most likely etiology is child abuse

• A multidisciplinary team approach - child abuse pediatrician, radiologist, endocrinologists, orthopedic surgeons - is needed for optimal evaluation in cases of suspected abuse