Lead Poisoning or Plumbism

- Remains a significant problem in the United States, despite an effort to reduce lead contaminants.

- The department of health and human services called lead poisoning “the most important environmental problem for young children.”
Epidemiology

- Most common sources for lead in a home are: lead-based paint, drinking water, and pottery.
- Lead is either ingested or inhaled.
- 98% of lead poisoning cases in children between 2-6 years old.
# Toxicity of Lead Exposure

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<th>Mild Toxicity</th>
<th>Moderate Toxicity</th>
<th>Severe Toxicity</th>
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<td>Myalgias</td>
<td>Abdominal Pain</td>
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<td>Paresthesias</td>
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Chronic Lead Exposure

- Shown to have neurological, behavioral, and cognitive effects.
- Has been correlated with a direct decrease in exposed children’s IQ scores.

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Radiology and Lead Poisoning

- Between 70%-95% of total body lead is found in osseous tissues.
- The half-life of lead in bone is up to 10 yrs.
- Nearly 70 years ago, Caffey and Park described radiologic manifestations of chronic exposure to lead in children.
Patient A:
2.5 Year Old Female

Film findings:
Dense Line at the metaphyses- a “lead line” or “lead band.” This appears at a blood lead level of between 70-80 micrograms/dl.
The Lead Line, A Disruption of Balance

- Normal growth at the metaphysis is the result of a balance between osteoblastic bone deposition and osteoclastic bone resorption at the Zone of Provisional Calcification.

- Lead ions are preferentially deposited at the ZPC, and disrupt this balance by inhibiting osteoclastic activity.

- Thus a “lead line” does NOT represent the radiopacity of the lead itself, but rather increased calcium deposition.
Differential Diagnosis of Dense Metaphyseal Lines

1) Normal variant
2) Lead Poisoning
3) Treated Leukemia
4) Healing Rickets
5) Other Heavy Metal Poisoning
6) Recovery from Scurvy
7) Vitamin D hypervitaminosis
8) Hypothyroidism
9) Hypoparathyroidism
10) Transplacental Infections
Patient B:
20 Month Old Female

Note Fibular Density

Image courtesy of Children’s Hospital, Boston, MA
Plumbism or Normal Variant?

- Identification of a metaphyseal density in the proximal fibula is a strong indicator of lead poisoning.
- This sign is the most reliable marker in differentiating between a normal and pathologic state.
Diagnosis

- Lead bands are NOT an early manifestation of lead toxicity and thus should NOT be used to assess acute toxicity.
- A clinical history of lead ingestion, symptoms, and blood lead levels are more reliable indicators.
- However, if blood lead levels are not readily available, radiography of knees should be considered in a symptomatic patient. Though not helpful in acute poisoning, they demonstrate findings with chronic exposure.
Patient C; The evolution of a lead line

- 4.5 year old female admitted with coma. History notable for fever, vomiting, and progressive lethargy.
- Parents also noted that she had a “history of eating paint from the veranda of her home.”
Patient C
8/20/66

Image courtesy of Children's Hospital, Boston, MA
Patient C
1/18/67

Image courtesy of Children’s Hospital, Boston, MA
Migration of Lead Lines

- Lead lines undergo a constant migration from the ZPC into the diaphysis.
- Different bones have different migration rates
  - Distal femur - ~22mm/year
  - Proximal tibia - ~15mm/year
- This growth related migration occurs for about 4 years, after which the lines disappear.
Patient D; Unknown History, Evidence of Chronic Lead Exposure

Note the alternating Narrow-Broad-Narrow pattern consistent among different bones.
Patient D - Chronic Lead Exposure

Image courtesy of Children’s Hospital, Boston, MA
KUB as a means of Diagnosis

- Evidence of lead ingestion - Multiple radiopaque flakes representing paint chips may be seen on plain abdominal film.
Patient E

Film findings
Radioopaque lead ingested in paint chips

Image courtesy of Children’s Hospital, Boston, MA
Another Radiographic Manifestation

- Widened cranial sutures may also be present in chronic lead poisoning, secondary to increased intracranial pressure
Summary

- Lead poisoning is a serious and potentially life-threatening condition affecting primarily children.

- Chronically, lead poisoning results in the inhibition of osteoclastic activity. This is visualized on plain films as dense metaphyseal thickening in growing bones.

- Acutely lead toxicity should be diagnosed by H+P, and measurement of blood lead levels, though sometimes evidence of lead ingestion is visible on KUB.
Sources

- Raber S. The dense metaphyseal band sign. Radiology 1999; 211: 773-774
- Caffey J. Pediatric X-ray Diagnosis. 7th edition. 1978
- Ellenhor M. Ellenhorn’s Medical Toxicology. 1997
- Children’s Hospital Radiology teaching files. Boston, MA
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