Interpreting Bone Mineral Density Studies

Daniel L. Metzger, MD, FAAP, FRCPC

BC Pediatric Society, November 14, 2015

LEARNING OBJECTIVES

• Learn the ins and outs of interpreting and taking action on BMD reports
• Learn about new treatment options for osteoporosis in children

INTERPRETING BMD

• usually measured by DXA
• highly dependent on:
  – age
  – height
  – gender
  – pubertal status
  – ethnicity
  – bone shape/fractures
  – instrument/software used

AREAL vs. VOLUMETRIC

<table>
<thead>
<tr>
<th></th>
<th>BMC, g</th>
<th>Bone area, cm²</th>
<th>aBMD, g/cm²</th>
<th>vBMD, g/cm³</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>B</td>
<td>8</td>
<td>4</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

Bone Densitometry Scan
Z-SCORE
• SD-score compared to age-, gender- (and height-) matched normals

OSTEOPOROSIS
• one or more vertebral compression (crush) fractures, in the absence of local disease or high-energy trauma
• presence of both a clinically significant fracture history and Z-score ≤ −2.0.
  – ≥2 long bone fractures by age 10 years
  – ≥3 long bone fractures at any age up to age 19 years

OTHER TERMS
• osteopenia: no DXA criteria in kids
• low bone mineral mass or low bone mineral density: preferred terms for pediatric DXA reports when BMC or areal BMD Z-scores are ≤ −2.0 SD

T-SCORE
• SD-score compared to white females, age 20–29 years, NHANES III database
• not used in kids!
• normal: +1.0 ≤ T-score ≤ −1.0
• low bone mass: −1.0 > T-score > −2.5
• osteoporosis: T-score ≤ −2.5
Update on Treating Osteoporosis in Children

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DDx OF OSTEOPOROSIS

- primary
  - osteogenesis imperfecta
  - idiopathic juvenile osteoporosis
  - calcium deficiency
- miscellaneous
  - immobilization (CP)
  - childhood malignancy and its therapy

2° OSTEOPOROSIS

- endocrine
  - hypogonadism
  - vitamin D deficiency
  - Cushing disease
  - diabetes mellitus
- chronic disease
  - IBD
  - protein malnutrition
  - juvenile arthritis
  - CF, celiac disease
- meds
  - glucocorticoids
  - anti-convulsants
- syndromes
  - homocystinuria
  - hyper-IgE syndrome
  - lysosomal storage disorders
  - osteoporosis–pseudoglioma syndrome
  - thalassemia

PREVENTION

- optimize calcium intake
- optimize Vitamin D intake (1000 IU)
- weight-bearing exercise as tolerated
- avoid smoking
- maintain good weight and nutrition
- anticipate problems in high-risk pts

BISPHOSPHONATES

- analogs of inorganic pyrophosphate
- high affinity for calcium hydroxyapatite
- ↓ osteoclast activity, number
  - ↓ bone turnover
- not “glue” for bone

RELATIVE IN VITRO POTENCY

<table>
<thead>
<tr>
<th>GENERATION</th>
<th>DRUG</th>
<th>POTENCY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td>etidronate*</td>
<td>1</td>
</tr>
<tr>
<td>2nd</td>
<td>clodronate*</td>
<td>10</td>
</tr>
<tr>
<td>2nd</td>
<td>tiludronate</td>
<td>10</td>
</tr>
<tr>
<td>2nd</td>
<td>pamidronate*</td>
<td>100</td>
</tr>
<tr>
<td>3rd</td>
<td>alendronate*</td>
<td>1,000–2,000</td>
</tr>
<tr>
<td>3rd</td>
<td>olpadronate</td>
<td>200–500</td>
</tr>
<tr>
<td>3rd</td>
<td>risedronate*</td>
<td>2,000</td>
</tr>
<tr>
<td>3rd</td>
<td>ibandronate</td>
<td>500–1,000</td>
</tr>
<tr>
<td>3rd</td>
<td>zoledronate*</td>
<td>10,000</td>
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*available in Canada
RATIONALE FOR USE IN OI

- OI associated with osteoporosis
- significant fractures, pain and immobilization, decreased QOL
- other therapies (fluoride, MgO, GH, calcitonin, anabolic steroids) don’t work
- surgical options often limited by bone fragility

IMPROVEMENT IN BMD

6-y/o ♂ treated × 18 months

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<tr>
<th>Time (years)</th>
<th>T-Score</th>
<th>Z-Score</th>
<th>BMD (g/cm²)</th>
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<tbody>
<tr>
<td>0</td>
<td>-1.2</td>
<td>-1.8</td>
<td>0.205</td>
</tr>
<tr>
<td>18</td>
<td>-0.5</td>
<td>-1.1</td>
<td>0.371</td>
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NEJM 1998;339:947–952

IMPROVEMENT IN BMD

2.3-m/o ♂ type III treated × 9.5 months

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JCEM 2000;85:1846–1850

IMPROVEMENT IN BMD

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GROWTH LINES

- 8-y/o ♂ treated × 7 cycles
- dense sclerotic bands in metaphysis
- calcified cartilage
- continuous growth during therapy

JCEM 2000;85:1846–1850
**BCCH TREATMENT**

- diagnosis of condition associated with severe osteopenia
  - OI
  - glucocorticoid-mediated
  - severe immobilization
- any spinal or repetitive long-bone Fx
- also used in hypercalcemia

**SIDE EFFECTS**

- flu-like illness:
  - muscle cramps, headache, fever, nausea and vomiting
  - happens within 24–72 hours after dose
  - usually only happen with 1st cycle
- hypocalcemia
- respiratory arrest in newborns!
- osteonecrosis of jaw, atypical femur Fx