Bone Health Basics

Outline

- What is osteoporosis?
- Who gets it?
- What are risk factors for fracture?
- How is osteoporosis diagnosed?
- What can you do to prevent fractures?
  - Lifestyle-related steps
  - Osteoporosis medications

OSTEOPOROSIS: systemic skeletal disorder of LOW BONE MINERAL DENSITY and MICROARCHITECTURAL DETERIORATION of BONE, resulting in REDUCED BONE STRENGTH and PROPENSITY to FRACTURE.

Dempster, J Bone Miner Res, 1999

Definition of Osteoporosis

- Low bone mineral density
- Microstructural deterioration
- Reduced bone strength
- Increased risk of fracture

Measured by bone density scanning

The real life event we want to prevent
Imbalance in Bone Cell Activity

- **OSTEOBLASTS**
  - Form new bone matrix
  - Lay down bone mineral (calcium & phosphate)
- **OSTEOCLASTS**
  - “Remodel” bone by digging out bone cavities
- **OSTEOCYTES**
  - Sense mechanical loading on bone

Bone is Constantly Remodeled

- **Bone is not dead!**
  - Even in adults
  - Even in advanced age
- Approximately 10% of your bones are “remodeled” each year
  - Releases minerals for our needs
  - Maintains “quality control” of bone
  - Prevents “microdamage” from building up

Normal Bone Remodeling

- Resorption:
  - Osteoclasts digest bone within a tiny pit and then die
- Reversal:
  - Osteoclasts dying
  - Osteoblasts
- Formation:
  - Osteoblasts build new bone then mineralize it

Balance: Formation vs. Resorption

- **Hormones (especially estrogen)**
- **Physical activity (skeletal “loading”), diet**
- **Diseases (e.g., cancer, GI, inflammatory), drugs**

- **Osteoblast** Bone Formation
- **Osteoclast** Bone Resorption

NORMAL: balanced
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  - *Lifestyle-related steps*
  - *Osteoporosis medications*

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**Age, Gender, and Fracture Risk**

![Graph showing the risk of fractures by age and gender.]

**Change in Bone Mass Over Time**

![Graph showing the change in bone mass with age.]

Cooper, J Bone Miner Res, 1992
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DXA Scanning

- Bone mineral density (BMD) is a good predictor of fracture risk
- Measured by dual energy X-ray absorptiometry (DXA)
  - Low radiation
  - Precise
  - Rapid scanning
  - Relatively inexpensive
- BMD used for screening and diagnosis

DXA Scanning

DXA Results

Scan Information:
Scan Date: 28 March 2006
Scan Type: DXA
Analysis: 28 March 2006 Version 12.4
Operator: JF
Model: Discovery C (S/N 42332)
Comment:

DXA Results Summary:

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<tr>
<th>Region</th>
<th>Area</th>
<th>BMC</th>
<th>BMD</th>
<th>T-Score</th>
<th>Z-Score</th>
<th>P-value</th>
<th>ANS</th>
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<tr>
<td>L1</td>
<td>21.52</td>
<td>27.92</td>
<td>0.377</td>
<td>-2.6</td>
<td>-2.6</td>
<td>0.125</td>
<td>1.3</td>
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<td>L2</td>
<td>21.94</td>
<td>28.96</td>
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<td>38.94</td>
<td>1.535</td>
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<td>0.128</td>
<td>1.7</td>
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<td>3.3</td>
<td>0.114</td>
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<td>Total</td>
<td>84.63</td>
<td>148.59</td>
<td>3.272</td>
<td>3.4</td>
<td>3.4</td>
<td>0.177</td>
<td>3.6</td>
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DXA Results

DXA Results Summary:

<table>
<thead>
<tr>
<th>Region</th>
<th>Area (cm²)</th>
<th>BMC (g/cm²)</th>
<th>T-score</th>
<th>FR (%)</th>
<th>Z-score</th>
<th>AM (%)</th>
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</thead>
<tbody>
<tr>
<td>Neck</td>
<td>4.81</td>
<td>0.93</td>
<td>-2.0</td>
<td>78</td>
<td>0.3</td>
<td>94</td>
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<td>Trochanter</td>
<td>1.33</td>
<td>0.23</td>
<td>-0.9</td>
<td>91</td>
<td>0.1</td>
<td>94</td>
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<td>Lute</td>
<td>24.26</td>
<td>0.99</td>
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<td>-1.2</td>
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<td>0.8</td>
<td>90</td>
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<td>WHFEM</td>
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<td>0.21</td>
<td>-2.5</td>
<td>61</td>
<td>0.4</td>
<td>93</td>
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</tbody>
</table>

 WHO Classification: Osteoporosis

T-scores

• Compare patient’s BMD value with the mean for healthy young adults of same gender
• Expressed as number of standard deviations (SD) above or below that young adult average
• Forms basis of diagnosis (WHO criteria)
• Aids in doctors’ decision-making

WHO Diagnostic Criteria

Diagnostic criteria

- T-score ≥ -1.0
- T-score -1.0 to -2.5
- T-score ≤ -2.5
- T-score ≤ -2.5 + fragility fracture

Classification

- Normal
- Osteopenia (low bone mass)
- Osteoporosis
- Severe osteoporosis


BMD and T-scores

Frequency of peak BMD in young adults

NOF Medical Center

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Who Should Be Tested?

- All women age 65 and older\(^1,2\)
- All men age 70 and older\(^1\)
- Younger postmenopausal women and men 50-69 years old if:\(^1\)
  - Concern based on clinical risk factor profile\(^1\)
    - Fracture risk equal to that of a 65 y.o. white woman\(^2\)
  - Fracture after age 50
  - Condition or medication associated with bone loss

1 National Osteoporosis Foundation, 2013
2 US Preventive Services Task Force, 2010

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  - Osteoporosis medications

Physical Activity and Fracture Risk

- Direct bone effects
- Protective effects on risk of falling
  - Strength
  - Balance

Physical Activity and Fracture Risk

- Strengthening of quadriceps and hip muscles
- Balance and gait training
  - Challenge balance in standing!
- Combine strength/resistance with other elements
- Progressive difficulty
- Pain management
- Increased complexity, staging
Choose the Best Posture and Movement

**DO:** neutral spine or extension

**AVOID:** flexion, rounding, twisting

**Photos:** Do It Right, American Bone Health, Sherri Betz, PT, GCS

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Choose the Best Posture and Movement

**Reduce the Risk of Falls**

- Poor vision → eyeglasses, cataract surgery
- Footwear with slippery soles → stop wearing them
- High heels → stop wearing them
- Address potential risks at home
  - Poor lighting, loose rugs, loose cables/cords
  - Uneven or wet surfaces, bathtubs without handrails or bath mats
  - Clutter at floor level
  - Pets
  - Environmental factors - wet or cracked paving/steps, ice/snow

**Calcium**

- Prevents bone loss & decreases fractures in the elderly by 25-40% with vitamin D
- **Current recommendations**
  - adolescent: 1300 mg/day
  - adult up to age 50: 1000 mg/day
  - ages 51+: 1200 mg/day
- **Recommended intake is total calcium intake** (diet + supplements)
- “Overdose” causes hypercalciuria

**Photos:** Do It Right, American Bone Health, Sherri Betz, PT, GCS

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Sources of Calcium

- **Food sources**
  - Dairy foods
  - Fortified cereal, OJ, cereal bars...
  - Tofu
  - Dark green leafy vegetables
- Dairy-free diet ≈ 300 mg calcium
- Supplements

Calcium Supplements

- Read labels carefully
  - Look at milligrams of elemental calcium
- Types of calcium supplements
  - Calcium carbonate
  - Calcium citrate
- Add up diet + supplements
- Get help from doctor or nutritionist
  - Bring in what you are taking for your doctor to check
- Many contain vitamin D, too

*1000-1200 mg per day*

Vitamin D

- Vitamin D deficiency is common
  - 50% of elderly hip fracture patients
  - 42% African American women
- Current recommendations *(controversial)*:
  - up to age 70: 600 IU/day
  - ages 71+: 800 IU/day
  - maximum: 2000-5000 IU/day in most people

Sources of Vitamin D

- Sunshine
- Multivitamin
- Milk: 100 IU/glass
- Cod liver oil: ~400 IU/teaspoon
- Sardines: 33 IU/sardine
- Tuna in fish oil: 170 IU per ½ cup
- Egg: 26 IU per large egg
- Supplements
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Vitamin D Supplements

- Look at international units (IU)
- Types of vitamin D supplements
  - D3 (cholecalciferol)
  - D2 (ergocalciferol)
- Get help from doctor or nutritionist
  - Bring in what you are taking for your doctor to check

Supplement Facts

<table>
<thead>
<tr>
<th>Amount Per Serving</th>
<th>% Daily Value</th>
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<tbody>
<tr>
<td>Vitamin D3 (as cholecalciferol)</td>
<td>1000 IU</td>
</tr>
<tr>
<td>Other ingredients: Soybean oil, gelatin, glycerin, purified water</td>
<td></td>
</tr>
</tbody>
</table>

Vitamin D Blood Levels

25-hydroxyvitamin D (25[OH]D)

- “deficiency”
- “insufficiency”
- “normal”

IOM – adequate for population

> 30 or 32 ng/mL = “expert” opinion

2013 NOF Guidelines: Treatment Initiation Post-menopausal Women And Men ≥50

Assess Risk Factors & Measure BMD if Sufficient Risk Factors

T-score between -1.0 and -2.5

Hip or Vertebral Fracture

T-score ≤-2.5
(Spine, Femoral Neck, or Total Hip)

10-year Probability of Hip Fracture >3%, or Probability of Any Major Fracture >20%

FRAX score!!!

http://www.nof.org
2013 NOF Guidelines: Treatment Initiation
Post-menopausal Women And Men ≥ 50

Assess Risk Factors & Measure BMD if Sufficient Risk Factors

If a person has a T-score in the “osteopenia” range, a “FRAX score” can further risk stratify for future fragility fractures

T-score between -1.0 and -2.5

10-year Probability of Hip Fracture >3%, or Probability of Any Major Fracture >20%

FRAX score!!!

http://www.nof.org

Estimating Fracture Risk with FRAX
http://www.shef.ac.uk/FRAX/tool.jsp

How Osteoporosis Medications Work

Anabolic agents increase bone formation

Antiresorptive agents decrease bone resorption

Osteoblast
Bone Formation

Osteoclast
Bone Resorption

Osteoporosis Medications

- Antiresorptive Agents
  - Estrogen
  - Raloxifine (Evista)
  - Bisphosphonates
    - Alendronate (Fosamax)
    - Risedronate (Actonel)
    - Ibandronate (Boniva)
    - Zoledronic acid (Reclast)
  - Calcitonin
  - Denosumab (Prolia)

- Anabolic Agents
  - Teriparatide (Forteo)
### Antiresorptive Agents

- **Bisphosphonates**
  - Alendronate (Fosamax)
  - Risedronate (Actonel)
  - Ibandronate (Boniva)
  - Zoledronic acid (Reclast)

  - **oral**, once weekly or monthly
  - **IV** once a year

  **Potential side effects:**
  - Irritation of esophagus (oral bisphosphonates)
  - Transient flu-like symptoms (IV bisphosphonate)
  - Very rare concerns for “oversuppression of bone turnover”:
    - Osteonecrosis of the jaw, atypical fractures

  **Decrease fracture risk by ~50% (varies by drug, fracture site)**

### Estrogen

- **Raloxifine (Evista)**

### Bisphosphonates

- Alendronate (Fosamax)
- Risedronate (Actonel)
- Ibandronate (Boniva)
- Zoledronic acid (Reclast)

### Calcitonin

- Denosumab (Prolia)

### Anabolic Agents

- **Teriparatide (Forteo)**

### Denosumab (Prolia)

- **SQ injection** every 6 months

### Antiresorptive Agents

- Estrogen
- Raloxifine (Evista)
- Bisphosphonates
  - Alendronate (Fosamax)
  - Risedronate (Actonel)
  - Ibandronate (Boniva)
  - Zoledronic acid (Reclast)
- Calcitonin
- Denosumab (Prolia)

### Anabolic Agents

- Teriparatide (Forteo)
Osteoporosis Medications

- **Anabolic Agents**
  - Teriparatide (Forteo)
  - Daily SQ injections

Decreases spine fracture risk by 70% and non-spine fracture risk by 55%
Possible side effects: Increased calcium in blood or urine, nausea, joint pain
Approved for 2 years of use – usually for severe osteoporosis

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Summary

- Osteoporosis: fragile bones at risk for fracture
- Bone health is determined by factors including age, nutrition, activity, genetics
  - Some factors you can’t change (e.g., age)
  - Some factors you can (e.g., smoking)
- DXA scanning measures bone density
- Preventing falls is key to preventing fractures
- Get enough calcium and vitamin D
- Medications can decrease the risk of fracture in osteoporosis

Information for Patients

**PATIENT ASSISTANCE**

Provides patients and families with information regarding scheduling physician appointments, lodging arrangements and other general inquiries.

- Phone: (888) 689-8273 (689-UCSF)
- Email: referral.center@ucsfmedctr.org

For more information on adult services, visit [www.ucsfhealth.org](http://www.ucsfhealth.org) and click on “Patient Guide.”

For more information on children’s services visit [www.ucsfbenioffchildrens.org](http://www.ucsfbenioffchildrens.org) and click on “For Parents and Patients.”