Buff Up Your Bones

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Rehabilitation Department
June 20th, 2018
OVERVIEW

- Importance
- Bone Remodeling
- Factors Affecting Bone
- Osteoporotic Fractures
- Activity Education
- Exercise as an Intervention
- Live Demonstration
- Resources
**WHY SHOULD I CARE?**

**BOTTOM LINE UP FRONT**

- **Osteoporotic Fractures**
  - 80% of all fractures attributable to osteoporosis
  - More common than heart disease or cancer
  - Affects 1 in 2 women and 1 in 4 men over 50.
  - Diagnosis associated with 2-3 fold increase in sustaining a fragility fracture
  - Avoid surgeries (i.e. hip replacements/spinal fusions)

- **Exercise**
  - Reduces overall fracture by 51% in adults aged >45 years old
  - Improve Strength:
    - Strong relationship between osteopenia and sarcopenia
  - Improve Balance
    - 1/3 of women in US and Canada over 60 years old fall annually
  - Enhance Bone Strength / Mitigate Bone Loss

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Kemmler et al, *Osteoporos Int*, 2013
Bone As You Age

- Genetics > Lifestyle
- Wolff’s Law: Bone dynamically adapts to the stresses placed on it
- Best time to start is now
- Benefit of exercise on bone is sustained if initiated in childhood but not adulthood
- Fracture Types
  - Cortical Versus Trabecular

Pocock et al., *J Clin Invest.*, 1987
Hernandez-de Sosa et al., *Calcif Tissue Int.*, 2014
OSTEOBLAST VERSUS OSTEOCLAST

Bone Builders
- Vitamin D
- Calcium
- Pharmacologic Drugs
  - Hormone Replacement Therapy
  - Bisphosphonates
- Higher Fat mass
- Exercise

Bone Breakers
- Smoking
- Excess Alcohol
- Menopause
- Hyperparathyroidism
- Protein Deficiency
- Low BMI (<21) or <60 kg
- Aromatase Inhibitors
- Immobilization

OSTEOPOROTIC FRACTURES

- Most common fracture sites: spine, hip, wrist, humerus
- Caucasian > African American
- Genetics
  - <69 years old heritability of hip fractures was 70%
- >50 years lifetime risk =
  - Females 1:2
  - Males 1:5
- Leading causes of death in the elderly
- Cataract Surgery?

Van Staa et al, Bone 2001
Michaelsson et al, Arch Intern Med, 2005
Ali et al, J Gerontol Nurs, 1992
FRACTURE WITH AGE

POSTURE

- Hyperkyphotic Posture
- Increased spinal compression
- Alters center of mass and balance
- Back Extension Exercises
  - Reduced vertebral fracture at 10 year follow up
- Exercises can help restore standing height

Fig. OP4
Left: Line of gravity in a normal spine. The forces are distributed equally on the surface of the endplate avoiding stress peaks.
Right: the kyphotic deformity creates asymmetrical loading of the endplate which increases the risk of further fractures and increasing deformity.

Sinaki et al, *Bone*, 2002
Physical Inactivity...Bad to the Bone

- Older Adults spend 80% of waking hours sedentary
- Participation in physical activity was associated with reduced hip fracture risk by 45% in men and 38% in women
- 60 Day Bed Rest Study
  - 2-3% loss in bone mineral content, 5% decrease in leg lean mass, 40% decrease in quad strength, 29% decrease in oxygen capacity

Harvey et al, J Aging Phys Act, 2015
Moayyeri, J Bone Miner Res, 2011
Kramer et al, Scientific Reports, 2017
Wactawski-Wende et al, J Bone Miner Res, 2012
EDUCATIONAL POINTS

What to Avoid?
- Forward Bending, especially with lifting
- Limit activities with rainy or slippery surfaces
- Abdominal Crunches
- Laziness

What to do?
- Care with transitional movements
- Good Posture
- Maintain Healthy Weight
- Remove clutter
- Optimize lighting
- Squat: bend hip & knees
- Sit down slowly, feel back of chair
- Use of an assistive device
- Review medication

Papaioannou et al, CMAJ, 2010
Sinaki and Mikkelsen, Arch Phys Med Rehabil, 1984
TRANSITIONAL MOVEMENTS: BED MOBILITY
Why Exercise? The Science...

- Weight Bearing
- Compressive Force: Bone Loading
- Tensile Force: Muscle Pull
- Exercise promotes release of growth hormone, prostaglandin, estrogen
- Research
  - Gymnasts versus Nongymnasts
  - Dominant versus Nondominant arm

Mechanical Loading of Bone

Karlsen et al, Calcif. Tissue Int., 1993
Smith et al, Cancer Epidemiol. Biomarkers, 2013
HOW TO EXERCISE? THE MATH...

- **Resistance Training**
  - Duration: Lifetime, >12 months
  - Frequency: 3-5x/week for all major muscle groups
  - Intensity: 7/10
  - Amount: 8-10 Repetitions
  - Start SLOWLY then increase

- **Balance Training**
  - Duration: Lifetime
  - Frequency: 4-7x/week
  - Time: 15-30 min/day
  - Type: one leg balance, tandem balance, walking with head turns/nods
  - Dual Task

Giangregorio et al, Osteopros Int, 2016
Fletcher, Clin J Sport Med, 2013
HOW TO EXERCISE? THE MATH...

- **High Impact**
  - Repetitions: 10-50/day
  - 3+/week (4-7x/week best)
  - >2 times body weight
  - Progressive
  - Multidirectional
  - Rest breaks

- **Walking**
  - No to minimal effects on bone
  - Helpful for reducing bone resorption in elderly women
  - Increasing steps by 25% in 65 year olds resulted in higher BMD.
  - Brisk Walking, Hill Walking
WHAT EXERCISES? THE PHYSICAL...

- Live Exercise Demonstration
- Strengthening
  - Wall Push ups
  - Sit to Stand
  - Forward/Sideways Lunge
  - Step up and Down
- Loading
  - Heel Drops
  - Jumping Jacks
  - Marching
  - Hopping
Next Steps

- Torrance Memorial Classes
  - 310-517-4666
  - Torrancememorial.org/classes
- Silver Sneakers
- City-Sponsored Classes
- Classes via Gym Programs
- Tai Chi
- Water Aerobics/Aquatics
- Yoga For Osteoporosis
  - Debi Robinson
Osteoporosis: Do I have it and where do I go from here?

{A Rheumatologist’s Perspective}

Dr. Joe Gamboa & Dr. Dilrukshie Cooray
Torrance Memorial Physician Network Rheumatologists
Miracle of Living
6/20/18
Background on Osteoporosis

Dr. Joe Gamboa
Osteoporosis

- Severe loss of bone mass
  - Bones withstand a lot of force
  - Loss of bone “strength”

- Silent
  - Don’t feel osteoporosis
  - May notice decrease in height
  - Can lead to bone fractures → painful

- Severe loss of bone density
  - Measured by a bone density scan
    - Dual Energy Xray Absorptiometry (DEXA) Scan

- Also diagnosed based on fractures

- Don’t confuse with:
  - **Osteoarthritis**
    - joint pain
    - “wear and tear” of the joint
    - not related to bone mass
Osteoporosis
Osteoporosis
Osteoarthritis

American College of Rheumatology
Osteoporosis

- First need to understand what happens in bone:
  - Body removes old bone
    - Called Bone Resorption
    - Done by Osteoclasts
  - Body replaces with new bone
    - Called Bone Formation
    - Done by Osteoblasts

- Equilibrium

- Bone Remodeling Cycle plays a role in Osteoporosis
Osteoporosis

Bone Remodeling Cycle

Pre-Osteoclasts → Active Osteoclasts → Resorption → Mononuclear Cells → Pre-Osteoblasts → Osteoblasts → Osteocytes

Resting Bone Surface → Resorption → Reversal → Bone Formation → Mineralization

American College of Rheumatology
Osteoporosis

- Lose more bone than the body can replace
  - Bone Resorption > Bone Formation
- Bones become thinner and weaker in structure
- Can lead to bone fractures
- Sometimes Osteoporosis is diagnosed via bone fractures

Bone Remodeling Cycle

Osteoclasts
- Bone Resorption
  - Bone resorption begins when osteoclasts remove a portion of the bone to be replaced later by the action of osteoblasts. This is a vital step for signaling bone formation.

Osteoblasts
- Bone Formation
  - Osteoblasts lay down collagen and mineral deposits over the area previously remodeled by osteoclasts. Osteoblast activity is vital for maintaining bone mineral density and bone strength.
Osteoporotic Fractures
Osteoporotic fractures
Risks of osteoporosis

- Advancing Age
- Low levels of sex hormones
  - Menopause
    - Low estrogen in women
    - Low testosterone in men
- Family history
- Eating disorders
  - Anorexia, Bulemia
- Cigarette Smoking
- Alcohol abuse
- Low Calcium and Vitamin D
- Sedentary lifestyle
- Medications
  - Steroids
Diseases can give rise to Osteoporosis

• Endocrine diseases
  • Hyperthyroidism
  • Hyperparathyroidism
  • Cushing’s disease

• Inflammatory arthritis
  • Rheumatoid Arthritis
  • Ankylosing Spondylitis
Who usually gets osteoporosis

• Most common in postmenopausal women
  • Usually > 50 years old

• Men
  • Usually > 70 years old

• In the US
  • 4.5 million women > 50 years old have osteoporosis
  • 800,000 men > 70 years old have osteoporosis
Diagnosis of Osteoporosis

- Measure the Bone Mineral Density (BMD)
  - Amount of bone in a given area

- Dual Energy Xray Absorptiometry (DEXA) Scan
  - Measures bone mineral density at bones that take the most force:
    - Spine
    - Hip
      - Femoral neck
      - Part of the hip on top of the thighbone

- Bone Fracture
  - Hips & Back most common; sustain the most force or impact
When to Get A DEXA Scan

• Women > 65 years old
• Menopausal women with risk factors for osteoporosis
• Men > 70 years old
• If you break a bone after age 50
DEXA Scan

• Painless
• Similar to xray but uses less radiation
• Should be avoided if pregnant
• Focuses on bone density in hips and lower back
DEXA Scan Scoring

• Uses a T-score
  • Determined by age and race

• Can use Z-score on younger population
  • Caused by diseases and/or medications

• Usually taken every 2 years
DEXA Scan scoring

**DEXA T-score**
- Not lower than -1.0
- Between -1.0 and -2.5
- -2.5 or lower

**Bone Mineral Density**
- Normal
- Osteopenia (mild BMD loss)
- Osteoporosis
DEXA Scan

Standard Normal Distribution
“Bell Curve”

- Standard Deviation: $\sigma$ (-3, -2.5, -2, -1.5, -1, -0.5, 0, +0.5, +1, +1.5, +2, +2.5, +3)
- Z-Score: (-3, -2.5, -2, -1.5, -1, -0.5, 0, +0.5, +1, +1.5, +2, +2.5, +3)
- Cumulative Percent: 0.1%, 0.5%, 1.7%, 4.4%, 9.2%, 15.0%, 19.1%, 19.1%, 15.0%, 9.2%, 4.4%, 1.7%, 0.5%, 0.1%

National Institute of Health
Osteopenia (versus Osteoporosis)

• Mild bone mass loss
  • DEXA Scan T score -1 to -2.5
• Not as bad as osteoporosis
• But may still have risk of fractures

• Check Fracture Risk Assessment Tool (FRAX)
  • Checks for 10 year probability of a fracture
  • Major
  • Hip
FRAX

• Treat for osteopenia based on FRAX score
  • Risk of 10 year fracture probability
  • Major $\geq 20%$
  • Hip $\geq 3%$

• If meet criteria, treat osteopenia like it is osteoporosis
Treatment of Osteoporosis

Dilrukshie Cooray, MD
Prevention of Osteoporosis

• Try to reverse the modifiable risk factors (NOF)
  • Assessment of dietary calcium and Vit D intake should be conducted
  • Inactivity or immobilization
  • Weight bearing exercises; walking
    • Aim for 2.5 hours/week or 30 min/day
  • Excessive intake of alcohol (>2 drinks/day)
  • Smoking
  • Low BMI

• Endocrine disorders such as thyroid disease or hyperparathyroidism and others can contribute to osteoporosis and need to be ruled out (need to see Endocrinologist if this is the case)
# Calcium

## How Much Calcium Do You Need?

The amount of calcium you need every day depends on your age and sex.

<table>
<thead>
<tr>
<th></th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>WOMEN</strong></td>
<td></td>
</tr>
<tr>
<td>Age 50 &amp; younger</td>
<td>1,000 mg* daily</td>
</tr>
<tr>
<td>Age 51 &amp; older</td>
<td>1,200 mg* daily</td>
</tr>
<tr>
<td><strong>MEN</strong></td>
<td></td>
</tr>
<tr>
<td>Age 70 &amp; younger</td>
<td>1,000 mg* daily</td>
</tr>
<tr>
<td>Age 71 &amp; older</td>
<td>1,200 mg* daily</td>
</tr>
</tbody>
</table>

*This includes the total amount of calcium you get from food and supplements.*
Calcium

Foods rich in calcium

• Dairy products
• Green vegetables
• Food/liquids fortified with calcium

Reading Food Labels – How Much Calcium Am I Getting?

To determine how much calcium is in a particular food, check the nutrition facts panel for the daily value (DV). Food labels list calcium as a percentage of the DV. This amount is based on 1,000 mg of calcium per day. For example:

• 30% DV of calcium equals 300 mg of calcium.
• 20% DV of calcium equals 200 mg of calcium.
• 15% DV of calcium equals 150 mg of calcium.
# Calcium in Dairy

<table>
<thead>
<tr>
<th>Dairy</th>
<th>Serving Size</th>
<th>Estimated Calcium*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ricotta, part-skim</td>
<td>4 oz</td>
<td>335 mg</td>
</tr>
<tr>
<td>Yogurt, plain, low-fat</td>
<td>6 oz</td>
<td>310 mg</td>
</tr>
<tr>
<td>Milk, skim, low-fat, whole</td>
<td>8 oz</td>
<td>300 mg</td>
</tr>
<tr>
<td>Yogurt with fruit, low-fat</td>
<td>6 oz</td>
<td>260 mg</td>
</tr>
<tr>
<td>Mozzarella, part-skim</td>
<td>1 oz</td>
<td>210 mg</td>
</tr>
<tr>
<td>Cheddar</td>
<td>1 oz</td>
<td>205 mg</td>
</tr>
<tr>
<td>Yogurt, Greek</td>
<td>6 oz</td>
<td>200 mg</td>
</tr>
<tr>
<td>American Cheese</td>
<td>1 oz</td>
<td>195 mg</td>
</tr>
<tr>
<td>Feta Cheese</td>
<td>4 oz</td>
<td>140 mg</td>
</tr>
<tr>
<td>Cottage Cheese, 2%</td>
<td>4 oz</td>
<td>105 mg</td>
</tr>
</tbody>
</table>
## Calcium in vegetables and fruits

<table>
<thead>
<tr>
<th>Produce</th>
<th>Serving Size</th>
<th>Estimated Calcium*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collard greens, frozen</td>
<td>8 oz</td>
<td>360 mg</td>
</tr>
<tr>
<td>Broccoli rabe</td>
<td>8 oz</td>
<td>200 mg</td>
</tr>
<tr>
<td>Kale, frozen</td>
<td>8 oz</td>
<td>180 mg</td>
</tr>
<tr>
<td>Soy Beans, green, boiled</td>
<td>8 oz</td>
<td>175 mg</td>
</tr>
<tr>
<td>Bok Choy, cooked, boiled</td>
<td>8 oz</td>
<td>160 mg</td>
</tr>
<tr>
<td>Figs, dried</td>
<td>2 figs</td>
<td>65 mg</td>
</tr>
<tr>
<td>Broccoli, fresh, cooked</td>
<td>8 oz</td>
<td>60 mg</td>
</tr>
<tr>
<td>Oranges</td>
<td>1 whole</td>
<td>55 mg</td>
</tr>
</tbody>
</table>
Calcium Supplements

• National Osteoporosis Foundation
  • Try to get the daily amount of calcium from food/diet
  • Take supplements if your diet is low on calcium

• Calcium Supplements
  • Choose calcium supplements that are pure
    • Have United States Pharmacopeia symbol (USP)
    • Means that the USP has tested and found calcium meets purity standards
  • Read serving size
  • Smaller amounts are better tolerated
  • Side effects: gas or constipation
    • Try the brand that gives you the least side effects
Prevention of Osteoporosis

• Vitamin D
  • Important for absorption of calcium
  • Low Vitamin D can increase risk of brittle bones or osteomalacia

How Much Vitamin D Do You Need?

<table>
<thead>
<tr>
<th>WOMEN AND MEN</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Under age 50</td>
<td>400-800 IU daily**</td>
</tr>
<tr>
<td>Age 50 and older</td>
<td>800-1,000 IU daily**</td>
</tr>
</tbody>
</table>

**Some people need more vitamin D. According to the Institute of Medicine (IOM), the safe upper limit of vitamin D is 4,000 IU per day for most adults.
Risks for low Vitamin D

• Spending little time or no time in the sun
• Medical conditions
  • Celiac Disease
  • Inflammatory bowel disease
• Anti-seizure medications
• Obesity
Vitamin D

• Ways to get Vitamin D
  • Sunlight
    • Skin makes Vitamin D in reaction to sunlight
    • As we age, skin loses ability to generate enough Vitamin D
  • Food
    • Vitamin D is naturally found in few foods
      • Salmon, Mackerel, Tuna
      • Vitamin D is added to dairy products and other drinks (orange juice, soymilk)
    • Very difficult to get enough Vitamin D from food alone
  • Supplements
    • Vitamin D2 (Ergocalciferol): weekly formulation (prescription)
    • Vitamin D3 (Cholecalciferol): usually daily vitamin

National Osteoporosis Foundation
Saag, Diagnosis and Management of Osteoporosis 2017
Calcium or Vitamin D

- Overall effect of calcium or Vitamin D alone on fracture risk is uncertain
- Studies show no difference between calcium alone or placebo in reduction of fracture.
- Data on efficacy of Vitamin D alone for reduction of fracture risk are mixed (National Osteoporosis Foundation)
Treatment for Osteoporosis – non-pharmacologic

• What do I do if I have Osteoporosis?
  • Make sure you keep up with the preventive measures
    • Calcium
    • Vitamin D - Important for absorption of calcium
    • Exercise/physical therapy
    • Fall prevention programs

• Rule out underlying causes
  • Disease states
  • Medications
  • Hormone imbalances
Treatment of Osteoporosis – drugs fall into 3 classes

- **Anti-resorptive drugs** - Decrease the breakdown of bone
  - Bisphosphonate therapy (4)
  - RANKL inhibitor: denosumab (Prolia)
  - SERMs – Raloxifene
  - Hormone replacement therapy

- **Anabolic drugs** – bone formation
  - Forteo
  - Tymlos

- **Strontium ranelate** – not much data; weak effects on bone remodeling
Bisphosphonates

**Generic Drug Name**
- Alendronate
  - Daily or weekly pill
- Risedronate
  - Daily, weekly or monthly Pill
- Ibandronate
  - Daily or monthly pill, Quarterly (every 3m) Intravenous Infusion
- Zoledronic Acid – most potent
  - Yearly Intravenous Infusion
  - Given for 3 years (lifetime span)

**Brand Name**
- Fosamax
- Actonel
- Boniva
- Reclast

***Evidence is insufficient to determine comparative effectiveness or superiority of one agent over another***
Bisphosphonate therapy

- Alendronate (Fosamax), risedronate (Actonel), and zoledronic acid (Reclast) shown to reduce the risk of vertebral/hip fracture in postmenopausal osteoporotic women
- Ibandronate (Boniva) reduces vertebral fractures but evidence insufficient to determine effect on hip fracture
- Typically length of treatment - approx 5 years
- Oral: Alendronate, Risedronate, Ibandronate
  - Take on an empty stomach with water only (ensures proper absorption of medications)
  - Remain upright for 30 min – 1 hour after taking (can irritate esophagus)
  - Contraindicated in Kidney disease
- Zolendronic Acid or Reclast
  - Yearly intravenous infusion
  - Also used to treat cancer that has spread to the bones (Called Zometa)
Side effects of Bisphosphonates

• Osteonecrosis of the jaw (Rare)
  • Usually occurs when bisphosphonates are used in high doses (example: cancer treatment) and/or for prolonged period of time
  • Usually occurs in patients who:
    • Recently had extensive/invasive dental procedure while on bisphosphonates
    • Recently had serious dental disease while on bisphosphonates
    • Poor fitting dentures

• Recommendations
  • Get invasive dental work done prior to starting bisphosphonates and let your dentist know you are taking these medications
  • Do not take bisphosphonates for > 5 straight years at a time (aka Drug Holiday)
    • Reclast is typically given for 3 years
  • Other side effects reports including GI upset, myalgias/arthritis. Flu-like symptoms with Zoledronic acid

National Osteoporosis Foundation
Saag, Diagnosis and Management of Osteoporosis 2017
Side effects of Bisphosphonates

• Atypical femoral fractures
  • Uncommon type of thighbone (subtrochanteric) fracture
  • More likely to break a bone from osteoporosis than have an atypical femoral fracture from bisphosphonates
  • Usually occurs when taking bisphosphonates for prolonged period of time (data suggests > 8y)
  • Try and avert by not treating with bisphosphonates for more than 5y

American College of Rheumatology
Denosumab/Prolica

• Subcutaneous injection every 6 months
• Human monoclonal antibody
  • Type of immune therapy
• Safe for kidney disease
  • Used in patients with chronic kidney disease who have osteoporosis
• Can stay on medication for > 5 years; have data for 10 years now

• Side effects:
  • Lowers serum calcium
  • Joint/muscle aches
  • Increased risk of infection reported
  • Risk of Osteonecrosis of the Jaw (ONJ)
Hormones

• Hormone Replacement Therapy
  • Estrogen
    • Recent moderate quality evidence shows no difference in reduction of fracture in postmenopausal patients with established osteoporosis

• Estrogen Receptor Modulators (SERMs) – Raloxifene
  • High quality evidence shows reduction in vertebral fractures in osteoporotic women however no reduction in non-vertebral or hip fractures compared to placebo

• Side effects
  • Increases risk of strokes, blood clots, heart attacks
Anabolic medications

• Teriparatide (Forteo), Abaloparatide (Tymlos)
  • Form of a parathyroid hormone
  • Stimulates bone formation
  • **Daily** subcutaneous injection (administer it at home)
  • Take for ~2 years (lifetime span): Forteo – 2y; Tymlos 18m
  • Indicated if you already have a bone fracture from osteoporosis
  • Indicated if there is a very high risk of bone fracture from osteoporosis

• Contraindications:
  • History of radiation treatment
  • Hyperparathyroidism
  • History of bone or muscle cancer in yourself or your family
Final thoughts

• Consequence of osteoporosis:
  • FRACTURE
  • Spine and hip fractures → Chronic pain, disability, increased morbidity/mortality

• Prevention and treatment of osteoporosis:
  • Prevents further bone loss/fractures
  • Regular exercise in combination with therapy is very important not only for bone health but prevention of falling
  • Protect yourself from falls – use a cane or walker

• DEXA scan
  • Bone mineral density if you are at risk

• Treatment
  • Discuss with your physician the best treatment path to take along with lifestyle changes
References

• American College of Rheumatology
  • Rheumatology.org

• National Osteoporosis Foundation
  • NOF.org

• National Institute of Health
  • NIH.gov

• Uptodate