Osteoporosis, Pain, and the Spine Patient

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Disclosures

• None related to this Topic

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  — Slide Kits and Publications for Patients and Physicians

Outline

1. Osteoporosis
   Introduction
   Influences on Bone

2. Vertebral Compression Fracture
   Incidence
   Consequences
   Presentation
   Work up
   Treatment
   Non operative
   Operative

3. Summary
   Identify, evaluate and treat the underlying cause of the fracture or pain
Osteoporosis

A disease characterized by low bone mass and micro-architectural deterioration of bone tissue leading to reduced bone strength and a consequent increase in fracture risk.

Lifetime risk at the age of 50

<table>
<thead>
<tr>
<th></th>
<th>Women</th>
<th>Men</th>
</tr>
</thead>
<tbody>
<tr>
<td>Osteoporotic fracture</td>
<td>46-53%</td>
<td>21-22%</td>
</tr>
<tr>
<td>Hip fracture</td>
<td>15-23%</td>
<td>5-11%</td>
</tr>
<tr>
<td>Radiographic vertebral fracture</td>
<td>27%</td>
<td>11%</td>
</tr>
<tr>
<td>Clinical vertebral fracture</td>
<td>15%</td>
<td>8%</td>
</tr>
<tr>
<td>Breast cancer</td>
<td>10-13%</td>
<td></td>
</tr>
<tr>
<td>Prostate cancer</td>
<td>9-11%</td>
<td></td>
</tr>
</tbody>
</table>

All fractures are associated with morbidity

- Death within one year: 20%
- Permanent disability: 30%
- Unable to walk independently: 40%
- Unable to carry out at least one independent activity of daily living: 80%

References:
Van Staa TP et al. (2001) Bone 29: 517
How do we know which bones will fail?

- No longer just BMD. Our criteria for Diagnosis of OP relies on BMD, a major determinant of bone strength, but not the whole answer
- Better tools to assess Bone quality includes micro-architecture, geometry, direction and rate of load
- Other Fx Prediction tools: Fracture Probability is dependent on more than BMD, including other risk factors such as age, prior fx, family hx of hip fx, gender, etc (fracture prediction models like FRAX)

Approximately 30% of women over the age of 50 have one or more vertebral fractures\(^2\)
Approximately one in five men over the age of 50 will have an osteoporosis-related fracture in their remaining lifetime\(^1\)

- How do we prevent this and better treat it?
  - Prevention of dz, prevention of first fx, prevention of subsequent fxs.
SO... how can we make bone better?
  - What makes bone vulnerable?
**ADDITIONAL INFLUENCES**

- Activity
- Body Mass
- Gender
- Heredity
- Illness
- Ethnicity
- Medication
- Hormones
- Calcium
- Malnutrition

**Hierarchical nature of bone structure**

- Macrostructure
- Microstructure
- Matrix Properties
- Cellular Composition and Activity

**Age v. Mechanical Properties**

<table>
<thead>
<tr>
<th>Mechanical Property</th>
<th>Age-Related Decline, % per decade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modulus</td>
<td>1.5–4</td>
</tr>
<tr>
<td>Strength</td>
<td>2.1–5</td>
</tr>
<tr>
<td>Ultimate tensile strain</td>
<td>5.1–9</td>
</tr>
<tr>
<td>Energy absorption (work)</td>
<td>6.8–12</td>
</tr>
<tr>
<td>Fracture toughness</td>
<td>4.1</td>
</tr>
<tr>
<td>Impact energy</td>
<td>300</td>
</tr>
</tbody>
</table>

Tissue-level mechanical properties degrade with age; this degradation is evident as early as age 20 [33]. Stiffness and strength degrade 1% to 5% per decade [33] [34], whereas ductility and toughness show a more severe degradation of 8% to 12% per decade [34] [35] [36], Age-related changes in collagen cross linking, formation of advanced glycation endproducts, and increases in mineralization and porosity all affect tissue stiffness and strength, but more importantly these factors have an inordinate effect on tissue ductility and fragility. Knowing how cellular activity affects tissue quality is important because the decline in toughness is thought to contribute to the age-related increase in bone fragility [37].

**Trabecular horizontal connections**

- 50 yo man
- 58 yo man
- 76 yo man
- 80 yo woman

Geometric contributions to bone strength and fracture risk. During the development of osteoporosis, the loss of horizontal connections between the trabecular is more prominent than the loss of vertical elements; this loss is a major factor in the loss of resistance to compressive forces. The microscopic architecture is shown in a 50-year-old man (A), a 58-year-old man (B), a 76-year-old man (C), and an 80-year-old woman (D).

Age-related changes in femoral neck cortex and association with hip fracture

Those with hip fractures have:
- Preferential thinning of the inferior anterior cortex
- Increased cortical porosity

Jordan et al. Bone, 2000; 6:305-13

Age-related changes in bone properties associated with fracture risk

- Decreased bone mass and BMD
- Altered geometry
- Altered architecture
  - Cortical thinning
  - Cortical porosity
  - Trabecular deterioration

Mayhew et al, Lancet 2005

Vertebral bodies: Thin cortex with extensive trabecular bone.
- Primarily Trabecular bone which has 5x turnover rate of cortex.
- Bone loss often occurs earliest where turnover is highest.

Osteoporosis:
- Beyond structure
  - Integrity and properties of the collagen, matrix, cellular, network and nodal systems, and signaling pathways
Vertebral compression fractures

- Most common osteoporotic fracture type, usually undetected and a significant cause of morbidity and mortality
- Often silent
- Insidious, progressive nature
- Associated with
  - Deformity, height loss, back pain
  - Impaired breathing
  - Increased morbidity and mortality
- Predict future spine and hip fractures

Possible causes of VCFs

- **Primary osteoporosis** – changes with aging and postmenopausal
- **Secondary osteoporosis**
  - Drug-induced (corticosteroids, tobacco, barbituates, heparin)
  - Endocrine (hyperparathyroidism, diabetes)
  - Miscellaneous (renal failure, COPD, rheumatoid arthritis, hepatic disease or transplant)
- Osteolytic lesions
  - Multiple Myeloma
  - Bone metastases
  - Paget’s disease
- Trauma
  - 1/3 of all trauma cases are misclassified

Presentation of VCF

**Acute Event:**
- Sudden onset of back pain with little or no trauma

**Chronic Manifestation(s):**
- **Loss of height** (1/2”/yr)
- Spinal deformity (“Dowager’s hump”)
- Protuberant abdomen

Consequences of vertebral fractures

- Kyphosis
- Loss of height
- Bulging abdomen
- Acute and chronic back pain
- Breathing difficulties
- Depression
- Reflux and other GI symptoms
- Difficulty with activity of daily living (bending, rising, dressing, climbing stairs)
- Need to use a walking aid

Gold et al., *Osteoporosis* 1996, 2002
Decreased Quality of Life

- Decreased activity
- Increased depression
- Lower self-esteem
- Increased anxiety
- Diminished social roles
- Increased dependence on others

Gold, Bone 1996

Biomechanics after VCF May Increase fall risk

- Knees bend, pelvis tilts forward to counteract forward bending
  - Change in balance
  - Decrease in gait velocity
  - Increased muscle fatigue
  - Increased risk of falls and additional fractures

1 Gold et al., Osteoporosis 2001
2 Ross et al., Annals Int Med 1991

Biomechanics of Pathologic Spine Fractures

- Center of gravity (CG) moves forward
- Large bending moment created
- Posterior muscles and ligaments must counterbalance increased bending
- Anterior spine must resist larger compressive stresses

White III and Panjabi 1990

All types of vertebral fractures are associated with morbidity

Adapted from Novitt MC et al. (2000) Arch Intern Med 160: 77
**Increased Mortality**

Prospective study of 9,575 women followed > 8 years demonstrated:

- Patients with VCF have a 23-34% increased mortality rate compared to patients without VCF
- VCF patients are 2-3xs more likely to die of pulmonary causes
- Most common cause of death was pulmonary disease, including COPD and pneumonia

*Kado et al., Arch Intern Med 1999*
**DIAGNOSIS**

- Identify painful level
- Define fracture configuration
- Define age of the fracture
- Osteoporosis?
- Other Processes?
- Heal this fracture
- Prevent the next fracture

**Work up**

- History and Physical Exam
- Labs
- Imaging:
  - Plain Radiographs
  - MRI
  - CT Scan
  - Bone Scan
  - DXA/VFA

**HISTORY AND PHYSICAL EXAM**

- MOI: Low Trauma? Has there been a recent event, prior to onset of pain?
- Is the pain different than usual back pain? typically mechanical in nature i.e. worse with loading, but different in characteristic than degenerative pain
- Many Patients have multiple collapsed levels
  - Acute vs chronic
    - Localizing acute injury - Palpation of spinous process and or flexion/extension provokes typical pain.

**Risk factors used in the calculation of 10-year risk of fracture**

- Femoral neck T-score
- Age
- Previous low trauma fracture
- Low BMI
- Ever steroid exposure
- Family history of hip fracture
- Current cigarette smoking
- High alcohol intake (> 2 units/day)*

*1 unit = 8 gm alcohol = ½ pt. beer = glass wine
Kanis JA et al, Bone, 2002;30:231-236
Kanis JA et al, Osteoporos Int, 2005;16:881-890
Basic Metabolic Bone Labs

- CBC with diff
- Comprehensive metabolic panel
  - To include Ca, Mag, Phos, Alk phos, albumin
- Vit D 25 OH
- Intact PTH
- TSH, Free T4
- PTH

Bone Turnover markers, still not routinely used
some have chosen one resorption and one formation marker to follow

X-RAY

Ideal is AP and Lateral x-ray
Parallel to endplate
Use comparison films to assess progression
Use cone down or centered AP & Lat views if needed
May also need to compare prior CXRs

Vertebral fractures

Semi-quantitative grading

<table>
<thead>
<tr>
<th>Grade</th>
<th>Anterior</th>
<th>Posterior</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Normal</td>
<td>Normal</td>
</tr>
<tr>
<td>1</td>
<td>Mild</td>
<td>Mild</td>
</tr>
<tr>
<td>2</td>
<td>Moderate</td>
<td>Moderate</td>
</tr>
<tr>
<td>3</td>
<td>Severe</td>
<td>Severe</td>
</tr>
</tbody>
</table>

Unrecognized vertebral fractures on X-ray

934 women age 60 and older, hospitalized for various reasons
Chest x-rays reviewed for fracture

- 52% mentioned in radiologist's report
- 23% mentioned in discharge summary
- 17% mentioned in record
- 7% treatment for osteoporosis

Not all VCFs are osteoporotic fractures. May need MRI, CT, or bone scan.

DXA/VFA

DXA based vertebral fracture analysis

Should be added to DXA studies of VCF pts

Knowing a patient has already had a fracture will affect our treatment decision and how the patient makes decisions, as well as their risk for subsequent fractures. Is predictive of fx, indep of BMD.
Treatment: Non Operative

- Treatment Protocol
  - Bed rest
  - Narcotic analgesics
  - Braces
  - Modalities for symptomatic relief
  - PT for fall assessment, mobility trg, d/c disposition, HEP

- Prevent the next fracture!
  Include in treatment plan how to identify and treat underlying bone disorder

Pharmacological agents for treatment of osteoporosis

Effective therapies are widely available and can reduce vertebral, hip and other fractures by 30% to 65%, even in patients who have already suffered a fracture

For Example: Ca, Vit D, Anitresorptives – Bisphosphonates, RankL inhibitor
Anabolic – Teraparatide
Calcitonin, Strontium, Raloxifine, HRT

Anti-fracture efficacy of the most frequently used treatments for postmenopausal osteoporosis
As derived from placebo controlled randomized trials

<table>
<thead>
<tr>
<th>Drug</th>
<th>Vertebral fractures</th>
<th>Non-vertebral fractures (hip)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alendronate</td>
<td>++ +</td>
<td>+ +</td>
</tr>
<tr>
<td>Calcitonin (nasal)</td>
<td>+</td>
<td>0</td>
</tr>
<tr>
<td>Etidronate</td>
<td>+</td>
<td>0</td>
</tr>
<tr>
<td>HRT</td>
<td>++ +</td>
<td>+ +</td>
</tr>
<tr>
<td>PTH</td>
<td>++ +</td>
<td>+ +</td>
</tr>
<tr>
<td>Raloxifene</td>
<td>++ +</td>
<td>0</td>
</tr>
<tr>
<td>Risedronate</td>
<td>++ +</td>
<td>+ +</td>
</tr>
<tr>
<td>Strontium ranelate</td>
<td>++ +</td>
<td>+ +</td>
</tr>
</tbody>
</table>

Adapted from Delmas PD, Lancet, 2002;359:2018-2026

PTH effects on risk of new vertebral fractures over 18 months

<table>
<thead>
<tr>
<th>Risk reduction (RR)</th>
<th>Placebo (n=448)</th>
<th>rhPTH 20 µg (n=444)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RR 0.35</td>
<td>Placebo</td>
<td>rhPTH 20 µg</td>
</tr>
<tr>
<td>64</td>
<td>65%</td>
<td>22</td>
</tr>
<tr>
<td>% of women</td>
<td>0</td>
<td>14</td>
</tr>
<tr>
<td>12</td>
<td>14</td>
<td>12</td>
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</table>
Pharmacologics for Acute Care

• May see antiresorptives and anabolic bone agents being used in the acute care of fragility fractures more in the future.
• When is it ok to start them?
• Which ones will help or hinder the acute fx healing process?
• How long to keep them on?
• Indications?
• May augment surgical care with Pharmacologics

VCF Treatment

Relative Rest: May Compound problem of bone loss

– Prolonged symptoms
  – decreased mobility, increased dependence, narcotic use
– May exacerbate bone loss –loss up to 2% per week reported after prolonged bed rest\(^1\)
– Further deformity may contribute to further problems
  – Poor appetite, increased fall risk, mech load on ant column

\(^1\) Johnell et al., Osteoporosis Int 2000

Operative VCFs

1. Persistent Pain – no improvement in 4-6 weeks
   - 260,000 pts/yr refractory to medical therapy,
   - 1 Cooper et al., J Bone Min Research 1992

2. Deformity Progression
   - Lieberman et al., Spine 2001

VCF Operative Treatment Options

Vertebral Augmentation

- Designed to stabilize painful VCFs
- Debate between best method
  - Each has reported complications and beneficial series
  - Is there a benefit to restoring height, correcting kyphotic deformity and not putting cement in under pressure
- Is there a benefit to vertebral augmentation over pharmacologic treatment for quicker relief of symptoms and earlier mobilization
Summary

Vertebral Fractures
- Are the most common osteoporotic fracture
- Are associated with excess mortality
- Are associated with significant morbidity, even if they do not come to clinical attention
- Increase the risk of subsequent vertebral fractures by 5-fold and the risk of other fragility fractures (including hip) by 2 to 4-fold

Who wants their next fracture prevented?

Summary

Identify, evaluate and treat the underlying cause of the fracture or back pain. Call a fx when you see it.

Always suspect a VCF, but look for other causes (other fx sites if on BPs)....pelvic or femoral insufficiency fx.

In all spine patients over 50 – Consider screening with FRAX (or similar), DXA and letter of education with reminder to discuss this with PMD.

Establish referral mechanisms for Bone Health Specialists, DXA, Metabolic Bone Panel at your facility so it is easy.

PREVENT THE NEXT FRACTURE