Osteoporotic Fractures

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Objectives

1. **Define osteoporotic fragility fracture and its incidence**
2. **Discuss science of osteoporosis and effect on bony architecture**
3. **Describe surgical principles in management of these fractures**
4. **Illustrate examples of surgical failures and how to avoid**
5. **Discuss bone health management after osteoporotic fractures**

Osteoporotic Fragility Fracture

- Typically low energy mechanism (e.g., ground level fall)
- Most commonly at distal radius, proximal humerus, hip, vertebrae
- Lifetime risk of fragility fracture ~40-50% in females and 13-22% in males
- Likelihood increases with age

Osteoporotic Fragility Fracture

- Risk factors for fracture:
  - Age >75
  - Low BMD
  - Smoking
  - History of prior fracture
  - Poor nutrition
  - Poor executive function

Osteoporotic Fragility Fractures

- Continued increasing healthcare costs related to fragility fractures
- In 2005, ~$17 billion spent on osteoporotic fractures in US
  - Expected to increase ~50% by 2025

Osteoporosis

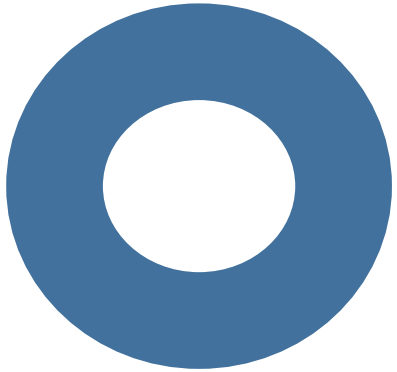
- Deterioration of microarchitecture of bone compromising strength
  - Increased risk of fractures
- Can be result of losing too much bone, making too little bone, or combination of both
- Most common bone disease

Osteoporosis Diagnosis

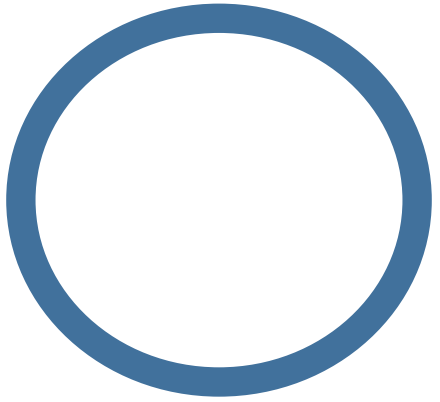
- Bone mineral density (BMD) measurement
  - Dual-energy x-ray absorptiometry (DXA) scan
- Osteoporosis defined by BMD that is 2.5 standard deviations or more below the average value for young healthy women (T-score)
  - Osteopenia = T-score -1.0 - -2.5
- Can also be diagnosed based on history of low energy fracture of vertebral body, hip, proximal humerus, or distal radius

Bone Changes Over Time

- Bone mass increases until age 25-30
- Osteoclast activity > osteoblast activity as age increases, particularly after menopause in women
- Results in thinned trabeculae and fragile cortices with increase in overall diameter of bone



Normal bone cross section



Osteoporotic bone cross section

Goals of Intervention on Fragility Fractures

- Stable construct that can allow early weight bearing
- Still following 4 AO principles:
    1. Fracture reduction to restore anatomical relationships
    2. Stabile fixation providing absolute or relative stability
    3. Preservation of blood supply
    4. Early and safe mobilization
- Soft tissue friendly techniques given often poor soft tissue envelope

Surgical Issues With Osteoporotic Bone

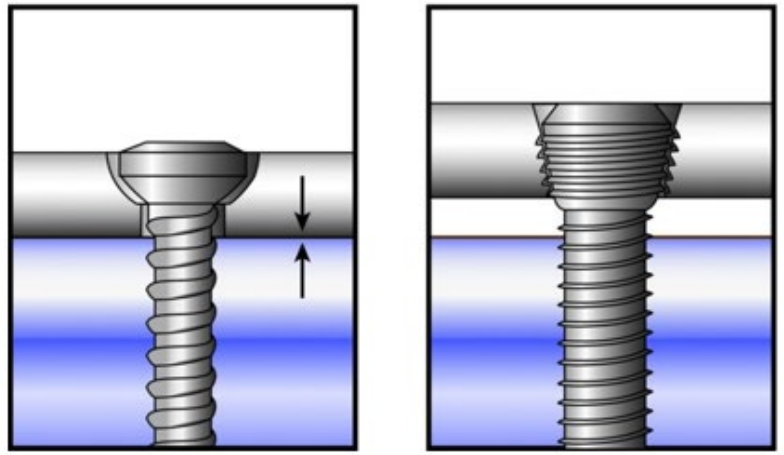
- Thin, fragile cortices
- Poor screw purchase
- High risk of screw “cutout”
- Difficult to obtain rigid fixation
- Patients ability to heal worse

Screw Failure Osteoporotic Bone

- If friction between bone and plate is overcome, fixation depending on stiffness of screws
- With standard plating, axial stiffness is dependent on torque between screw and near cortex which can be weak in osteoporotic bone
- Leads to screw loosening and pullout

Locking Plates/Screws

- Locking screws are fixed-angle devices
- Do not rely on friction between screw head and plate for fixation
- Preferred in osteoporotic bone where plate-to-bone compression is limited

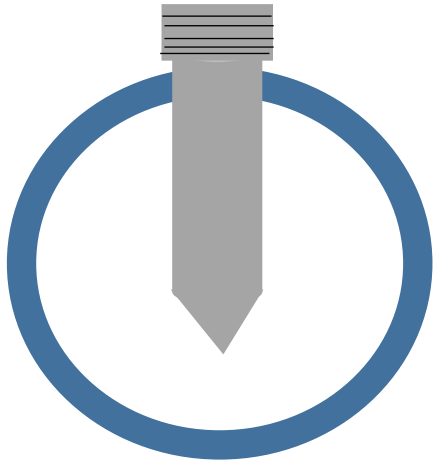


Conventional plate/screw Locking plate/screw

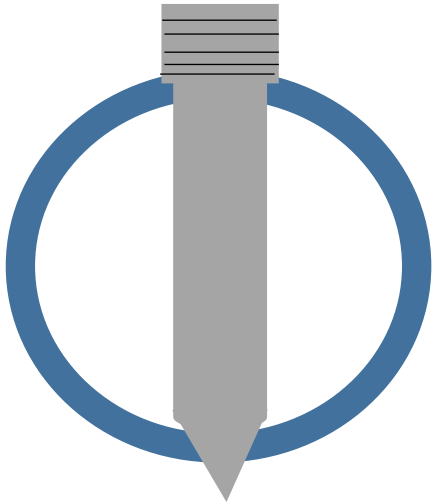
Image from: Bishop J, Behn AW, Gardner MJ. Principles of Internal fixation. In: Tornetta P, Ricci WM, eds. Rockwood and Green's Fractures in Adults, 9e. Philadelphia, PA. Wolters Kluwer Health, Inc; 2019

Locking Plates/Screws

- In normal bone, bicortical fixation is not necessary with locking screws
- In osteoporotic bone, bicortical fixation of locking screws can enhance the torsional stability of the construct



~3x More stable with bicortical fixation



Conventional plate/screw failure

- Screws pull out of bone sequentially

Locking plate/screw failure

- Plate/screw fails as unit

Bridging

- Bridge plating can be useful technique in osteoporotic bone
- Long plates for bone protection
- Still want anatomic reduction of articular surfaces

Peri-implant Considerations

- As patients life-expectancy has increased and longevity of arthroplasty has increased, increased frequency of peri-implant/periprosthetic fractures in geriatric population
- Main goals similar to any fracture:
  1. Uncomplicated fracture union
  2. Restoration of length/alignment/rotation
  3. Return patient to preinjury level of function

Peri-implant Considerations

- Preserve soft tissue attachments
- Likely need to employ indirect reduction techniques
- If performing ORIF, use long working lengths, avoid stress risers, and protect length of bone if possible
- Be prepared for revision arthroplasty if concern that implant is loose

Peri-implant Considerations

- Avoid stress risers by bypassing implants
- Utilize bridging constructs
- Indirect reduction techniques to limit soft tissue stripping

Peri-implant Considerations

- Revision arthroplasty if loose prosthesis

Fixation Failure in Osteoporotic Bone

- Screw cut-out
- Plate pull-off
- Varus collapse
- Malunion
- Nonunion

Factors for Fixation Failure

Patient Factors

- Poor bone quality
- Metabolic bone issues
- More medical comorbidities in geriatric population

Surgical Factors

- Implant choice
- Inappropriate implant position
- Poor reduction
- Poor soft tissue management

Hip Fracture Fixation Failure

- Non-displaced geriatric femoral neck fracture treated with CRPP

Hip Fracture Fixation Failure

- Hip pain with weight bearing ~3 weeks post-operatively
- XR shows screw cutout on lateral view

Hip Fracture Fixation Failure

- Converted to hemiarthroplasty, healed without issue

Inappropriate Implant Use/Positioning

- Geriatric female with prior THA, TKA, and supracondylar periprosthetic distal femur fracture treated with ORIF
- New ground level fall and RLE pain

Inappropriate Implant Use/Positioning

- New fracture distal to THA stem at proximal screw site
- No screw fixation to overlap fixation of plate and stem causing stress riser

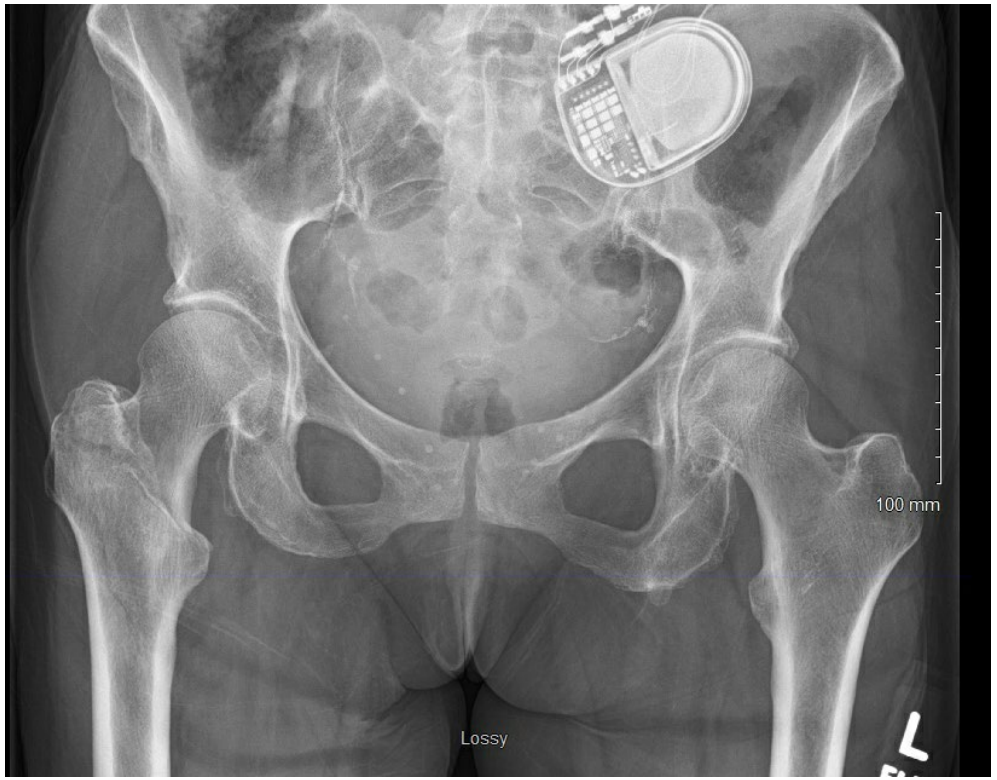
Inappropriate Implant Use/Positioning

- Revised with hardware removal and ORIF with new long plate bypassing implants
- Healed with good callus formation
- Ambulating pain free at 6 months

2 weeks post-op

6 months post-op

Poor Reduction/Hardware Positioning



- Non-displaced right IT fracture

Poor Reduction/Hardware Positioning

- Poor reduction, fixed in varus relative to contralateral hip
- Tip-apex distance >25mm

Poor Reduction/Hardware Positioning

- Increased pain ~2 months post-op
- Superior screw cut-out, varus collapse on XR

Poor Reduction/Hardware Positioning

- Converted to THA, diaphyseal fit stem

Post-Fragility Fracture Management

- High risk for secondary fracture
  - 50% of fragility fracture patients will have a second fracture
  - 50% of hip fracture patients will have had a prior fragility fracture

- ***Yet only 16-20% of post fragility fracture patients get placed on therapy for osteoporosis***

Burden of Hip Fracture

- 2M osteoporotic fx annually
- 432,000 hospital admissions
- 2.5M medical office visits
- 10,000 nursing home visits
- 14% hip fractures
  - 72% fracture related medical expenses
  - 6 month post hip fx expense $34,509- $54,054
- 20-30% mortality within 1 year
- 50% will never ambulate without assistance
- 25% will end up in long term care

Lewiecki et al, Osteo Int 2018

Surgeon Buy-In Necessary

- Often mentality of *“Fix it and Forget it”*
- Treating Osteoporosis: “ Not our expertise!”
- “We are not…”
  - Primary Care Provider
  - Rheumatologists
  - Endocrinologists

What is The Orthopedic Surgeon's Role?

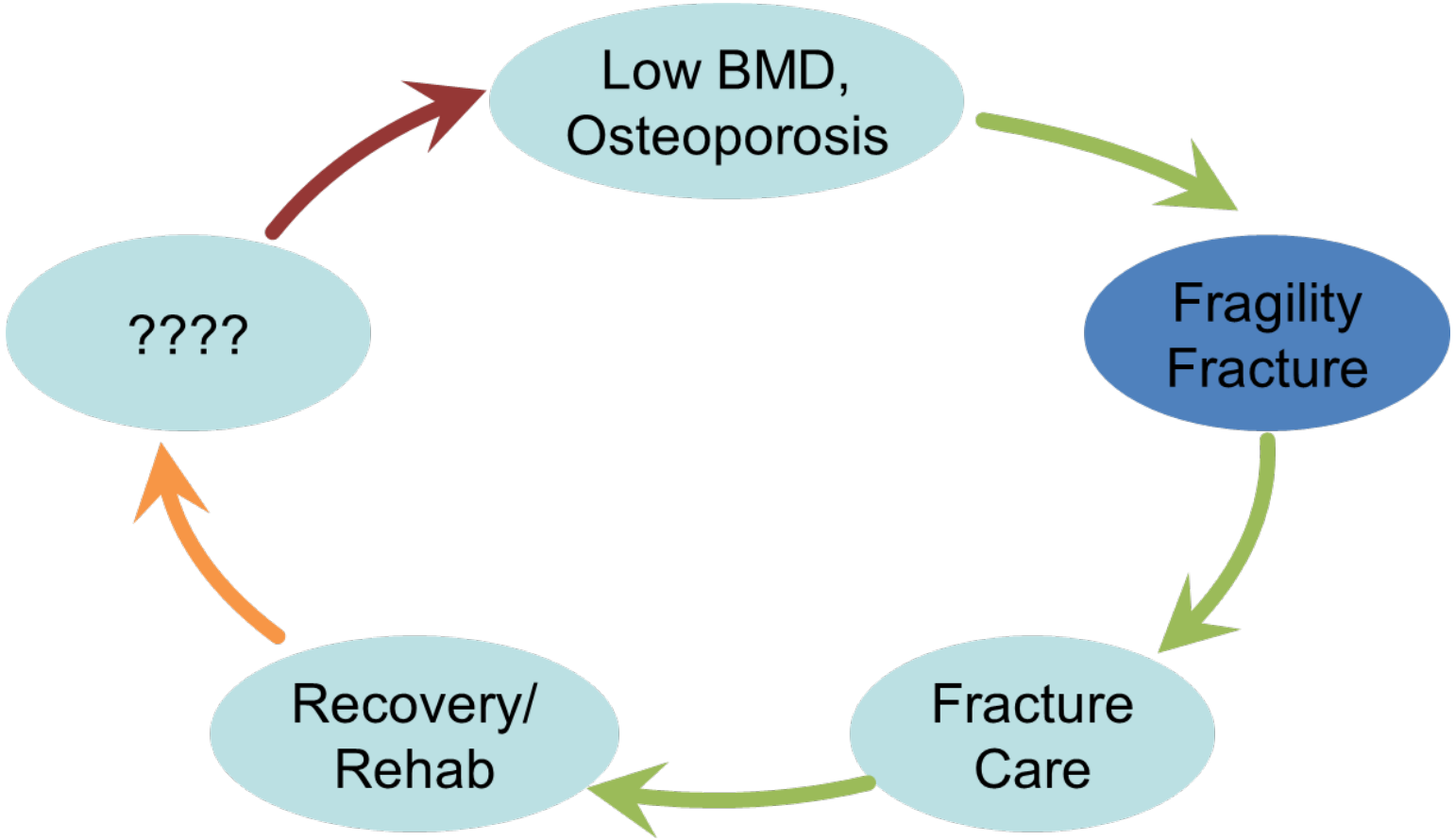
AAOS American Academy of Orthopaedic Surgeons
American Association of Orthopaedic Surgeons

Position Statement

Osteoporosis/Bone Health in Adults as a National Public Health Priority

- Every orthopedic surgeon should work diligently to participate in prevention and treatment of osteoporosis and fragility fracture care

Must Break the Fragility Fracture Cycle



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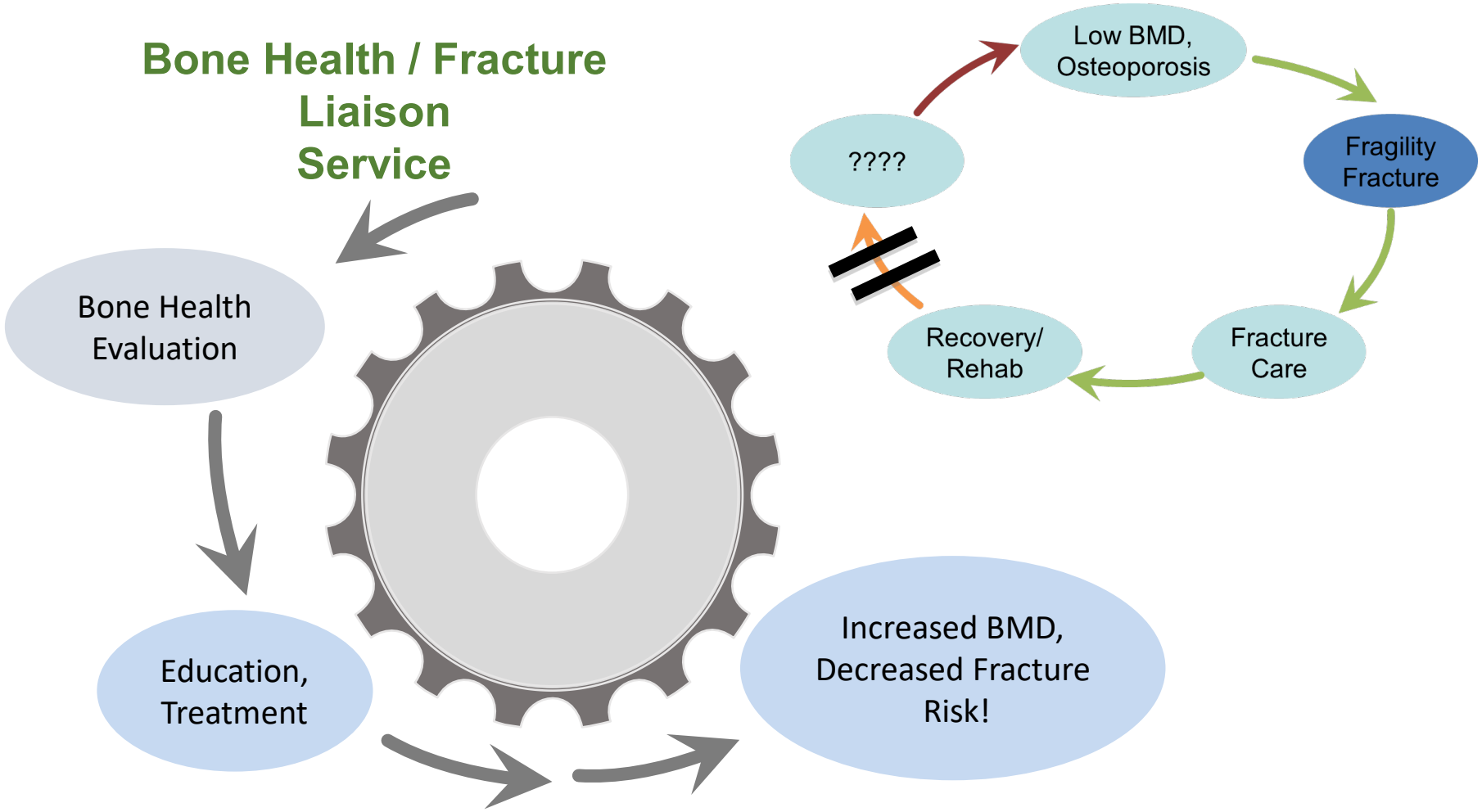

Effects of Treatment After Initial Fragility Fracture

- Anti-osteoporosis therapy reduces risk of a second fragility fracture after a primary fracture
- ~40% risk reduction of secondary fracture in three years after initial fragility fracture

Bawa et al, JBJS 2015

Fracture Liaison Service (FLS)

- FLS program helps patients reduce risk of suffering a second fragility fracture
- Patients enrolled after initial fragility fracture
- FLS provides a bone evaluation and plan for patients to improve bone health
- Improved adherence to osteoporosis treatment when patients enrolled in FLS

Boudout et al, Osteo Int 2011

Workup For Fragility Fracture Patient

- Thorough history (hormonal issues, medications)
- Nutrition status
- Lifestyle (exercise, tobacco, alcohol use)
- Family history

- Laboratory evaluation:
  - PTH
  - (25)-Vitamin D Level
  - Serum Calcium
  - Albumin
  - TSH

Treatment Options

- Nutrition
- Exercise
- Lifestyle changes
- Fall prevention
- Anti-osteoporosis medications

Nutrition

- Calcium requirements:
  - Young – 1000mg/day
  - Older – 1500mg/day
- Multiple forms of calcium. Can be taken in whatever form is tolerated:
- Healthy body weight
  - BMI < 18 is risk factor for fracture
  - Obese patients are at increased risk of falls

Nutrition

- Vitamin D3
  - Young – 400U/day
  - Older – 800U/day
- If deficient on laboratory workup, treat with 50,000U/week
- Sunlight helpful for Vitamin D

Exercise

- Weight bearing exercise for bone health
- Low impact exercises can help to prevent falls

Fall Prevention

- Polypharmacy places geriatric patients at risk of falls
  - Work with PCP and FLS for medication management
- Home safety evaluation to reduce risks:
  - Rugs
  - Poor lighting
  - Steps
  - Pets

Anti-Osteoporosis Medications

- Antiresoptive medications – inhibit bone breakdown
  - Bisphosphonates (oral and IV)
  - Selctive estrogen reuptake modulators (SERMs)
  - Calcitonin
- Anabolic medications – stimulate bone formation
  - Parathyroid hormone analog (Teriparatide)
  - Parathyroid hormone related protein analog (Abolopaeratide)
  - Sclerostin Inhibitors (Romososumab)

Anti-Osteoporosis Medications Effects on Fracture Healing

- Little evidence of anti-resorptive drugs showing change in healing
  - Bisphosphonates may form larger and stronger callus with delayed remodeling, but no sign of delayed healing
- Parathyroid hormone analogs may accelerate healing in distal radius and pelvic fragility fractures
- Overall, no significant clinical data showing delay in fracture healing. Given patients are at high risk for subsequent fracture, providers should not delay initiation of anti-osteoporosis therapy

Ho Shin et al, J Bone Metab 2020

Summary

- Understand poor bone quality in osteoporotic fracture patients and adjust implant choice/fixation strategies accordingly
- Adhere to AO principles of fracture fixation
- Osteoporosis is significantly under-treated after fragility fracture
- Orthopaedic surgeons have active role in bone health care particularly after osteoporotic fracture