

Osteoporosis screening: DEXA interpretation



Disclosure Information

Spring Refresher 2009

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I have no financial relationships to disclose.

I will not discuss off label use and/or investigational use in my presentation.

By the end of this session, you will be able to...

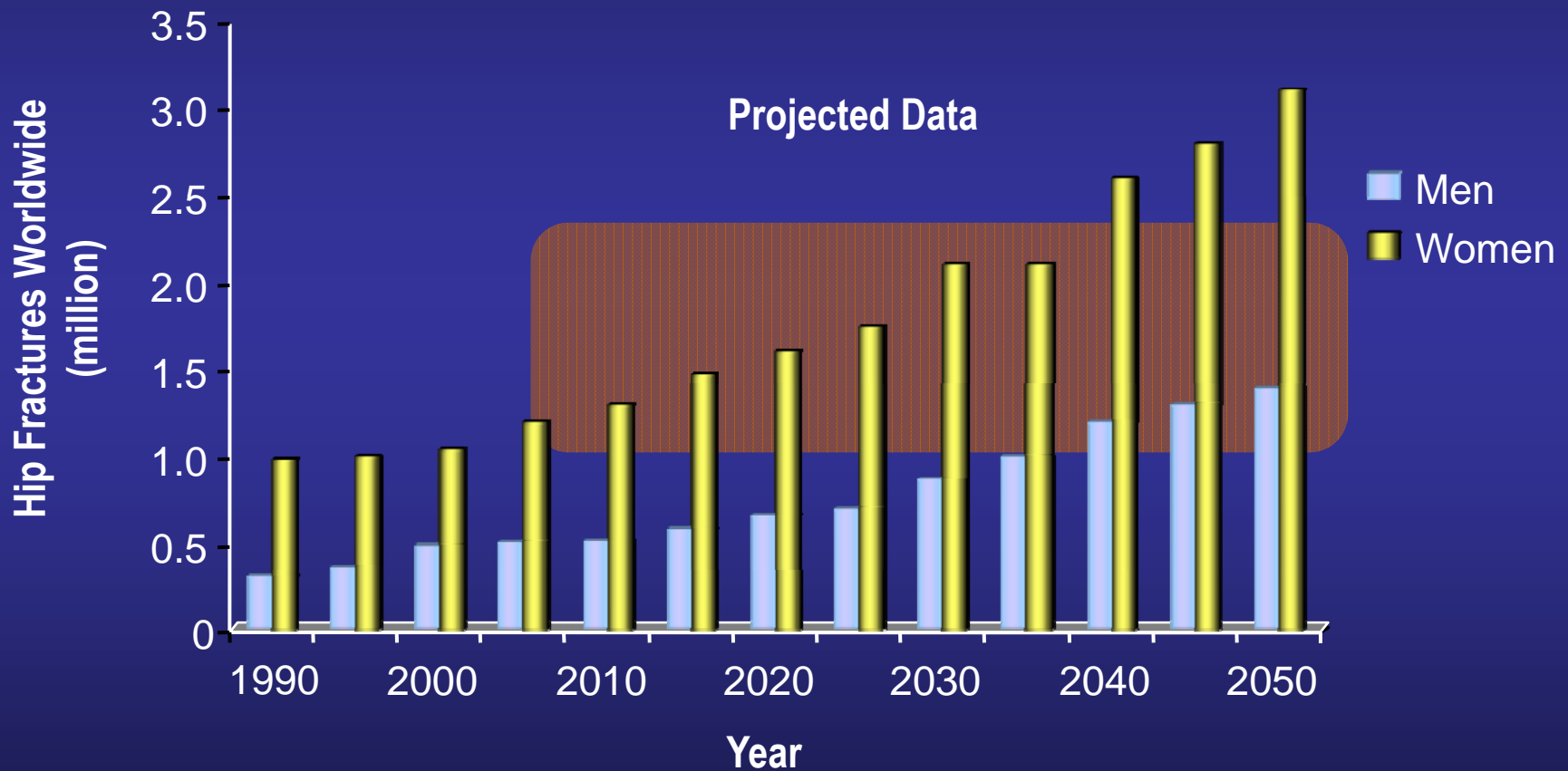
- Recognize that treatment of osteoporosis in mature women is important and effective.
- Order appropriate screening studies for causes of osteoporosis.
- Use T-scores and Z-scores appropriately in the interpretation of DEXA scans.
- Know various options for treatment and prevention of osteoporosis.

Osteoporosis: Why do we care?

- Lifetime risk of fracture of common sites for white women is 40%
 - Same as for breast, ovarian, and colon cancer combined

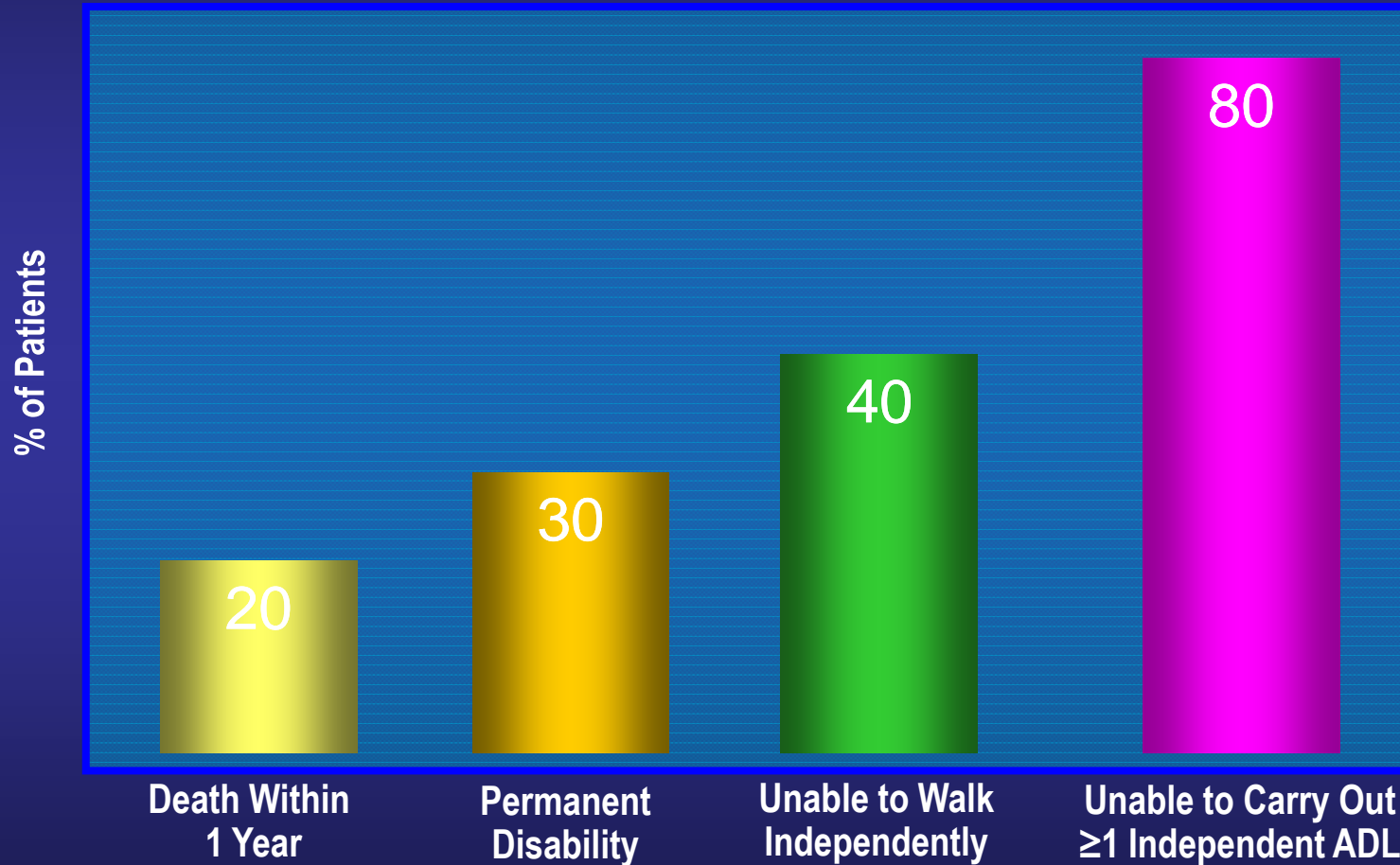
Hip Fractures Are Common

Numbers Are Projected to Increase



Increased Morbidity and Mortality

1 Year After Hip Fracture

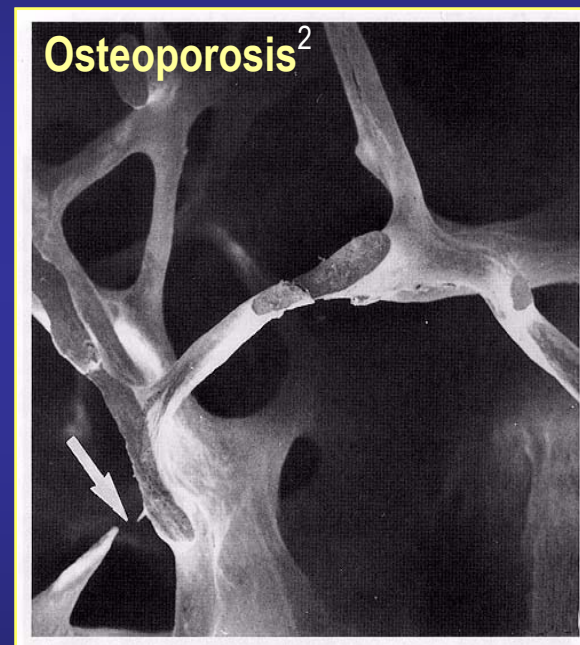
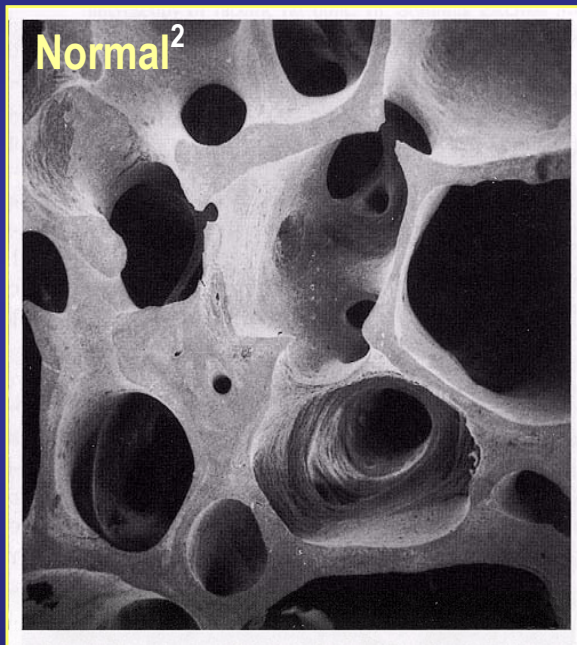


ADL = activity of daily living.

Cooper C. *Am J Med.* 1997;103(suppl):12S-17S.

NIH Consensus Conference Defines 'Osteoporosis'

A skeletal disorder characterized by compromised *bone strength* predisposing to an increased risk of fracture



BONE STRENGTH = BONE DENSITY + BONE QUALITY¹

1. NIH Consensus Conference, 2000. Available at: <http://consensus.nih.gov/2000/2000Osteoporosis111html.htm>. Accessed 12-16-05.

2. Dempster, DW et al. *J Bone Miner Res.* 1986;1:15-21.

Who to test?

Individuals at high risk for low BMD and future fracture

- All women 65 or older
- Postmenopausal women younger than 65 with additional risk factors
 - thin body habitus, family hx of fracture, smoker
 - not on hormone therapy
- On steroids for >3 months/year
 - dose equivalent to 5 mg prednisone daily
- Prior fracture with minor trauma
- Vertebral deformity consistent with fracture
- Chronic diseases/drugs associated with bone loss

Osteoporosis Risk Factors

Increased age

White race

Low weight

Family history

Smoking

History of fracture with insignificant trauma

Sedentary lifestyle

Steroid use

Inadequate calcium

Vitamin D deficiency

Secondary causes

Secondary Causes: Medical Conditions Contributing to Osteoporotic Fracture Risk

- Endocrine Diseases
 - Hyperthyroidism
 - Hyperparathyroidism
 - Hypogonadism
 - Diabetes Mellitus
- GI Diseases
 - Malabsorption syndromes
 - Chronic liver disease
 - Gastric operations
- Organ Transplant
- Other Chronic Diseases
 - Rheumatoid arthritis
 - Chronic lung disease
 - Malignancy
 - Renal Insufficiency
- Dietary Disorders
 - Vitamin D deficiency/insufficiency
 - Excess alcohol intake
 - Anorexia nervosa

Secondary Causes: Medications Contributing to Osteoporotic Fracture Risk

- Glucocorticoids
- Long-acting progestin
- Aromatase inhibitors
- Gonadotropin-releasing hormone agonists
- Anticonvulsants
- Cytotoxic drugs
- Long-term heparin
- Lithium
- Proton pump inhibitors ²
- Selective serotonin receptor inhibitors³
- Glitazones

1. National Osteoporosis Foundation. *The State of Osteoporosis and Low Bone Mass in the U.S.* Washington, DC: National Osteoporosis Foundation; 2005.

2. Yu-Xiao Yang; James D. Lewis; Solomon Epstein; David C. *JAMA*. 2006; 296: 2947-2953.

3. Richards, JB et al. *Arch Int Med*. 2007;167:188-194.

Testing for Secondary Causes

Depends on the clinical situation

Always consider:

- Renal panel

- Calcium

- Liver function tests

- TSH

Further testing as indicated by clinical situation, abnormal labs, or abnormal DEXA

- PTH, 25-OH Vitamin D, 24 hour urinary calcium

Bone Mineral Density Testing

- DEXA
 - Dual-energy X-ray Absorptometry
 - Values taken at lumbar spine and hip

Pitfalls

- errors in demographics
- improper positioning
- incorrect scan analysis
- mistakes in interpreting

DEXA

- T-score: number of SD above or below the average BMD for healthy young white women
- Z-score: number of SD above or below the average BMD for age, ethnicity and gender -matched controls

Diagnostic Categories of Osteoporosis based on BMD

- Normal: T-score greater than or equal to -1.0
- Low bone mass (osteopenia): T score between -1.0 and -2.5
- Osteoporosis: T score less than or equal to -2.5
- Z-scores lower than -1.5 or lower than T scores are suggestive of secondary osteoporosis

Case Study 1

History

- Mrs Brown is a 70 yo white female presents for a physical exam
- HTN x 12 years
- Mild COPD (last exacerbation requiring oral steroids >1 year prior)
- Depression x 2 years
- Smoker ½ ppd

Medications

- Amlodipine
- Albuterol prn
- Sertraline

Physical Exam/Study Findings

- 5'3", 118 pounds, healthy appearing Caucasian female
- BP 122/78, NAD
- T-scores: - 1.3 at lumbar spine (LS) and - 1.5 at the femoral neck (FN)

10-year Probability of Fracture in Women

By Age and FN T-Score

| Age (years) | T-Score 0 | T-Score -0.5 | T-Score -1.0 | T-Score -1.5 | T-Score -2.0 | T-Score -2.5 | T-Score -3.0 |
|-------------|-----------|--------------|--------------|--------------|--------------|--------------|--------------|
| 50 | 3.8 | 4.7 | 5.9 | 7.4 | 9.2 | 11.3 | 14.1 |
| 55 | 4.1 | 5.3 | 6.7 | 8.5 | 10.7 | 13.4 | 16.8 |
| 60 | 5.1 | 6.5 | 8.2 | 10.4 | 13.0 | 16.2 | 20.2 |
| 65 | 6.3 | 8.0 | 10.0 | 12.6 | 15.6 | 19.3 | 23.9 |
| 70 | 7.1 | 9.0 | 11.5 | 14.6 | 18.3 | 22.8 | 28.4 |
| 75 | 7.0 | 9.1 | 11.8 | 15.2 | 19.4 | 24.5 | 30.8 |

Fracture Risk Assessment

- The use of clinical factors can improve identification of people at higher fracture risk
- The WHO Fracture Probability approach will determine an individual's 10 -year hip and major osteoporotic fracture risk based on BMD and other important risk factors

Risk Factors Included in the WHO Fracture Risk Assessment Model

- Current age
- Use of oral glucocorticoid therapy
- Gender
- Secondary osteoporosis (e.g., rheumatoid arthritis)
- Personal history of a fracture
- Parental history of hip fracture
- Femoral neck BMD
- Current smoking
- Low body mass index (kg/m²)
- Alcohol intake 3 or more drinks/day



WHO Risk Assessment Tool (FRAX)

FRAX™ WHO Fracture Risk Assessment Tool

HOME CALCULATION TOOL PAPER CHARTS FAQ REFERENCES

Calculation Tool

Please answer the questions below to calculate the ten year probability of fracture with BMD.

 Country : **US(Caucasian)** Name / ID : [About the risk factors](#) 

Questionnaire:

1. Age (between 40-90 years) or Date of birth
Age: Date of birth: Y: M: D:

2. Sex Male Female

3. Weight (kg)

4. Height (cm)

5. Previous fracture No Yes

6. Parent fractured hip No Yes

7. Current smoking No Yes

8. Glucocorticoids No Yes

10. Secondary osteoporosis No Yes

11. Alcohol 3 more units per day No Yes

12. Femoral neck BMD
T-score

BMI 20.8
The ten year probability of fracture (%)

with BMD

| | |
|--------------------|------------|
| Major osteoporotic | 22 |
| Hip fracture | 4.3 |

Summary of Mrs B's Fracture Risk

- Lab work all came back normal limits
- 70-year postmenopausal female with a femoral neck T-score of -1.5
- Based on other major risk factors her 10-year probability of:
 - Hip fracture: 4.3%
 - Major osteoporotic fracture: 22%
- Should she be treated?

National Osteoporosis Foundation

2008 Updated Treatment Guidelines

- Initiate treatment in postmenopausal women and in men age 50 and older with:
 - Low bone mass (T-score -1 to -2.5, osteopenia) at the femoral neck, total hip, or spine and 10-year hip fracture probability $\geq 3\%$
- OR-----
- 10-yr all major osteoporosis-related fracture probability of $\geq 20\%$, based on the US-adapted WHO absolute fracture risk model.
- FRAX tool calculates probability for major osteoporotic fracture and hip fracture

Clinical Pearls



- BMD should be completed on all women over 65 or younger postmenopausal women with risk factors for osteoporosis
- T-scores don't tell the whole story
- Age and BMD are independent risks for fracture
- The WHO FRAX tool will help clinicians identify patients who should receive treatment by incorporating other risk factors into a 10-year fracture risk determinant

Clinical Case 2 – Mrs. Smith

- History:
65-year-old P1001 female, menopausal at age 51.
No fracture hx
Family hx of osteoporosis
Former smoker
HT for 1 yr during early menopause
minimal exercise
- Medications:
Synthyroid - .50mg/day
Tums 3 times/day
Advair 50/100 1 puff bid

Exam:

Ht: 61.5" (63" 2 yrs ago). Wt. 150 lbs.
BP 130/70, NAD
mild kyphosis upper spine
Rest of exam unremarkable

You order a DEXA

Why did you order a DEXA?

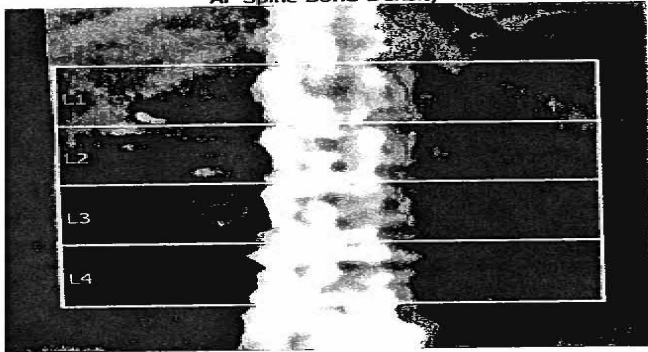
- Risk factors
 - family hx
 - previous smoker
 - inhaled steroids
 - thyroid disease
 - inactivity

DEXA of the lumbar spine

CASE 1

Patient:
Birth Date: _____ years
Height / Weight: 61.5 in. 150.0 lbs.
Race / Ethnic: Female White

AP Spine Bone Density



| Region | BMD ¹ (g/cm ²) | Young-Adult ² (%) | T-Score | Age-Matched ³ (%) | Z-Score |
|--------|--|---------------------------------|---------|---------------------------------|---------|
| L1 | 0.876 | 78 | -2.1 | 96 | -0.3 |
| L2 | 0.921 | 77 | -2.3 | 93 | -0.5 |
| L3 | 1.004 | 84 | -1.6 | 102 | 0.2 |
| L4 | 1.098 | 92 | -0.8 | 112 | 0.9 |
| L1-L2 | 0.898 | 78 | -2.1 | 96 | -0.3 |
| L1-L3 | 0.932 | 80 | -2.0 | 98 | -0.2 |
| L1-L4 | 0.980 | 83 | -1.7 | 102 | 0.1 |
| L2-L3 | 0.962 | 80 | -2.0 | 98 | -0.2 |
| L2-L4 | 1.014 | 85 | -1.5 | 103 | 0.2 |
| L3-L4 | 1.056 | 88 | -1.2 | 107 | 0.6 |

Total T-score
 L1 - L3 -2.0

Image not for diagnosis

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 0.60x1.05 23.3:%Fat=44.5%
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 Scan Mode: Standard

- 1 -Statistically 68% of repeat scans fall within 1SD (± 0.010 g/cm² for AP Spine L1-L3)
- 2 -NHANES/USA, AP Spine Reference Population, Ages 20-40
- 3 -Matched for Age, Weight (females 25-100 kg), Ethnic
- 11 -World Health Organization - Definition of Osteoporosis and Osteopenia for Caucasian Women: Normal = T-Score at or above -1.0 SD; Osteopenia = T-Score between -1.0 and -2.5 SD; Osteoporosis = T-Score at or below -2.5 SD; (WHO definitions only apply when a young healthy Caucasian Women reference database is used to determine T-Scores.)

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Prodigy
 DF+10331

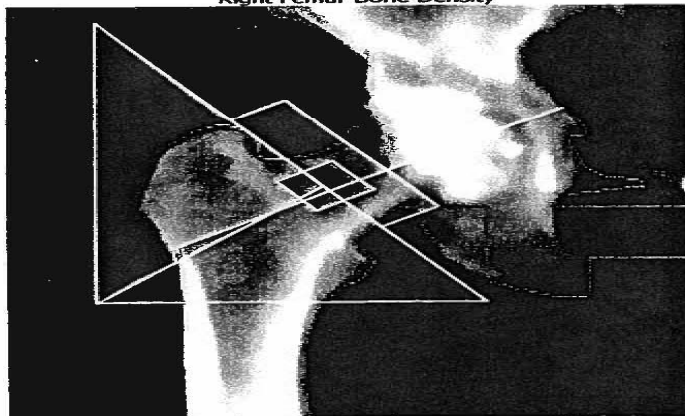
DEXA of the hip

CASE 1

Patient:
Birth Date: _____ years
Height / Weight: 61.5 in. 150.0 lbs.
Sex / Ethnic: Female White

Facility ID:
Physician:
Measured:
Analyzed:

Right Femur Bone Density



| Region | BMD ¹ (g/cm ²) | Young-Adult ² (%) T-Score | Age-Matched ³ (%) Z-Score |
|------------|--|---|---|
| Neck | 0.648 | 62 -3.3 | 89 -0.7 |
| Upper Neck | 0.482 | 59 -2.8 | 82 -0.9 |
| Troch | 0.693 | 81 -1.6 | 109 0.6 |
| Shaft | 0.893 | - | - |
| Total | 0.774 | 77 | 101 0.1 |

-2.7

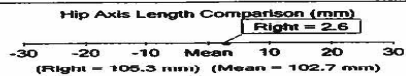


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 0.00:0.00 0.00:0.00
 Neck Angle (deg)= 55
 Verify there is sufficient pelvis-shaft separation.
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 Scan Mode: Standard

- 1 -Statistically 68% of repeat scans fall within 1SD (± 0.012 g/cm² for Right Femur Total)
- 2 -NHANES/USA, Femur Reference Population, Ages 20-40
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Hip interpretation

- Note the femoral neck
- T= -2.8

Case Study 2

- Mrs. Smith's lab work all came back within normal limits
- T-score of femoral neck is -2.8
- Based on other risk factors and using the WHO FRAX tool, what is her 10-year probability of hip fracture and major osteoporotic fracture?

WHO Risk Assessment Tool (FRAX)

Country : **US (Caucasian)** Name / ID : Mrs. Smith [About the risk factors](#) 

Questionnaire:

1. Age (between 40-90 years) or Date of birth
Age: Date of birth: Y: M: D:

2. Sex Male Female

3. Weight (kg)

4. Height (cm)

5. Previous fracture No Yes

6. Parent fractured hip No Yes

7. Current smoking No Yes


8. Glucocorticoids No Yes

9. Rheumatoid arthritis No Yes

10. Secondary osteoporosis No Yes

11. Alcohol 3 or more units per day No Yes

12. Femoral neck BMD (g/cm²)
T-Score

BMI 27.9
The ten year probability of fracture (%) 

| with BMD | |
|--|------------|
| <input checked="" type="checkbox"/> Major osteoporotic | 48 |
| <input checked="" type="checkbox"/> Hip fracture | 6.9 |

NOF 2008 Treatment Recommendations

- Postmenopausal women and men age 50 and older presenting with the following should be treated:
 - Hip or vertebral fracture
 - Other prior fractures and low bone mass (T -score between -1.0 and -2.5 at the femoral neck, total hip, or spine)
 - T -score < -2.5 at the femoral neck, total hip or spine after appropriate evaluation to exclude secondary causes
 - Low bone mass and secondary causes associated with high risk of fracture (such as glucocorticoid use or total immobilization)
 - Low bone mass + 10-yr probability of hip fracture $\geq 3\%$ or 10-yr probability of any major osteoporosis related fracture $\geq 20\%$

Prevention Measures

Nonpharmacologic

- Regular weight-bearing exercise
 - Strength training maintains or increases BMD, improves muscle mass, strength, and balance
 - Nurses Health Study: active women with 24 metabolic equivalent task (MET)-h/wk had 55% lower risk of hip fracture (linear relationship)
- Fall prevention strategies
 - Avoid tobacco & excessive consumption of alcohol
 - Good general nutrition
 - Adequate calcium through diet/supplementation
 - Adequate vitamin D through sunlight/supplementation

Recommendations for Calcium and Vitamin D

- Calcium
 - 1200-1500 mg/day
- Vitamin D
 - 800-1000 IU/day
 - May safely use up to 2000 IU/day
 - Aim for level \geq 30 ng/mL
 - Toxicity rare unless chronic doses $>$ 10,000 IU daily
- For deficient vitamin D levels
 - 50,000 IU once/twice weekly for 8-12 doses
 - After correction, use 1000 IU/day or 50,000 IU 1-2x/mo

FDA-Approved Pharmacologic Options for Osteoporosis Treatment in Women

- Antiresorptive Agents
 - Lower bone turnover, maintain/improve bone mass, stabilize bone architecture
 - Hormone (Salmon calcitonin)
 - SERM (Raloxifene)
 - Bisphosphonates
 - Alendronate *with/without vitamin D* – Risedronate
 - Ibandronate – Zoledronic acid
- Anabolic Agent
 - Increase bone turnover with bone formation > bone resorption, increase bone mass and improve bone architecture
 - Teriparatide

Assessing Therapeutic Response

Follow-up BMD in the Treated Patient

- Repeat labs and BMD after two years in patients taking pharmacotherapy for osteoporosis
- BMD maintained or increased = satisfactory response
- BMD decline
 - Assess technical issues e.g., validity of DEXA comparison
 - Assess compliance and dosing
 - Consider and re-evaluate for secondary causes
 - Patient may be a true “non-responder”

Individualizing Therapy

Each Modality has its Clinical Place

Calcium and vitamin D

Exercise

Raloxifene

Alendronate

Teriparatide

Zoledronic Acid

Fall Risk Evaluation

Risedronate

Ibandronate

Calcitonin



Summary

Treatment of Osteoporosis

- Osteoporosis is an important public health concern
- Fracture risk incorporates both BMD and other important risk factors and should be calculated to help determine need for therapy
- Age and T- scores are independent risk factors
- Consider secondary causes of bone loss
- Recommend lifestyle modifications in all patients with or at risk for osteoporosis
- Pharmacotherapy should be individualized to the patient
- Patients who have fractured are at high risk for future fractures and should be targeted for pharmacologic intervention