Metabolic Bone Disease

- Osteoporosis
- Osteomalacia and Rickets
- Hyperparathyroidisme
- Paget's Disease

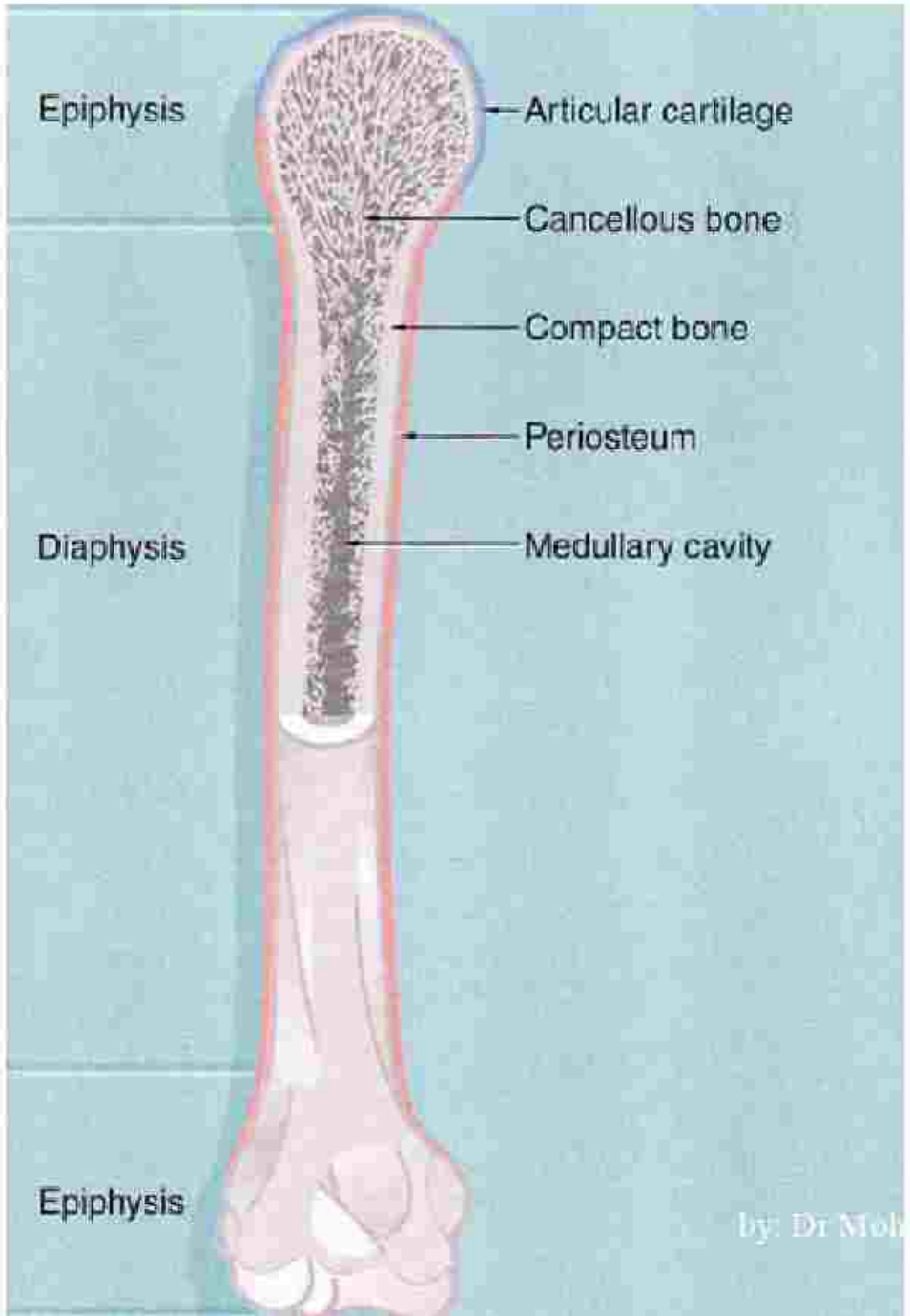
Normal Bone Structure

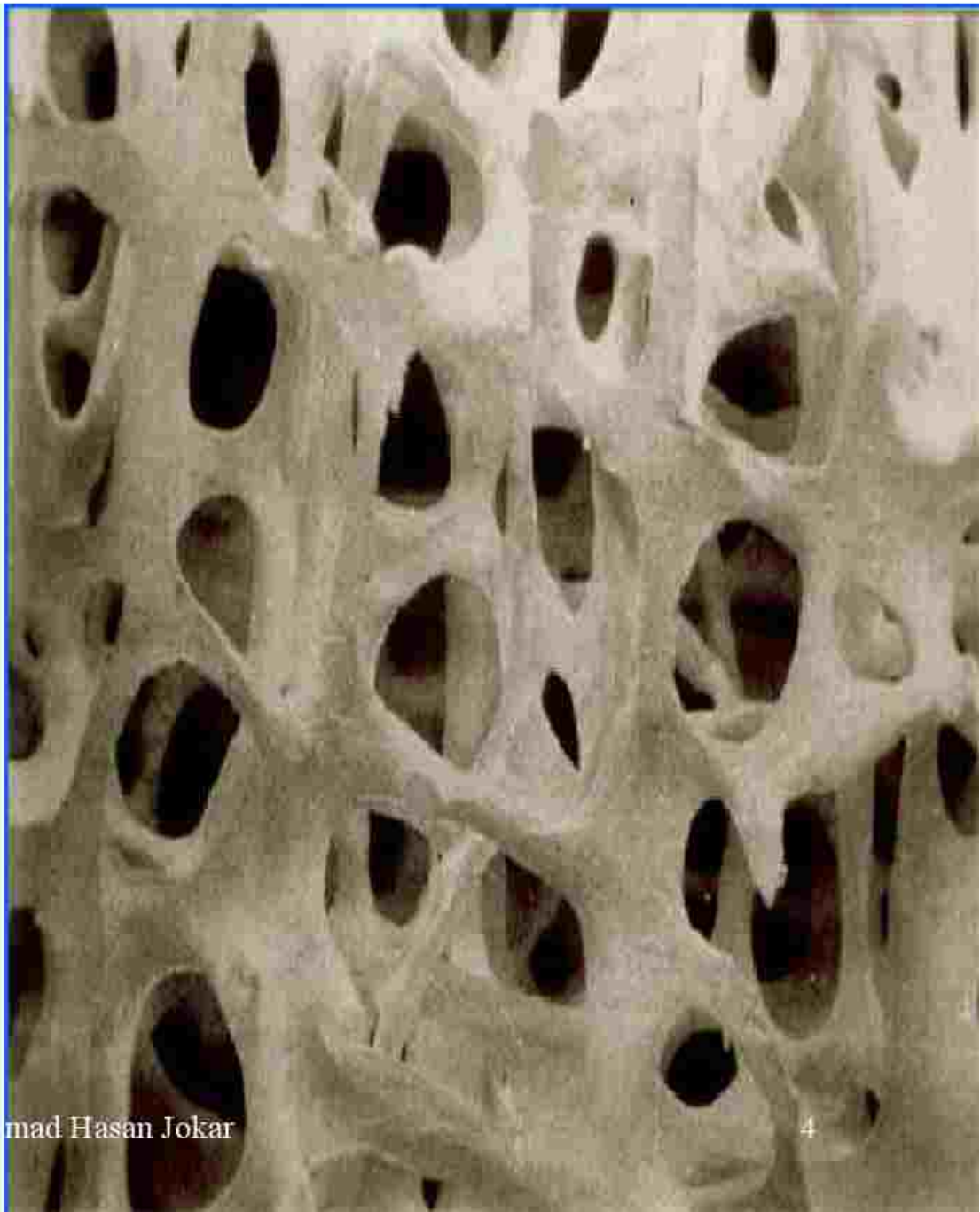
- **The cells**
  - osteo-clast/blast/cyte/progenitor
- **The matrix**
  - 40% organic
    - » Type 1 collagen (tensile strength)
    - » Proteoglycans (compressive strength)
  - 60% inorganic
    - » Calcium hydroxyapatite

Normal Bone Structure

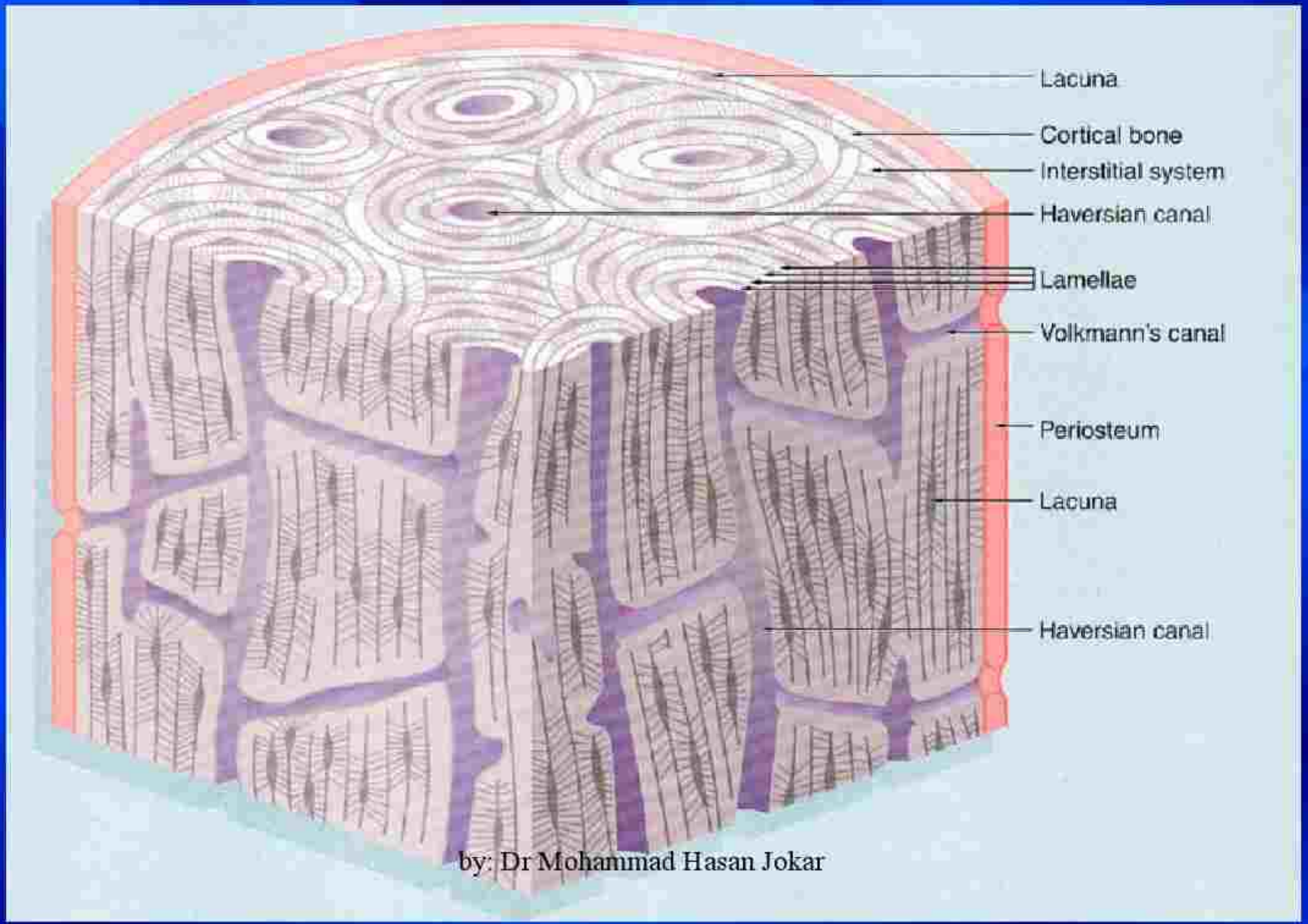
What are the normal types of bone in the mature skeleton?

- Lamellar
  - Cortical
  - Cancellous
- Woven
  - Immature
  - Healing
  - Pathological


Epiphysis
Articular cartilage
Cancellous bone
Compact bone
Periosteum
Diaphysis
Medullary cavity
Epiphysis



Cortical Bone



اعمال استخوان

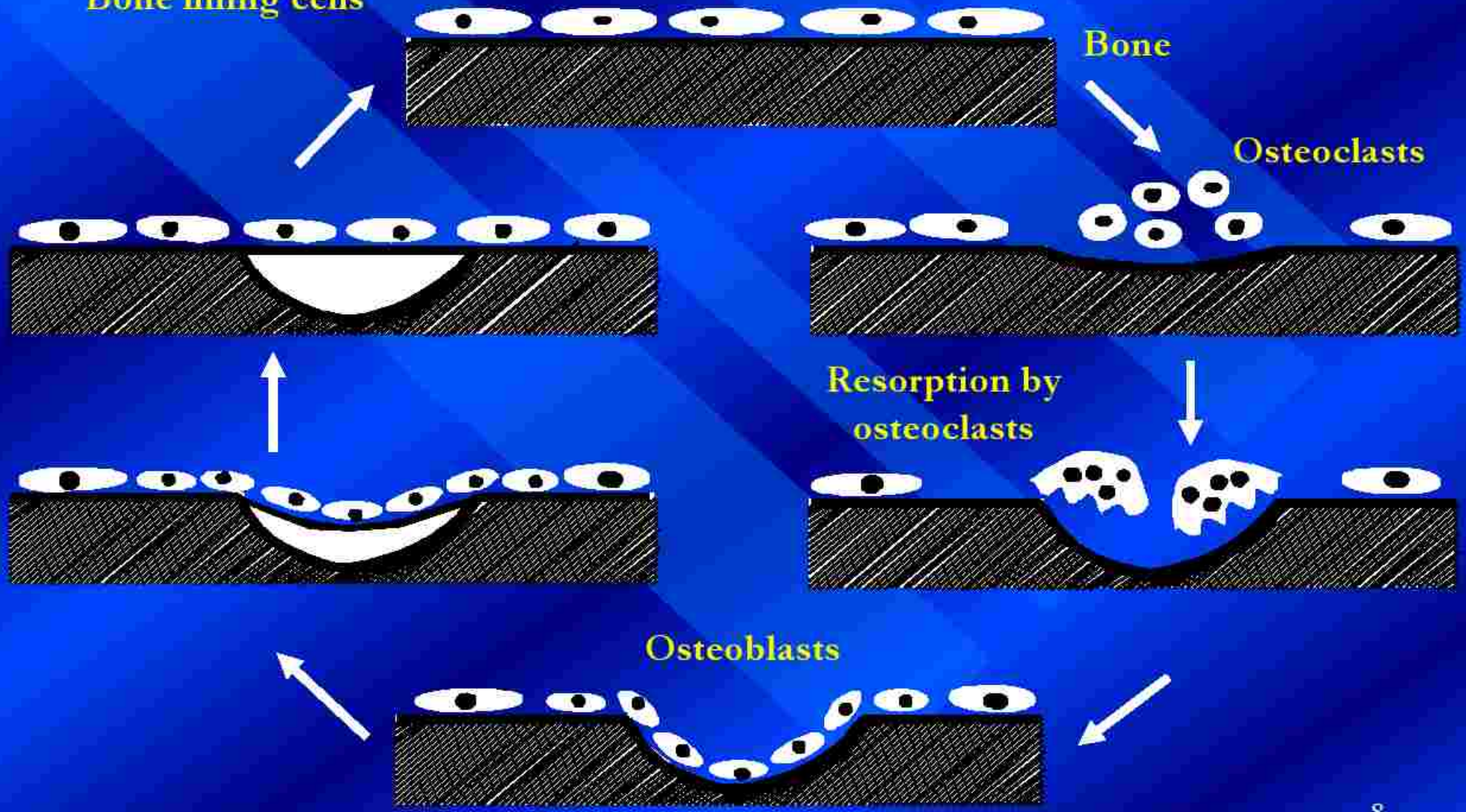
ذخیره خوارزمشاهی:

آفریدگار تبارک و تعالی از جمله اندامهای یکسان استخوان را صلب تر آفرید از بهر آنکه بنیاد تن استخوان است و راستی و استواری او بدانست و همچون حصاری است نگاه دارنده اندام که اندر میان او نهادست

Bone Functions

- Skeleton
- Protection of vital soft tissue
- Protection of bone marrow
- Reservior for Ca,Mg,P

Bone Remodeling Cycle

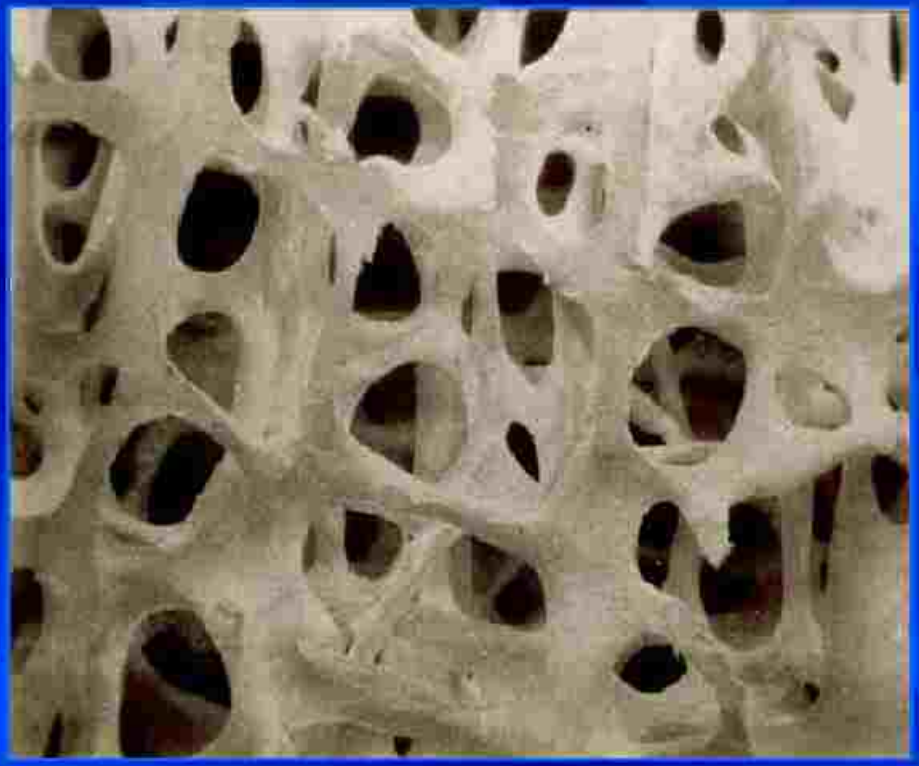


Osteoporosis(Definition)

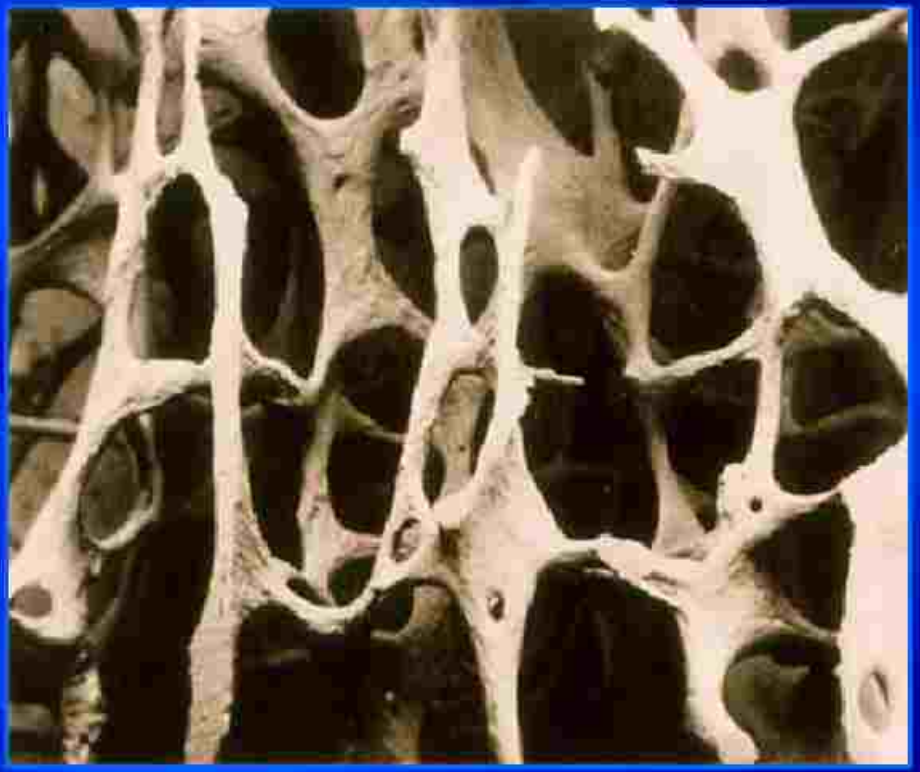
- **Osteoporosis**: A condition of skeletal fragility characterized by reduced bone mass and microarchitectural deterioration of bone tissue, with a consequent increase in bone fragility and susceptibility to fractures

- **Osteopenia** – Reduction in bone mass which can lead to full osteoporosis ("At Risk")

Osteoporosis(Definition)



Normal bone



Osteoporosis

Osteoporosis (Importance)

Osteoporosis (Epidemiology)

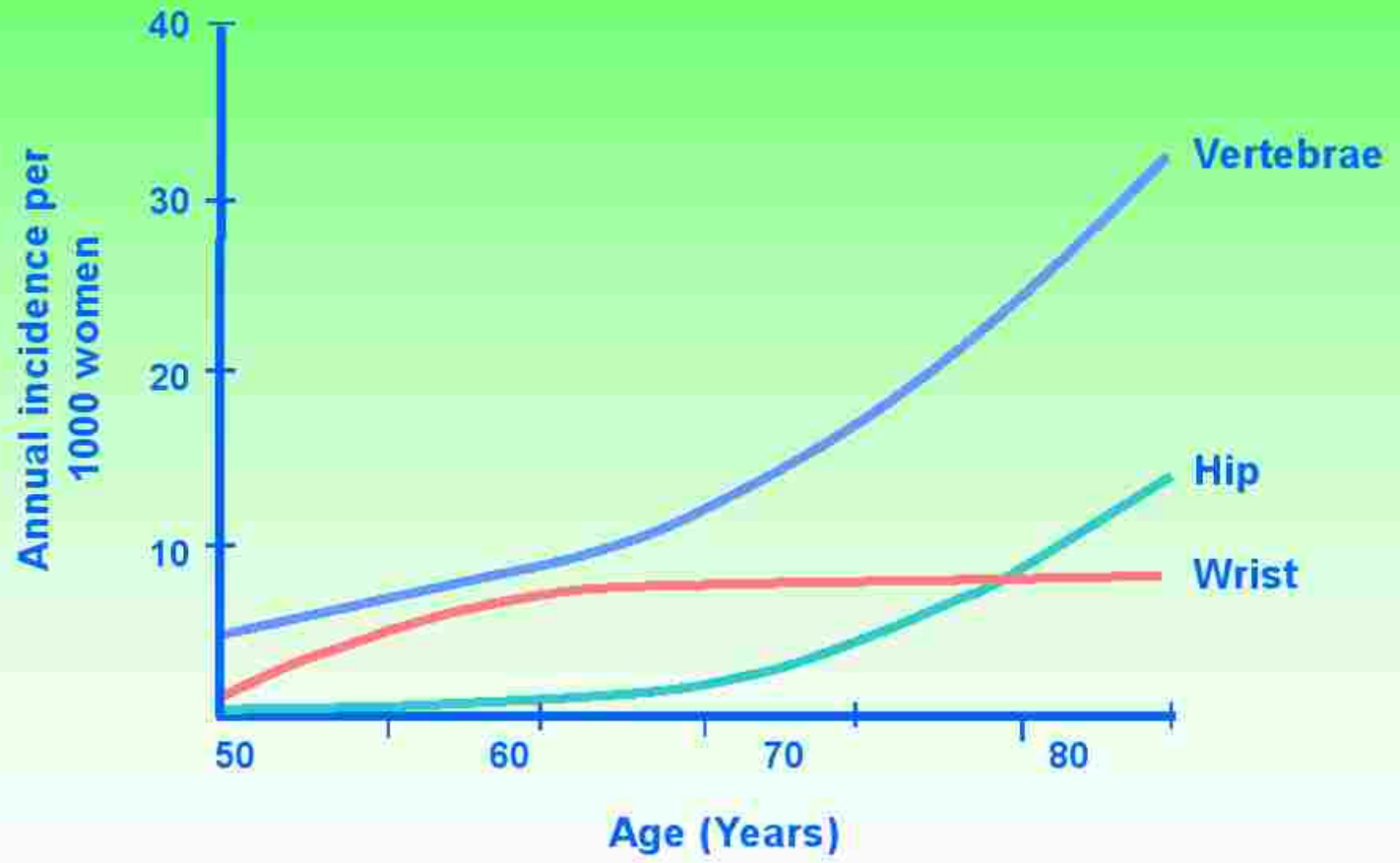
- Affects 200 million women worldwide
  - 1/3 of women aged 60 to 70
  - 2/3 of women aged 80 or older

- Approximately 20-25% of women over the age of 50 have one or more vertebral fractures
  - United States: 25%
  - Australia: 20%
  - Western Europe: 19%
  - Scandinavia: 26%
  - Denmark: 21%

Osteoporosis(Epidemiology)

- 10 million people have osteoporosis in USA (8 mil women, 2 mil men)
- 18 million people or more have low bone mass(USA)
- Most prevalent among postmenopausal woman but can occur at any age
- 24% of hip fracture patients age 50 and older die in one year following fx
- Only 1/3 fully regain their prefracture level of independence
- Cost > $20 billion/yr(USA)

Incidence Rates for Vertebral, Wrist & Hip Fractures in Women after Age 50

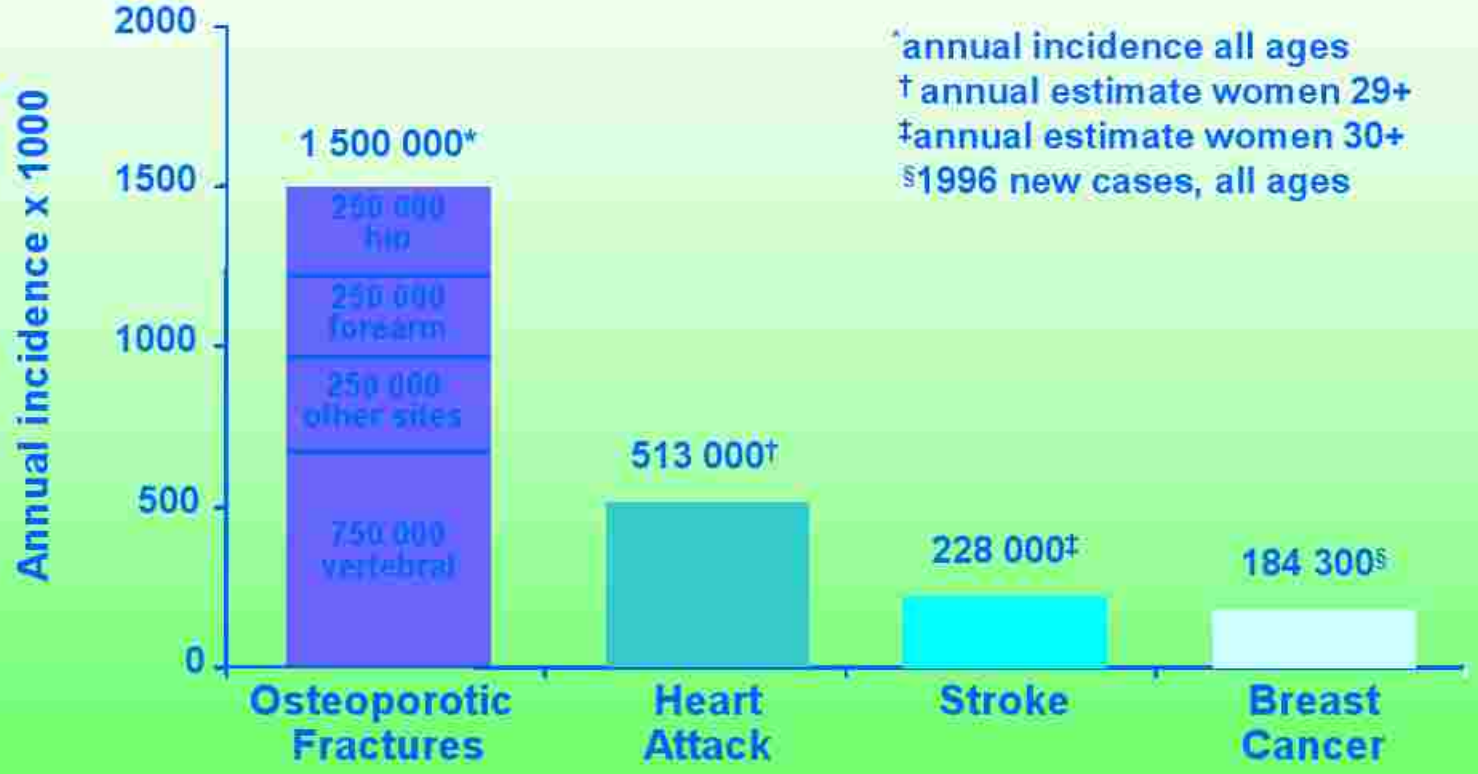


by: Dr Mohammad Hasan Jokar

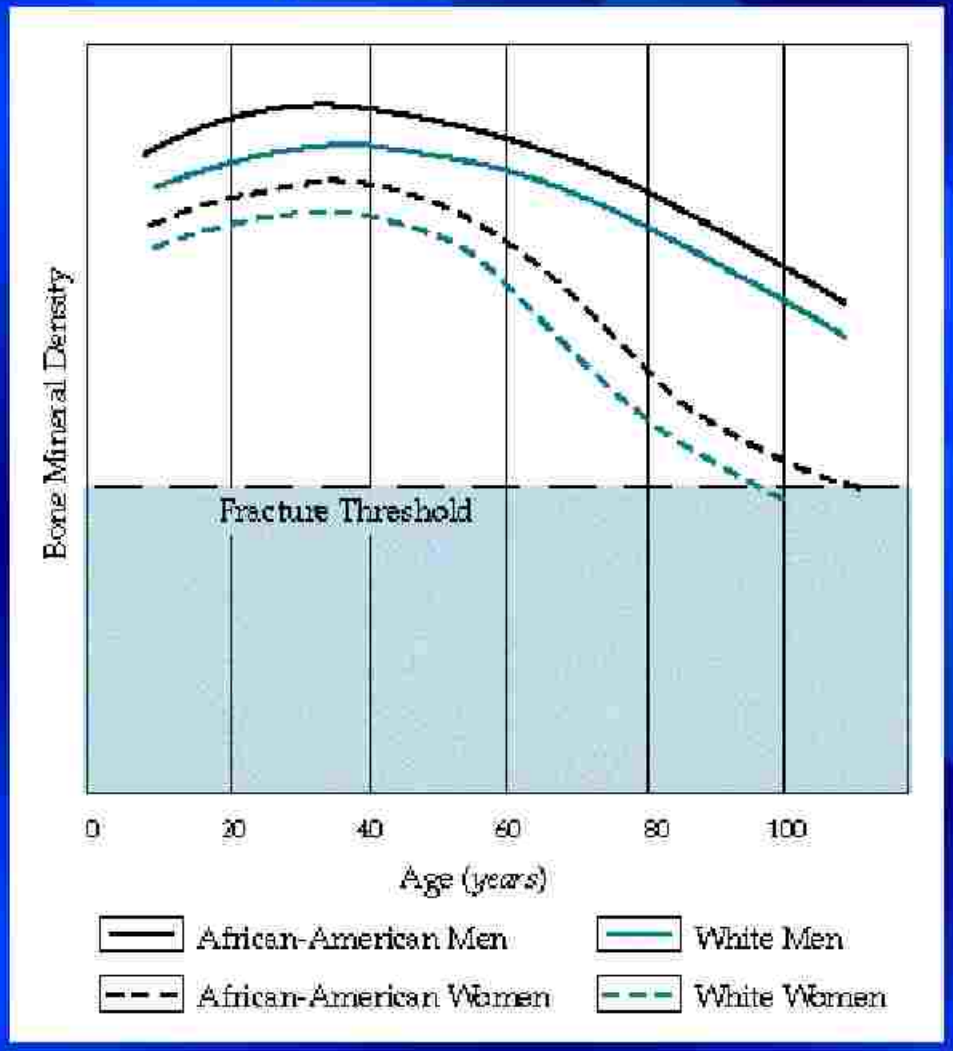
Osteoporosis(Epidemiology)

- **Fractures**
  - 1.5 million fx/yr(USA)
  - 300,000 hip
  - 700,000 vertebral
  - 250,000 wrist
  - 250,000 at other sites

Osteoporotic Fractures in Women: Comparison with Other Diseases



Osteoporosis(Pathophysiology)



- Peak bone mass is achieved by men and women in the middle of the third decade of life.
- After a plateau period, there begins a period of net bone loss (about 0.3% to 0.5% a year).
- With menopause, women may lose bone at the rate of 3% to 5% a year.

Risk Factors in Osteoporosis

- **Nonmodifiable**
  - » Personal history of fracture as an adult
  - » History of fracture in first degree relative.
  - » Caucasian race
  - » Advanced Age
  - » Female sex
  - » Dementia
  - » Poor Health/frailty

- **Potentially Modifiable**
  - **Smoking**
  - **Low Body Weight (<127 lbs)**
  - **Estrogen deficiency:**
    Early Menopause (<45 yr) or
    Prolonged amenorrhea
  - **Excess alcohol intake**
  - **Sedentary lifestyle**
  - **Low calcium intake**
  - **Inadequate physical activity**
  - **Poor health, poor eyesight and recurrent falls.**

Pathogenesis of Osteoporosis: Genetic Factors

- Genetic factors play an important role in the development of osteoporosis.
- Family history of fractures in postmenopausal women is a predictor of osteoporosis.
- Correlation between abnormal receptors for vitamin D and osteoporosis in multiple generations.
- May be other genetic abnormalities that explain the expression of an osteoporosis phenotype.

Pathogenesis of Osteoporosis: Hormonal Factors

- Osteoporosis occurs in postmenopausal women (and men with testosterone deficiency) and is related to the loss of gonadal function.
- Estrogen loss leads to elevated levels of IL-6 which may stimulate osteoclast precursors in trabecular bone and increase bone resorption.
- Osteoporosis is also associated with normal aging and a progressive decline in osteoblasts. Fractures of cortical bone are more common.

Pathogenesis of Osteoporosis: Other Factors

- Physical stress increases bone mass, but immobilization leads to bone loss.
- Obesity is associated with higher bone mass.
- Insufficient dietary intake of calcium, phosphorus, and vitamin D are associated with age-related bone loss.
- Late menarche and early menopause, alcohol use, and cigarette smoking may decrease bone mass.
- Blacks and Hispanics have > bone mass than whites and Asians, and men have > bone mass than women.

Classification

- **Primary**
  - Postmenopausal
    - **Decreased estrogen results in increased osteoclastic activity without increased osteoblastic activity**
    - **Bone loss – 2-3% per year of total bone mass**
    - **Most common fx: vertebral, distal forearm**
  - Age related – **4rd decade of life starts slow decline in bone mass at rate of 0.5-1% per year**
    - **Most common types of fx: hip and radius**
    - **F>M**
- **Secondary**

Secondary Osteoporosis

Disease states

- Acromegaly
- Addison's disease
- Amyloidosis
- Anorexia
- COPD
- Hemochromatosis
- Hyperparathyroidism
- Lymphoma and leukemia
- Malabsorption states
- Multiple myeloma
- Multiple sclerosis
- Rheumatoid arthritis
- Sarcoidosis
- Severe liver dz, esp. PBC
- Thalessemia
- Thyrotoxicosis

Secondary Osteoporosis
Drugs

- Aluminum
- Anticonvulsants
- Excessive thyroxine
- Glucocorticoids
- GnRH agonists
- Heparin
- Lithium

Osteoporosis

Clinical manifestation

No clinical manifestation until there is a ***fracture***

Osteoporosis is a silent ***Thief***

Clinical manifestation of fractures

- Pain , tenderness and swelling
- Impairment of function
- Deformity and ecchymosis
- Abnormal mobility and crepitus
- Nerve and vessele injury

The most common fractures

- Vertebral fracture
- Hip fracture
- Distal of radius fracture

Vertebral fracture

- The most common fracture
- Usually spontaneous
- Thoracolumbar junction

vertebral fracture

short-term outcome

- May be asymptomatic
- Acute onset of pain(shurp or dull)
- Pain may radiates into the anterior abdomen
- Pain radiation into the legs is rare
- Movement aggravate the discomfort
- Acute episode resolve after 4-6 weeks

vertebral fracture

long-term morbidity

- Chronic pain
- Thoracic kyphosis (Dowager's hump)
- Height loss
- Getting fat
- Dyspnea
- Gastrointestinal complaints
- Costoiliac impingment syndrome

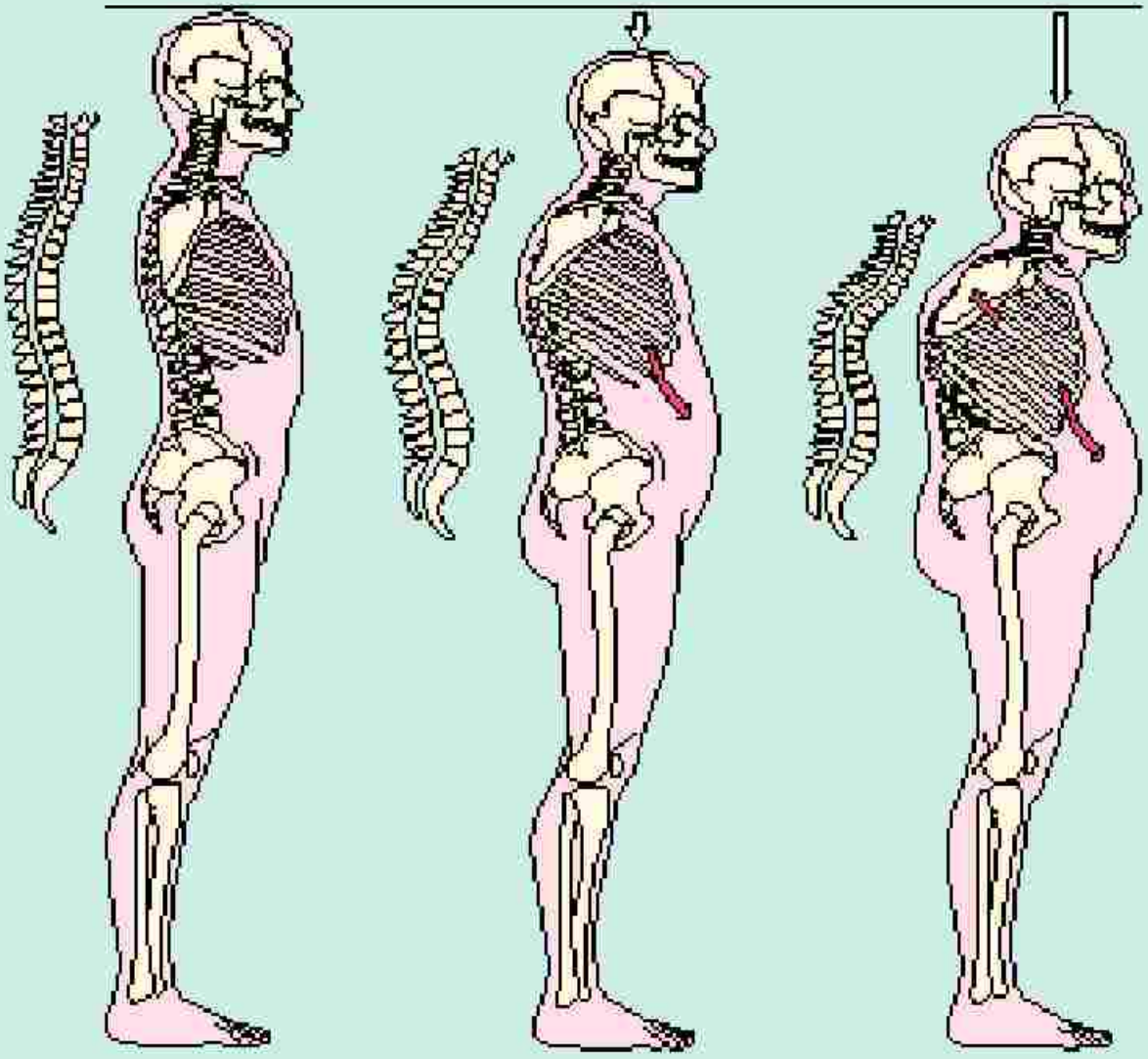
Hip fracture

- Core of the osteoporosis probleme
- Usually follow falls
- Sudden pain and disability
- Leading to hospitalisation
- High morbidity and mortality

Distal radius frature
(Colles' fractur)

- Usually follow falls
- Localizied pain ,swelling and disability
- RSDS
- Good prognosis

PROGRESSIVE KYPHOSIS



Types of BMD testing

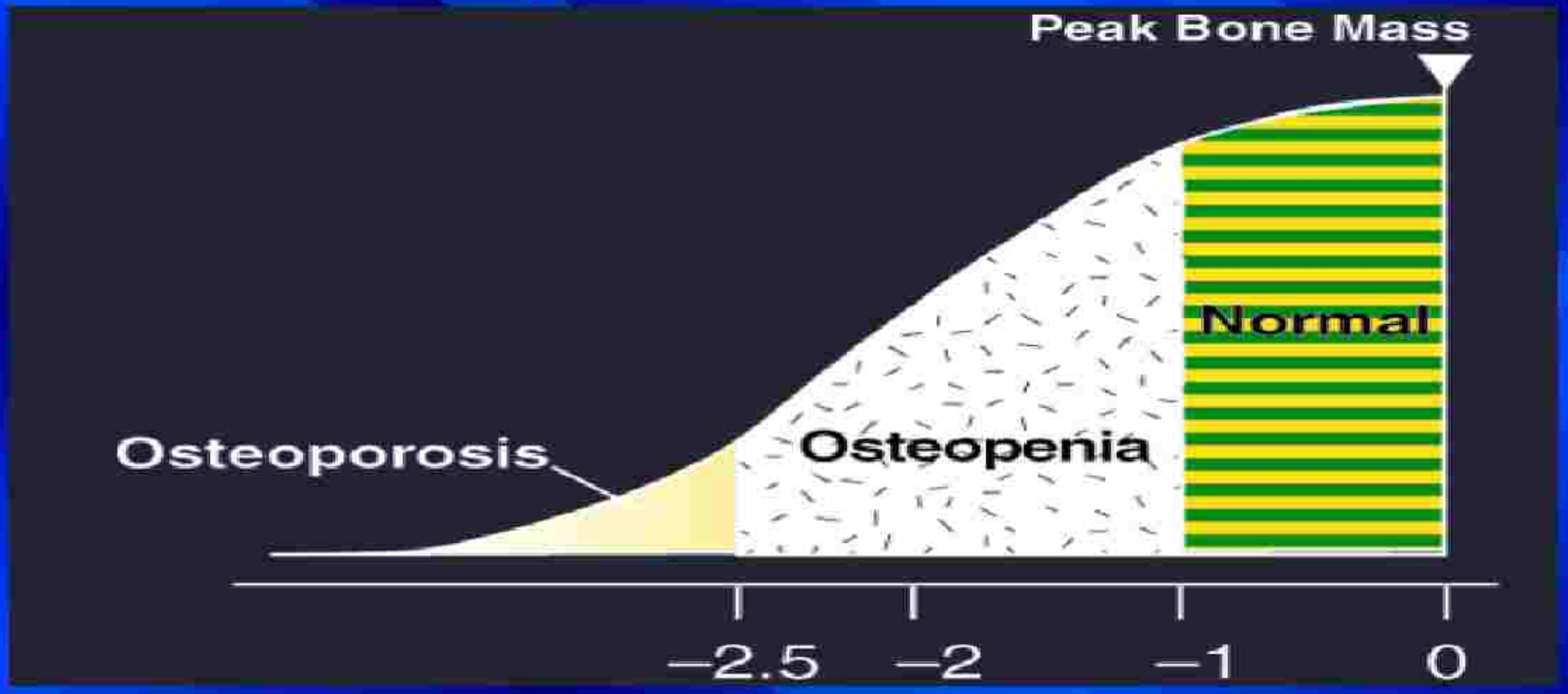
- Dual –energy x-ray absorptiometry (DXA or DEXA).
  - Gold Standard
  - Measures BMD in spine, hip, or wrist
  - Completed in a few minutes
  - Radiation exposure less than 1/10 of standard x-ray

- Ultrasound densitometry
  - Measures BMD in heel, patella
  - Cost-effective

T scores vs. Z scores

- T score – number of SDs a patient's BMD deviates from a reference population of normal young adults
- Z score – number of SDs a patient's BMD deviates from a reference population of subjects of the same age and sex
  - Z scores indicate whether the BMD result is expected for the patient's age. If it is much less than expected, suspect a secondary cause of osteoporosis (use –2 as a cutoff)

World Health Organization (WHO) Osteoporosis Guidelines



WHO, *Guidelines for Preclinical Evaluation and Clinical Trials in Osteoporosis*, 1998.

World Health Organization (WHO) Definition Based on BMD testing

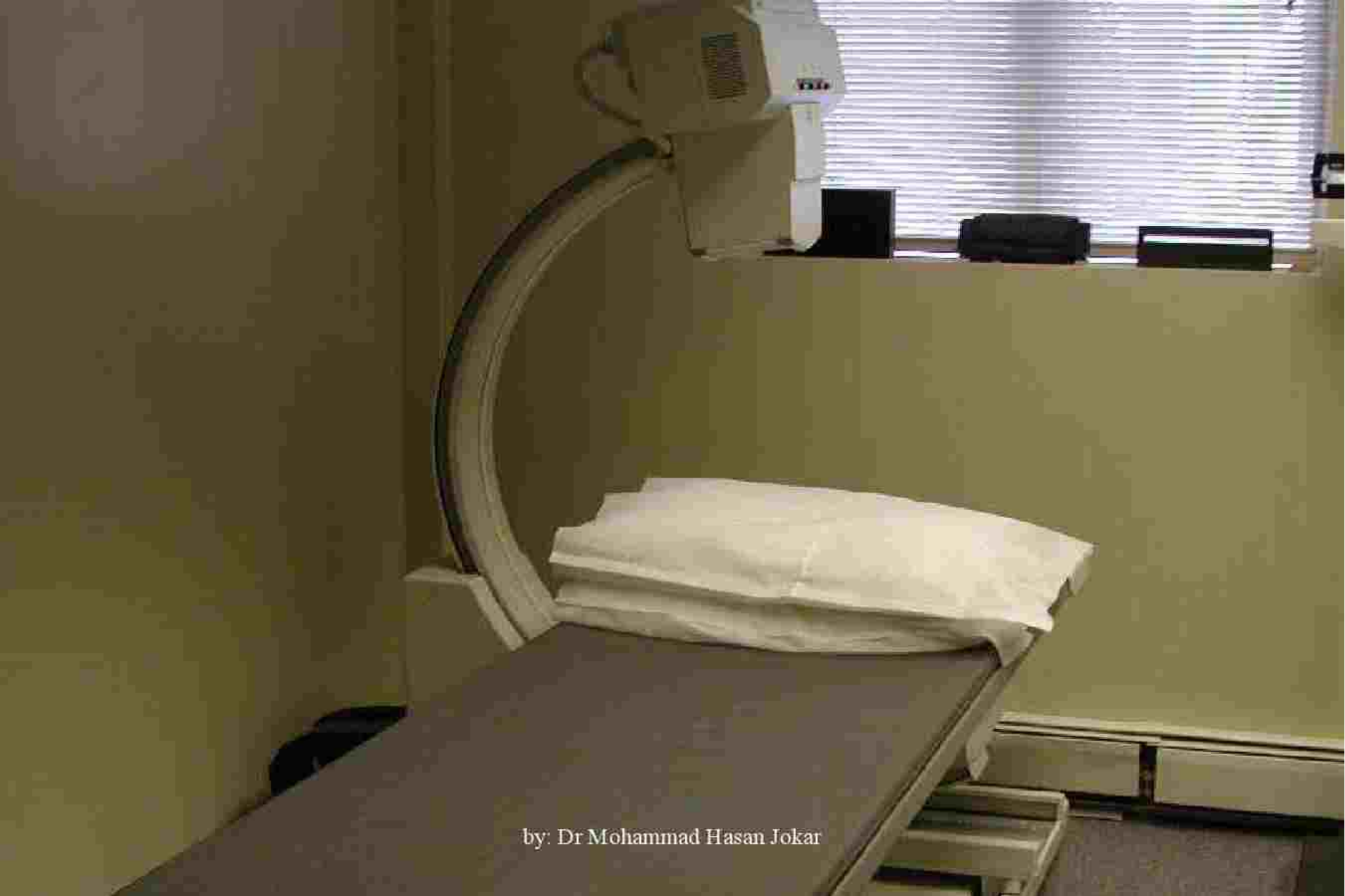
- Normal: T score above –1
- Osteopenia: T score between –1 and –2.5
- Osteoporosis: T score at or below –2.5
- Severe osteoporosis: T score –2.5 or lower in the presence of 1 or more fractures

When to perform a bone density test
National Osteoporosis Foundation (NOF) Guidelines

- All postmenopausal women under age 65 who have one or more additional risk factors for osteoporotic fx (besides menopause)
- All woman aged 65 and older regardless of additional risk factors

Work-up

- BMD testing
- Screen for secondary causes
  - CBC, ESR, CRP
  - Serum calcium, phosphorus, alk phos
  - PTH if calcium is high (hyperparathyroidism)
  - 25-hydroxyvitamin D if low ca, low phos and high alk. phos (osteomalacia)
  - Thyroid function tests (thyrotoxicosis)
  - SPEP (multiple myeloma)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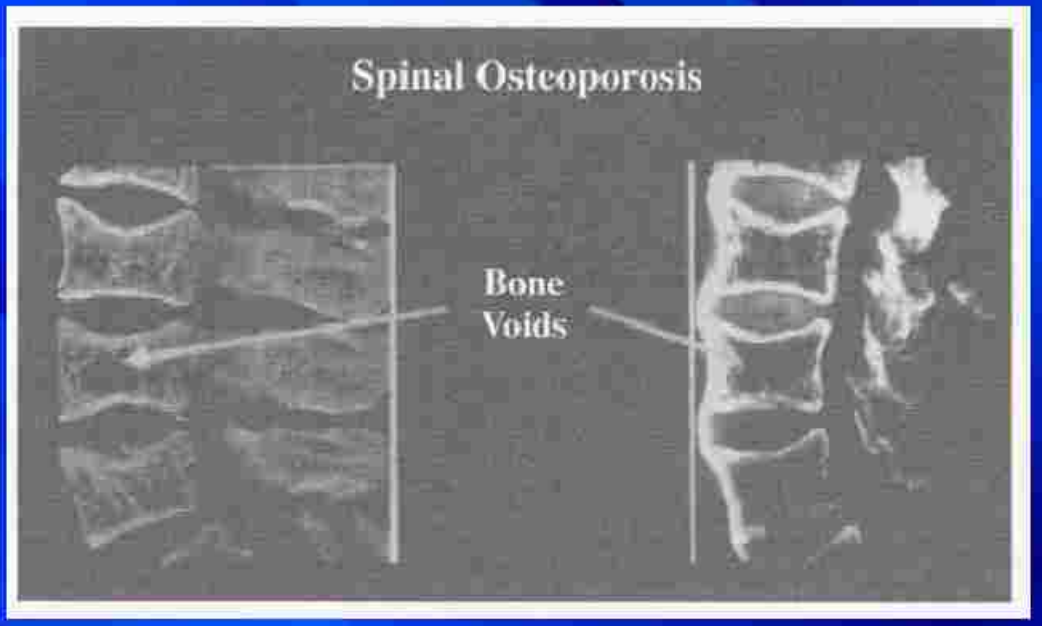
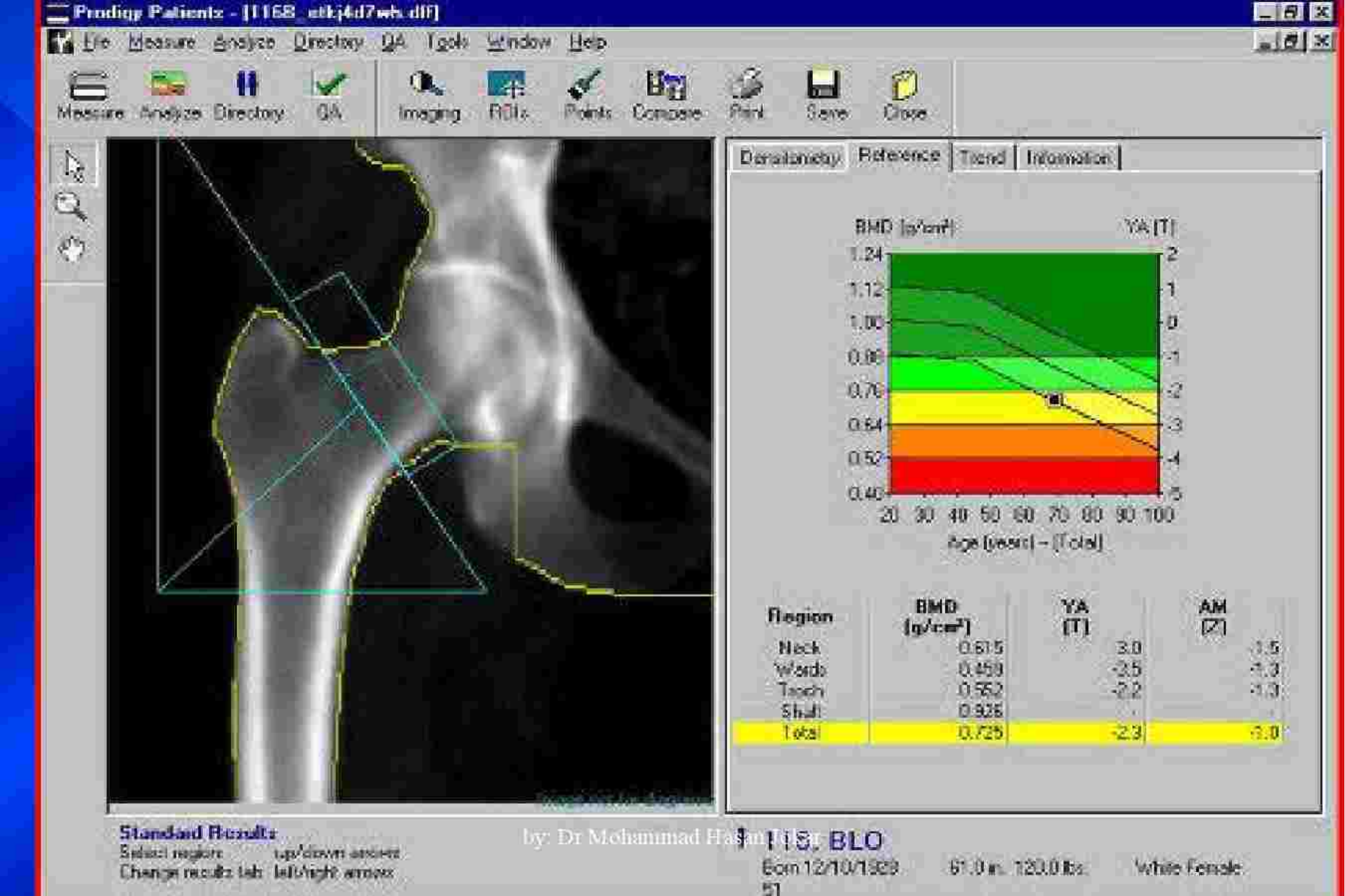
Radiographic Assessment



Vaccaro 2003

Vertebral Fractures
Semi-quantitative reading / visual scoring

Genant et al. J Bone Miner Res 199


Prodigy Patientx - [1168_etkj4d7wb.dff]
File Measure Analyze Directory QA Tools Window Help
Measure
Analyze
Directory
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ROIs
Points
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Reference
Trend
Information
BMD [g/cm²]
YA [T]
1.24
1.12
1.00
0.88
0.76
0.64
0.52
0.40
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1
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-1
-2
-3
-4
-5
20 30 40 50 60 70 80 90 100
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Region
BMD [g/cm²]
YA [T]
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Wards 0.459 -2.5 -1.3
Troch 0.562 -2.2 -1.3
Shaft 0.926
Total 0.725 -2.3 -1.0
Standard Results
Select region up/down arrows
Change results tab left/right arrows
by: Dr Mohammad Hasan
BLO
Born 12/10/1929
51
61.0 in. 120.0 lbs.
White Female

Treatment
Preventive Measures

- Calcium
- Vitamin D (400-800 IU)
- Regular weight bearing exercise
  - Weight lifting, walking, jogging, tennis
- Smoking cessation
- Minimize etoh
- Fall prevention

Calcium Requirements

Recommended elemental calcium needs by age in mg/ca/day

Children	800
Up to age 24	1200-1500
Women 25 –50	1000
Pregnant and breast feeding	1200-1500
Women over 50	
Taking ERT	1000
Not taking ERT	1500
Women over 65	1500
Men 25 to 65	1000
Men over 65	1500

Treatment

- Calcium
- Exercise
- Vit D
- Biphosphonates ++
- Calcitonin
- Raloxifen
- Anabolic steroids (increase bone mass but seldom used (lipids)
- Relief of symptoms