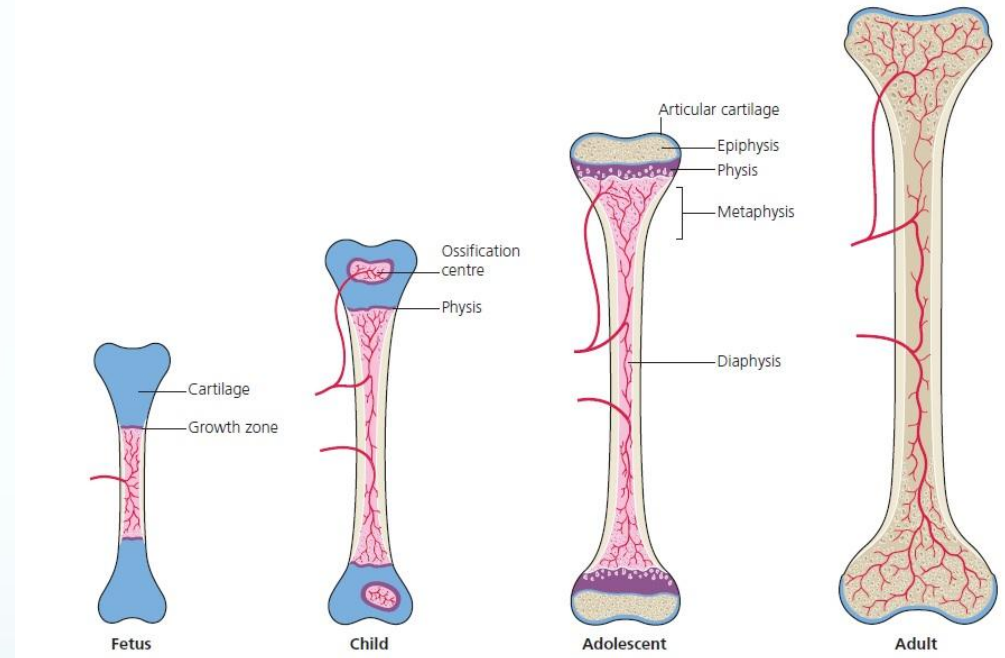


Metabolic Bone Disorders

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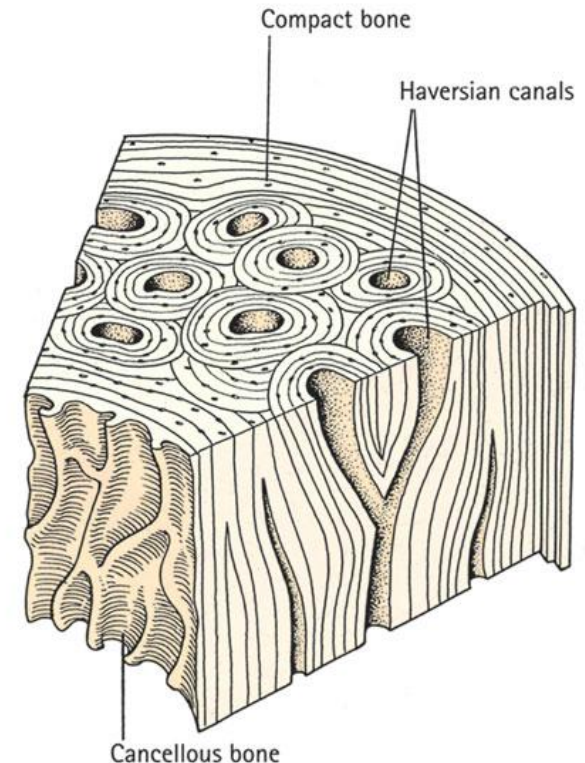
Orthopedic Surgeons and Bone

- Orthopedic surgeons have to deal with all types of bone: healthy or diseased; so they have to know about bone metabolism
- Bones in the body protect vital organs and give support to muscles and tendons
- Bone may become weak in certain conditions



Bone is a living structure

- Continuous activity in bone during all stages of life
- Continuous bone resorption and bone formation as well as remodeling
- Bone is not only for protection and support but its contents play an important part in blood homeostasis



Bone Metabolism

- Calcium
- Phosphorus
- Parathyroid gland
- Thyroid gland
- Estrogen
- Glucocorticoid hormones
- Intestinal absorption
- Renal excretion
- Diet
- Vitamin D
- Sun exposure

Bone Structure

Matrix

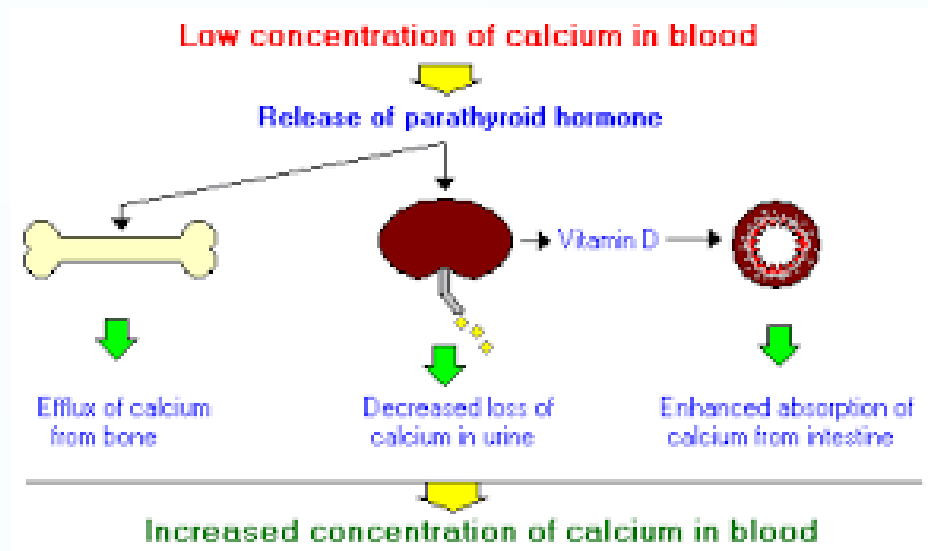
- 40%
- collagen type1
- responsible for tensile strength
- Cells in bone: osteoblasts, osteoclasts, osteocytes

Minerals

- 60%
- mainly Calcium hydroxyapatite, Phosphorus, and traces of other minerals like zinc

Parathyroid Hormone (PTH)

- Production levels are related to serum calcium levels
- PTH secretion is increased when serum calcium is low
- PTH increases calcium levels by:
 - increasing its release from bone
 - increase reabsorption from the kidney (also increase secretion of phosphorus)
 - increase absorption from the intestine



Calcitonin

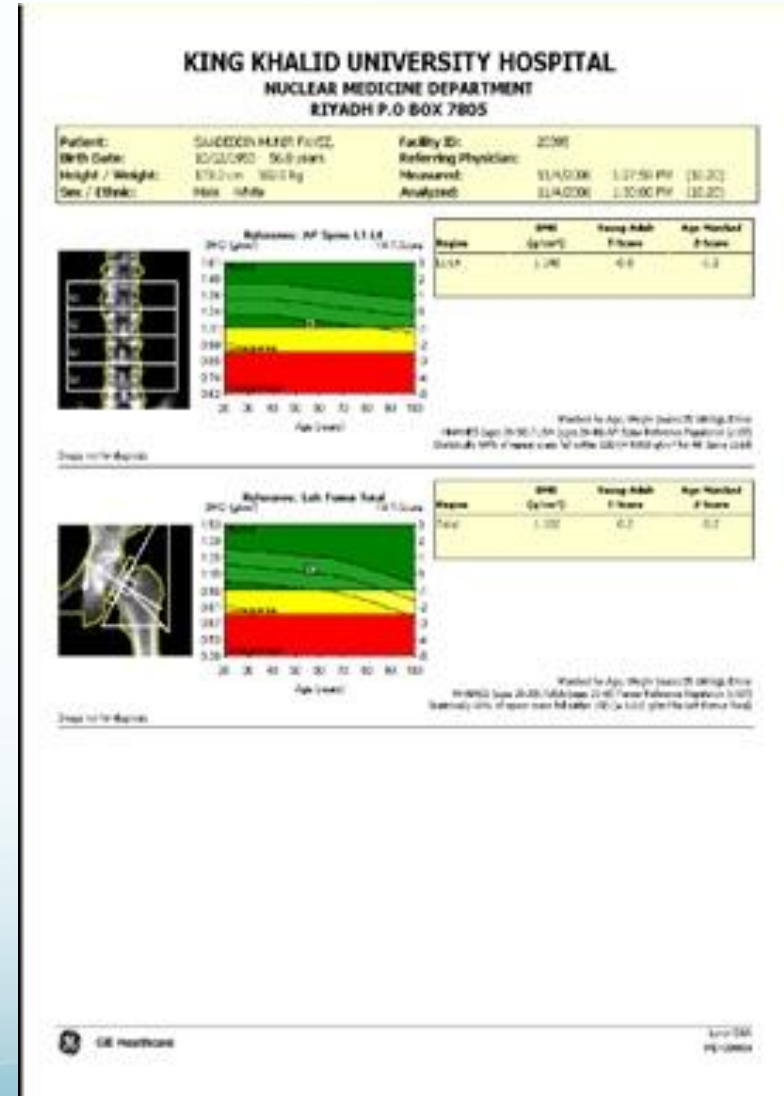
- Secreted by C cells of thyroid gland
- Secretion is regulated by serum calcium
- It decreases serum calcium by inhibition of bone resorption and increasing calcium excretion

Bone Strength

- Bone strength is affected by mechanical stress; exercise and weight bearing
- Bone strength gets reduced with menopause and advancing age
- Reduced bone density on X rays is called **Osteopenia**
- Osteopenia is also a term used to describe a degree of reduced bone density, which if advanced becomes **Osteoporosis**

Bone Density

- Bone density is diagnosed by a test done at radiology department called **DEXA** scan (**D**ual **E**nergy **X**-ray **A**bsorptiometry).



Bone Density

- Normal or increased bone density does not always mean increased bone strength
- Brittle bone disease (Osteogenesis imperfecta): bone density is normal but bone is not strong and fragile and may break easily
- Marble bone disease (osteopetrosis): bone is extremely dense, hard but brittle.



Disorders to be discussed

- Rickets
- Osteomalacia
- Osteoporosis
- Hyperparathyroidism

Rickets & Osteomalacia

- Different expressions of the same disease due to **Inadequate mineralization**
- Rickets affect areas of endochondral growth in **children**
- Osteomalacia: all skeleton is incompletely calcified in **adults**

Rickets & Osteomalacia

- **Causes**

- Calcium deficiency
- Hypophosphataemia
- Defect in Vitamin D metabolism

nutritional

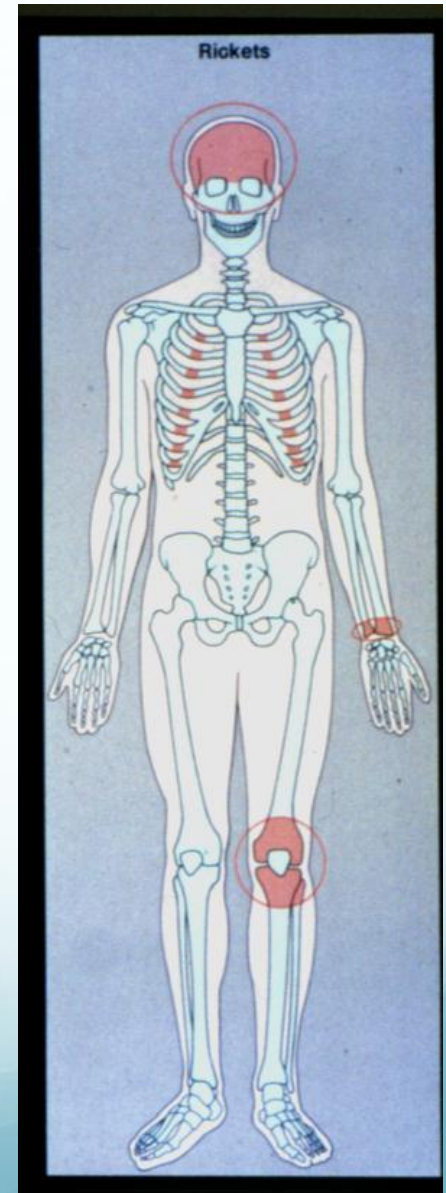
underexposure to sunlight

intestinal malabsorption

liver & kidney diseases

Rickets: Symptoms and Signs

- Child is restless, babies cry without obvious reason
- Failure to thrive
- Muscle weakness
- In severe cases with very low calcium: tetany or convulsions



Rickets: Symptoms and Signs

- Craniotabes



- Pigeon chest deformity (Pectus Carinatum)



Rickets: Symptoms and Signs

- Rickety (Rachitic) rosary :enlargement of the costochondral junctions

Rachitic rosary

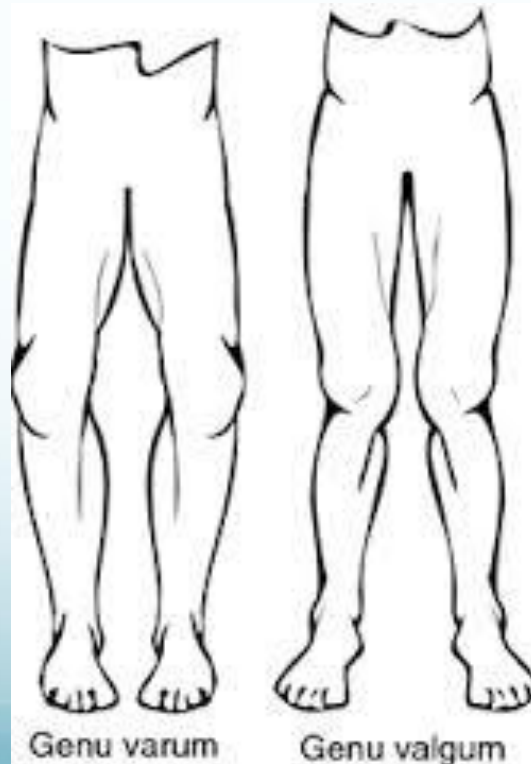


- lateral indentation of the chest (Harrison's sulcus or groove)



Rickets: Symptoms and Signs

- Joint thickening especially around wrists and knees
- Deformity of limbs, mostly genu varum or genu valgum



Rickets: X-ray

- Growth plate widening and thickening
- Metaphyseal cupping
- Long bones deformities



Rickets: X-ray

- Growth plate widening and thickening
- Metaphyseal cupping
- Long bones deformities

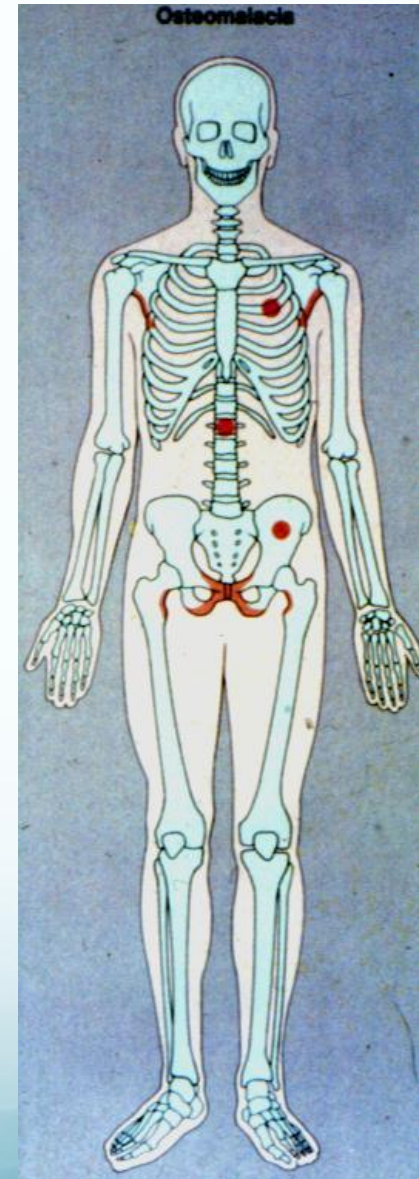


Rickets & Osteomalacia: Biochemistry

- Hypocalcaemia, Hypocalciuria
- High alkaline phosphatase

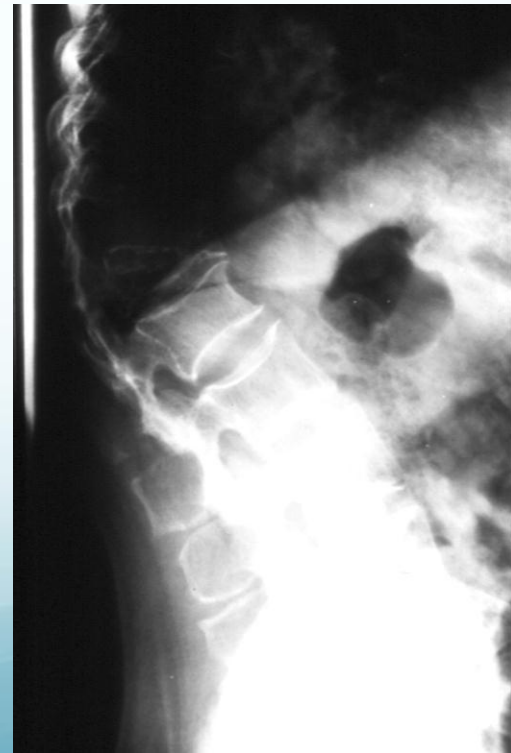
Osteomalacia: symptoms and signs

- Bone pain, mainly backache
- Muscle weakness



Osteomalalacia: X-ray

- Reduced bone density
- Vertebral changes:
Bi-concave vertebra,
vertebral collapse,
kyphosis
- Insufficiency fractures:
Loosers zones in
scapula, ribs ,pelvis,
proximal femur



Rickets & Osteomalacia: Treatment

➤ Rickets

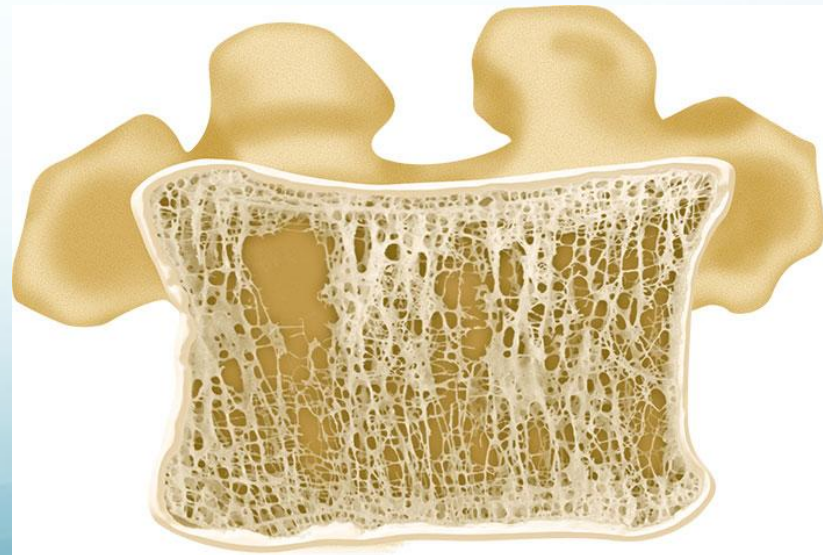
- *Adequate Vitamin D replacement
- *Sun exposure
- *Correct residual deformities

➤ Osteomalacia

- *Vitamin D + Ca
- *Fracture management
- *Correct deformity if needed

Osteoporosis

- Decreased bone mass: decreased amount of bone per unit volume (reduced density)
- Mineralization is not affected
- Mainly post-menopausal and age related



Osteoporosis: Primary and Secondary

Primary Osteoporosis:

- Post-menopausal
- Senile

Post-menopausal Osteoporosis

- Due to rapid decline in estrogen level
- This results in increased osteoclastic activity
- Normal bone loss usually 0.3% per year
- Post menopausal bone loss 3% per year



Post-menopausal Osteoporosis: Risk Factors

- Race
- Hereditary
- Body build
- Early menopause
- Smoking/ alcohol intake/ drug abuse
- ? Calcium intake

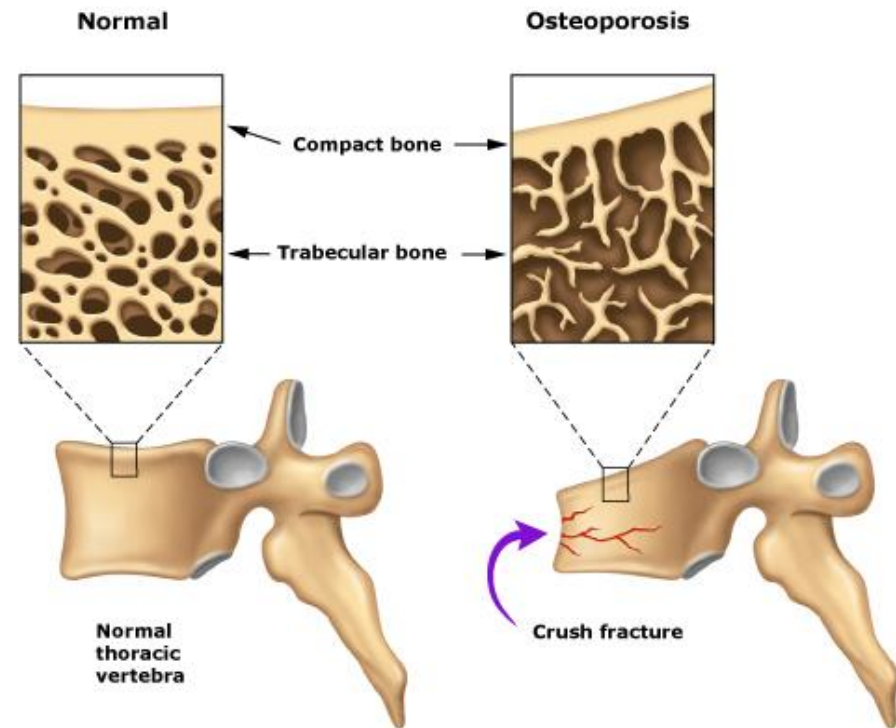
Senile Osteoporosis

- Usually by 7th to 8th decades
- Steady loss of at least 0.5% per year
- Part of physiological manifestation of aging
- Risk factors in Senile Osteoporosis :
 - Dietary: less calcium and vitamin D and protein
 - Muscle weakness
 - Reduced activity



Osteoporosis: Clinical Features

- Silent disease
- Serious due to possible complications: mainly fractures
- Does not usually cause pain



Osteoporosis: Clinical Features

- Causes gradual increase in dorsal kyphosis and loss of height
- Osteoporosis is not osteoarthritis; but the two conditions may co-exist



Osteoporotic Fractures

- Pathological fractures
- Most common is osteoporotic vertebral compression fracture (OVC)
- Vertebral micro-fractures occur unnoticed (dull ache)
- Most serious is hip fractures

Secondary Osteoporosis

- Drug induced: steroids, alcohol, smoking, phenytoin, heparin
- Hyperparathyroidism, hyperthyroidism, Cushing's syndrome, gonadal disorders, malabsorption, malnutrition
- Chronic diseases: RA, renal failure, tuberculosis
- Malignancy: multiple myeloma, leukemia, metastasis

Disuse Osteoporosis

- Occurs locally adjacent to immobilized bone or joint
- May be generalized in bed ridden patients
- Awareness of and attempts for prevention are helpful

Osteomalacia vs. osteoporosis

Osteomalacia

Unwell

Generalized chronic ache

Muscles weak

Looser's zones

Alkaline phosphatase
increased

Serum phosphorus
decreased

Osteoporosis

Well

Pain only after fracture

Muscles normal

No Looser's zones

Normal

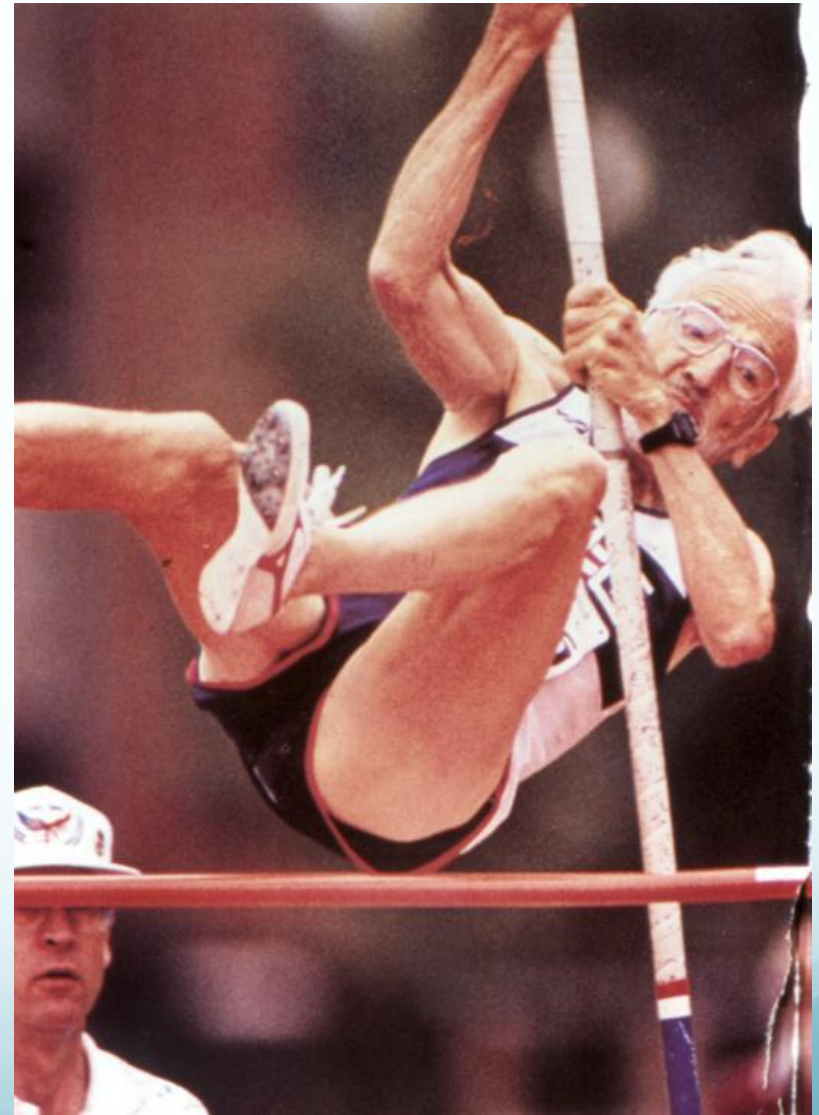
Normal

Prevention of Osteoporosis

- Prevention should start from childhood
- Healthy diet, adequate sunshine, regular exercise, avoidance of smoking or alcohol, caution in steroid use
- At some time in the past there was a recommendation of HRT (Hormone Replacement Therapy) for post menopausal women; but now this is discontinued

Management of Osteoporosis

- Drugs
- Exercise
- Management of fractures



Drug Therapy in Osteoporosis

- **Estrogen** has a definite therapeutic effect and was used extensively as HRT but cannot be recommended now due to serious possible side effects
- Adequate intake of **calcium and vitamin D** is mandatory
- Drugs which **inhibit osteoclast** activities: e.g. Bisphosphonates like sodium alendronate (FOSAMAX)
- Drugs which **enhance osteoblast activities**: bone stimulating agents like Teriparatide (FORTEO), strontium ranelate (PROTELOS)

Exercise in Osteoporosis

- Resistive exercises
- Weight bearing exercises
- Exercise should be cautious to avoid injury which may lead to fracture



Management of Fractures in Osteoporosis

- Use of load-shearing implant (nail) in fracture internal fixation instead of load-bearing implant (plate)



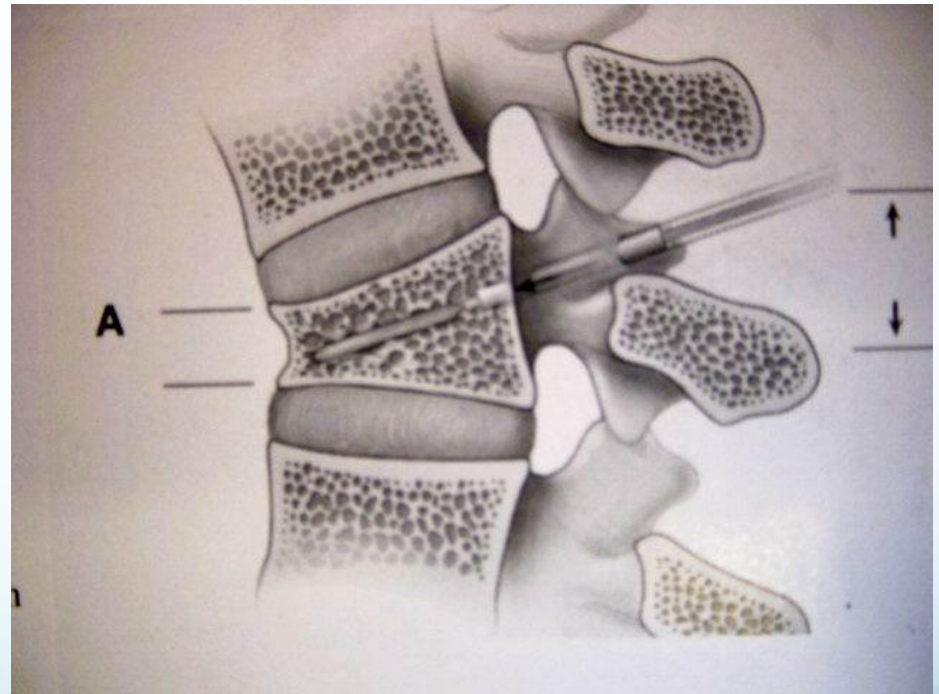
Vertebral Osteoporotic Compression Fracture: Management

- Pain relief
- Prevention of further fractures
- Prevention of instability
- Vertebroplasty
- Kyphoplasty



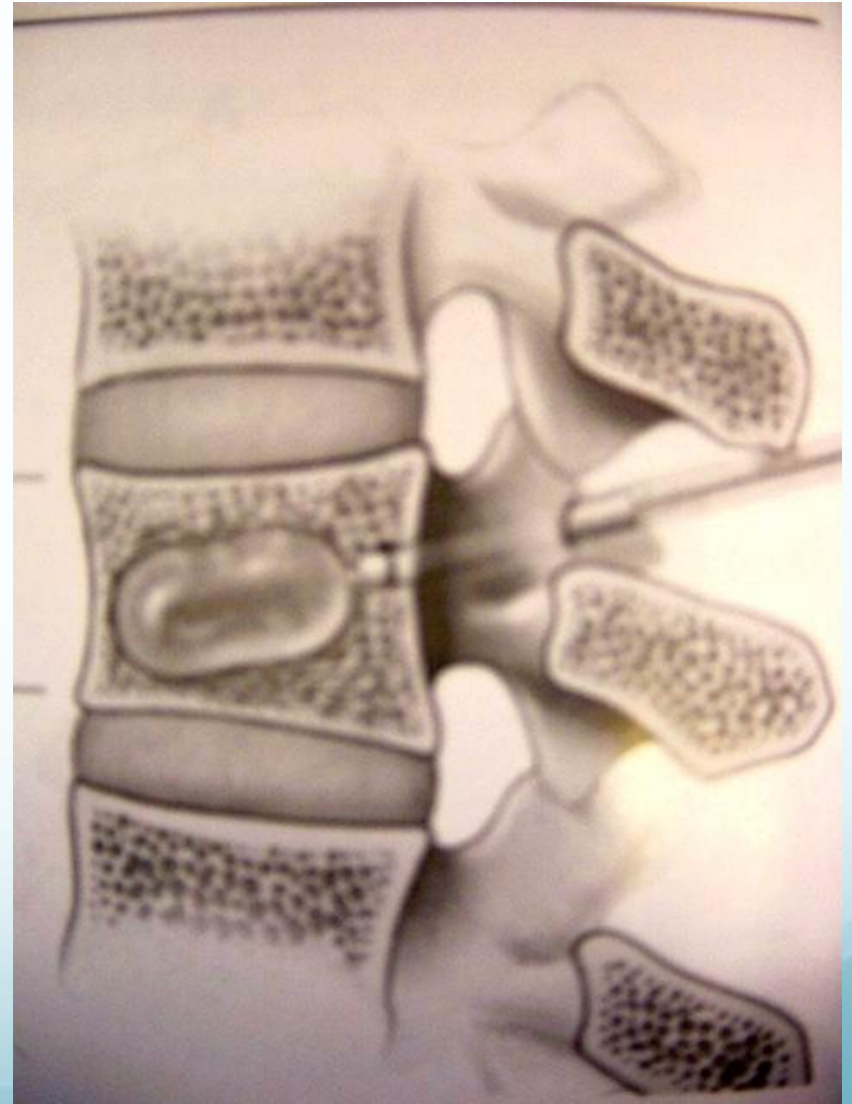
vertebroplasty

- Injection of bone cement into the collapsed vertebra
- under X ray control
- Results in immediate pain relief and helps to prevent further collapse
- Possible complication is leakage of cement into spinal canal (nerve injury) or venous blood (cement embolism)



Kyphoplasty

- Injection of bone cement into the collapsed vertebra AFTER inflating a balloon in it to correct collapse and make a void (empty space) into which cement is injected
- It is possible that some correction of kyphosis is achieved
- It is safer because cement is injected into a safe void



Hyperparathyroidism

- Primary: Adenoma of the gland
- Secondary: as a result of low calcium
- Tertiary: as a result of prolonged or sustained stimulation; hyperactive nodule or hyperplasia

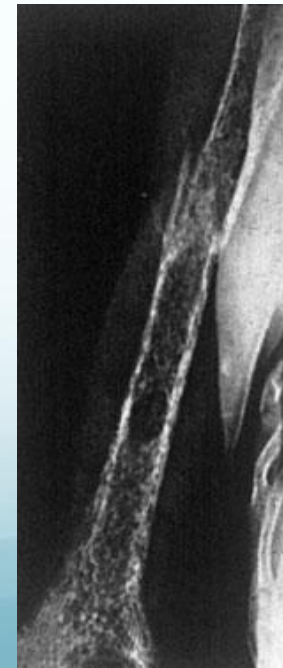
Hyperparathyroidism

- Leads to increased bone resorption, subperiosteal erosions, osteitis manifested by fibrous replacement of bone
- Significant feature is hypercalcemia
- In severe cases: osteitis fibrosa cystica and formation of Brown tumors



Hyperparathyroidism: Radiological changes

- Generalized decrease in bone density
- Sub-periosteal bone resorption (scalloping of metacarpals and phalanges)
- Brown tumors
- Chondrocalcinosis (wrist, knee, shoulder)



Hyperparathyroidism: Management

- Treatment of the underlying cause
- Primary hyperparathyroidism due to neoplasm (adenoma or carcinoma) by excision
- Secondary hyperparathyroidism by correcting the cause of hypocalcaemia
- Tertiary hyperparathyroidism by excision of hyperactive (autonomous) nodule
- Extreme care should be applied after surgery to avoid hypocalcaemia due to hungry bones syndrome

Thank you