

The Radiology of Metabolic Bone Disease

*Ranju T Dhawan
Consultant Radiologist,
St Mary's Hospital, London*

This is an edited version for your intranet learning. Some representative pictures are included . Keep it simple, try and get the big picture and you'll have done enough. If you have any queries you can email me.

*Ranju T Dhawan, Consultant Radiologist,
St Mary's Hospital,
Imperial College NHS Healthcare Trust, London
Ranju.Dhawan@imperial.nhs.uk*

Metabolic Bone Disease

Systemic disorder of the skeleton resulting from a metabolic disturbance

Metabolic Bone Disease

- **THE DISEASES**
- **THE RADIOGRAPHIC SIGNS**
- **The TOOLS** : X-Rays, Densitometry, CT, MRI, Bone Scans

Metabolic Bone Disease

THE DISEASES

- Osteoporosis
- Osteomalacia & Rickets
- Hyperparathyroidism : Primary
- Hyperparathyroidism : Secondary / Renal osteodystrophy

Metabolic Bone Disease

The radiographic signs

- **OSTEOPENIA**
- **OSTEOSCLEROSIS**

The TOOLS

- X Rays
- CT Scans
- MRI Scans
- Radionuclide Bone Scans
- Bone Densitometry

- X Rays \propto density
- Densitometry \propto density/attenuation
- CT Scans \propto density/attenuation
- MRI Scans \propto chemical / water content
- Radionuclide Bone Scans \propto Bone turnover NOT density

Metabolic Bone Disease

The Radiographic Signs (not diseases)

- **OSTEOPENIA**
- **OSTEOSCLEROSIS**

OsteoPENIA & OsteoSCLEROSIS



Osteopenia, Osteomalacia & Osteoporosis

OsteoPENIA = “Poverty” of bone

a sign NOT a disease

Seen in both Osteoporosis Osteomalacia

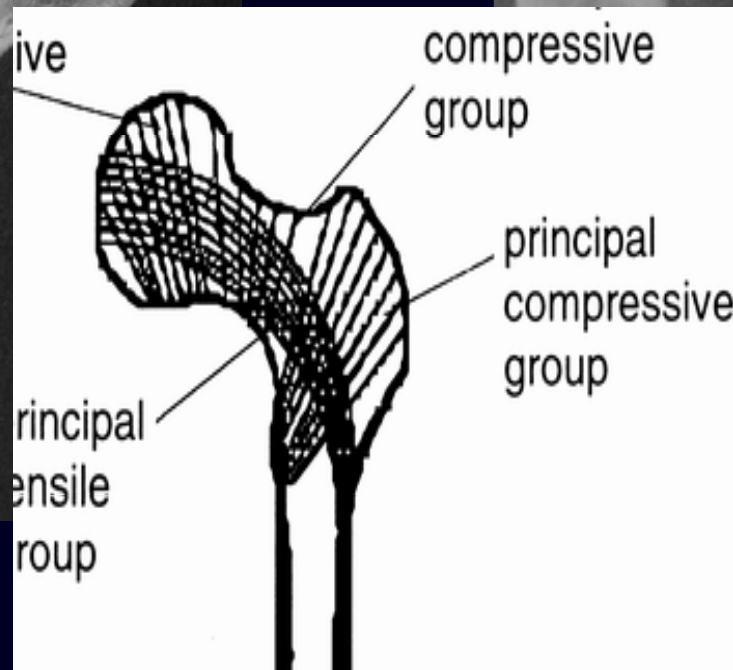
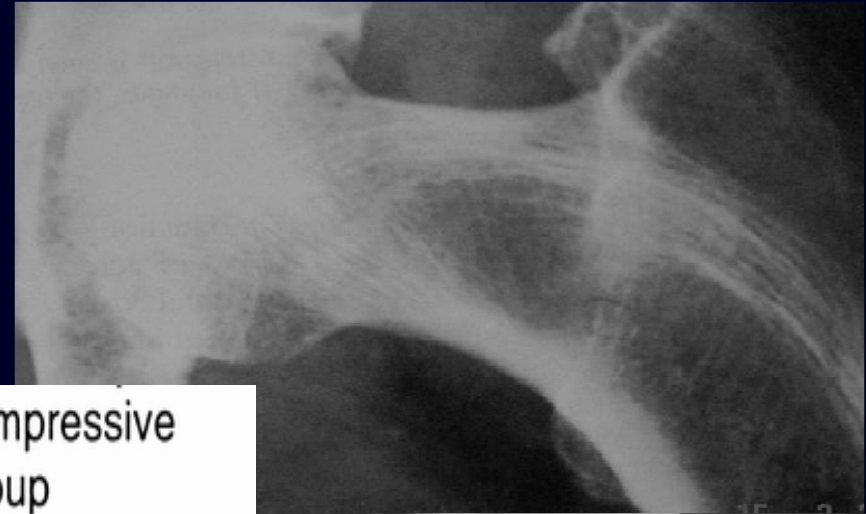
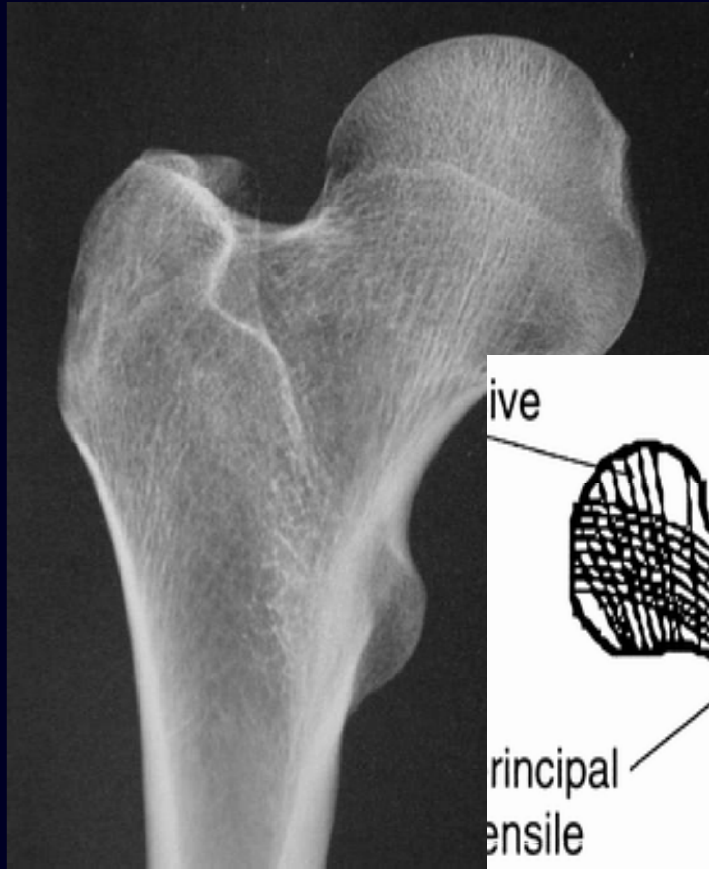
Osteoporosis : decreased bone mass

Osteomalacia : decreased mineralization

OSTEOPOROSIS

Decreased quantity of bone overall
(bone mass), microstructure normal

Osteoporosis: Systematic bone loss



OSTEOPOROSIS



OSTEOPOROSIS

- Normal Biochemistry
- Decreased quantity of bone overall (bone mass), microstructure normal
- Fragility Fractures / Deformity / Pain

OSTEOMALACIA

(& Rickets)

Osteomalacia (& Rickets)

- Vit D deficiency
- Biochemistry: Vit D ↓ Ca: N / ↓ PTH↑
Inadequate/ Delayed mineralization
- Radiology \propto Age / growth plate closure

OSTEOMALACIA (& Rickets)

- Too little mineral Osteopenic & Soft Bone bends and deforms
- Too much osteoid Looser's zones
- If Ca stays low secondary hyperparathyroidism may be superimposed

Osteomalacia

- Pseudofracture / 'Loosers Zone'
 - narrow lucency, perpendicular to bone cortex
 - pubic rami, proximal femur, scapula, lower ribs

Osteomalacia

'Codfish' vertebra

- Biconcave loss of height
- Osteopenic
- pencilled-in margin



OSTEOMALACIA

Less mineral

- Osteopenia
- Bend and bow before break
- Codfish vertebrae: uniform spine deformity

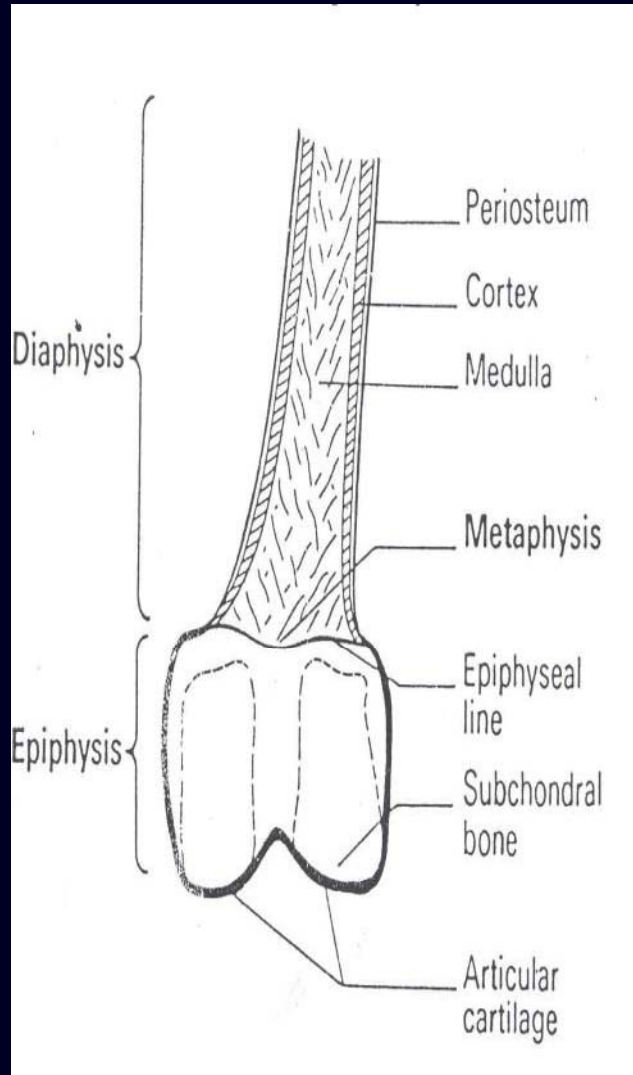
OSTEOPOROSIS

Less Bone

- Osteopenia
- Break
- Anterior wedging

RICKETS

Osteomalacia of
childhood



OSTEOMALACIA

- Changes in mature bone
- Osteopenia
- Looser's Zone's
- Codfish vertebrae
- Bending deformities

RICKETS

- Before growth plate closure
- Changes related to growth plates dominate
- Changes of osteomalacia co exist

RICKETS

**Metaphysis most rapid growth
= most obvious changes**

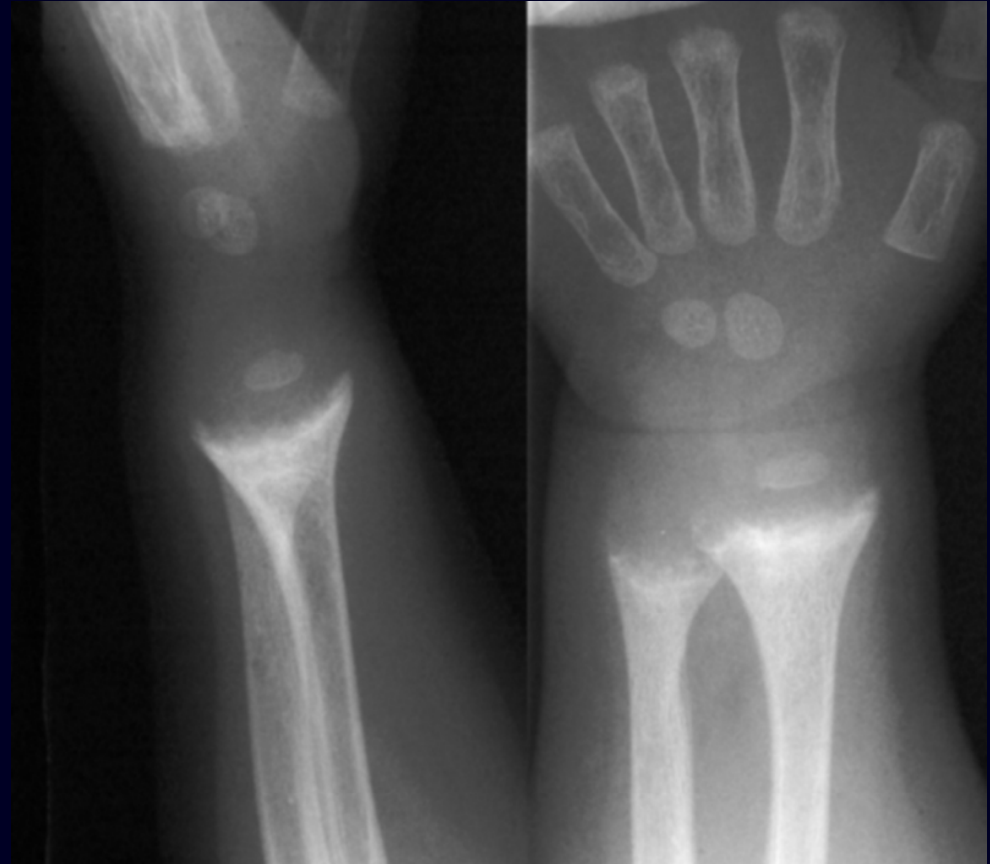
- indistinct frayed metaphyseal margin
- widened growth plate (no calcification)

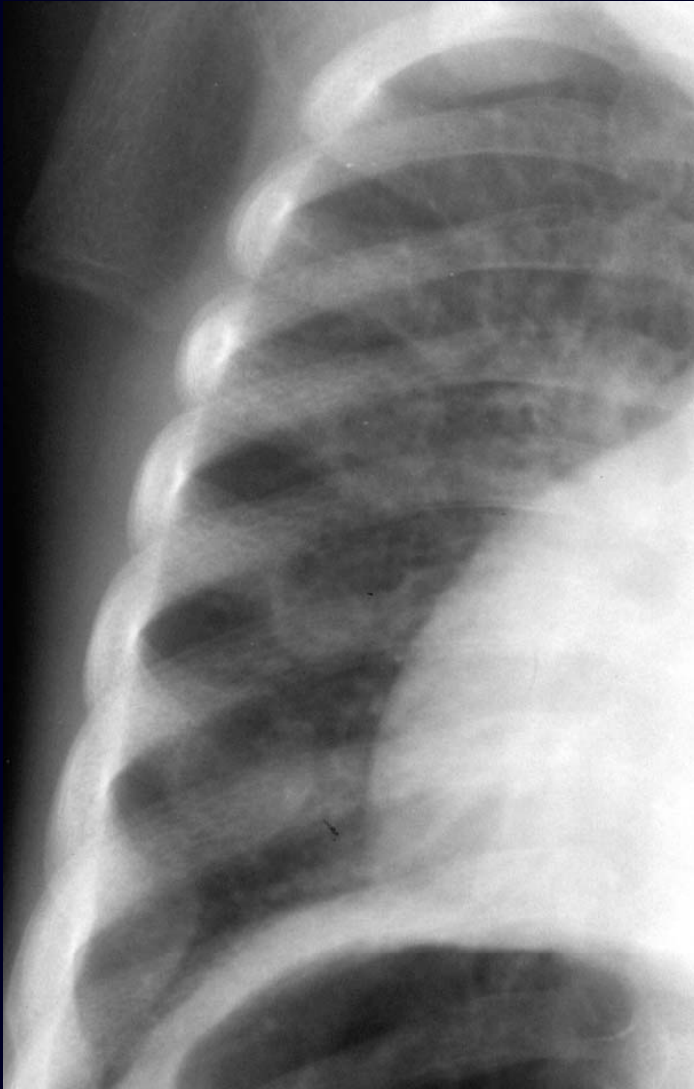
RICKETS



- metaphysis indistinct / frayed margin
- cupping/ splaying metaphyses - due to weight bearing

Rickets





Rickets

Rickety Rosary

- Splayed & cupped anterior ends of ribs

Rickets



- Rickets:
Bowling of
weight bearing bones

RICKETS

- metaphysis most rapid growth/most obvious changes
- **indistinct frayed metaphyseal margin**
- widened growth plate (no calcification)
- **cupping/ splaying metaphyses - due to weight bearing**
- **enlargement of anterior ribs (rickety rosary)**
- **osteopenia**

Hyperparathyroidism

- 1° HPTH **Primary (PTH adenoma)**
- 2° HPTH **Secondary**
- 3° HPTH **Tertiary (autonomous)**

Classification of HPT

- Primary HPT : ↑ PTH ↑ Ca ↓ P
- Secondary HPT: ↑ PTH ↓ Ca, n or ↓ P
CRF / Rickets / Osteomalacia
- Tertiary HPT: ↑ PTH ↑ Ca ↓ P

HPT

- Primary (high Ca)

Radiology: **Bone Resorption**

- Secondary (low / N Ca)

Renal osteodystrophy

Resorption + Increased density

(anabolic & resorptive features of PTH)

HPT: Bone Resorption

subperiosteal

subchondral

Intracortical

brown tumours

BONE LOSS

SLOW : Involutional Osteoporosis

Bone has time to remodel / bone loss occurs according to mechanical needs

FAST : Hyperparathyroidism / Disuse Osteoporosis

Bone loss is too rapid

Loss does not cater to mechanical needs

HPT: Bone Resorption

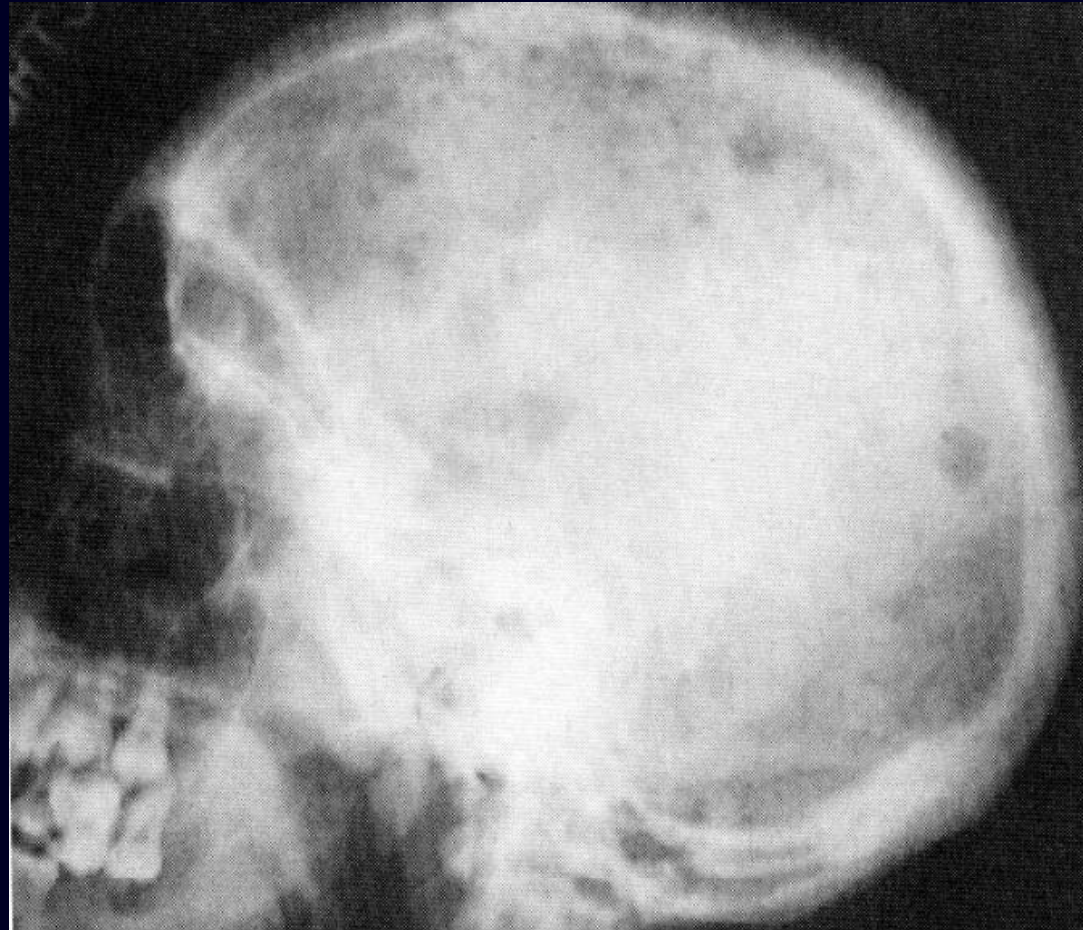
– subperiosteal

(radial aspect middle and ring fingers phalanges)



HPT: Bone Resorption

- subperiosteal
- subchondral
- intracortical
- eg pepper-pot skull)



HPT: Bone Resorption

- subperiosteal
- subchondral (distal clavicle, pubis)



HPT: Bone Resorption

- subperiosteal
- subchondral
- intracortical
- brown tumours
(bigger, ++
osteoclastic
activity)



Renal Osteodystrophy (CRF)

Radiology

- Osteomalacia and Osteoporosis
- 2° HPTH
 - sub-periosteal **erosions**, brown tumours,
 - sclerosis - axial skeleton/vertebral end plates** **rugger jersey spine**
 - soft tissue calcification (**arteries/cartilage**)

Renal Osteodystrophy (CRF)

Radiology

- Osteomalacia ,
Osteoporosis
- 2° HPTH

Bone **Resorption**

Bone **Sclerosis**

axial skeleton/

vertebral end plates

rugger jersey spine

Soft tissue calcification

(arteries/cartilage)



Renal Osteodystrophy (CRF)

Radiology

- Osteomalacia ,
Osteoporosis
- 2° HPTH

Bone **Resorption**

Bone **Sclerosis**

axial skeleton/

vertebral end plates

rugger jersey spine

Soft tissue calcification

(arteries/cartilage)



BONE : Dynamic System Constantly turning over

Mediators of Bone metabolism

- Ca / P / Vit D / PTH / Calcitonin
- Other hormones : Thyroxine, Growth hormone, Glucocorticoids, Estrogens, Androgens, Insulin
- Other factors: Vit C and other nutrients, Cytokines, Prostaglandins, Several growth factors

BONE

Think

REMODELLING ADAPTING
OSTEOBLASTS / OSTEOCLASTS
FORMATION / RESORPTION

Think:

DYNAMIC not DEAD