Rickets
Rickets

- IS defined as failure of mineralization of growing bone or osteoid tissue due to vitamin D deficiency.
- Vitamin D appear as rickets in children and as osteomalacia in post pubertal adolescents.
Vitamin D synthesis

In the skin 7-dehydro cholesterol in sun exposure changed by the effect of ultra violet β radiation to Vitamin D3 (3-cholecalciferol) this substance bind to Vitamin D binding protein transferred to the liver and by 25 hydroxylase enzyme to form (25 hydroxy vitamin D) and this substance transferred to the kidney and in the presence of 1α hydroxylase enzyme changed to (1-25 dihydroxy vitamin D {calcitriol}) which is the active form and act by increasing the absorption of calcium and phosphorus from the intestine.
Vitamin D function

- Both vitamin D2 & D3 are hydroxylated in the liver to 25-hydroxy vitamin D (calcidiol) which is further hydroxylated in the kidney to 1-25 dihydroxy vitamin D (calcitriol) which acts as hormone & the most biologically active form of the vitamin it:
  - 1. Stimulate calcium absorption in the small intestine.
  - 2. Increase bone formation & growth plate mineralization by providing sufficient circulating calcium also mediating resorption.
  - 3. May have a direct anabolic effect on the bone.
  - 4. Has direct feedback to the Parathyroid gland & inhibit secretion of parathyroid hormone.
- Mineralization cannot occur unless adequate calcium & phosphorus are present.
Vitamin D sources:

1. Cutaneous synthesis.

2. Dietary sources:
   - Breast milk has low vitamin D content approximately (12-60) IU/L.
   - Fortified food especially fortified formula which contain (400 IU/L).
   - Fish liver oil have a high vitamin D content, other good sources is fatty fish & egg yolk.
   - Supplemental vitamin D like ergocalciferol which comes from plants or yeast & cholecalciferol (mammalian form) both can be produced synthetically & available as dietary supplements.
Causes of vitamin D deficiency:

1. Inadequate direct sun exposure.
2. Decreased vitamin D intake.
4. Dark pigmented skin.
5. Secondary vitamin D deficiency
   a. Malabsorption (cholestatic liver disease, defect in bile acid metabolism, cystic fibrosis, coeliac disease, crohn's disease).
   b. Increase degradation by medications as Phenobarbitone & Phenytoin
   c. Decrease phosphate absorption by Aluminum containing antacids
   d. Chronic renal failure
Clinical manifestations:

- Are most common during the first 2 years of life & may become evident only after several months of vitamin D deficient diet, vitamin D deficient rickets is rare later in childhood.

The head:

- Craniotabes is one of the early signs of rickets due to thinning of the outer table of the skull, it is felt as a ping-pong ball sensation when pressing firmly over the occiput or posterior parietal region.
- Non rachitic craniotabes seen in normal infants in the immediate postnatal period & disappear by the second to fourth month but also can be seen in hydrocephalus & osteogenesis imperfecta.
Clinical manifestations

- 2. Frontal bossing
- 3. The anterior fontanel is enlarged & its closure may be delayed until after the second year of life.
- 4. Caput quadratum means box like appearance of the head.

The teeth:
- Eruption of the temporary teeth may be delayed & there may be defect of the enamel & extensive caries.
- Permanent teeth that are calcifying during period of vitamin D deficiency may also be affected.

Extremities:
- 1. Thickening of the wrist & ankle felt as widening of the wrist is an early sign of rickets.
- 2. Bowing of the legs.
- 3. Wind swept deformity (combination of valgus deformity of leg & varus deformity of other leg).
- 4. Anterior of tibia & femur
- 5. Coxa vara
Clinical manifestations

- The chest:
  - Rachitic rosary: is palpable enlargement of the costochondral junction.
  - Pigeon chest deformity due to projected sternum forward.
  - Harrison groove or sulcus seen on the lower border of the chest due to pulling of the softened ribs by the diaphragm during inspiration.
  - Recurrent respiratory infections due to softening of the ribs which impair air movement & predispose patients to atelectasis.

- Pelvis:
  - Deformity of the pelvis in girls lead to obstructive labor.
Clinical manifestations

- **Muscles**: are poorly developed & lack tone as a result of children with moderately severe rickets don’t stand & walk at usual ages. (Delayed walking)
- Relaxation of ligaments leading to deformities like knock knees, kyphosis & scoliosis.

- **In advanced rickets:**
  - 1. scoliosis & lordosis may be present.
  - 2. Bow legs (genu varus) & knock knees (genu valgus).
Bowed legs and swollen wrists in rickets
Harrison groove
Widening of the wrist
Rachitic rosary
Diagnosis:

1. Clinical
2. X-ray of the wrist: will show characteristic radiographic changes of the distal ulna & radius include:
   - Widening
   - Concave cupping & fraying (poorly demarcated ends).
   - There is increased distance between the distal ends of radius & ulna & the metacarpal bones.
3. Lab investigations:
   - Serum Calcium usually is normal but may be low.
   - Serum phosphorus level usually is reduced due to PTH induced renal loss of phosphate combined with decrease in intestinal absorption.
   - Serum alkaline phosphatase activity is elevated.
Rickets & hypocalcaemia

- Normal serum Ca level is (8.5-10.5) mg/dl when it become 7.5 mg tetany will occur.

- Symptomatic hypocalcaemia is treated by I.V Calcium infusion followed by oral Calcium supplement for 2-6 weeks of about 1000 mg/day.

- Hypocalcaemia either causing:
  - Tetany
  - Stridor secondary to laryngeal spasm
  - Convulsion
Radiological changes of rickets
Prevention:

1. Direct sun exposure.
2. Vitamin D supplementation of all breast infants in the amount of \((200-400)\text{IU/day}\) started in the first 2 months of life.
Treatment:

1. Single dose of (300,000-600,000) IU of vitamin D orally or IM the effect will be seen after 2-4 weeks radiologically healing is rapid allowing earlier differential diagnosis from genetic vitamin D resistant rickets.

2. The alternative is oral administration of daily high dose vitamin D in adose (2000-6000) IU/day of vitamin D3 over 4-6 weeks followed by daily vitamin D intake of 400 IU/day.

Healing rickets:

- Calcification takes place in the zone of preparatory calcification ZPC which will be seen radiologically.
Congenital vitamin D deficiency

- 1. Severe maternal vitamin D deficiency during pregnancy
- 2. Lack of adequate sun exposure
- 3. Closely spaced pregnancies
- Newborn presented with symptomatic hypocalcaemia, IUGR, decrease bone ossification with classic rachitic changes with defect in dental enamel.
- Prevention by maternal supplementation of multi vitamins including vitamin D.
Other types of rickets

- Vitamin D dependant rickets type 1:
  - It is autosomal recessive disorder, due to defect in gene encoding 1α hydroxylase enzyme in the kidney so conversion of 25-vitamin D to 1-25 vitamin D will not occur.
  - Diagnosis: low level of 1-25 vitamin D
  - Treatment by 1-25 vitamin D (calcitriol 0.25-2 μg/day)
Vitamin D dependant rickets type -2

- There is mutation in gene encoding the vitamin D receptor preventing the normal physiologic response to 1-25 vitamin D.
- Diagnosis: elevated 1-25 vitamin D
- Treatment: 3-6 μg of vitamin D with oral calcium (1000-3000) mg/day
X-linked dominant hypo phosphatemic rickets

- There is increase phosphate excretion in renal tubules & decrease synthesis of 1-25 vitamin D calcitriol.
- Treatment; combination of oral phosphorus 1-3 gm divided to 4-5 doses with 1-25 vitamin D calcitriol
Autosomal dominant hypo phosphatemic rickets

- There is decrease reabsorption of phosphorus in the renal tubules & decrease hydroxylation of 25-vitamin D