RICKETS

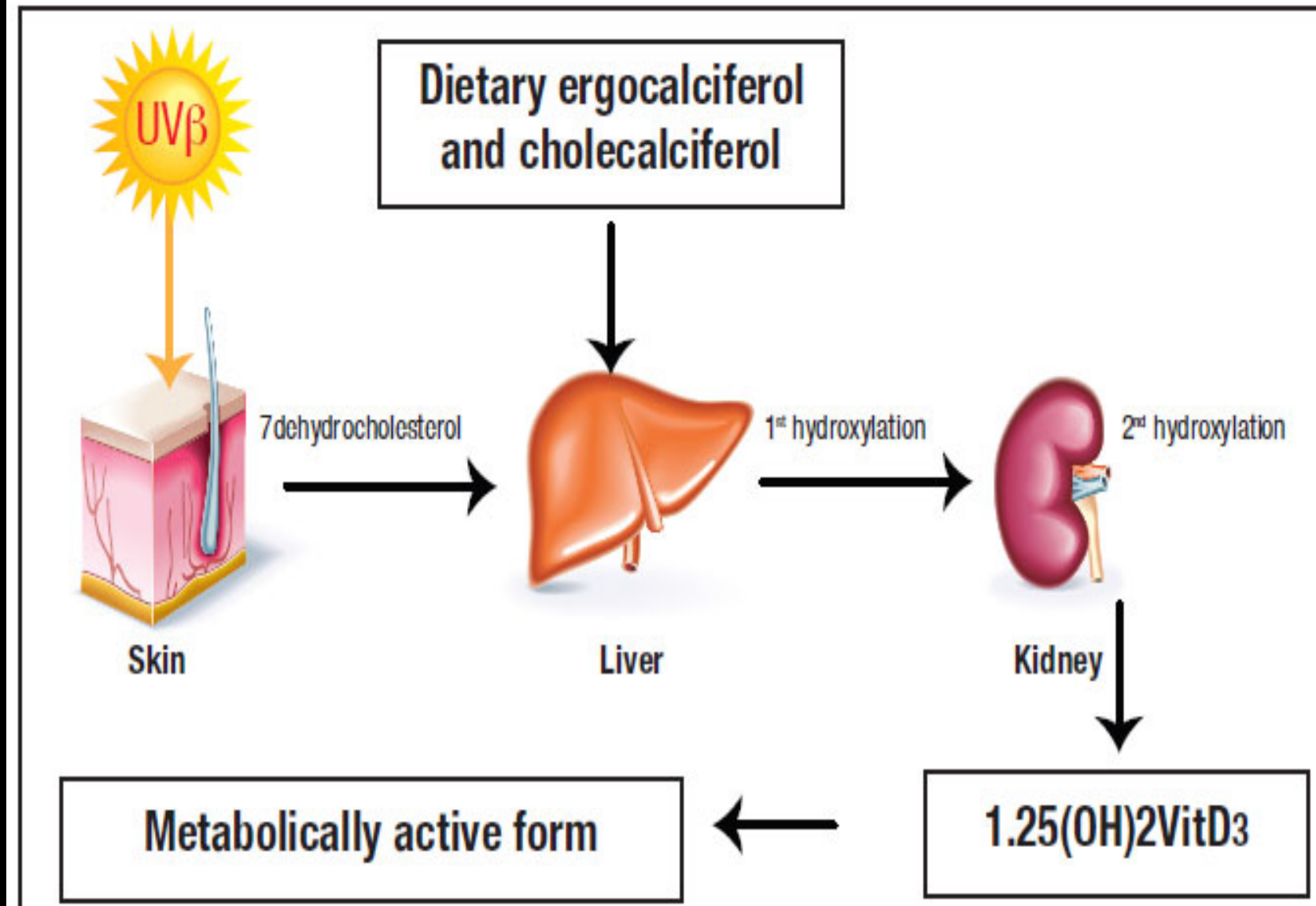
Rickets is a disease of growing bone that is caused by unmineralized matrix at the growth plates and occurs in children only .before fusion of the epiphyses

Pathophysiology

- Cholecalciferol (ie , vitamin D-3) is formed in the skin from 7-dihydrochlesterol. This .steroid undergoes hydroxylation in 2 steps
- **first hydroxylation** :-occurs at the liver, .producing (25-hydroxycholecalciferol)
- **second hydroxylation**:- step occurs in the kidney, where it undergoes hydroxylation to the active metabolite calcitriol .(1,25-dihydroxycholecalciferol)

Calcitriol acts at 3 known sites to tightly regulate calcium metabolism:

- it promotes absorption of calcium and **(1)** phosphorus from the intestine.
- it increases reabsorption of phosphate **(2)** in the kidney.
- it acts on bone to release calcium and **(3)** phosphate.


UVβ
Dietary ergocalciferol and cholecalciferol
7dehydrocholesterol
1st hydroxylation
2nd hydroxylation
Skin
Liver
Kidney
1.25(OH)2VitD3
Metabolically active form

Causes of Rickets

.....There are many causes of rickets

.vitamin D disorders

.calcium deficiency

.phosphorous deficiency

.distal renal tubular acidosis

Other causes of 2nd rickets

Clinical Features of Rickets

GENERAL
Failure to thrive
Listlessness
Protruding abdomen
Muscle weakness (especially proximal)
Fractures

HEAD
Craniotabes
Frontal bossing
Delayed fontanel closure
Delayed dentition; caries
Craniosynostosis

CHEST
Rachitic rosary
Harrison groove
Respiratory infections and atelectasis*

BACK
Scoliosis
Kyphosis
Lordosis

EXTREMITIES
Enlargement of wrists and ankles
Valgus or varus deformities
Windswept deformity (combination of valgus deformity of 1 leg with varus deformity of the other leg)
Anterior bowing of the tibia and femur
Coxa vara
Leg pain

HYPOCALCEMIC SYMPTOMS†
Tetany
Seizures
Stridor due to laryngeal spasm

Clinical Features of Rickets

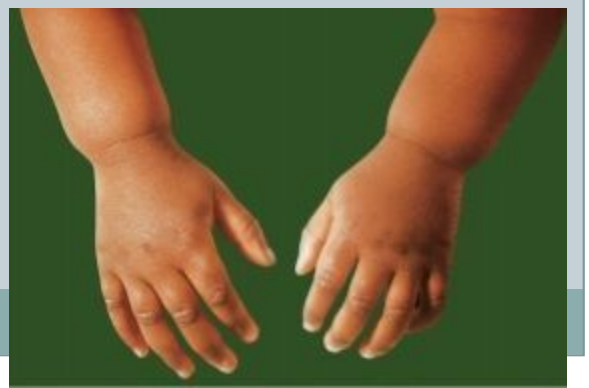
- **Most manifestations of rickets are a result of . skeletal changes**
- **Craniotabes** is a softening of the cranial bones and can be detected by applying pressure at the occiput or over the parietal bones. The sensation is similar to the feel of pressing into a ping-pong ball and then releasing. **Craniotabes may also be secondary to osteogenesis imperfecta**, **hydrocephalus**, and **syphilis**. **It is a normal finding in many newborns, especially near the suture lines, but it typically disappears within a few .months of birth**

Widening of the costochondral junctions results in a rachitic rosary, which feels like the beads of a rosary as the examiner's fingers move . along the costochondral junctions from rib to rib

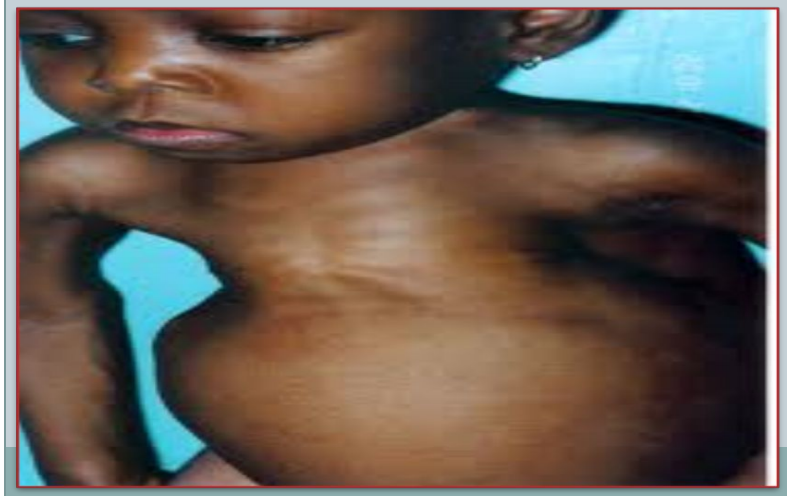
Growth plate widening ;because growth plate cartilage and osteoid continue to expand but mineralization is inadequate, the growth plate thickens . There is also an increase in the circumference of the growth plate and

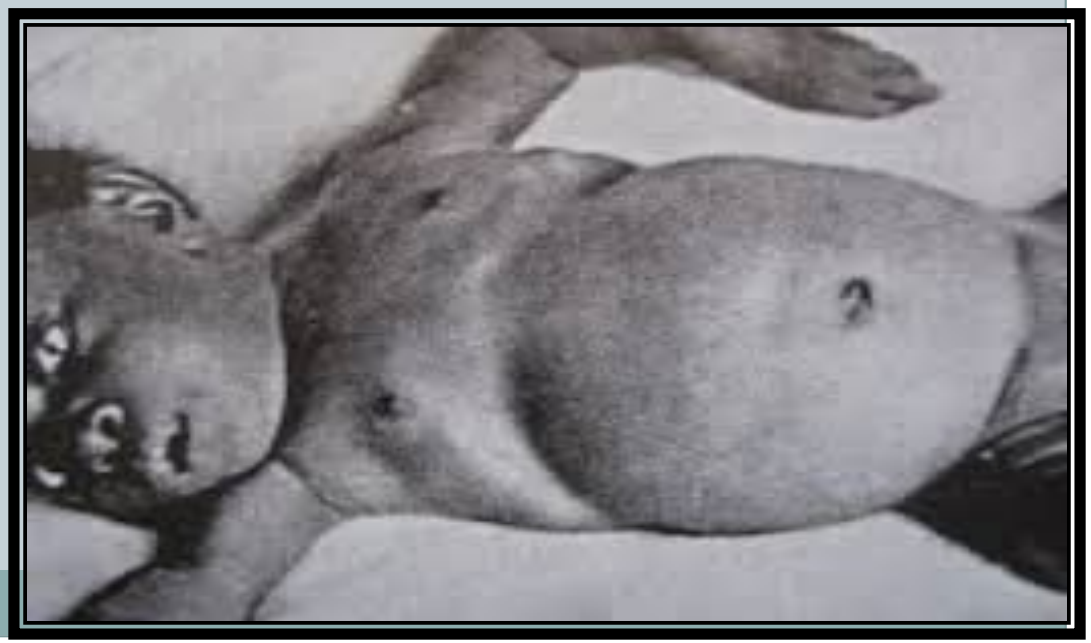
the metaphysis , increasing bone width at the location of the growth plates and causing some of the classic clinical manifestations, such as

.widening of the wrists and ankles

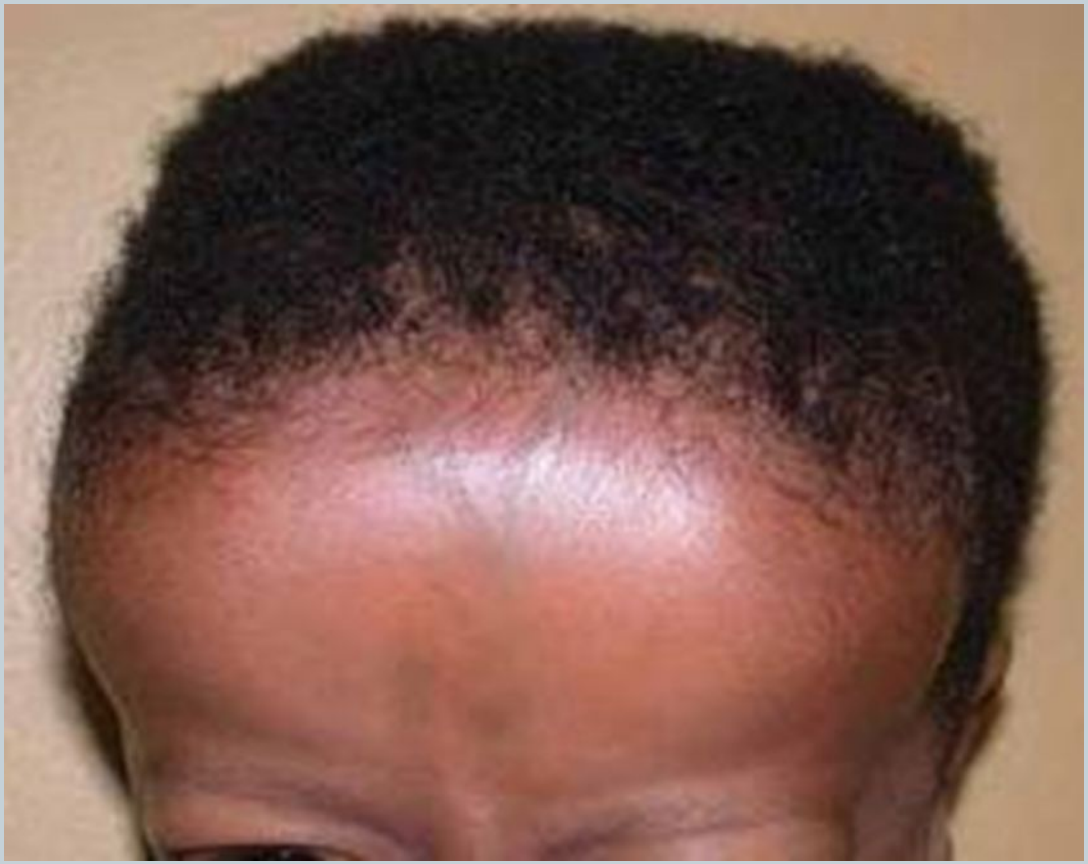


The horizontal depression along the lower anterior chest known as **Harrison groove** occurs from pulling of the softened ribs by the diaphragm during inspiration .Softening of the ribs also impairs air movement and predisposes patients to atelectasis and pneumonia

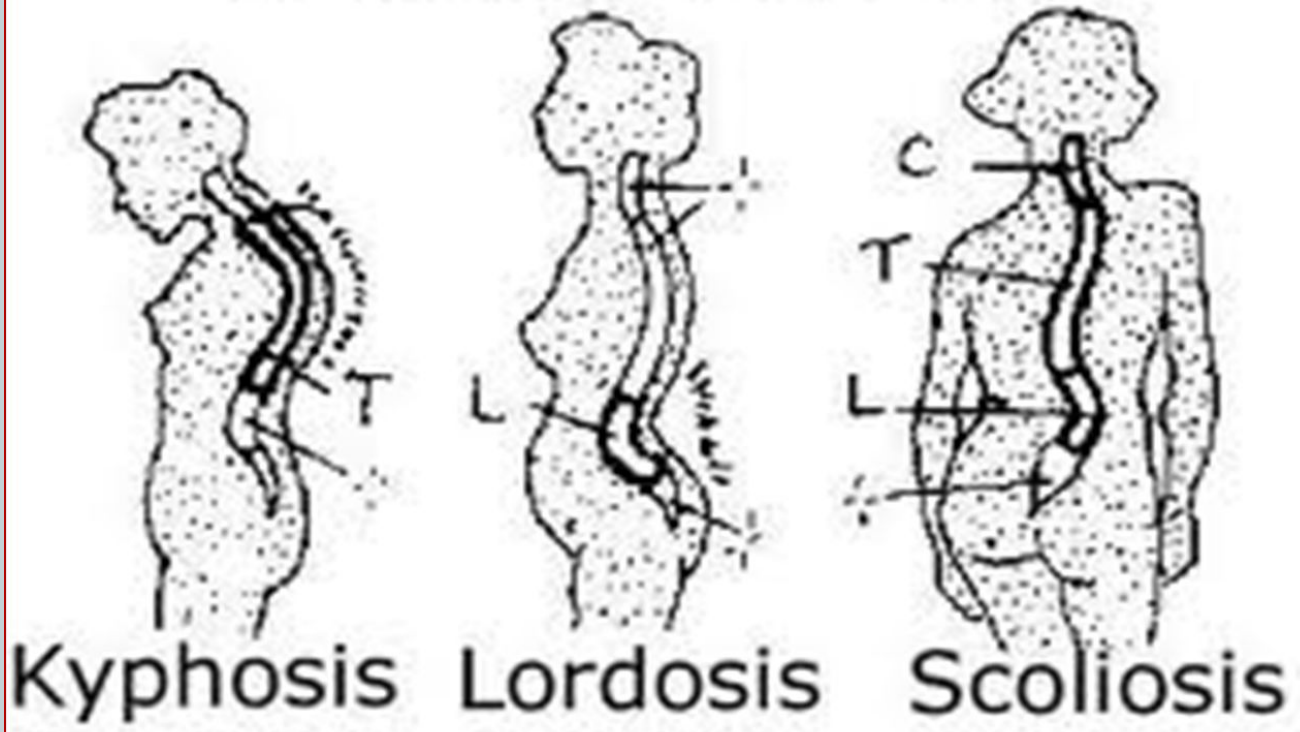


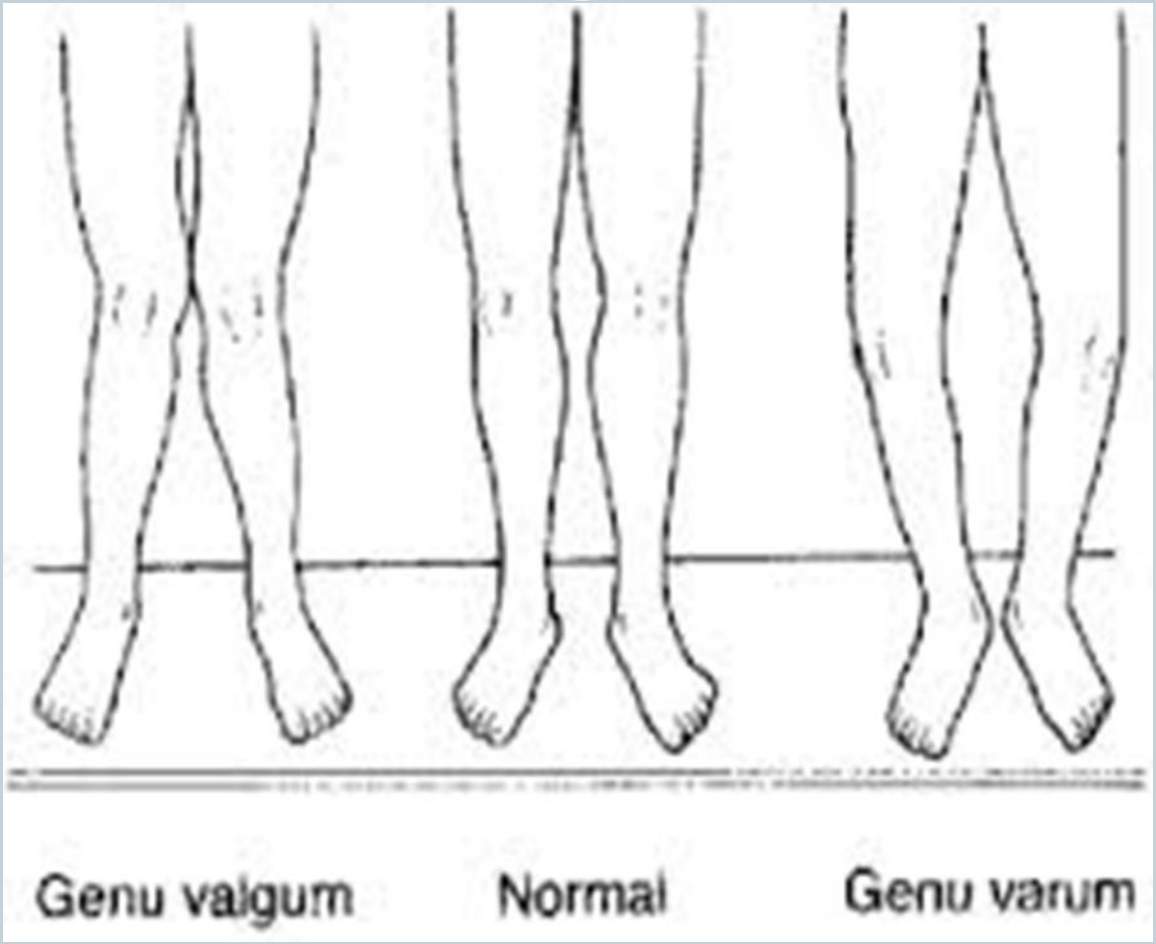


The chief complaint in a child with rickets is quite variable. Many children present because of skeletal deformities, whereas others have difficulty walking owing to a combination of deformity and weakness. Other common presenting complaints include failure to thrive . and symptomatic hypocalcemia



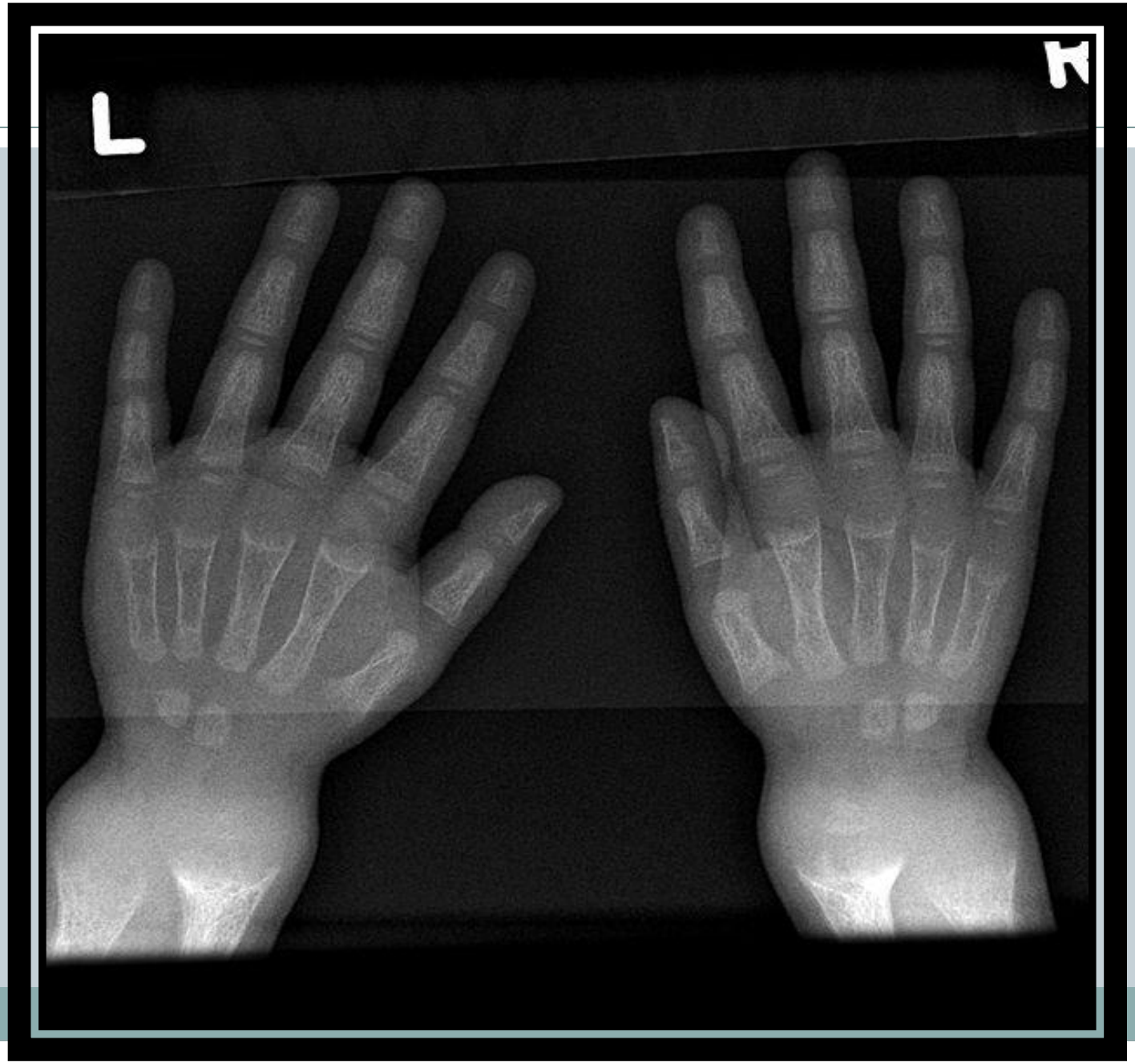
Vertebral Disorders



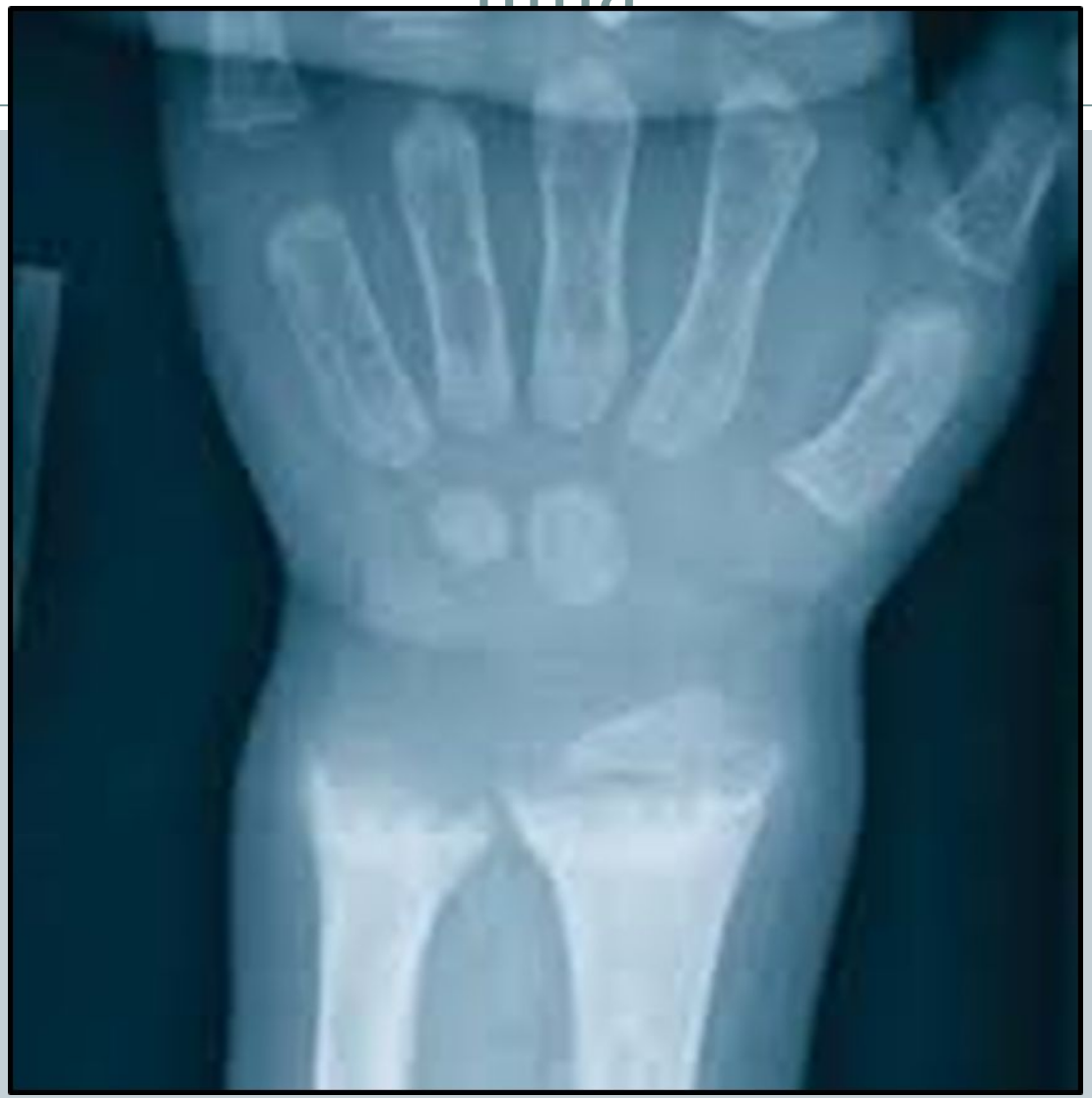

Genu valgum
Normal
Genu varum

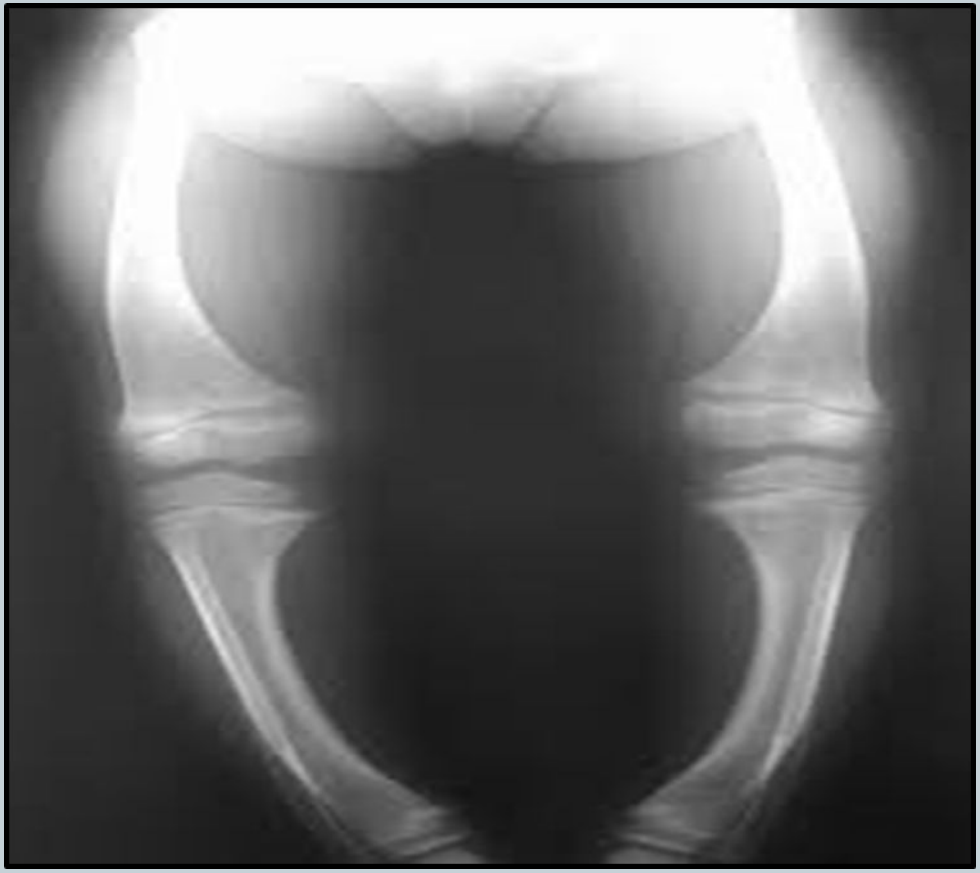
Radiology

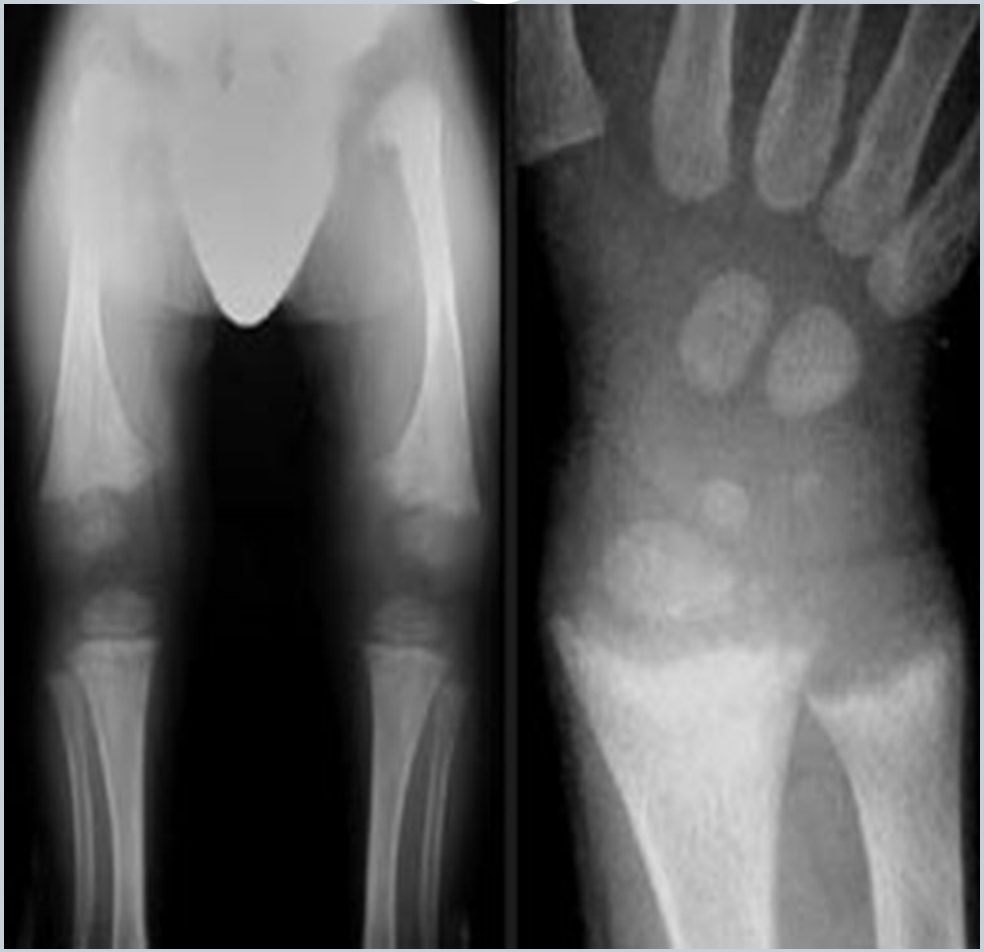
- The edge of the metaphysis loses its sharp border, which is described as fraying. The edge of the metaphysis changes from a convex or flat surface to a more concave surface. This change to a concave surface is termed cupping and is most easily seen at the distal ends of the radius, ulna, and fibula. There is widening of the distal end of the metaphysis, corresponding to the clinical observation of thickened wrists and ankles, as well as the rachitic rosary. Other radiologic features include coarse trabeculation of the diaphysis and generalized rarefaction


L
R

fraying and cupping of the distal radius and ulna







Diagnosis

- The diagnosis is supported by physical examination findings and a history and laboratory test results that are consistent .with a specific etiology

Clinical Evaluation

The initial evaluation should focus -:on

- A dietary history(determining a child's intake of dairy products:- the main dietary source of calcium, high dietary fiber can .interfere with calcium absorption) **-1**
- .Intake of vitamin D and calcium **-2**
- It is important to ask about time spent ,outside, sunscreen use, and clothing **-3**

- especially if there may be a cultural reason .for increased covering of the skin
- Cutaneous synthesis mediated by sunlight exposure is an important source of vitamin .D
- The child's medication use is relevant,-4 because certain medications, such as the anticonvulsants (phenobarbital and phenytoin), increase degradation of vitamin D, and aluminum-containing antacids .interfere with the absorption of phosphate

- Malabsorption of vitamin D is suggested by a history of liver , intestinal and renal diseases. Children with rickets might have a history of dental caries, poor growth, delayed walking, waddling gait, pneumonia, .and hypocalcemic symptoms -5
- The family history is critical, given the large number of genetic causes of rickets, .although most of these causes are rare -6

The physical examination focuses on

. **a-**detecting manifestations of rickets

.**b-**observe the child's gait

c-auscultate the lungs to detect atelectasis or .pneumonia

.**d-**plot the patient's growth

- **The initial laboratory tests(serum chemistry)** in a child with rickets should include:-

1- serum calcium (ionized fraction) is low.

2-phosphorus level is invariably low for age. The hypophosphatemia is caused by PTH-induced renal losses of phosphate, combined with a decrease in intestinal absorption.

3-Alkaline phosphatase levels are uniformly elevated.

4- parathyroid hormone (PTH) is increased.

5- 25-hydroxyvitamin D, **-**
1,25-dihydroxyvitamin D.

.creatinine and electrolytes **-6**

Table 51-4 Laboratory Findings in Various Disorders Causing Rickets

DISORDER	Ca	Pi	PTH	25-(OH)D	1,25-$(OH)_2$D	Alk Phos	URINE Ca	URINE Pi
Vitamin D deficiency	N, ↓	↓	↑	↓	↓, N, ↑	↑	↓	↑
Chronic kidney disease	N, ↓	↑	↑	N	↓	↑	N, ↓	↓
Dietary Pi deficiency	N	↓	N, ↓	N	↑	↑	↑	↓
Tumor-induced rickets	N	↓	N	N	RD	↑	↓	↑
Fanconi syndrome	N	↓	N	N	RD or ↑	↑	↓ or ↑	↑
Dietary Ca deficiency	N, ↓	↓	↑	N	↑	↑	↓	↑

Treatment

Treatment Children with nutritional vitamin D deficiency should receive vitamin D and adequate nutritional intake of calcium and phosphorus. **There are 2 strategies for administration of vitamin D**. With stoss therapy, 300,000-600,000 IU of vitamin D are administered orally or intramuscularly as 2-4 doses over 1 day(vitaminD3is preferred to D2 because of longer half-life of D3). since the doses are observed, stoss therapy is ideal in patients in whom adherence to therapy is . questionable

- **The alternative strategy** is daily vitamin D, minimum-dose of 2,000 IU/day for the minimum of 3 mo.. Either strategy should be followed by daily vitamin D intake of 400 IU/day if <1 yr old or 600 IU/day if >1 yr.Adequat sun exposure . It is important to ensure that children receive adequate dietary calcium and phosphorus; this dietary intake is usually provided by milk, formula, and other dairy products.
- Children who have symptomatic hypocalcemia might need intravenous calcium acutely, followed by oral calcium supplements, which typically can be tapered over 2-6 wk.

- The single-day therapy avoids problems with compliance and may be helpful in differentiating nutritional rickets from familial hypophosphatemia rickets (FHR). In nutritional rickets, the phosphorus level rises in 96 hours and radiographic healing is visible in 6-7 days. Neither .happens with FHR
- If severe deformities have occurred, orthopedic correction may be required after healing. Most of .the deformities correct with growth

Secondary Vitamin D Deficiency

Inadequate absorption

Cystic fibrosis and other causes of pancreatic dysfunction, celiac disease, and Crohn disease.

Malabsorption of vitamin D can also occur with intestinal lymphangiectasia and after intestinal resection.

Severe liver disease: Because of the large reserve of 25-hydroxlase activity in the liver, vitamin D deficiency due to liver disease usually requires a loss of >90% of liver function.

anticonvulsants such as phenobarbital or phenytoin or antituberculosis medications such as isoniazid or rifampin.

Treatment

Treatment of vitamin D deficiency due to malabsorption requires high doses of vitamin D.

The dose is adjusted based on monitoring of serum levels of 25-D. Alternatively, patients may be treated with 1,25-D, which also is better absorbed in the presence of fat malabsorption.

chloride or 100 mg/kg of calcium gluconate). Some patients require a continuous intravenous calcium drip, titrated to maintain the desired serum calcium level. These patients should transition to enteral calcium, and most infants require approximately .1,000 mg of elemental calcium

Chronic Renal Failure

With chronic renal failure, there is decreased activity of 1α-hydroxylase in the kidney, leading to .diminished production of 1,25-D

unlike the other causes of vitamin D deficiency, patients have hyperphosphatemia as a result of . decreased renal excretion

Treatment

which both permits adequate ,(calcitriol) absorption of calcium and directly suppresses the .parathyroid gland

Thank You