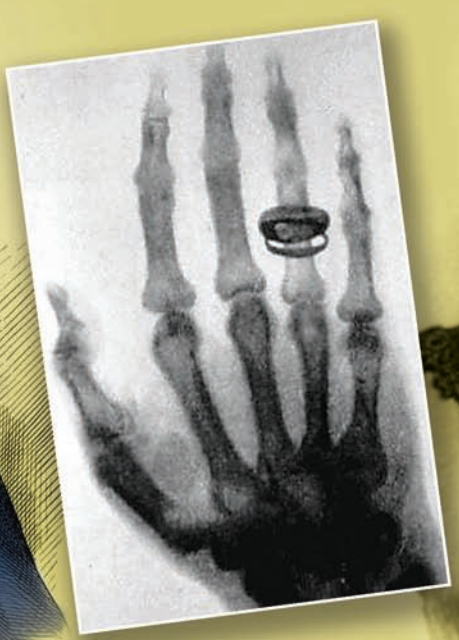
An Atlas of Hand Radiographs in Pediatrics

Prof. Kakarla Subbarao

KREST

Wilhelm Conrad Roentgen
(1845 - 1923)



Reproduction of original radiograph of the hand of **ANNA BERTHA LUDWIG**
"His wife" (Dec. 1895)

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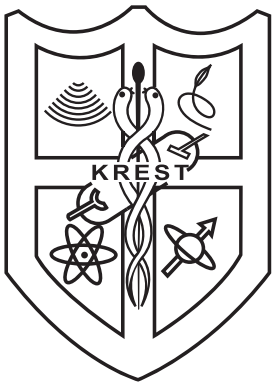


KREST

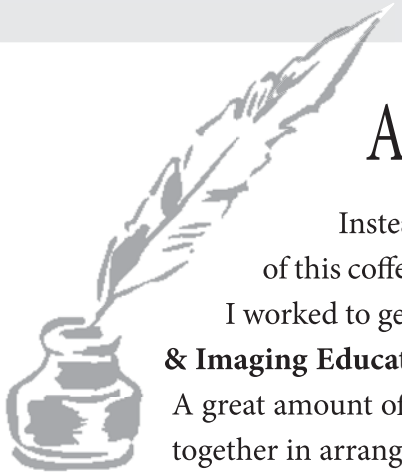
An Atlas of Hand Radiographs in Pediatrics

Prof. Kakarla Subbarao

Kakarla Subbarao Radiological & Imaging Educational Sciences Trust (KREST)

OBJECTIVES:

- To promote the practice of radiological and imaging sciences education, training and research
- To build institutions for training in radiology and sonography
- To network Indian and International radiologists
- To extend cost effective radiological services to the poor
- To initiate distance education through teleradiology services
- To create information and documentation services for exchange of data and expertise
- To Update professional skills through contact programes.



AUTHOR'S FOREWORD

Instead of calling myself an author, the better term may be 'compiler' of this coffee-table book. I owe it to many radiologists and institutions where I worked to get the material. Establishment of **Kakarla Subbarao Radiological & Imaging Educational Sciences Trust (KREST)** enabled me to have a museum. A great amount of gratitude is due to **Dr B Rama Subba Raidu** for working hours together in arranging the films in a particular order for the benefit of the residents. This helped the examine going residents a great deal. Most of this material is from **KREST** museum. I acknowledge the help of **Prof. S Rammurti** and **Prof. Sujatha Patnaik** for providing me with all the interesting cases from NIMS. I also thank the residents at KIMS and **Dr Joe Th omas**a rheumatologist from Kochi for sending all the challenging cases. Finally, I thank **Mr G Bharath Kumar** for preparing the manuscript. I also thank **Mr D Venkatesh** & his team of **Kalajyothi** for designing this booklet.

It is well nigh impossible to include every entity regarding pediatric hands. Children have their own congenital anomalies, dysplasias and syndromes. This atlas will certainly enhance the knowledge of radiologists and pediatricians, present and future. It is said "a picture speaks thousand words". This atlas provides maximum number of illustrations and minimum number of words to explain. Hand radiograph is only an initial study pointing out to other investigations to be followed. Plain radiography is still the foundation upon which all the other sophisticated imaging is built.

"I would give great praise to the physician whose mistakes are small, for perfect accuracy is seldom to be seen"

- Hippocrates

Introduction

Each hand consists of 27 bones. These bones, reflect fairly and accurately, normal skeletal development, congenital and acquired systemic disorders of the peripheral skeleton. Conventional radiographs are adequate most of the time for initial diagnosis. At times, it may be necessary to perform advanced imaging specially for identification of early calcifications and soft tissue structures. Clinical history, laboratory data and skeletal survey whenever necessary are taken into consideration to confirm the diagnosis. In skeletal dysplasias and other lesions chromosome and genetic analysis are essential for diagnosis and counselling.

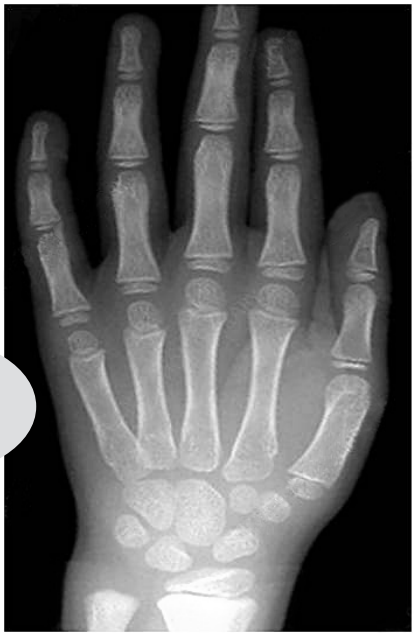
Anatomy

Hand anatomy is complex and intricate. This enables hands to do gross as well as precise functions. A total of 27 bones constitute the basic skeleton of the wrist and hand [8 carpals, 5 metacarpals, 14 phalanges (3 for each digit except thumb which has 2)]. The hand is innervated by the median, ulnar, and radial nerves — each of which has sensory and motor components. The blood supply is from radial and ulnar arteries. The muscles of the hand are divided into intrinsic and extrinsic groups. The sessamoids vary with age and develop full potential after maturation

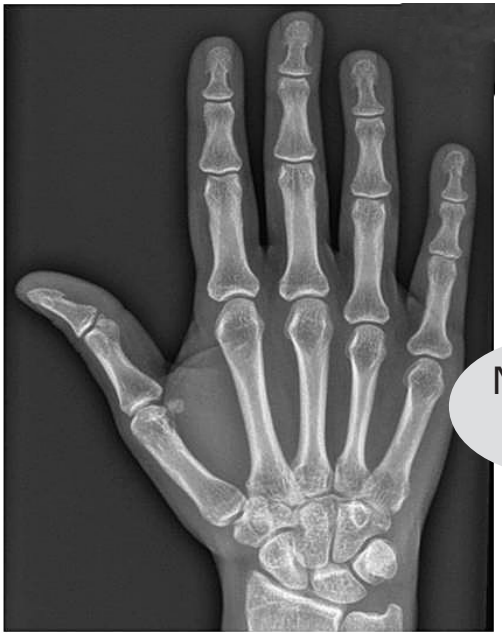
Sections - Pediatric hand radiographs

Section-1

Bone age



Normal
10 yrs



Normal
30 yrs

Many congenital, developmental and systemic disorders affect the bones of the hand. Interpreting a hand radiograph includes not only the bones but the joints and soft tissues surrounding them. Although, ultrasonography and magnetic resonance imaging are the best modes of imaging of soft tissues, this Atlas deals with conventional radiographs. The posterior anterior views of the hand are adequate. Occasionally oblique and lateral views are added. Radiographs of both hands and wrists are included only, where ever necessary to make a definitive diagnosis. Occasionally advanced cross sectional images are included for better learning

Bone age assessment from radiographs of the hands

Bone age determination is made from radiograph of right hand in right handed people and of left hand in left handed people.

It is not wise to rely on any single area of the skeleton to assess bone age. Several areas must be assessed and the bone age is interpreted as a whole.

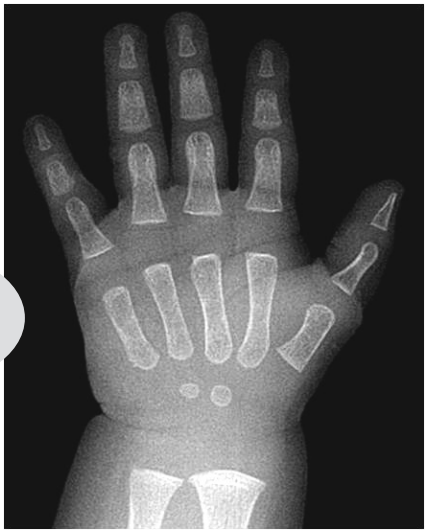
Bone age is an important parameter when children with growth disorders are investigated, and it is the basis for calculation of height prediction. Hand-wrist radiographs have been used for determination of maturation and subsequent evaluation of growth potential during preadolescence and adolescence.

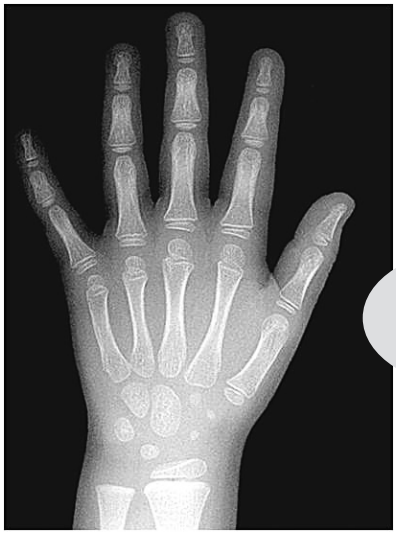
Several methods have been developed for assessment of skeletal age on hand-wrist films. For evaluation of skeletal age, the Greulich-Pyle and Tanner-Whitehouse methods are generally used in clinical practice. The Greulich-Pyle atlas focuses on a number of maturational indicators, which represent stages of bone development or ossification events specific for each age, whereas Tanner-Whitehouse composite scores are based on osseous stages and events at each level.

Hand and Wrist

Carpal bones are much more erratic in development than tubular bones

2 yrs





8 yrs

Carpal Centres

Age in years - centres

1	-	2
2	-	3
3	-	4
4	-	5
5	-	6
10 - 11		7

+ /- few months

Skeletal Maturation

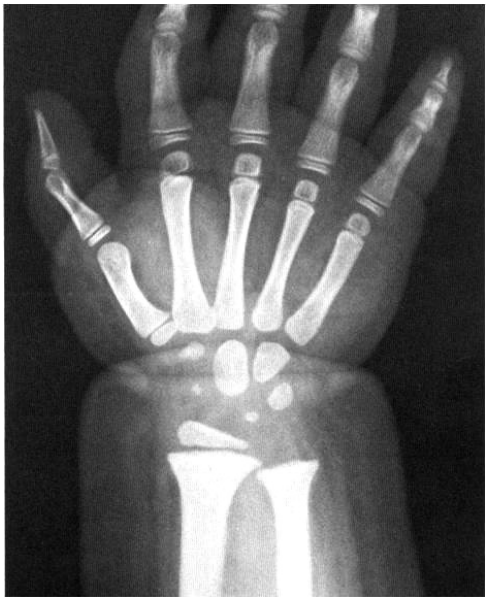
Advanced

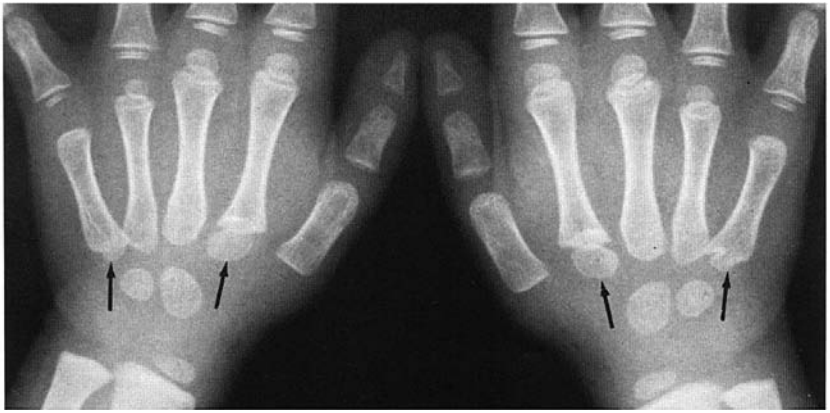
- Adrenogenital Syndrome
- Adrenal hyperplasia
- Albright Syndrome
- Cerebral gigantism
- Hypergonadism
- Hyperthyroidism
- Low flow AVM
- Neurofibromatosis
- Pinealoma
- Tuberous sclerosis
- Miscellaneous

Retarded

- Celiac disease
- Congenital heart disease
- Cushing – steroid therapy
- Dwarfism syndromes
- Hypogonadism
- Hypopituitarism
- Hypothyroidism
- Juvenile diabetes
- Malnutrition – rickets Etc.,
- Renal, Hepatic Disorders
- Miscellaneous

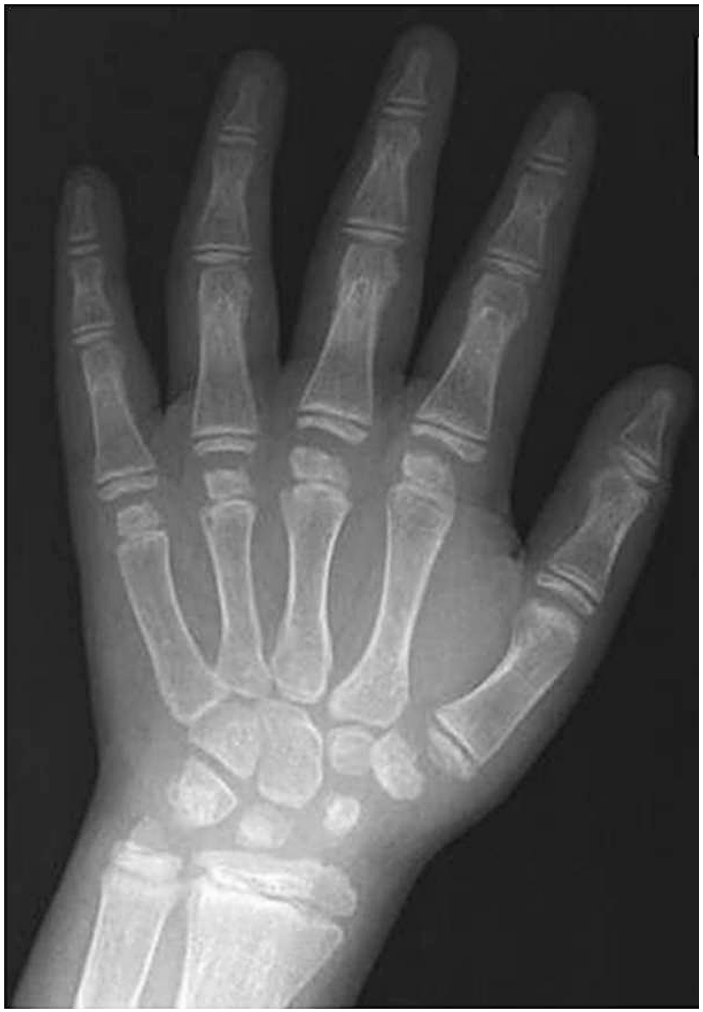
Accelerated bone age with obesity. The bone age is six years, while the chronologic age is two years. Eg. adrenal hyperplasia, cushing syndrome, hypothalamic hamartoma etc.,





3 year old child with accessory ossification Centers which generally signify skeletal age lag.

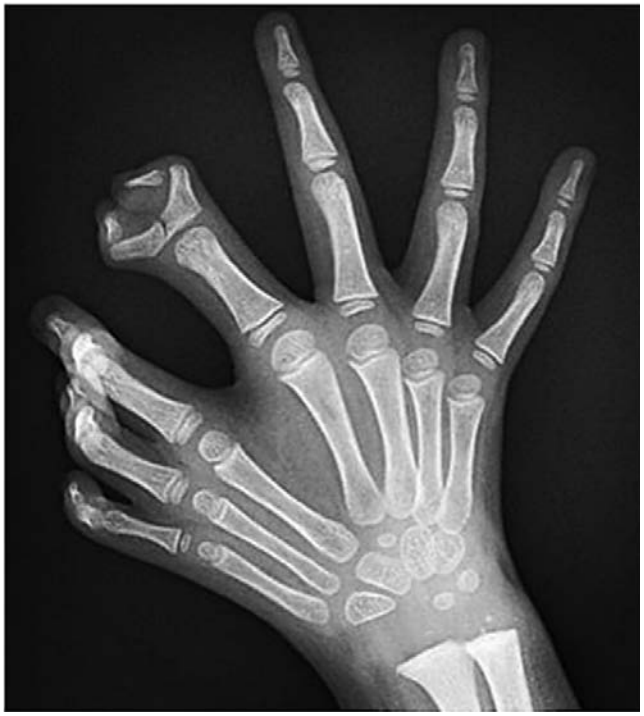
Delayed bone age is due to several systemic and endocrinal causes.



Congenital hypothyroidism (Cretin) Delayed ossification centres in a fifteen yr old. Bone age is 10 yrs.

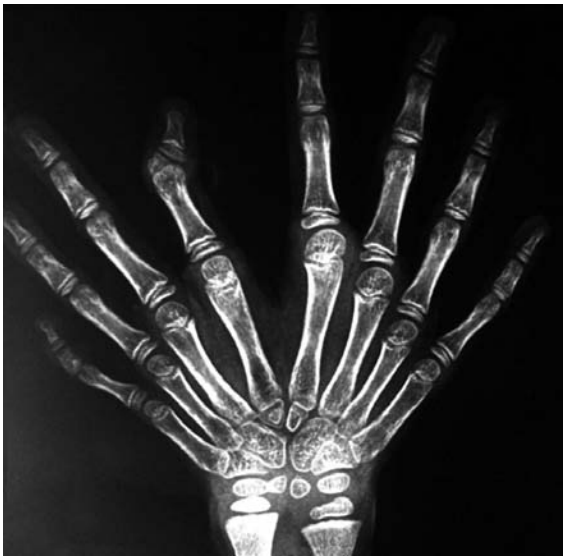
Congenital - anomalies may be isolated or may be part of systemic disease.

Ulnar dimelia – Mirror hand

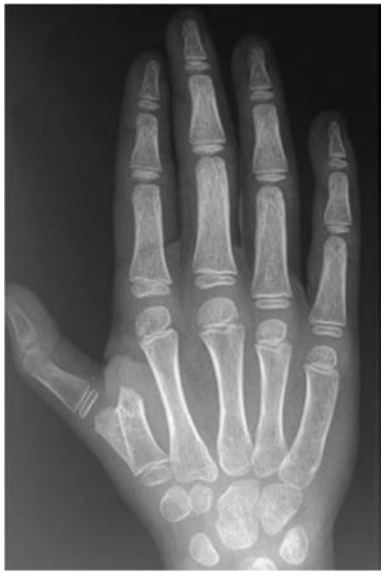


Ulnar dimelia

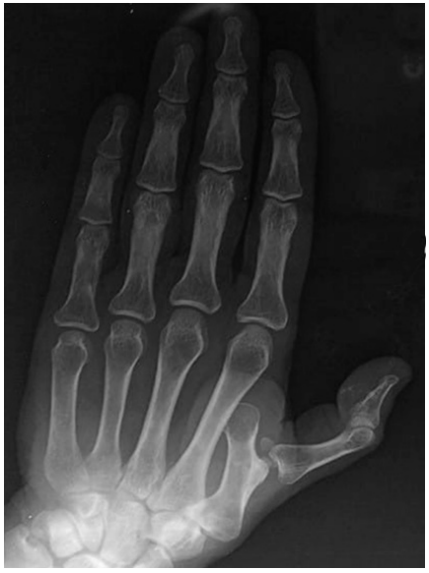
- **Rare**
- **Symmetric duplication of the limb in midline**
- **A central digit with 3 digits (long, ring, little) on either side**
- **Total 7 digits, but thumb is absent**
- **Two ulnae, no radius (Ulnar dimelia)**
- **Due to transplantation/ replication of ZPA**



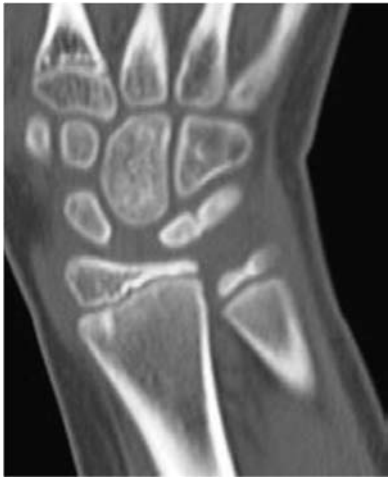
Dimyelia



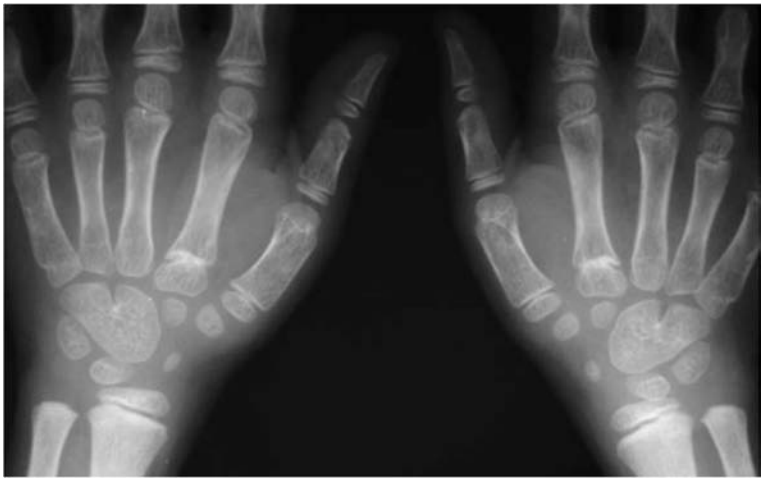
Bifid first metacarpal



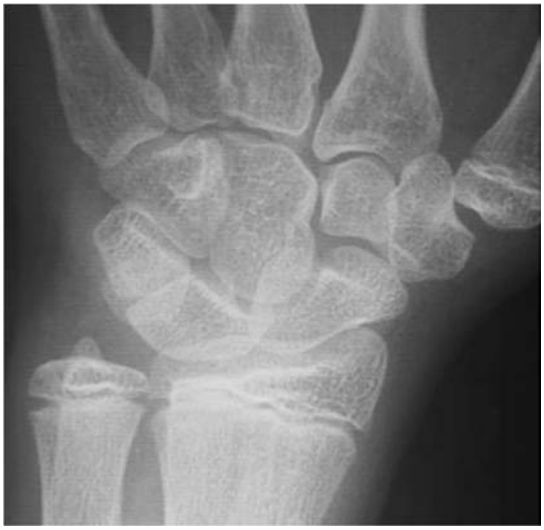
Partial duplication of thumb (? Wassel type V)



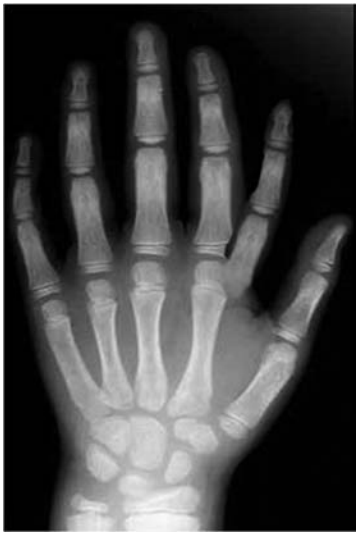
12 M, Lunate triquetrum coalition



Hamate capitate coalition

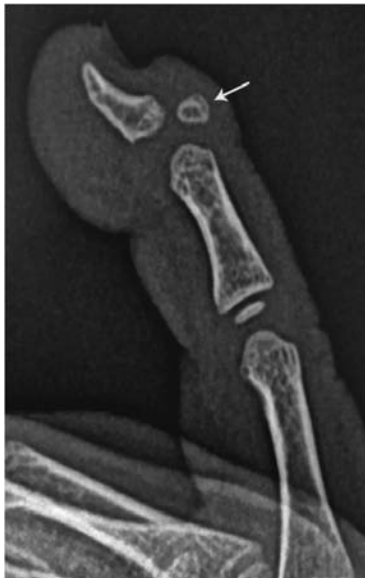


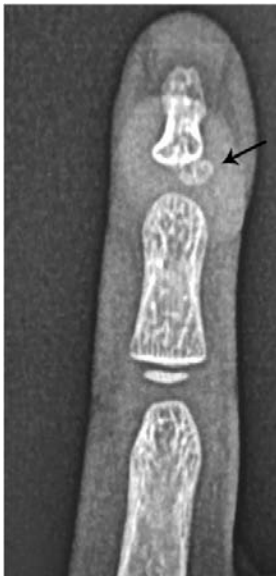
Coalition of triquetrum and lunate



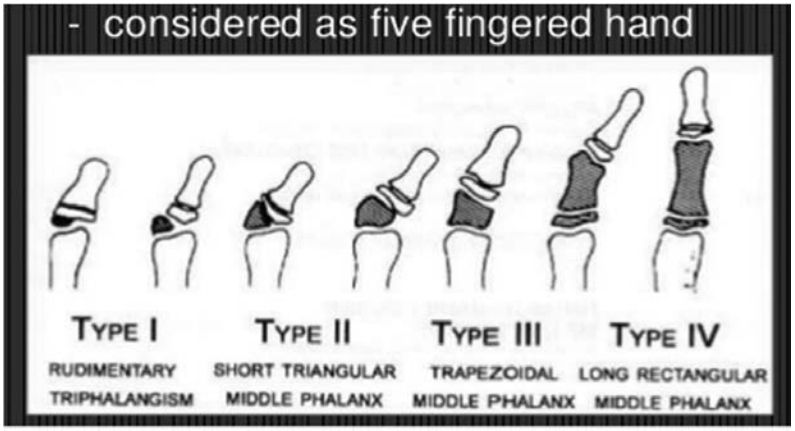
Duplication of index finger

Triphalangeal Thumb

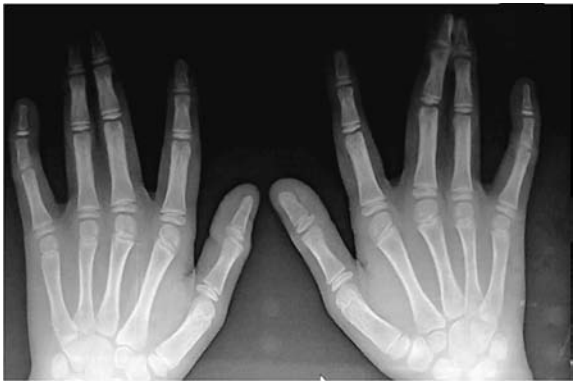




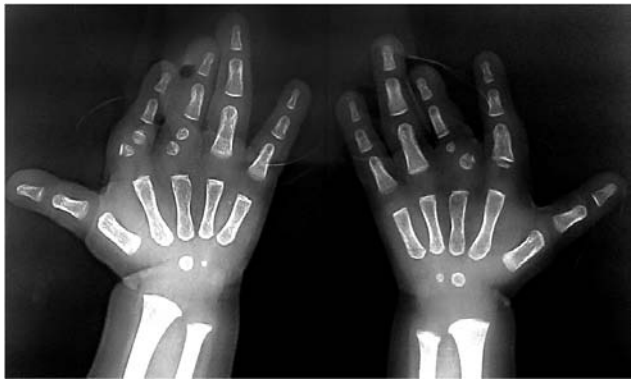
- **AD**
- **Extra phalanx of variable size, variable shape (triangular/trape zoid/ rectangular) normal appearing thumb**
- **Fully developed extra phalanx lying in the finger plane**



From internet

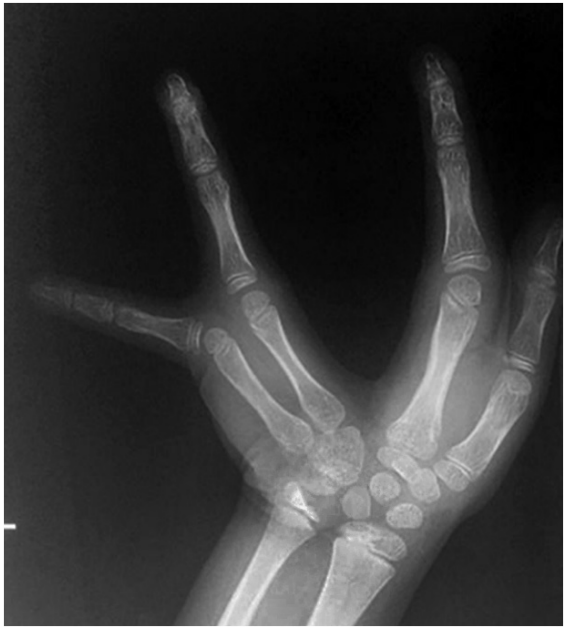


Syndactyly bilateral –
no known etiology

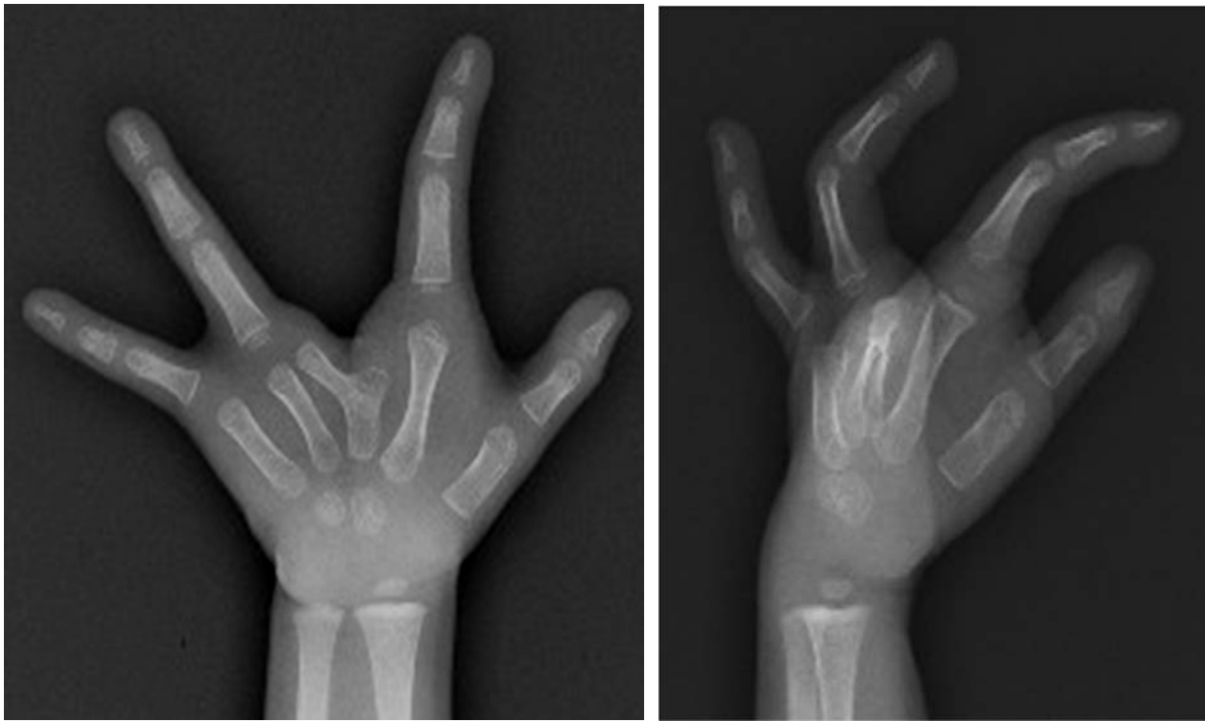


Ectrodactyly

Ectrodactyly represents a split hand, cleft hand, derived from the Greek ektroma (abortion) and daktylos (finger) involves the deficiency or absence of one or more central digits of the hand or foot and is also known as split hand/split foot malformation (SHFM).

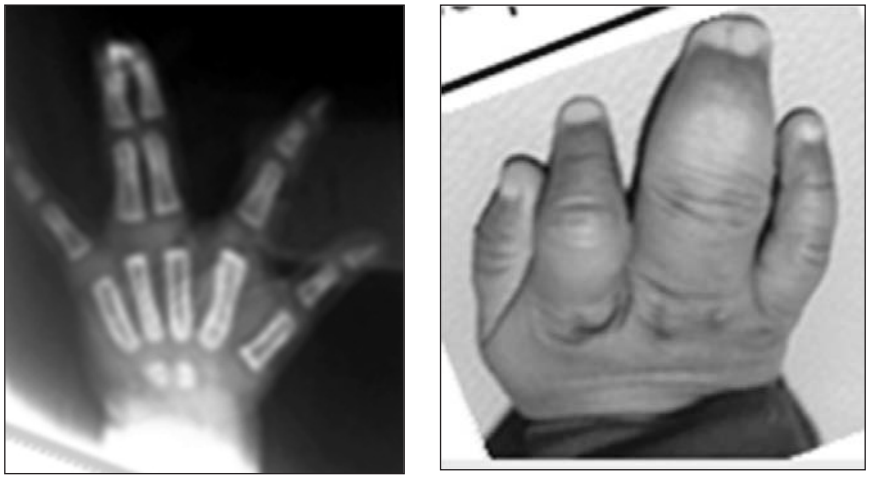


2M – Ectrodactyly



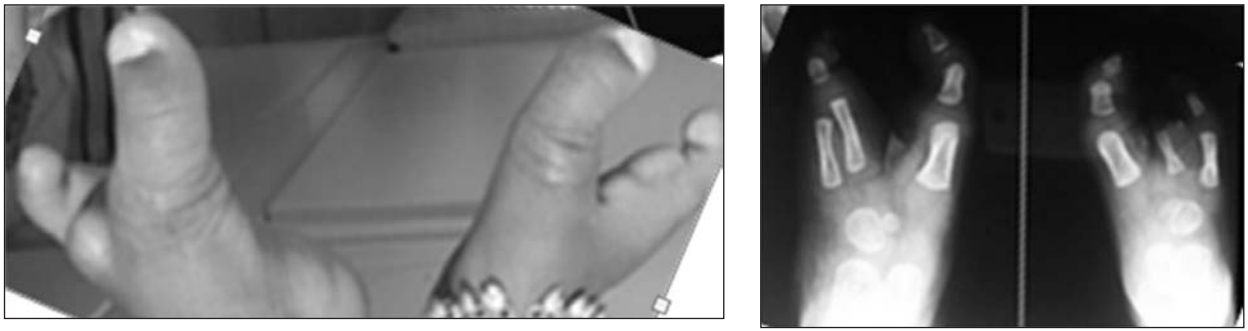
Split hand

Congenital split hand & foot



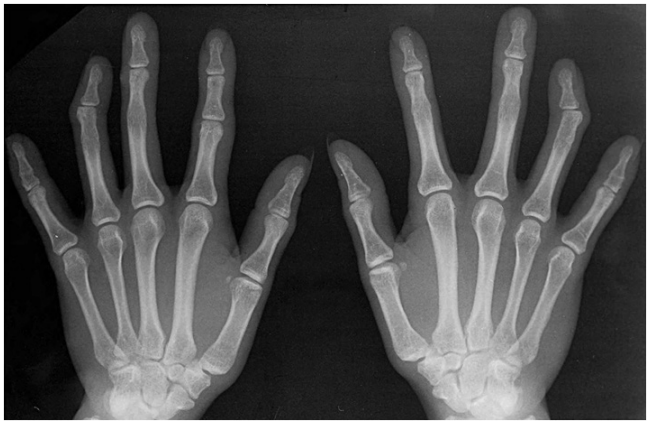
split hand

A rare form of a congenital disorder in which the development of the hand is disturbed. ... Split hand/foot malformation (SHFM) is characterized by underdeveloped or absent central digital rays, clefts of hands and feet, and variable syndactyly of the remaining digits.

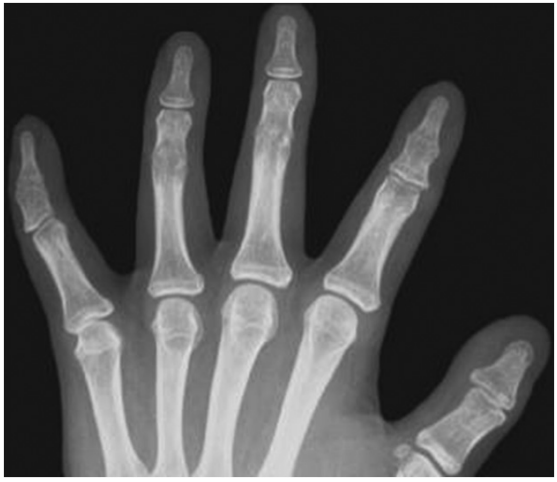


split hands & feet

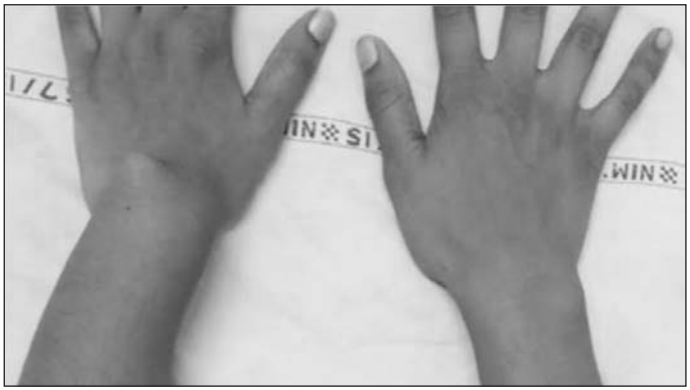
Phalangeal synostosis (symphalangism)



Symphalangism refers to ankylosis of the interphalangeal joints (i.e. fusion of the phalanges) in either the toes or the fingers. Less commonly, the metacarpophalangeal joints may be affected.

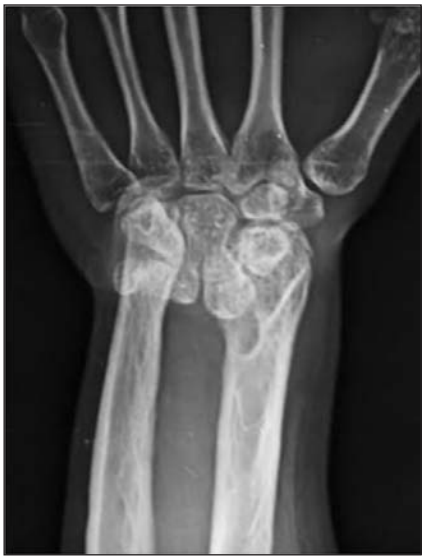


Madelung deformity



Madelung Normal

Radial & palmar angulation of distal radius due to growth disturbance of Ulnar & palmar part of distal radial physis.

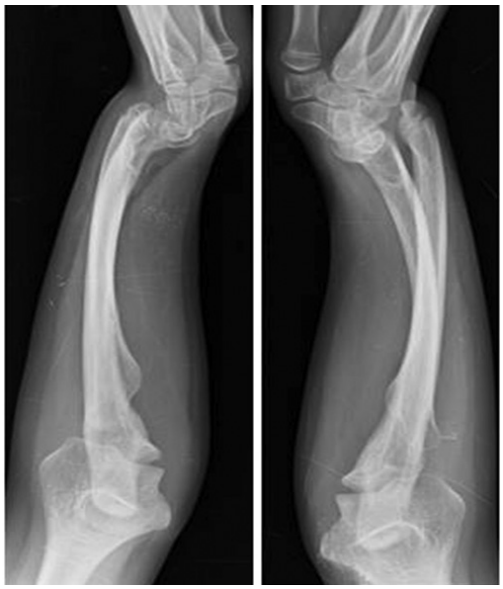


It is due to premature closure or defective development of the ulnar third of the distal epiphysis of the radius. This deformity results in a radial shaft that is bowed with increased interosseous space and dorsal subluxation of the distal radioulnar joint. It can be bilateral in 50-66% of patients.

Associated disorders – Madelung and pseudo Madelung

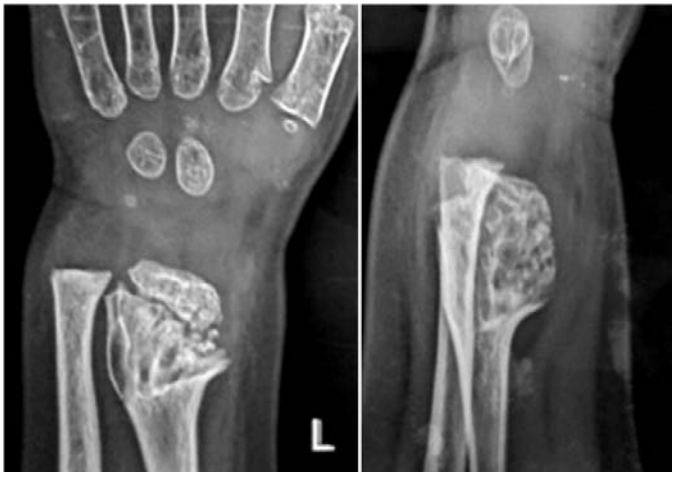
- Leri-Weill syndrome
- Turner syndrome
- Nail-patella syndrome
- Hereditary, multiple exostosis
- Ollier's disease
- Achondroplasia
- Multiple epiphyseal dysplasias
- Mucopolysaccharidoses (Hurler and Morquio syndromes)
- Neurofibromatosis 1

Madelung deformity



Lateral views of both forearms

Leri weill dyschondrosteosis is a skeletal dysplasia characterized by short stature and an abnormality of the wrist bones called Madelung deformity.

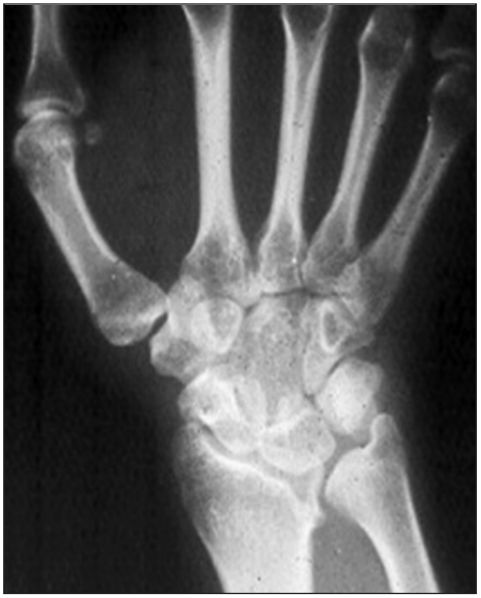


Ollier's dyschondroplasia involving the distal radius

In Leri Weill syndrome, Madelung deformity presents as a spectrum of findings. It may affect the entire radius or it may affect only the distal radius. Extremities with involvement of the entire radius have a shorter radius and ulna, decreased height, and a more severe deformity of the extremities than with involvement of only the distal radius.

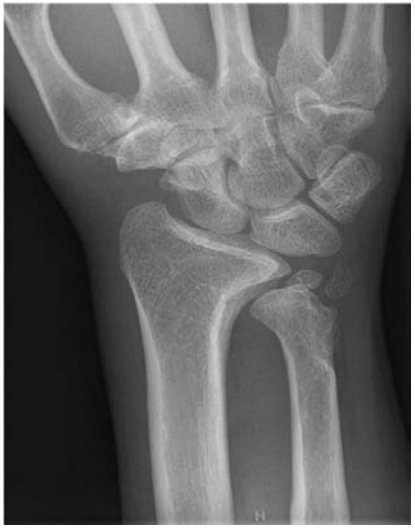
Radiological findings of Madelung deformity

- **Dorsal and radial bowing of the radius**
- **Exaggerated palmar (up to 35°) and ulnar tilt (up to 60°) of the radiocarpal articulation**
- **Failure of ossification of the ulnar side of the distal radial epiphysis**
- **Exaggerated radial inclination**
- **Decreased carpal angle below 118°; normal from 118° to 139°.**
- **Carpal subluxation in a palmar and ulnar direction**
- **Lunate is gradually forced to the apex of the V-shaped radioulnar carpal joint**
- **"V-shaped" proximal carpal row = herniated proximal carpal row.**
- **Dorsal subluxation of the distal ulna**
- **Elongation of the ulna with positive ulnar variance**
- **Wedging of the carpus between the radius and ulna**

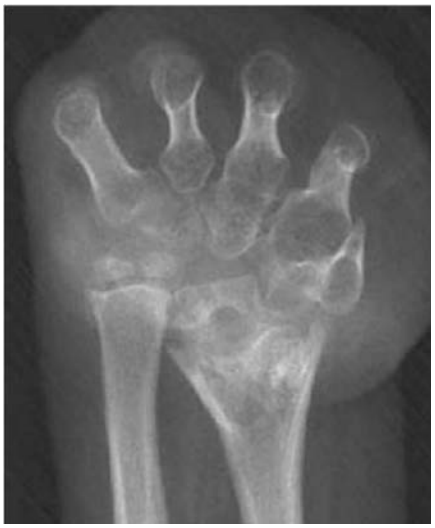


Turner syndrome
(Monosomy X)
V shaped proximal carpal row
Carpal angle 130 degrees
Associated with coarctation of aorta

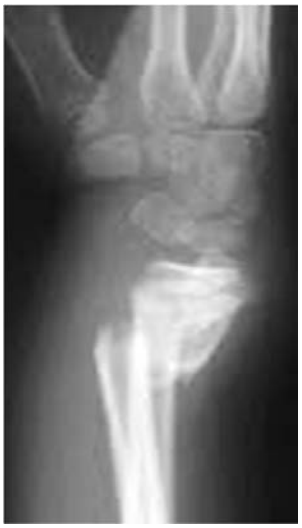
Pseudo madelung



Congenital



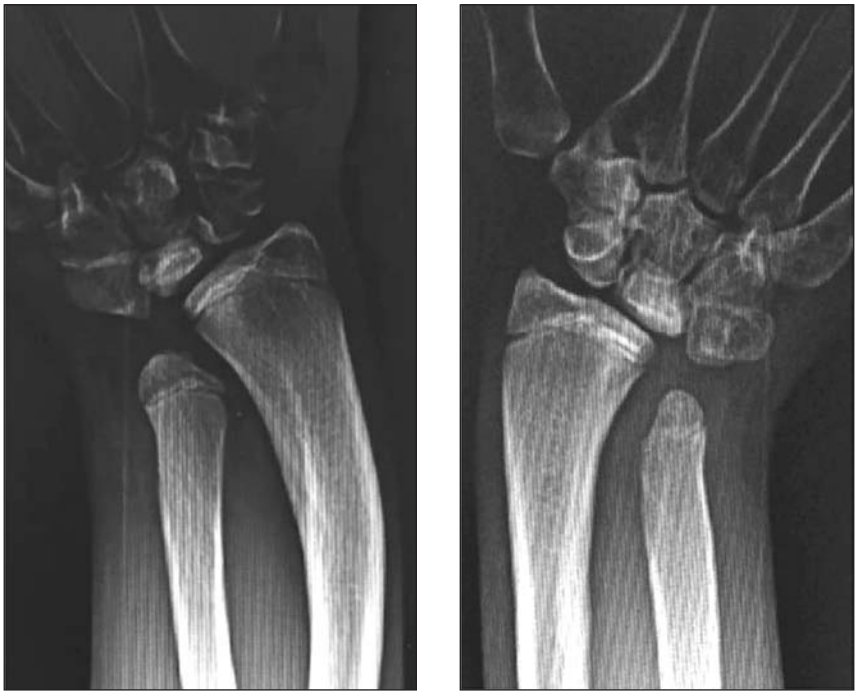
Congenital



Congenital

- **No dorsal subluxation of the distal ulna and positive ulnar variance**
- **No wedging of the carpus between the radius and ulna**
- **No dorsal and radial bowing of the radius**
- **No failure of ossification of the ulnar side of the distal radial epiphysis**
- **No "V-shaped" proximal carpal row (herniated proximal carpal row)**

Idiopathic - Congenital



REVERSE MADELUNG DEFORMITY

Note the negative ulnar variance associated with Kienbock disease and ulnar impingement syndrome. However, in young children there may not be any change in the lunate.

Ulnar variance

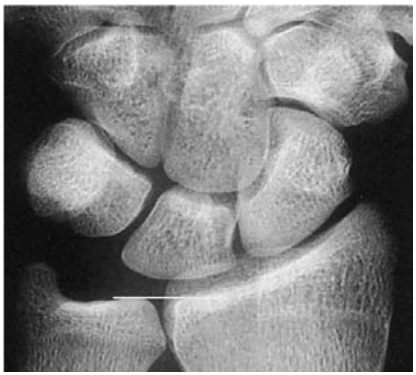
Also known as Hulten variance refers to the relative lengths of the distal articular surfaces of the radius and ulna.

Neutral - both the ulnar and radial articular surfaces at the same level.

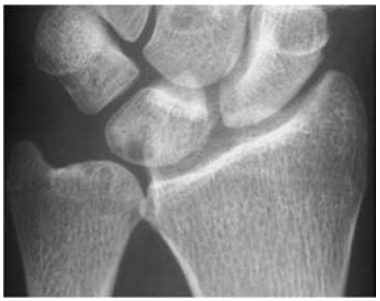
Positive - Ulna projects more distally. The level of the ulna is > 2.5mm beyond the radial articular surface.

Negative - Ulna projects more proximally. The level of the ulna is ≤ 2.5mm below the radial articular surface.

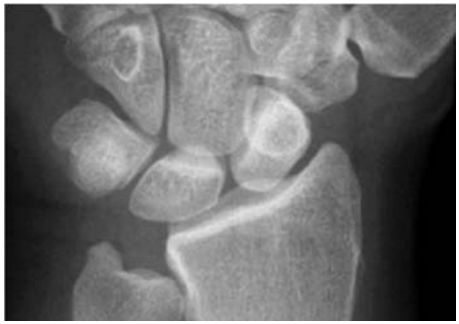
This variance is independent of the length of the ulnar styloid process.



Neutral

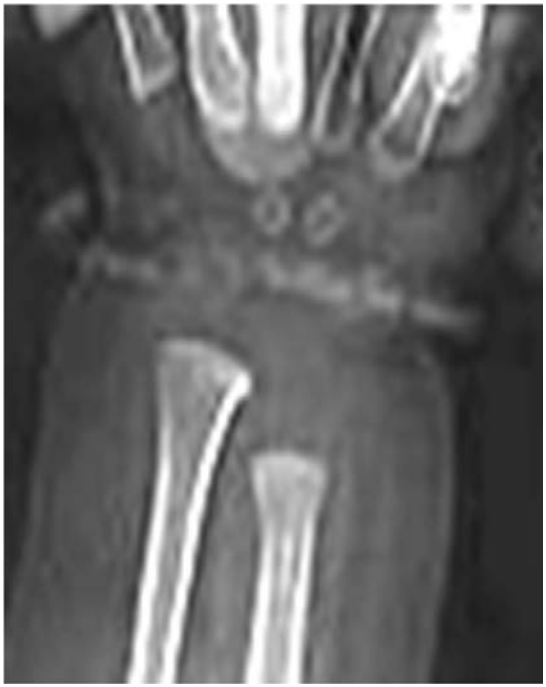


+ve ulnar variance

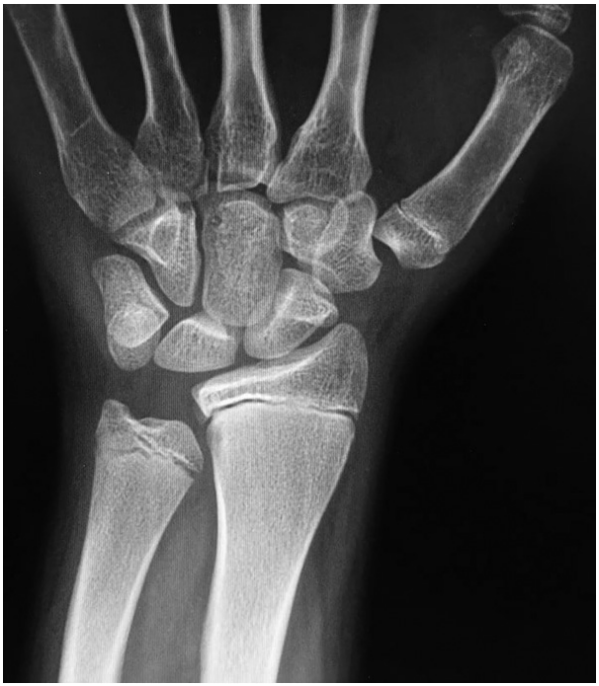


-ve ulnar variance

No changes of the lunate at this stage



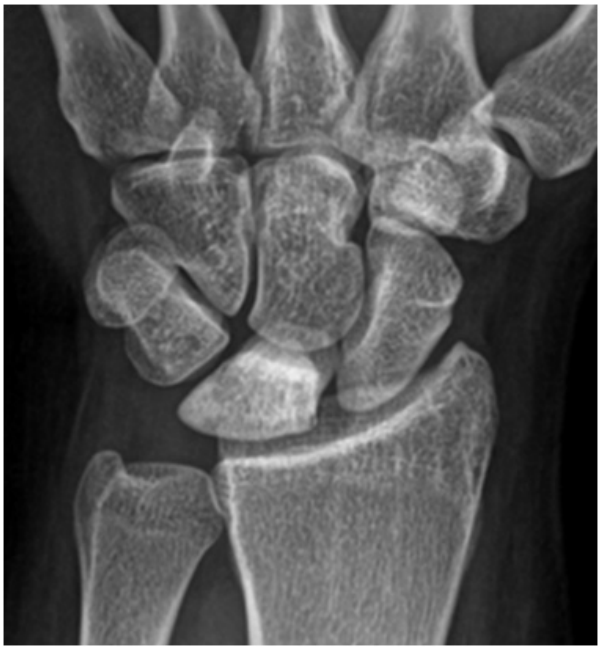
Negative ulnar variance



Negative ulnar variance

In general, ulnar variance particularly negative ulnar variance is frequently observed without any symptoms. Although it is incidental, follow-up studies were not conducted.

- **Negative Ulnar variance is associated with lunate malacia (Kienbock disease). Severe ulnar negative variance may result in ulnar impingement on the distal radius !**

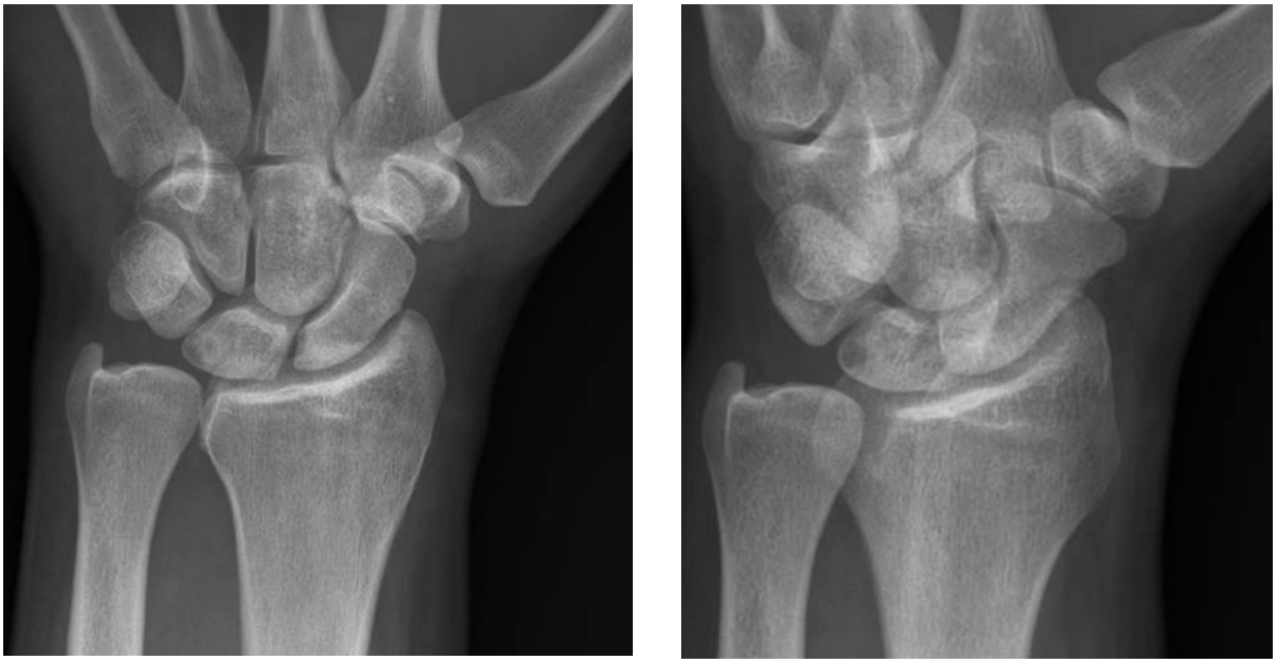


Kienbock disease:
Only occurs after the fusion of the epiphyses. There are other causes of Kienbock apart from negative ulnar variance.

Eponyms such as this indicate the individual who made the original observations and were not recognized earlier.

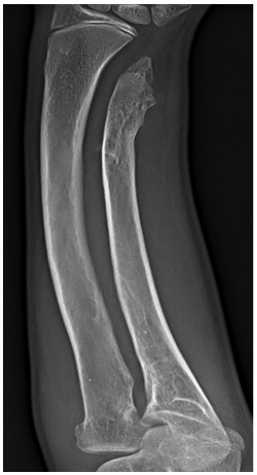
Positive ulnar variance is associated with proximal lunate degenerative changes as indicated by the cyst formation. Also called ulnar impaction syndrome. It is associated with ulnar abutment.

Only occurs after the fusion of the epiphyses

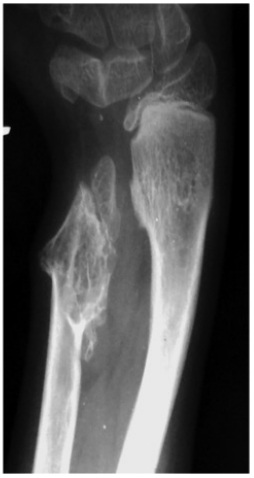


Positive Ulnar Variance with cyst formation of lunate

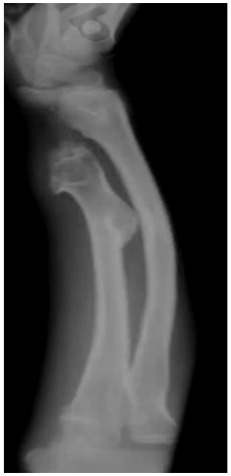
Bayonet Hand Deformity



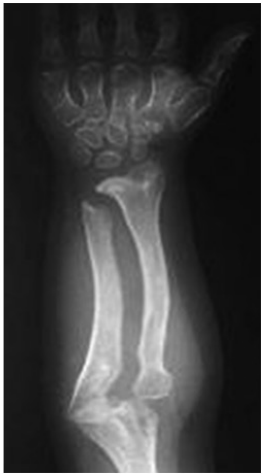
Congenital



Multiple exostoses



Osteochondroma

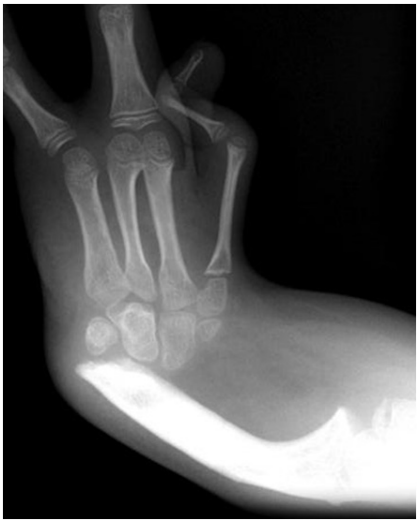


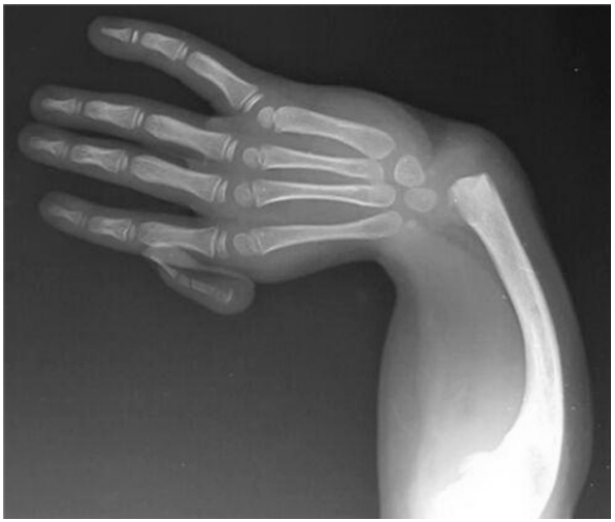
Achondroplasia

Comprises of –

- **Shortening of ulna**
- **Outward bowing of radius**
- **Subluxation of the inferior radioulnar joint**

VACTERL - nemonic





Absent radius

V – **Vertebral & vaginal defects**

A – **Anal atresia**

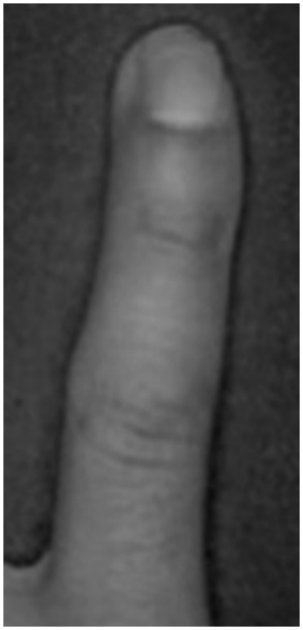
C – **Cardiac defects**

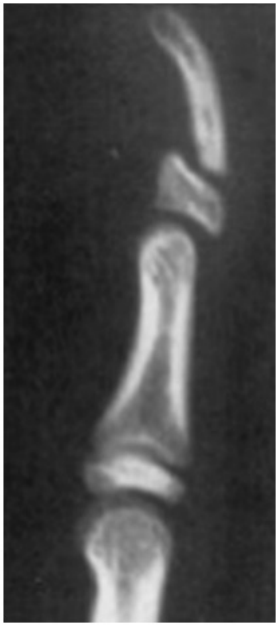
TE – **Tracheoesophageal**

R – **Renal, radial anomalies**

L – **Limb abnormalities**

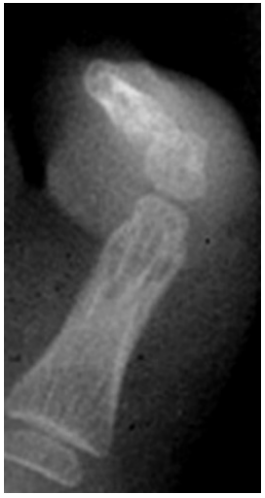
Patients diagnosed with VACTERL association typically have at least three of the above characteristic features.





Kirner syndrome

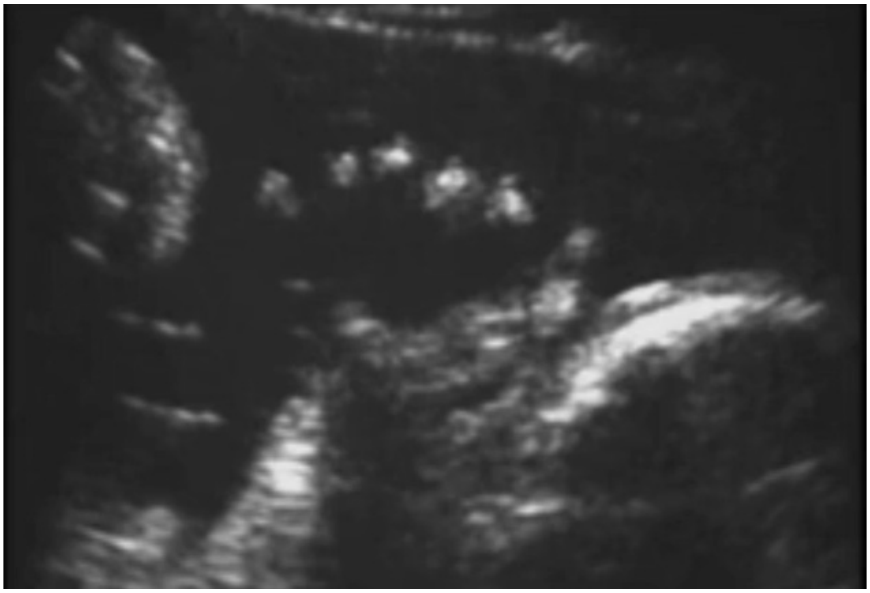
Progressive palmar radial curvature of the distal phalanx of little fingers bilaterally (deviation in 2 planes). Distortion & Widening of physeal plate along with curvature of the diaphysis of the distal phalanx.



Clinodactyly

Clinodactyly is a minor congenital malformation (birth defect). The basis for the clinodactyly is that the middle bone in the fifth finger is underdeveloped and instead of being rectangular, is wedge- shaped in a medio lateral plane. May be associated with many syndromes including Down syndrome, Klinefelter syndrome, Turner syndrome, Fanconi anemia and others.

Polydactyly



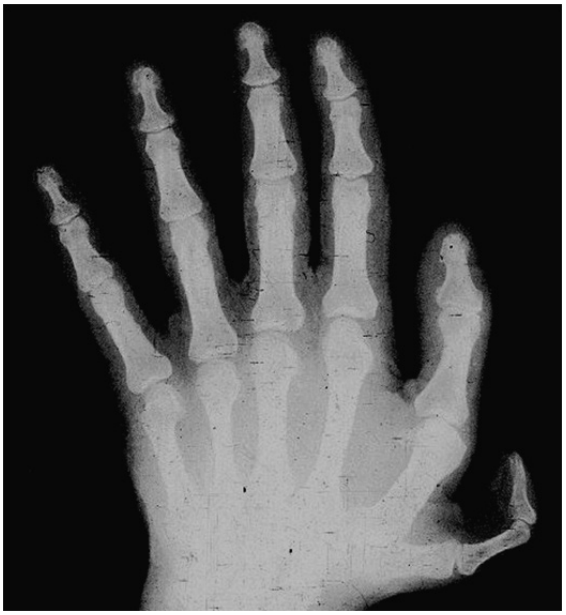
Polydactyly in utero - Ultrasonography

Central polydactyly – Three types: Type I is a central duplication, not attached to the adjacent finger by osseous or ligamentous attachments; it frequently does not include bones, joints, cartilage, or tendons. Type IIA is a nonsyndactylous duplication of a digit or part of a digit with normal components, and articulates with a broad or bifid metacarpal or phalanx. Type IIB is a syndactylous duplication of a digit or part of a digit with normal components and articulates with a broad or bifid metacarpal or phalanx. Type III is a complete digital duplication, which has a well-formed duplicated metacarpal.

Polydactyly – post axial and pre axial

- Over segmentation
- Jeune syndrome (ATD)
- Ellis Van Creveld (CED)
- Trisomy 13
- Carpenter
- Lawrence – Moon – Biedl
- Meckel – Gruber
- Polysyndactyly

More common



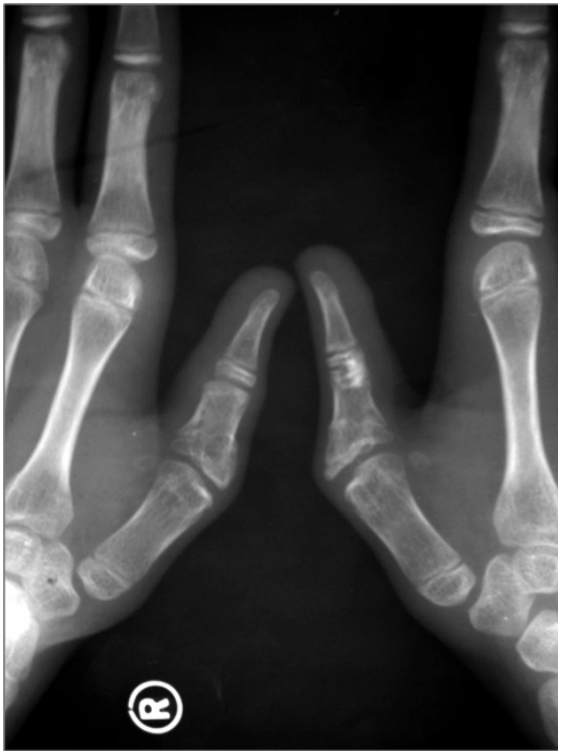
Super numerary and rudimentary thumb (Pre axial)

Ulnar polydactyly – **The two-stage classification, according to Temtamy and McKusick, involves type A and B. In type A there is an extra little finger at the metacarpophalangeal joint, or more proximal including the carpometacarpal joint. The little finger can be hypoplastic or fully developed. Type B varies from a nubbin to an extra, non-functional little finger part on a pedicle. According to the three-type classification, type I includes nubbins or floating little fingers, type II includes duplications at the MCPJ, and type III includes duplications of the entire ray.**

Radial polydactyly – **The Wassel classification is the most widely used classification of radial polydactyly, based upon the most proximal level of skeletal duplication. The most common type is Wassel 4 (about 50% of such duplications) followed by Wassel 2 (20%) and Wassel 6 (12%).**

Fibrodysplasia calcificans progressiva congenita

Formerly known as myositis ossificans progressiva



Note microdactyly of the thumbs due to fibrodysplasia. Similar changes are seen in the feet. Extensive calcification and ossification of muscles and soft tissue structures. A rare hereditary muscular problem.

Section-3

Skeletal dysplasias

Skeletal Dysplasias (SD) are clinically a heterogeneous group of genetic disorders characterized by the presence of generalized disorder of bone growth.

Sclerosing skeletal dysplasias

- Osteopetrosis (Albers – Schonberg disease)
- Pycnodysostosis (Maroteaux – Lamy disease)
- Osteopoikilosis (Spotted bone disease)
- Osteopathia striata (Voorhoeve disease)
- Progressive diaphyseal dysplasia (Camurati - Engelmann)
- Melorheostosis
- Fibrous dysplasia – sclerosing type
- Overlap syndromes

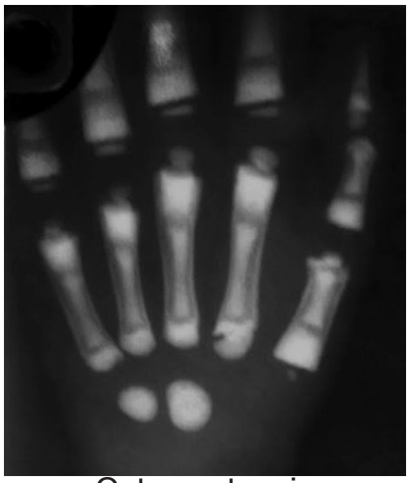
Osteopetrosis (Albers – Schonberg disease)

Four well established forms

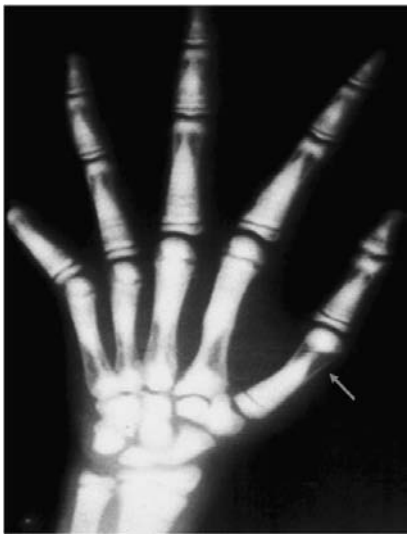
1. **Benign common form– autosomal dominant**
2. **Malignant form – autosomal recessive associated with death in childhood**
3. **Intermediate – Autosomal recessive**
4. **Osteopetrosis with renal tubular acidosis and cerebral calcifications**

   Well defined inborn error of metabolism namely deficiency of the carbonyl anhydrase 2 Isoenzyme - (Marble Brain disease)

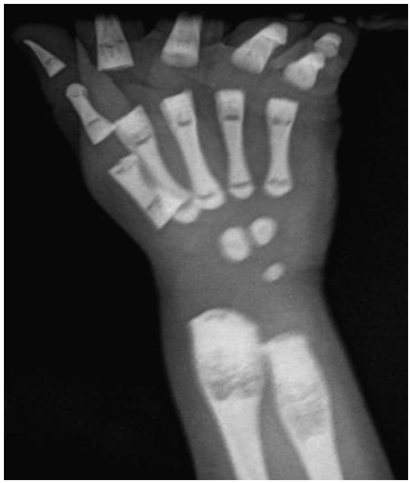
   A 5th variant with neuronal storage disease may also exist



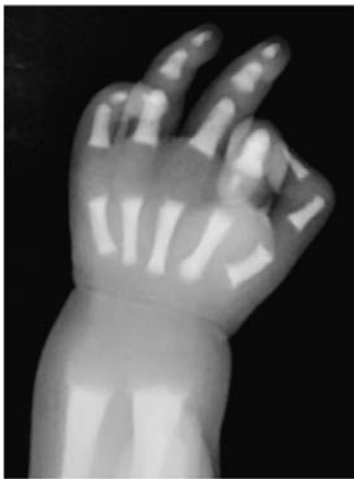
Osteopetrosis
Bone in a bone appearance

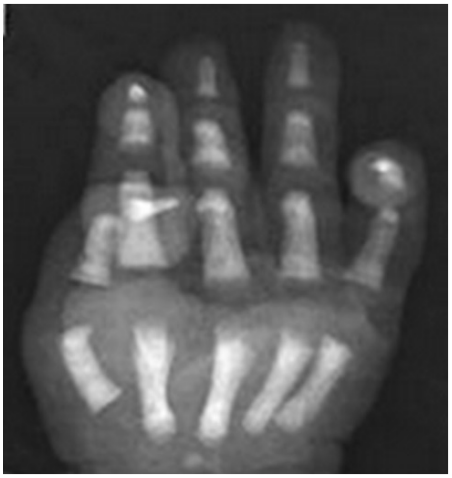


Intermediate form

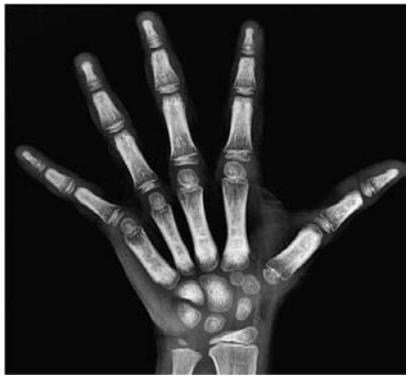


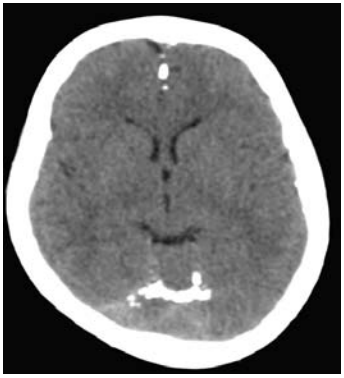
Osteopetrosis with tubular acidosis





New born hand with rachitic changes





Autosomal recessive Osteopetrosis

Carbonil anhydrase deficiency

1. **Osteopetrosis**
2. **Tubular deficiency**
3. **Cerebral calcifications**

Osteopetrosis and genes

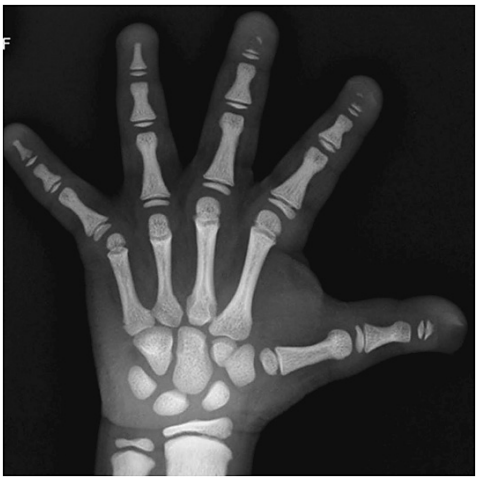
Name	OMIM	Gene
OPTA1	607634	*LRP5*
OPTA2	166600	*CLCN7*
OPTB1	259700	*TCIRG1*
OPTB2	259710	*TNFSF11*
OPTB3	259730	*CA2* (renal tubular acidosis)
OPTB4	611490	*CLCN7*
OPTB5	259720	*OSTM1*
OPTB6	611497	*PLEKHM1*
OPTB7	612301	*TNFRSF11A*

Pycnodysostosis (Maroteaux – Lamy disease)

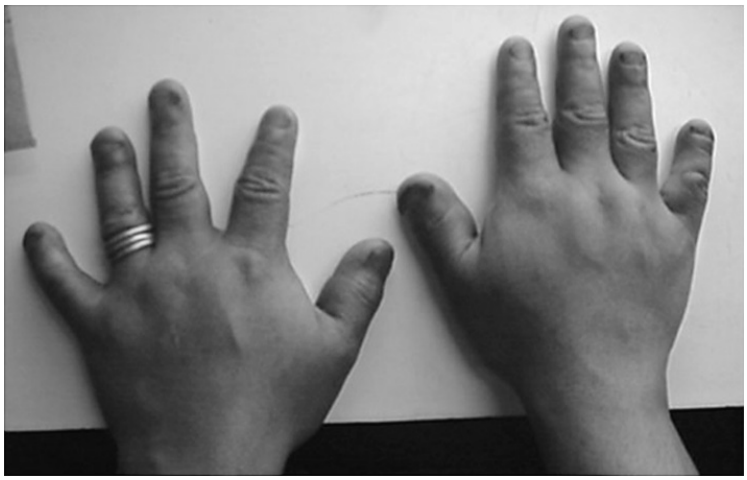
(Toulouse-Lautrec - French Artist had similar features)

A hybrid between osteopetrosis and Cleidocranial dysostosis. Major sites include skull, mandible, clavicles and spine. All the bones are uniformly sclerotic. However, skull findings include frontal bossing, persistent fontanels, wormian bones. An obtuse angle of mandible is noted. Clavicular hypoplasia and Acro osteolysis are present.

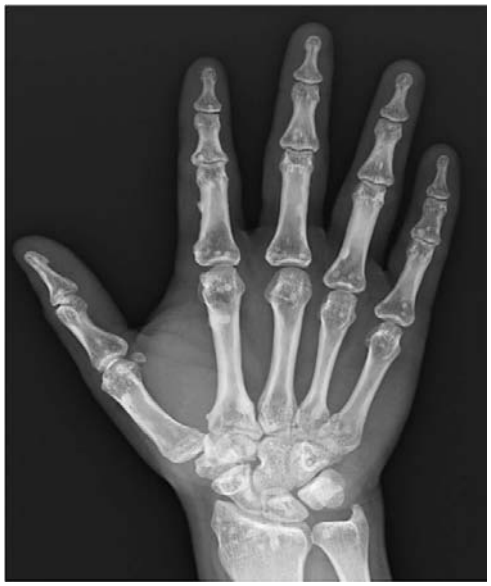
Gene location – CTSK[a]



Pyknodyostosis



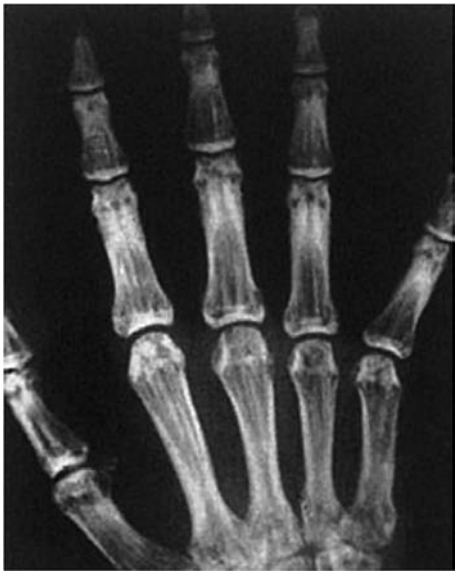
5 yr child with Pycnodysostosis



Osteopoikilosis

Osteopoikilosis is a benign, autosomal dominant sclerosing dysplasia of bone characterized by the presence of numerous bone islands in the skeleton. Often these are placed juxtaarticularly. They may assume the shape of round or oval.

Osteopathia striata is typically bilateral, although occasionally it can be unilateral, typically in tubular bones. Radiographically prominent vertical striations predominate in the metaphyses and epiphyses of the long bones (celery stalk metaphysis).



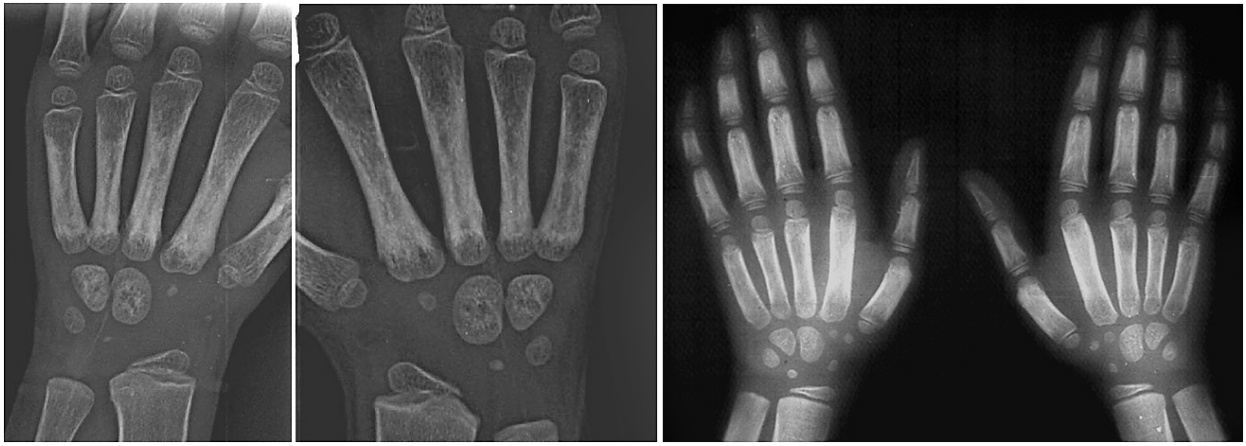
Osteopathia striata

DENSE VERTICAL METAPHYSEAL LINES

1. **Congenital transplacental infections ('celery stalk' metaphyses) (eg, STORCH).**
2. **Metaphyseal injury (localised).**
3. **Osteopathia striata (Voorhoeve disease).**
4. **Enchondromatosis (Ollier).**
5. **Goltz S (Focal dermal hypoplasia).**
6. **Hypophosphatasia.**
7. **Metaphyseal chondrodysplasia.**
8. **Mixed sclerosing bone dysplasia.**
9. **Osteopathia striata with cranial sclerosis.**
10. **Phenyl ketonuria**
11. **Sponastrime dysplasia (Spondyloepimetaphyseal dysplasia).**

Progressive diaphyseal dysplasia

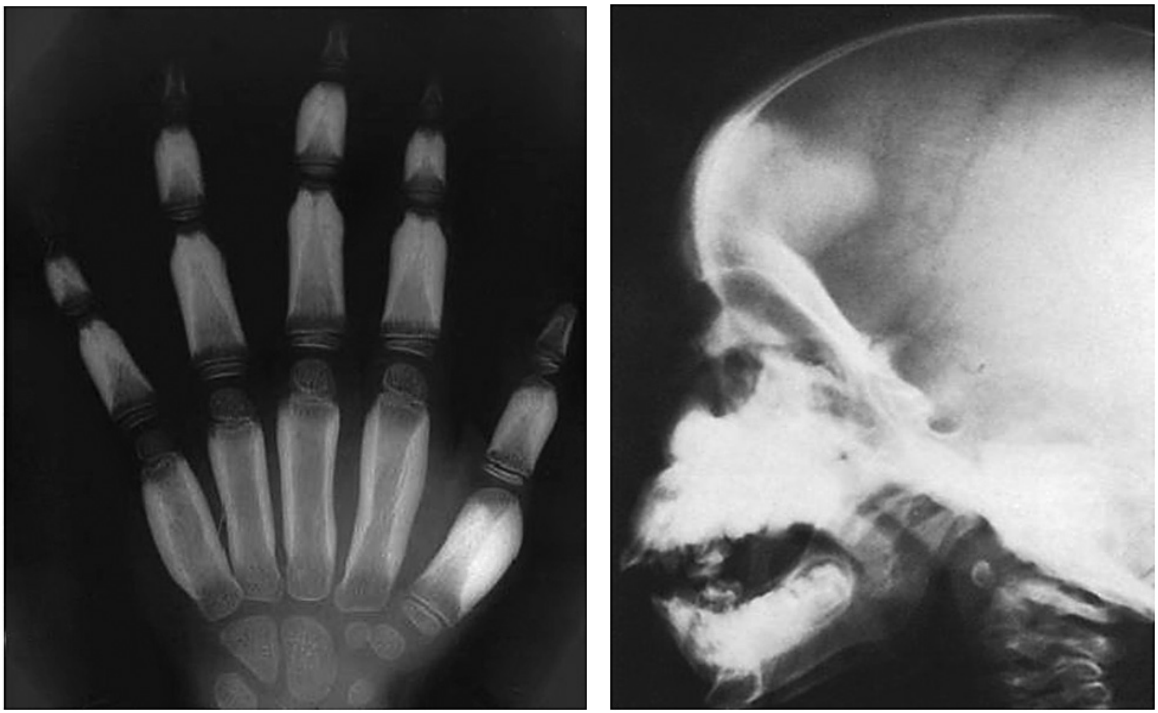
Camurati Engelmann disease presents during childhood with bilateral and symmetrical bone involvement, whereas ribbing disease may be unilateral and asymmetrical. In Engelmann's the skull is involved whereas in Ribbing's disease only long bones are involved. Engelmann is autosomal dominant while ribbing is autosomal recessive in fact both of them may represent phenotypic variation of the same disorder.



4 yrs 7 yrs

Note the dense, stubby metacarpals and phalanges

Craniodiaphyseal dysplasia (also known as CDD or lionitis) is an extremely rare autosomal recessive bone disorder that causes calcium to build up in the skull, disfiguring the facial features and reducing life expectancy.



Dense cortices with widening metacarpal phalanges.
Sclerosis of frontal and basicraneum.

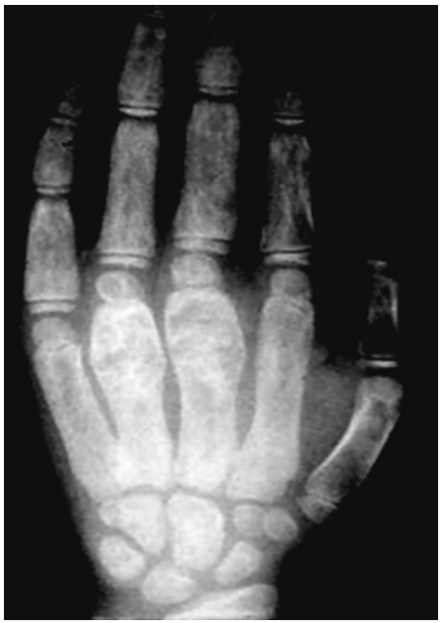
Fibrous dysplasia

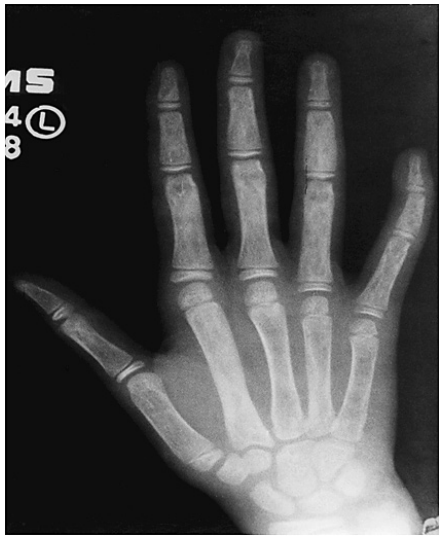
Fibro osseous aberration by replacement of medullary area by fibrous tissue and new bone

- **Monostotic**
- **Polyostotic**
- **Albright syndrome**
- **Mazabaud syndrome (FD + myxoma of soft tissues)**

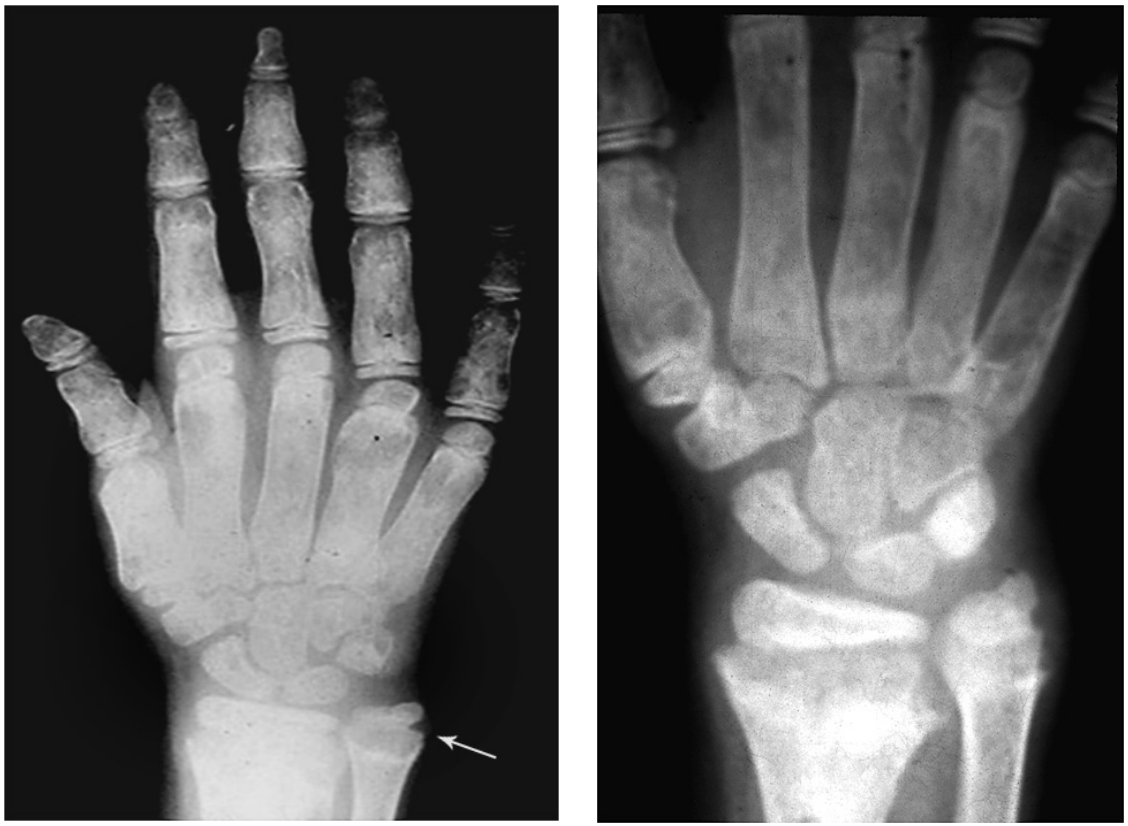
- **Ground glass / radiolucent area of trabecular alteration in long bones. Occasional calcifications**
- **Bulging of the bone with endosteal scalloping & cortical thinning**
- **Deformities**

POLYOSTOTIC FIBROUS DYSPLASIA

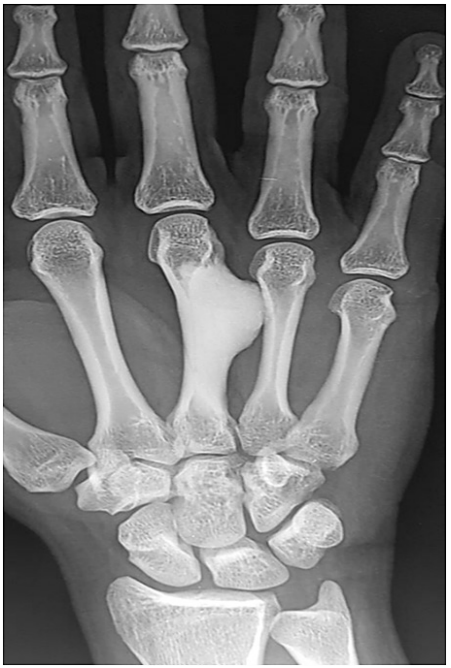




Fibrous Dysplasia with Rickets explained by humoral mechanism, such as seen in oncogenic osteomalacia. Manufacture of polypeptides by mesenchymal tumors etc.,



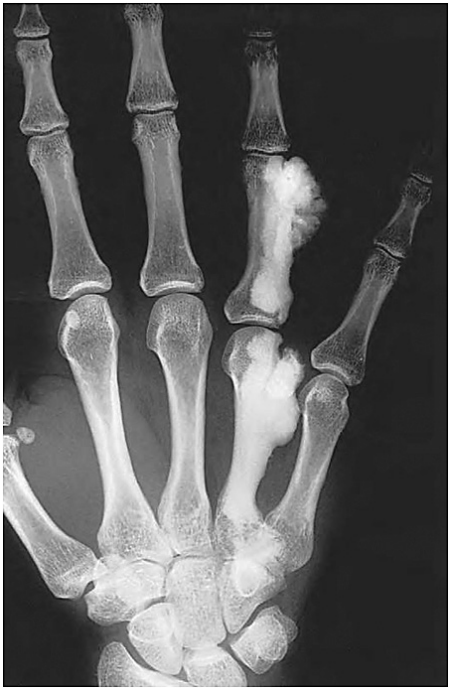
Fibrous Dysplasia with Rickets



17 yrs

Melorheostosis, also known as Leri disease, is an uncommon mesenchymal dysplasia manifesting as regions of sclerotic bone with a characteristic dripping wax or flowing candle wax appearance. It may cross the joints and soft tissues may be involved. It may be monostotic or polyostotic

In infants, contractures of the fingers may be noted due to fibrosis and linear scleroderma

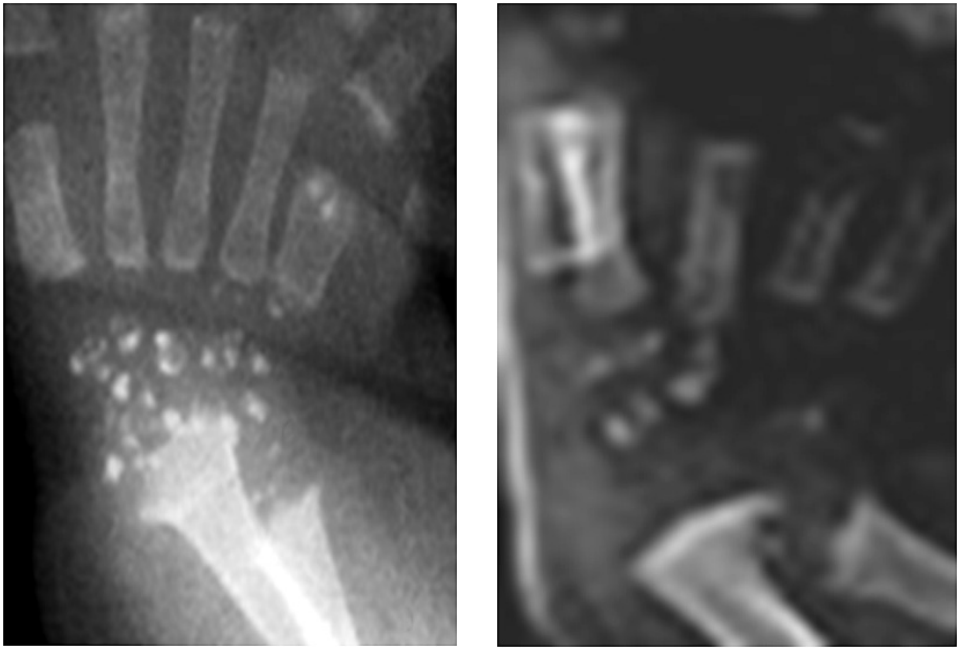


18 yrs

Nonsclerosing skeletal dysplasias

- Chondroectodermal Dysplasia (Ellis Van Creveld Syndrome)
- Chondrodysplasia Punctata (Conradi-Hunermann)
- Multiple epiphyseal dysplasia
- Spondylo Epiphyseal Dysplasia With Polyarthropathy (Pseudo Rheumatoid Type)
- Metaphyseal Chondrodysplasia (Meta. Dysostoses)
- Spondylo metaphyseal dysplasia
- Spondylo Multiple epi metaphyseal dysplasia
- Pyle Disease -Frontometaphyseal Dysplasia
- Kniest dysplasia
- Cleidocranial Dysplasia
- Diastrophic dysplasia
- Mucopolysaccharidosis

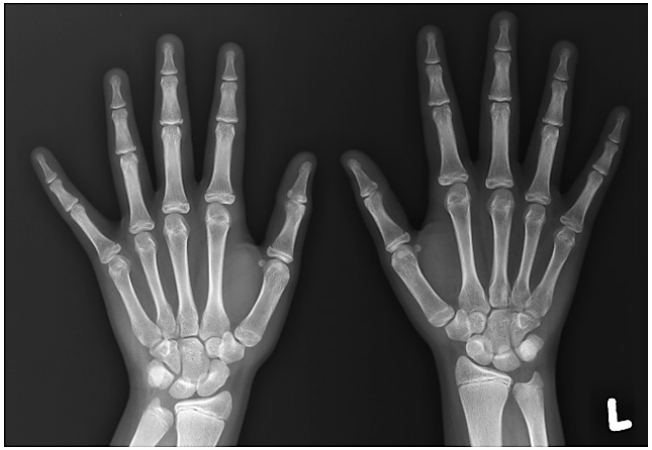
X Linked Chondrodysplasia Punctata (Conradi-Hunermann AD)



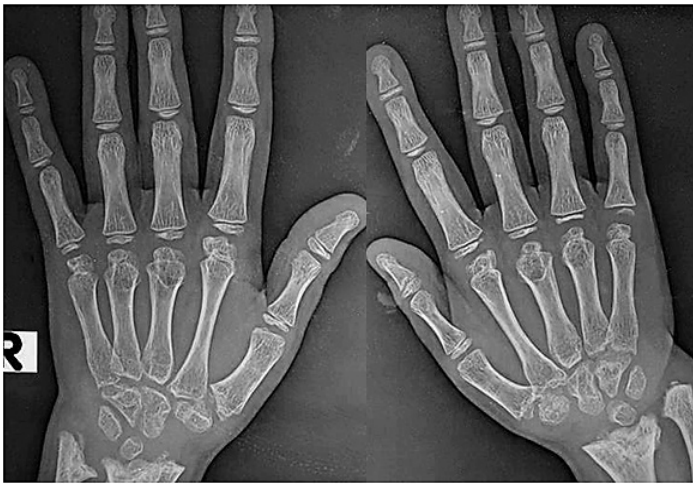
Rhizomelic – AR
Prominent metacarpals
Short humerus & femur

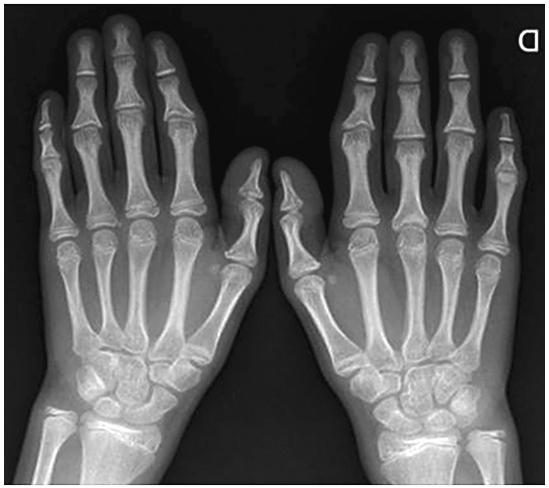
- **Stippled calci. ends of bones and ossification centers**
- **Calci. Adjacent to vertebrae**
- **Vertebral deformities**
- **Asymmetric shortening of long bones**

Multiple epiphyseal dysplasia

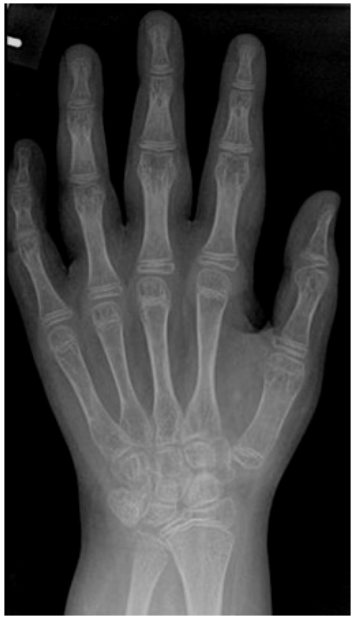


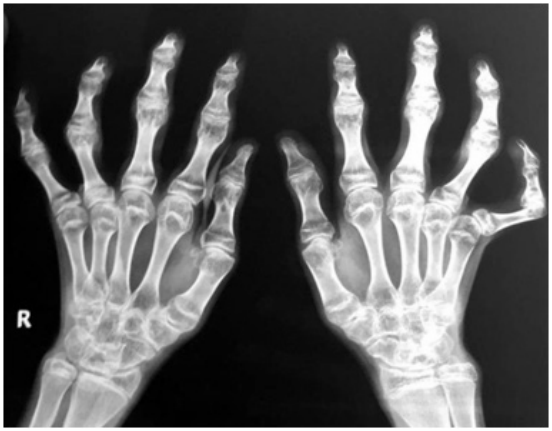
It is a disorder of cartilage and bone development primarily affecting the ends of the long bones in the arms and legs (epiphyses).



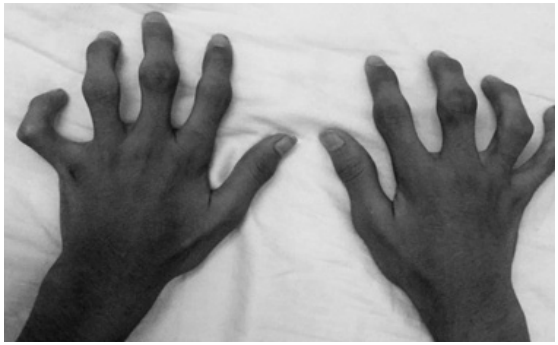


Epiphyseal dysplasia
- pseudo rheumatoid type



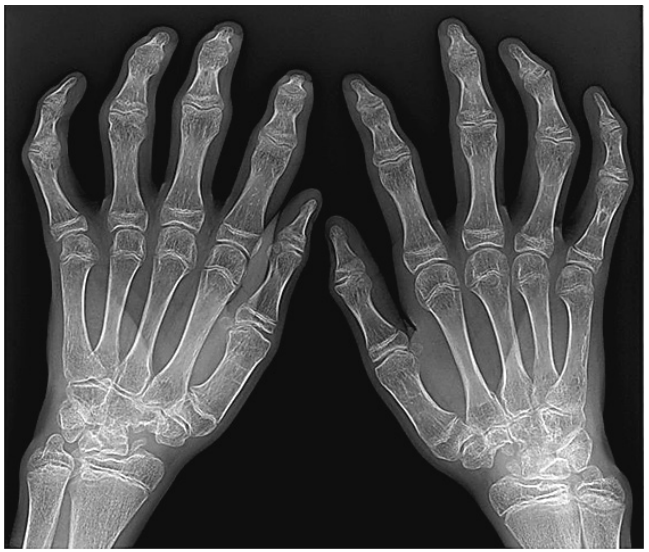


16 M, Pseudorheumatoid



Molecular genetics:A novel mutation in WISP3 was detected Interpretation: C145R is assumed to be a reason for progressive pseudorheumatoid dysplasia in this patient and confirms the diagnosis in this patient and provides specific Mutation information that can be used for carrier testing and prenatal diagnosis In the family.

Spondylo Epiphyseal Dysplasia With Polyarthropathy (Rheumatoid Type)



- Simulates R.A.
- No erosions as in R.A
- Large meta carpal heads
- Soft tissue swellings

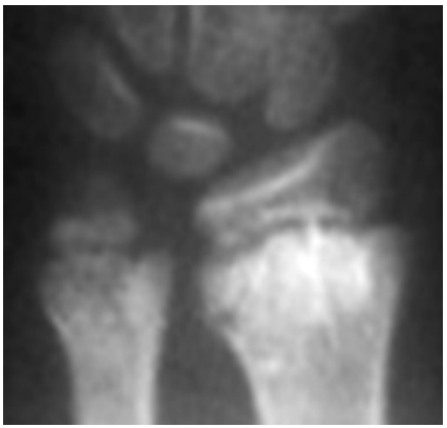
Metaphyseal Chondrodysplasia
(Meta. Dysostoses)

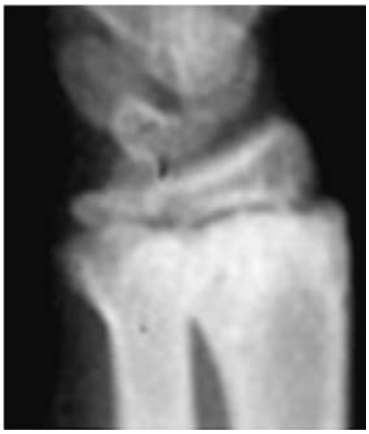
- Common - Schmid
  - Jansen
  - McKusick

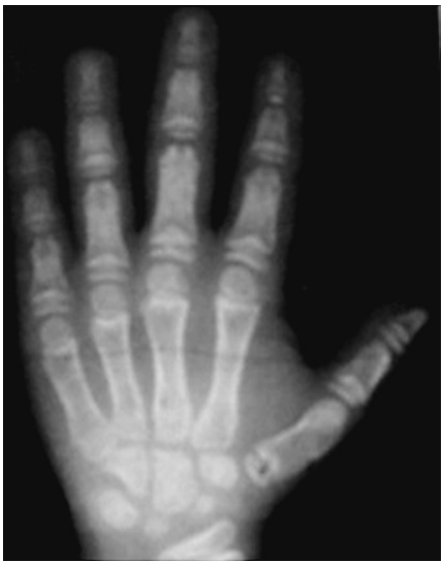
  Cartilage hair Dysplasia
  - Meta, Chon. with panc.
  Insuf and neutropenia (Schwachman)

- Uncommon - 10 types

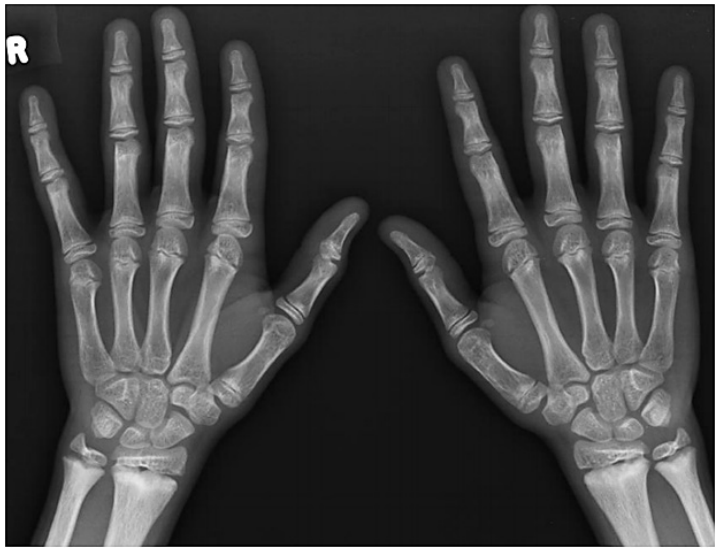
Metaphyseal dysplasia



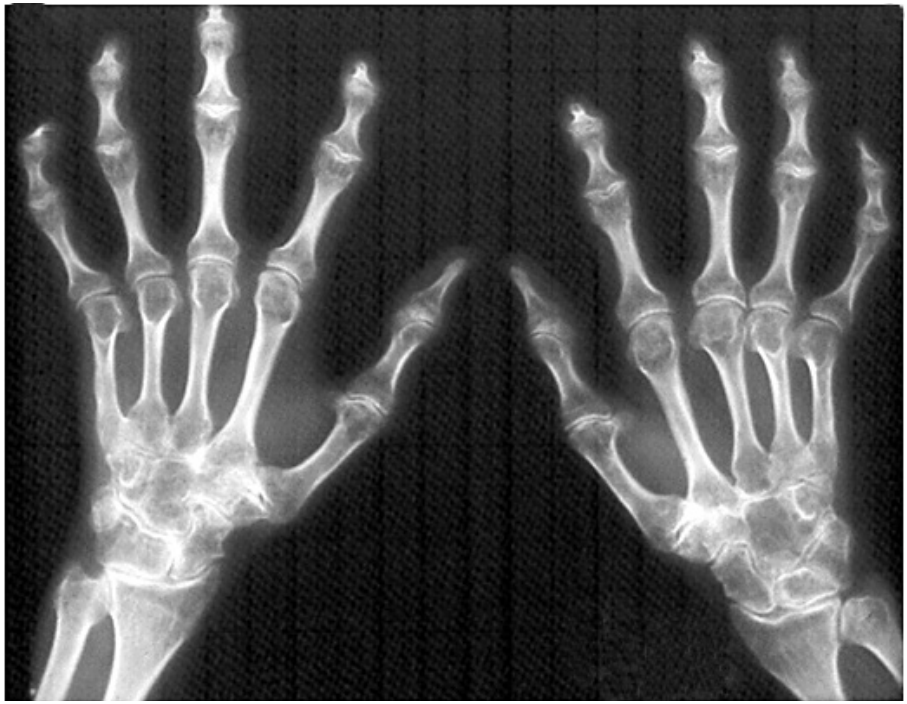




Mckusick type of metaphyseal dysplasia



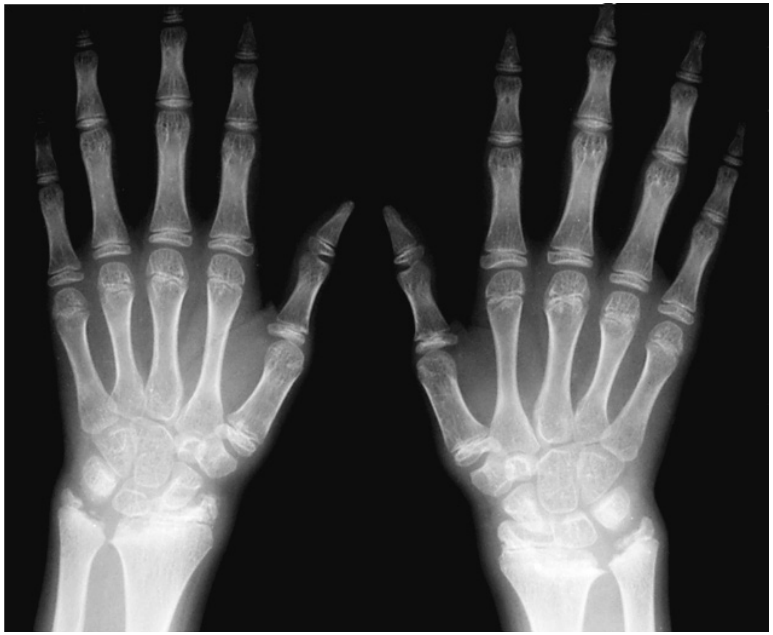
Note the irregularity and increased density of the metaphysis



Spondylo Metaphyseal Dysplasia

- Peripheral arthropathy
- Retarded Carpal and Tarsal bones
- Large articular ends
- Metaphyseal changes
- Degenerative changes
- Spinal changes

Spondylo epi metaphyseal dysplasia
(Sponastrime dysplasia)



This is a rare type of skeletal dysplasia.
The differential diagnosis includes:

Congenital hypothyroidism (cretinism)

Chondrodysplasia calcificans

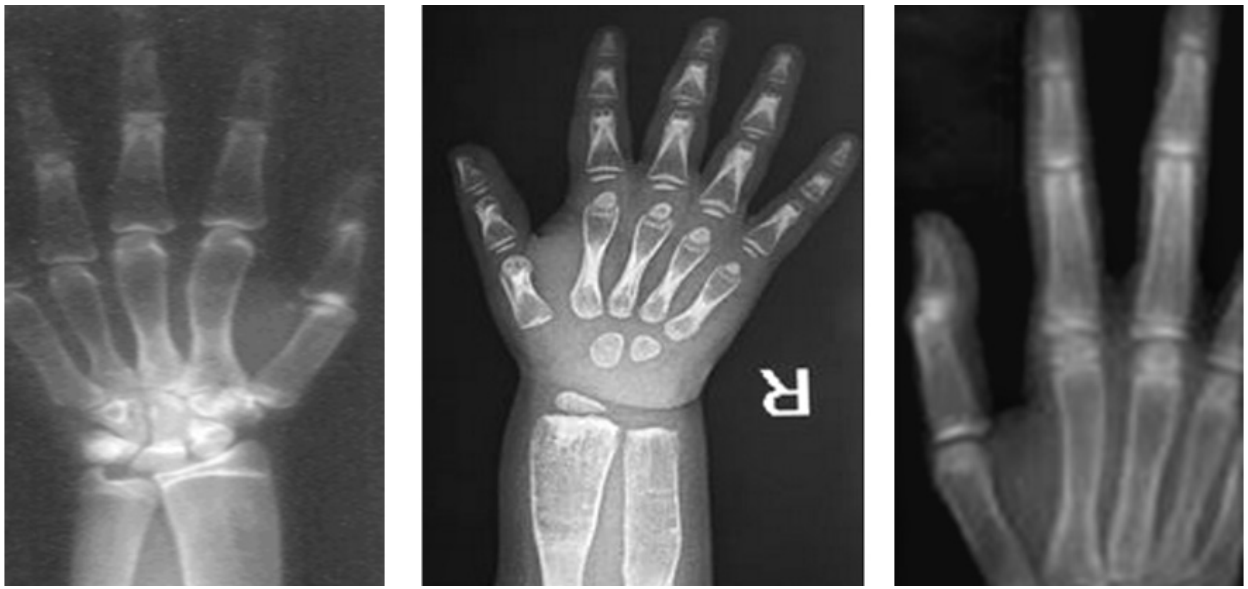
Congenita -

Mother on anticoagulant therapy

Changes in the epiphyses and metaphyses, vertebra are involved

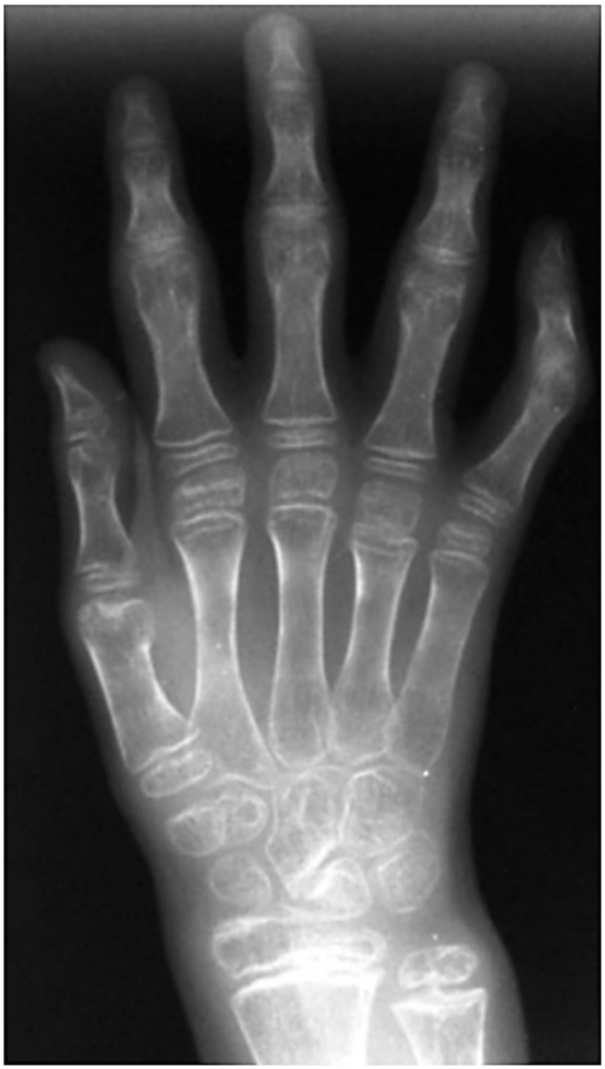
Pyle Disease -Frontometaphyseal Dysplasia

Involvement of metaphyses of bones of the feet, hands, ribs and clavicles. Thinning of cortices with widening, loss of corticomedullary differentiation, and ground glass opacity.



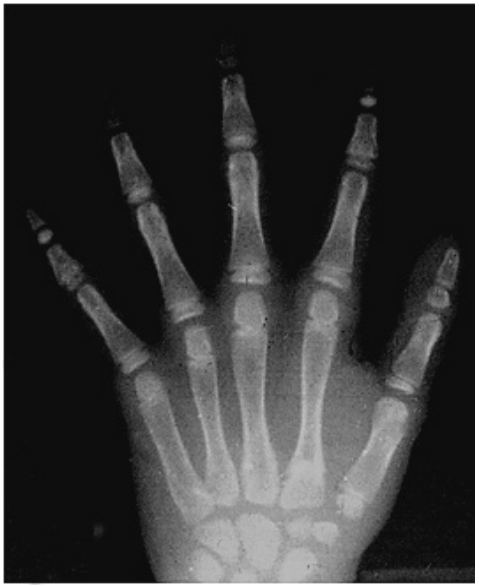
Widened metaphyses with ground-glass background

Kniest dysplasia

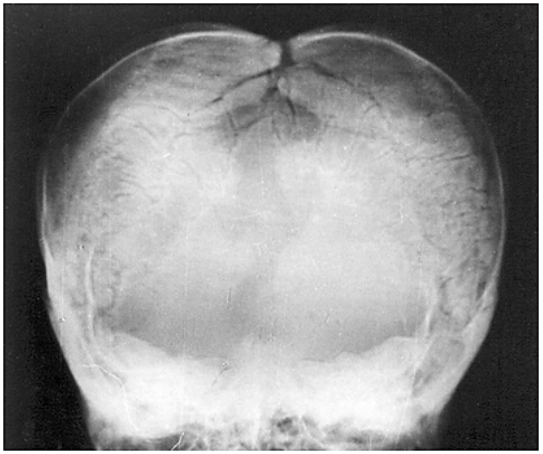


Kniest dysplasia includes broad ends of the bones at both poles, flattened metacarpal epiphyses, osteoporosis and a truncation of the tuft of the first digit. Carpal centers may also appear deformed after the age of three years. "Megaepiphyses" resemble pseudo rheumatoid type of spondylo epiphyseal dysplasia.

Cleidocranial Dysplasia

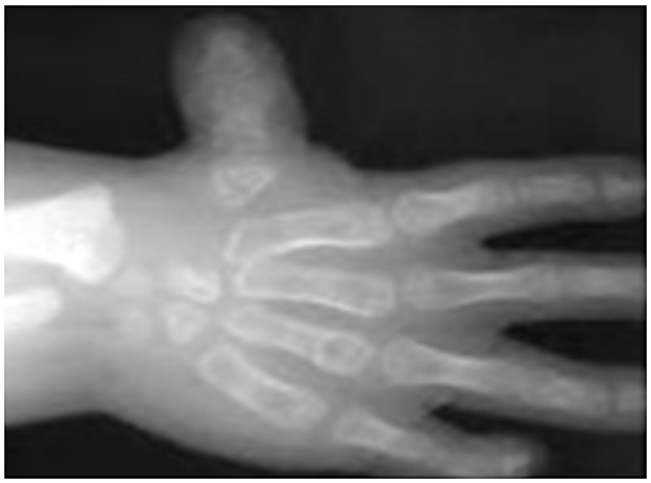


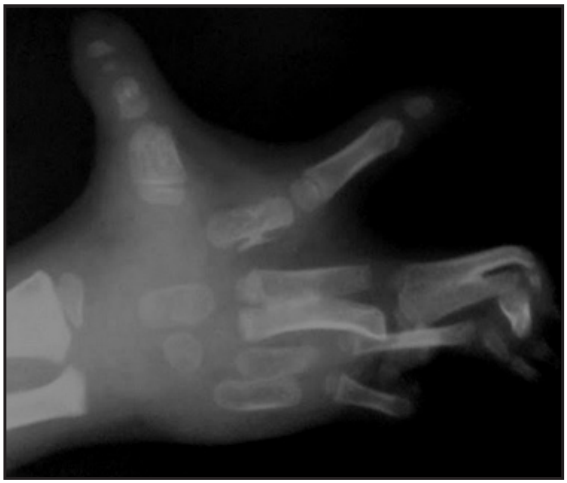
- Pointing of tufts of terminal phalanges, acroosteolysis
- Brachymeso phalangia of 2nd and 5th fingers (middle phalanges short)
- Long 2nd metacarpal with accessory epiphysis at the base



- Midline defects, Wormian bones in skull

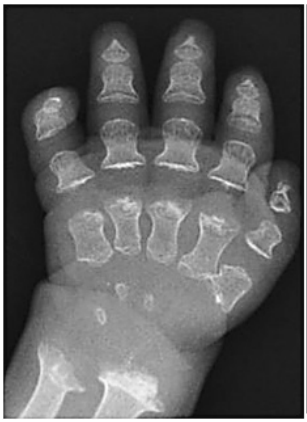
Diastrophic dysplasia - Hitch hiker's thumb

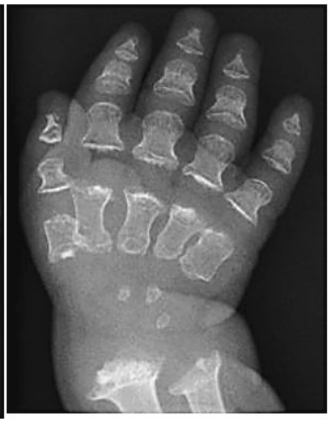


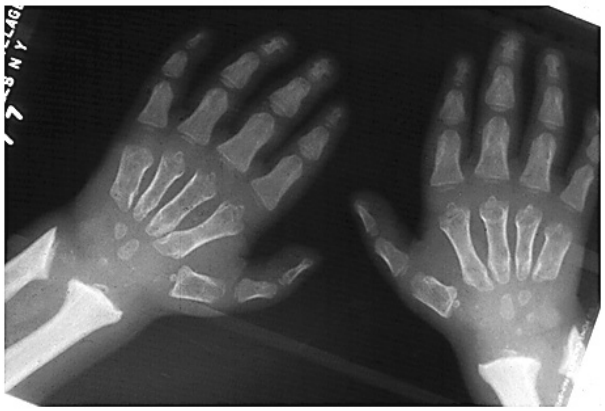


Diastrophic dysplasia is also called diastrophic dwarfism, a disorder of cartilage and bone development. Affected individuals have short stature with very short arms and legs. Most also have early-onset joint pain (osteoarthritis) and joint deformities called contractures, which restrict movement. The thumb is mobile and adducted.

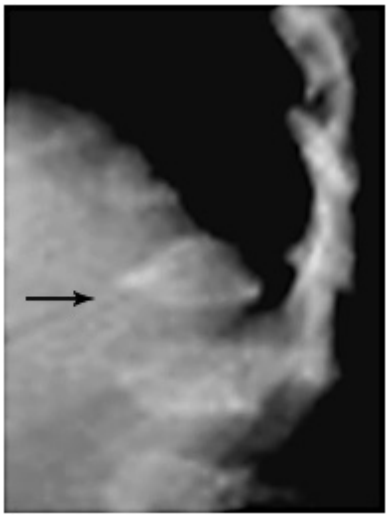
Mucopolysaccharidosis – 7 types – Morquio, MPS IV





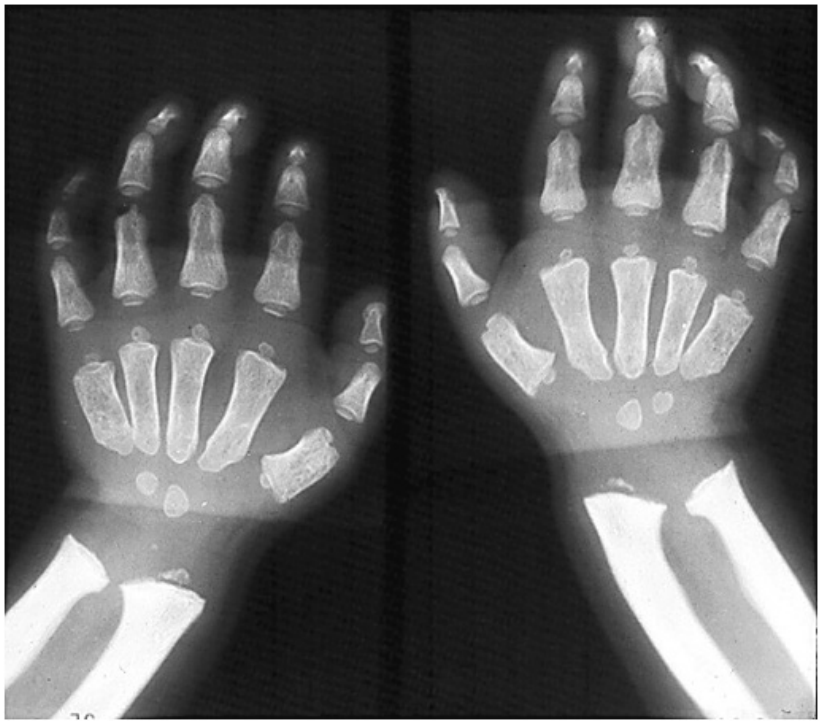


Central beaking of the vertebral bodies



- **Pointing of metacarpal bases**
- **Short metacarpals**
- **Carpal bones irregular**
- **Distal ends of radius and ulna are cup shaped and irregular**
- **Normal Mentation**

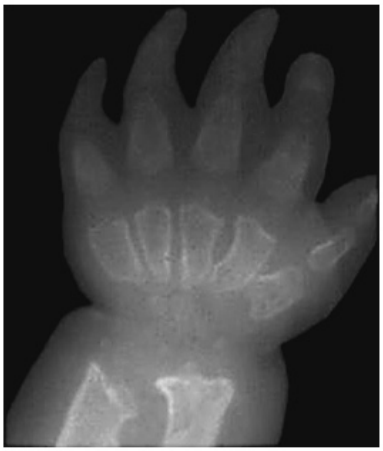
Hunter – MPS II A

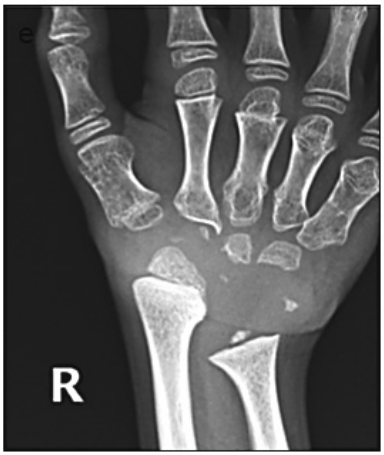


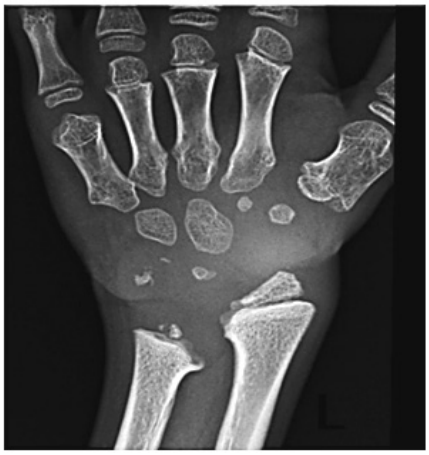
Widening of the metacarpals with
proximal pointing

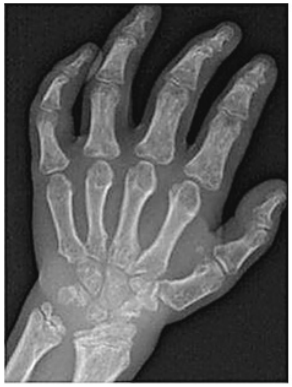
There is a deficiency in iduronate-2-sulfatase, which leads to an accumulation of heparan sulfate and dermatan sulfate. Hunter syndrome is X-linked recessive and primarily affects male subjects.

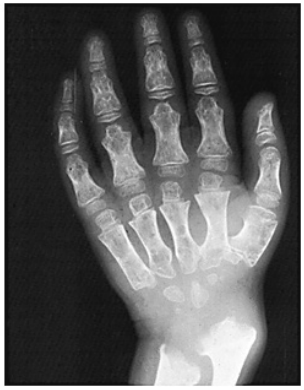
Hurler – MPS 1-H





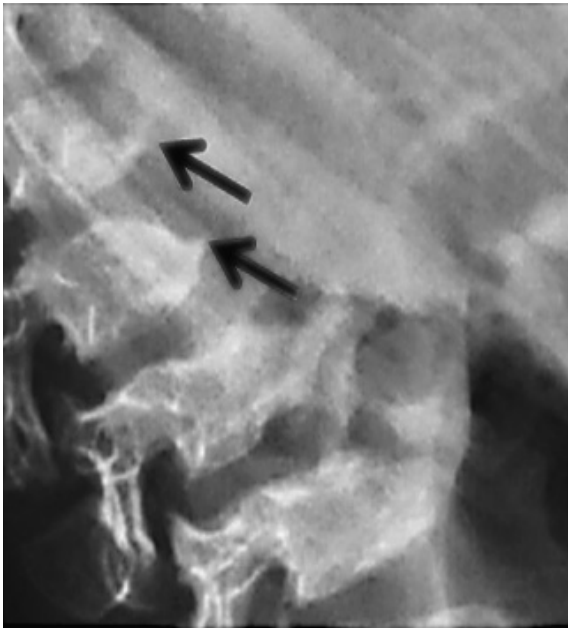




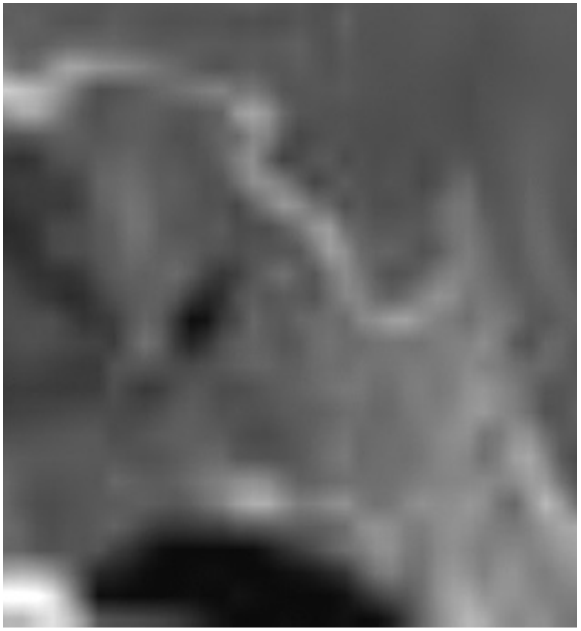


- Proximal pointed metacarpals
- Irregular, small carpals with delayed maturation
- Radioulnar surfaces slope towards each other
- Mental retardation
- DISTAL PHALANGES ARE SMALL

Hurler – MPS I



Inferior beaking of the vertebral bodies



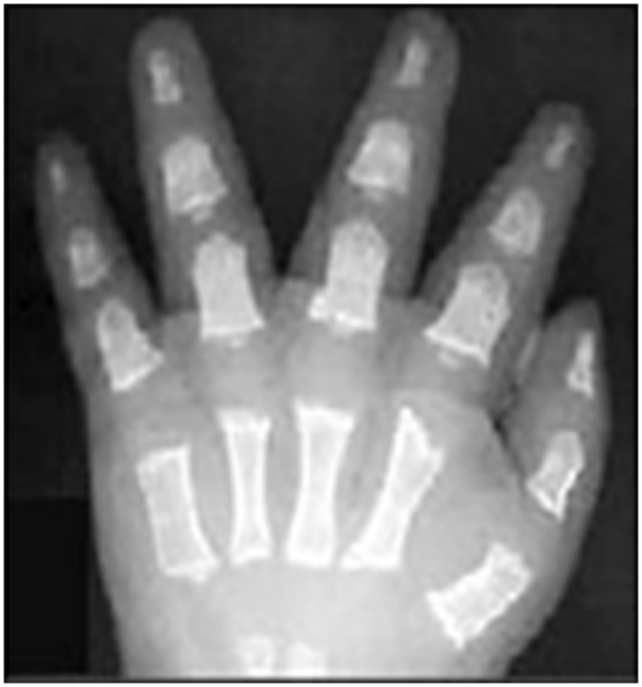
"J" Shaped sella in cone down position

Short Hands & Feet

- Peripheral Dysostosis
- Hypoparathyroidism
- Pseudo Hypoparathyroidism
- Pseudo Pseudo Hypoparathyroidism
- Fair Bank's Epiphyseal Dysplasia
- Diastrophic Dwarfism
- Ellis-Van Creveld Chondro Ectodermal Dysplasia
- Noonan's Syndrome
- Prader-Willi Syndrome
- Achondroplasia
- Ollier's
- Mucopolysaccharidosis (E.g., Hurler, Hunter, Morquio)
- Hypochondroplasia

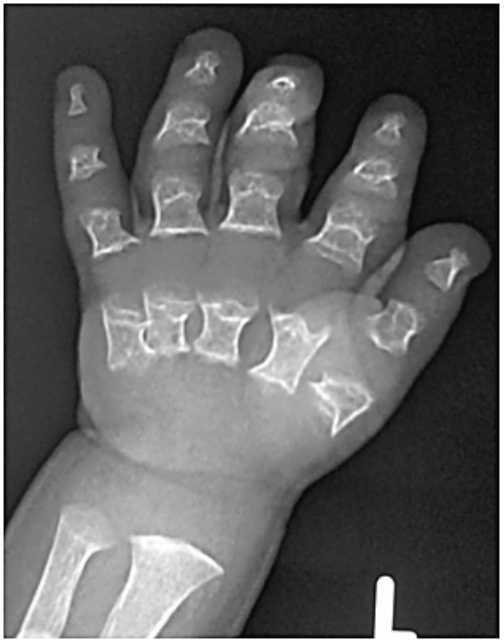
Short Hands and Feet

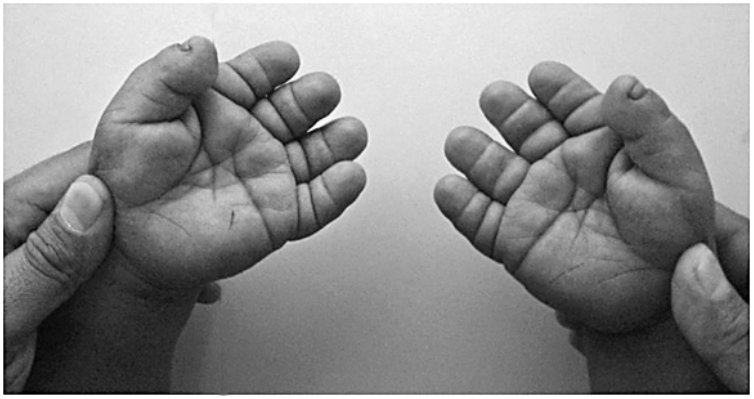
Trident hand



Short metacarpals and phalanges with wide epiphyses
Differentiation by interpedicular distance in lumbar spine
Gradual narrowing in achondroplasia, normal in pseudo

Achondroplasia -
Most common type of dwarfism

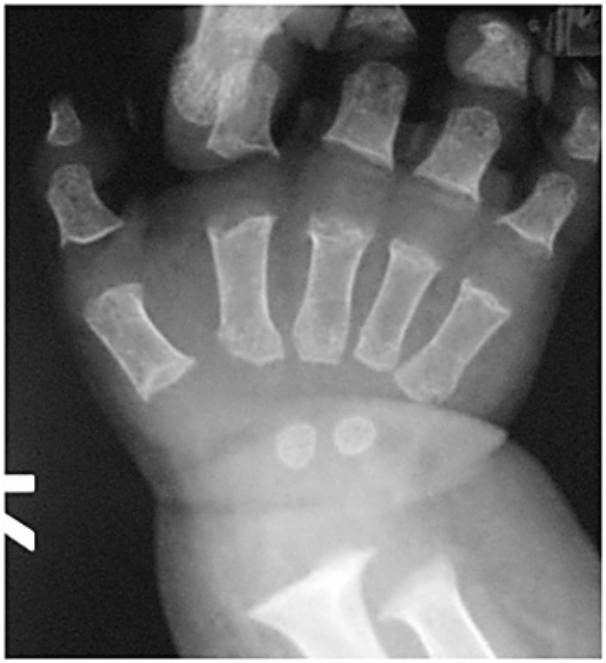




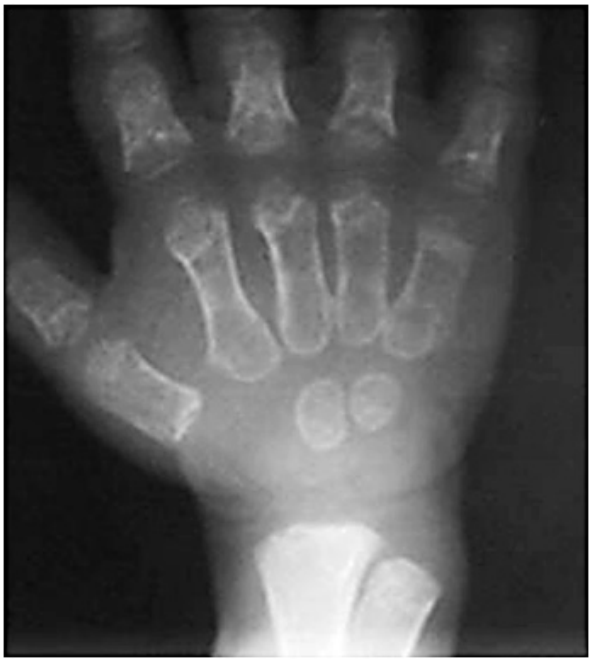
Both palms

Shortening of metacarpals and phalanges,

irregular articular ends



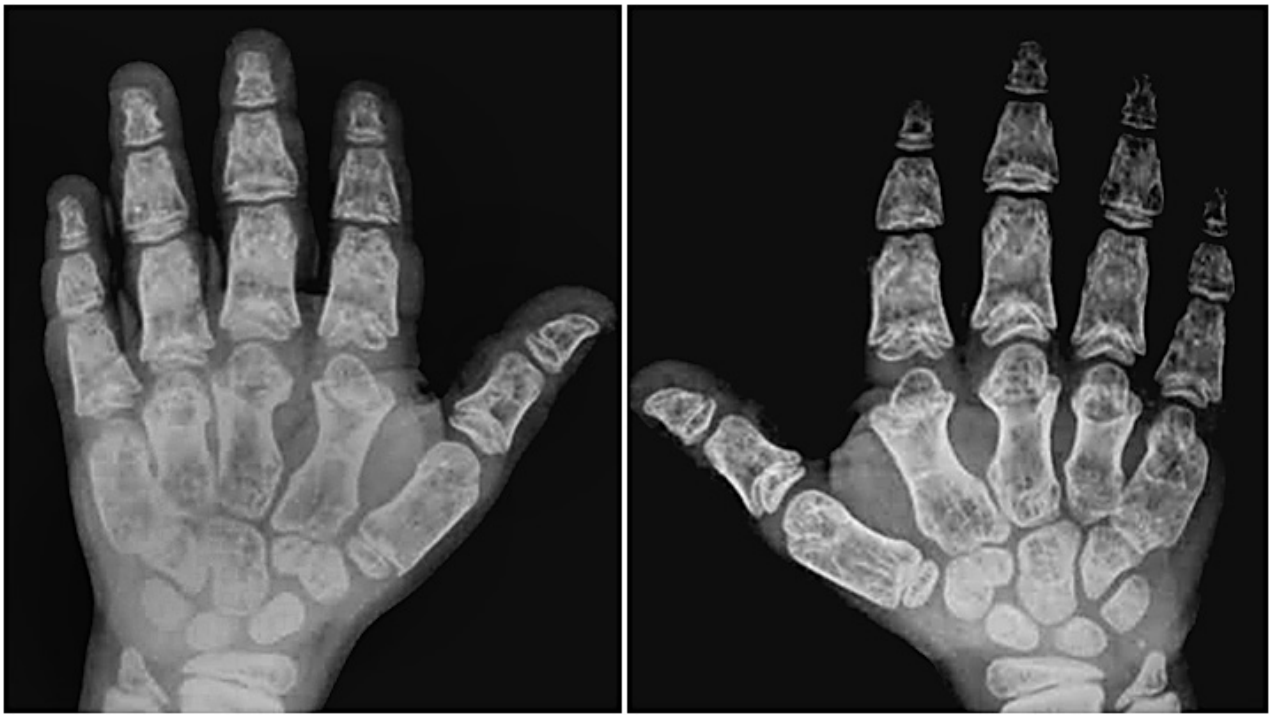
Achondroplasia
Trumpet appearance of the metaphyses



Pseudoachondroplasia includes changes in the epiphyses

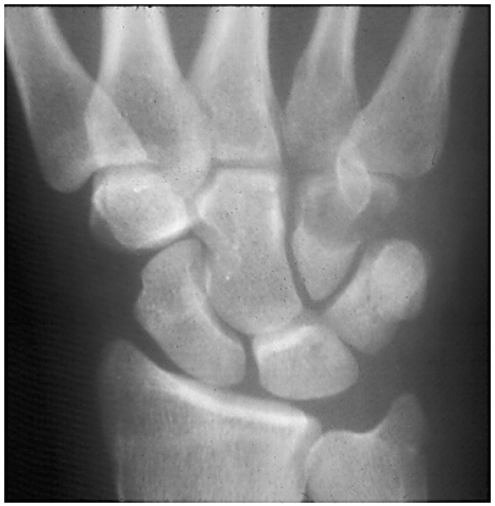
Peripheral dysostosis

Singleton et al. (1960) reported a form of dysostosis limited essentially to the tubular bones of the hands and feet. The epiphyses in the fingers are conical with their apex set into the metaphyseal ends of the phalanges.

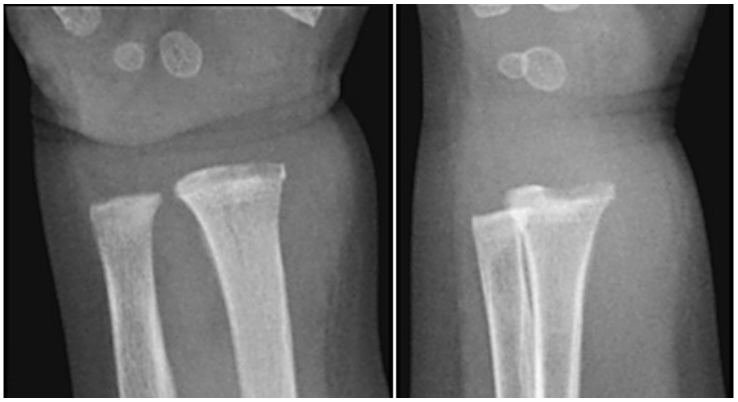


11 yr old short girl – Peripheral dysostosis

Bacterial



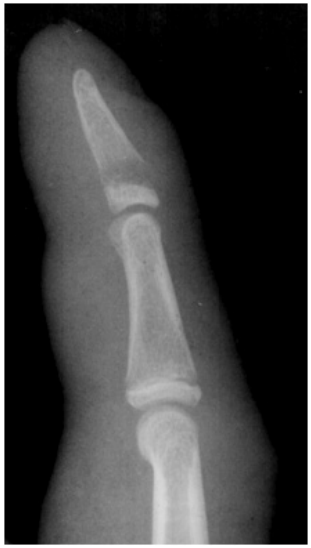
17 M, Osteomyelitis of hamate with lysis. Post intravenous injections. Cuboidal bones do not exhibit periosteal reaction.



Early Osteomyelitis

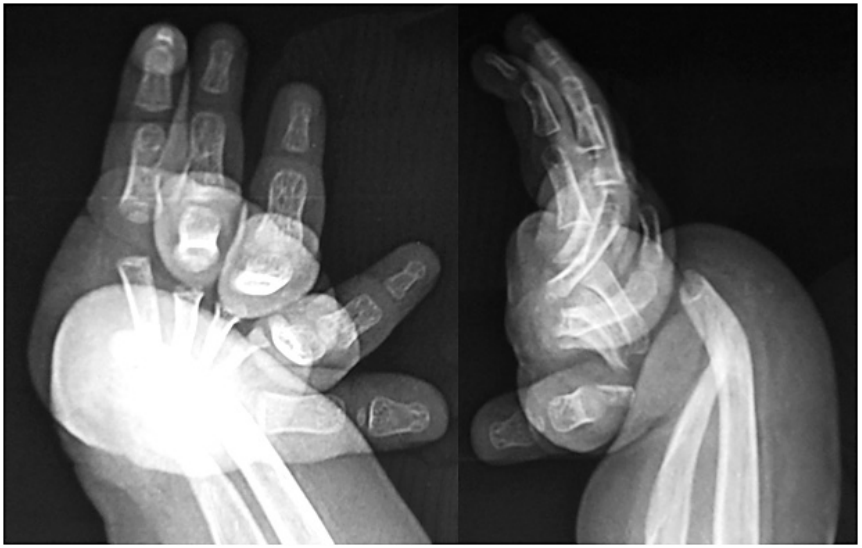
Soft tissue swelling and lytic lesion in the distal end of radius

Staphylococcal infection



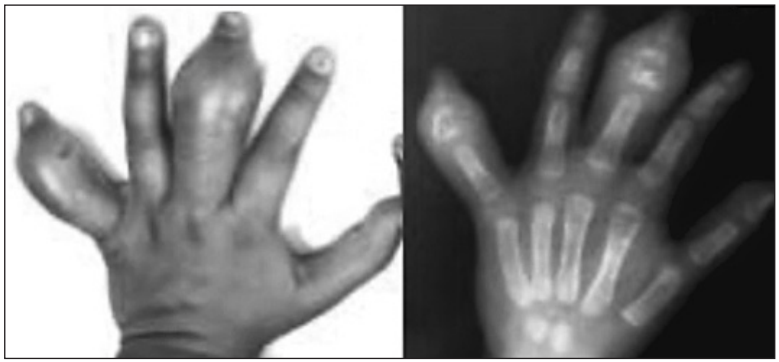
Early osteomyelitis
Distal phalanx

Post cellulitis

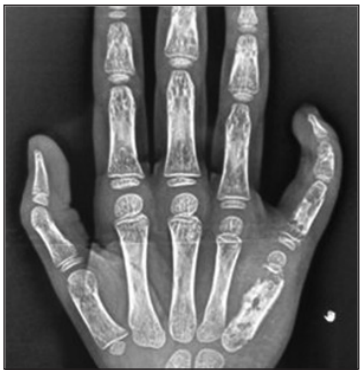


Carpal osteolysis and osteolysis of bases of metacarpals, distal ends of radius and ulna

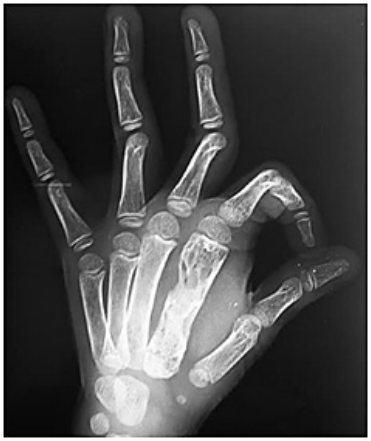
Tuberculosis



Spina Ventosa – lytic lesions with expansion



TB



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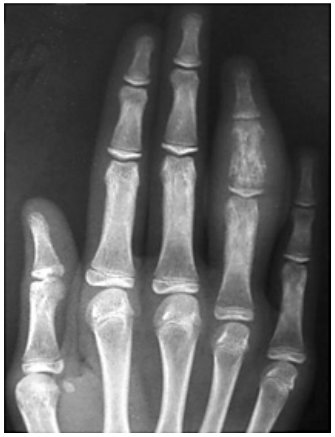
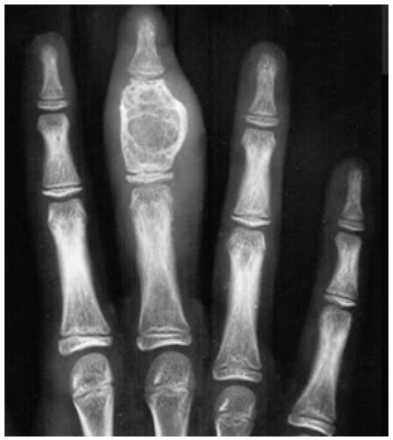
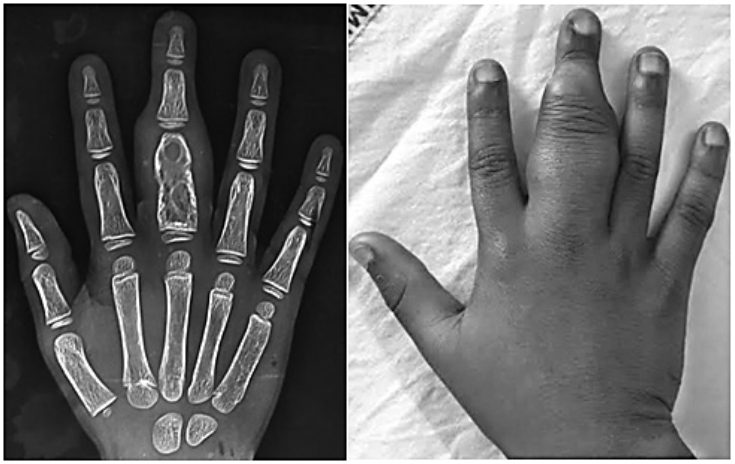


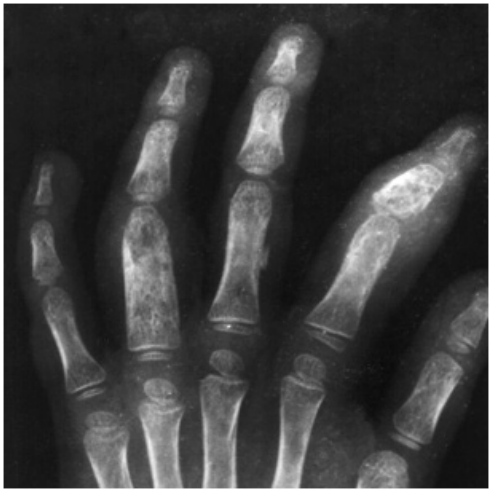
Spina ventosa

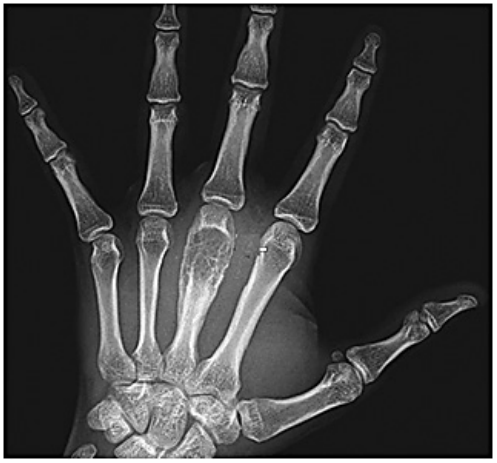


Tuberculosis dactylytis

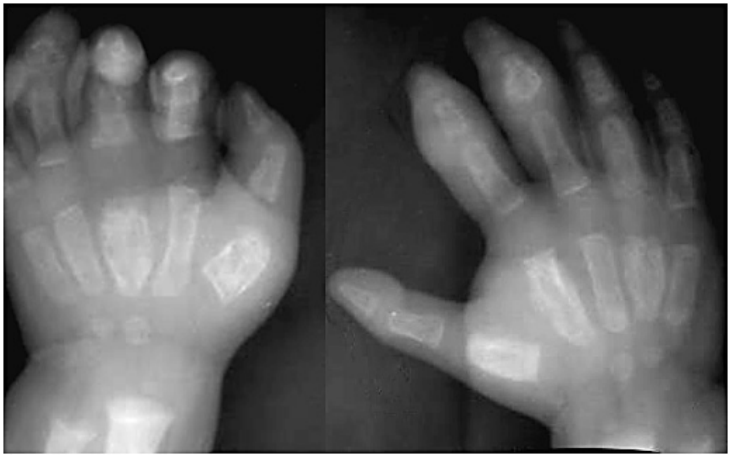


Tubercular dactylitis

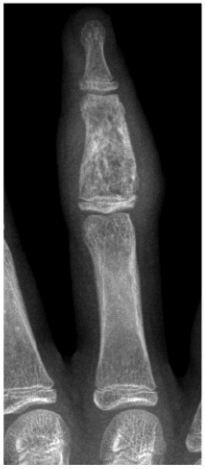




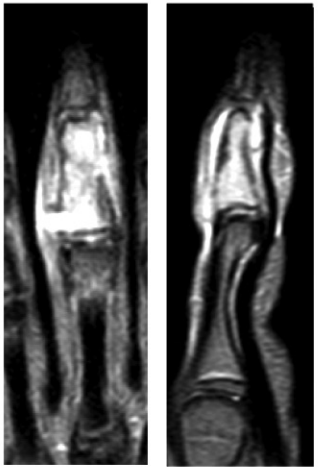
Spina ventosa



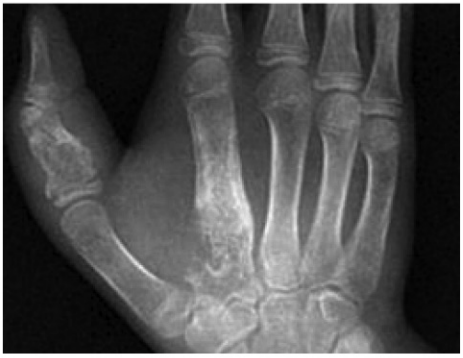
Simulates sickle dactylitis



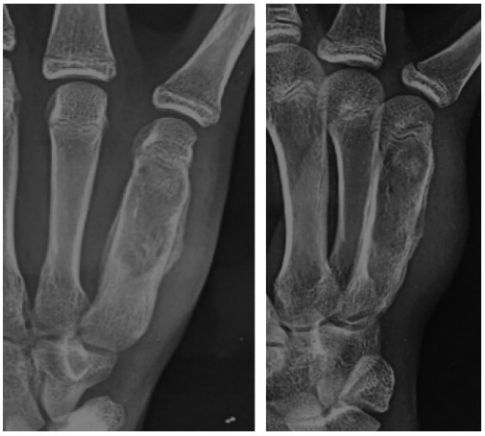
TB middle phalanx



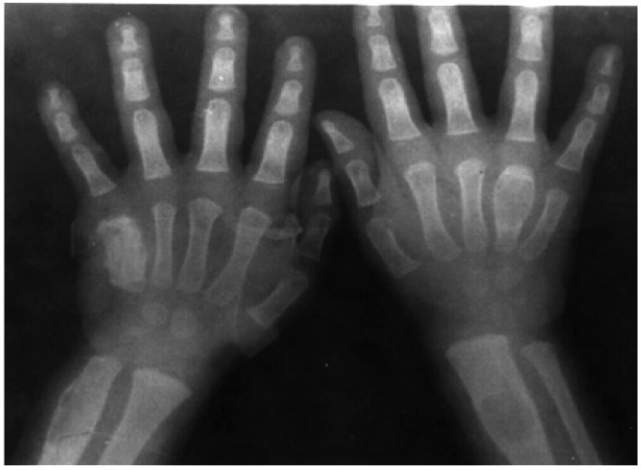
MRI



TB dactylitis

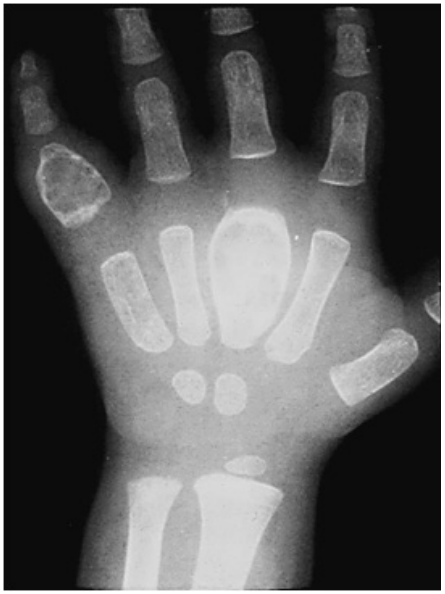


TB 5th metacarpal



Multicentric cystic Tuberculosis simulating enchondromata

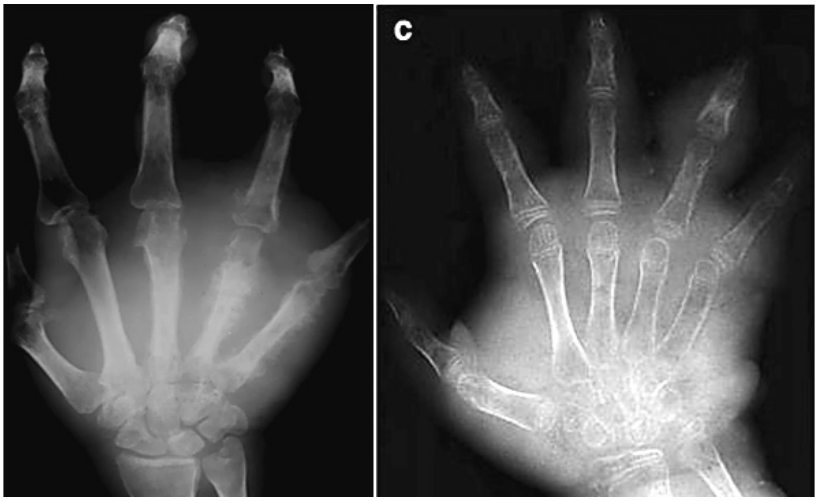
(Torulosis)



CRYPTOCOCCUS NEOFORMANS

Expanding lytic lesions with no periosteal reaction. Simulates spina ventosa of TB

Actinomycosis

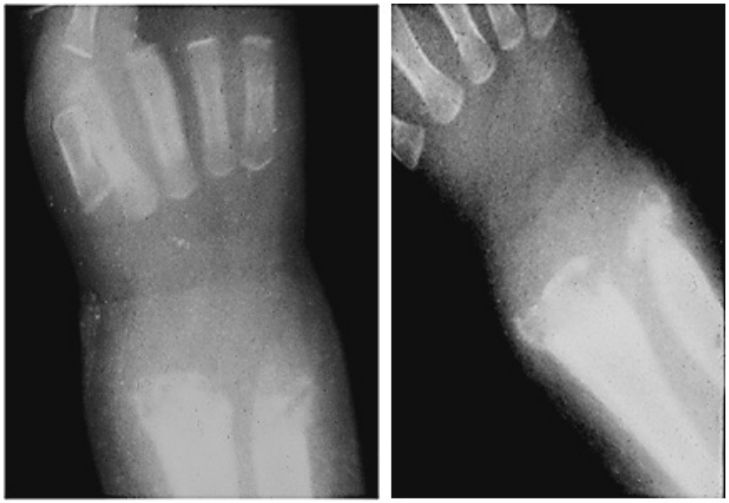


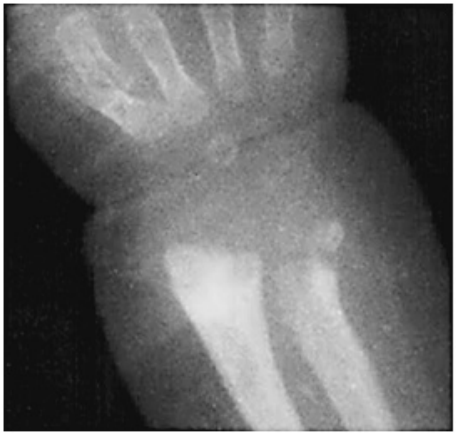
Bitten by girlfriend

Diffuse soft tissue swelling, sclerosis and periosteal reaction of the metacarpals

Fungal infection of the hand – Actinomycetes group. Diffuse soft tissue swelling with osteoporosis of bones

Congenital Syphilis



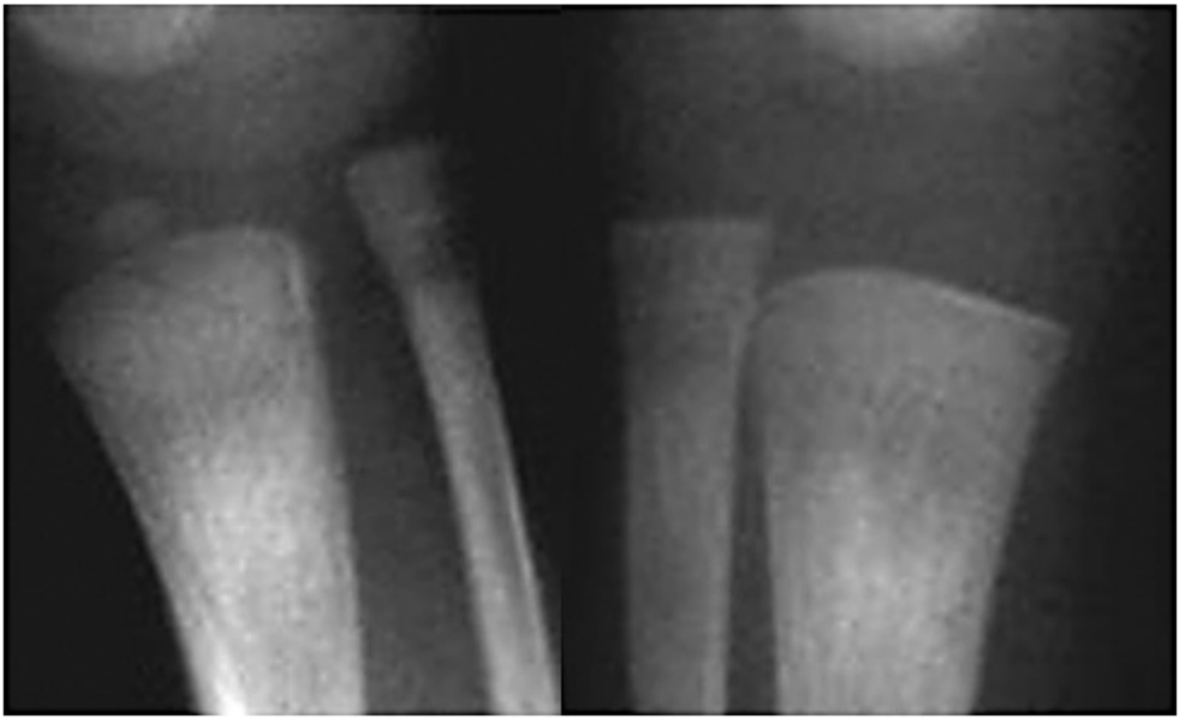


Osteochondritis, osteitis, periostiitis, osteomyelitis. Bilateral, symmetrical

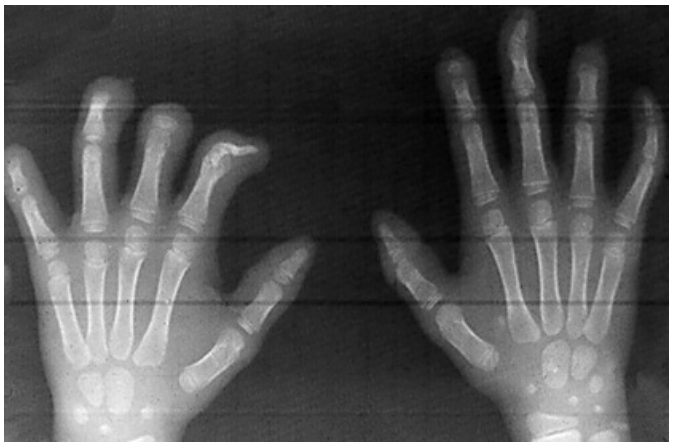
Syphilitic dactylitis

Diffuse sclerosis, periosteal reaction and soft tissue swelling

Maternal Rubella syndrome



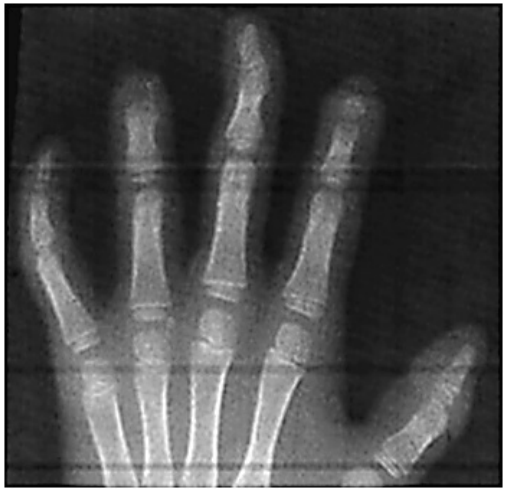
ENCOUNTERED IN INFANTS WITH MATERNAL RUBELLA
RADIOLOGICALLY METHAPHYSES ARE INVOLVED DENSE METHAPHYSES WITH CELERY STALK APPEARANCE.
NO PERIOSTEAL REACTION

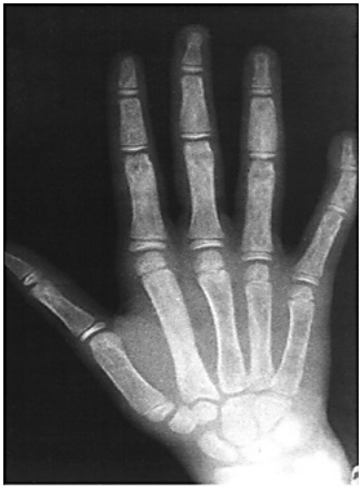


Acroosteolysis

Leprosy

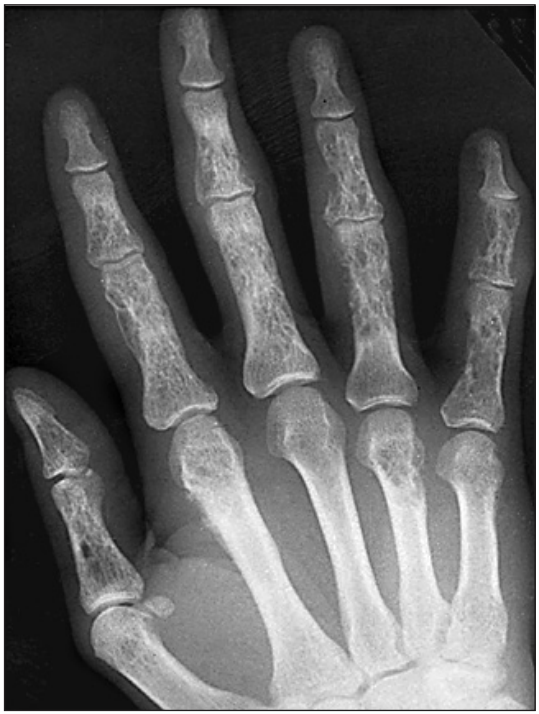
The most common specific bone changes are primary periosteitis and the areas of bone destruction. Nonspecific bone changes include absorptive changes. The absorption of the terminal phalanges acroosteolysis is present.



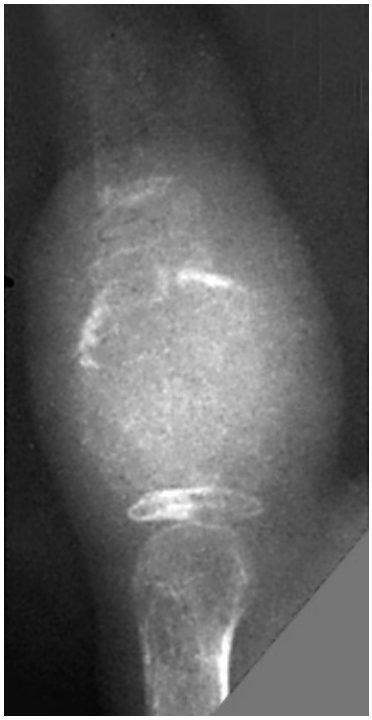


Leprosy

Osteoporosis and small cystic changes in the phalanges. Findings often simulate sarcoidosis.

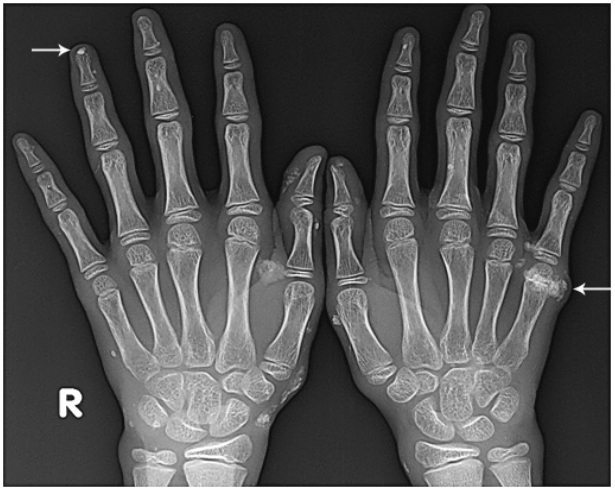


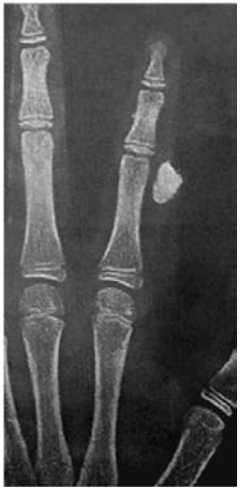
16 F, Sarcoidosis
Multiple lytic areas, some with honey combing



Giant cell reparative granuloma. Radiological appearances similar to giant cell tumor except the epiphysis is not involved

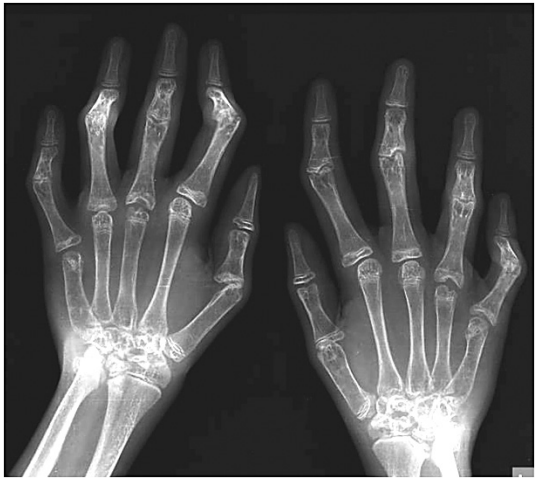
Collagen disorders

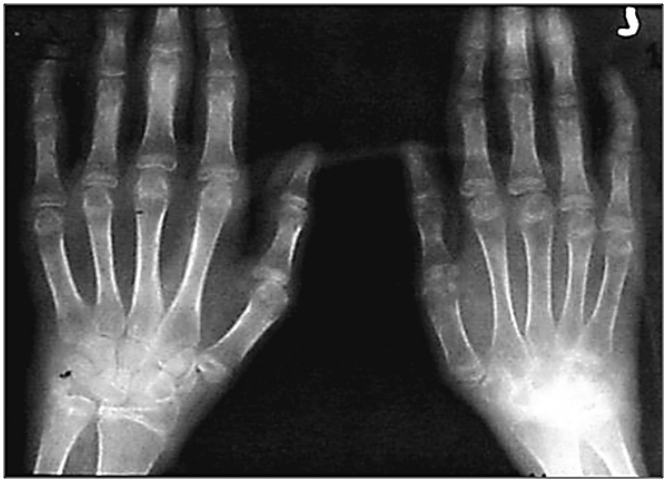




- Scleroderma
- Lupus erythematosis
- Dermatomyositis
- Rheumatoid
- Poly arteritis nodosa

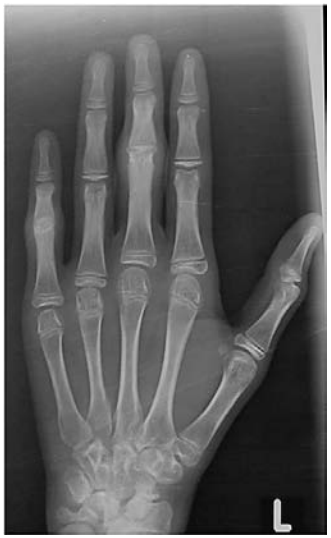
SCLERODERMA – Soft tissue calcifications

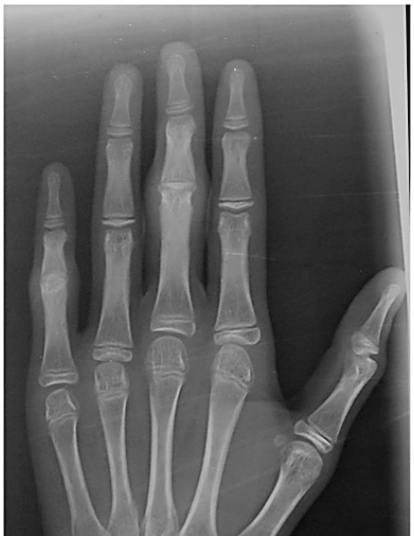




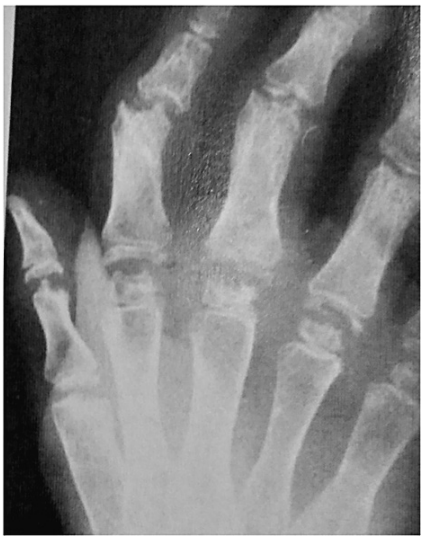
Juvenile idiopathic arthritis

Juvenile idiopathic arthritis formerly known as juvenile rheumatoid arthritis



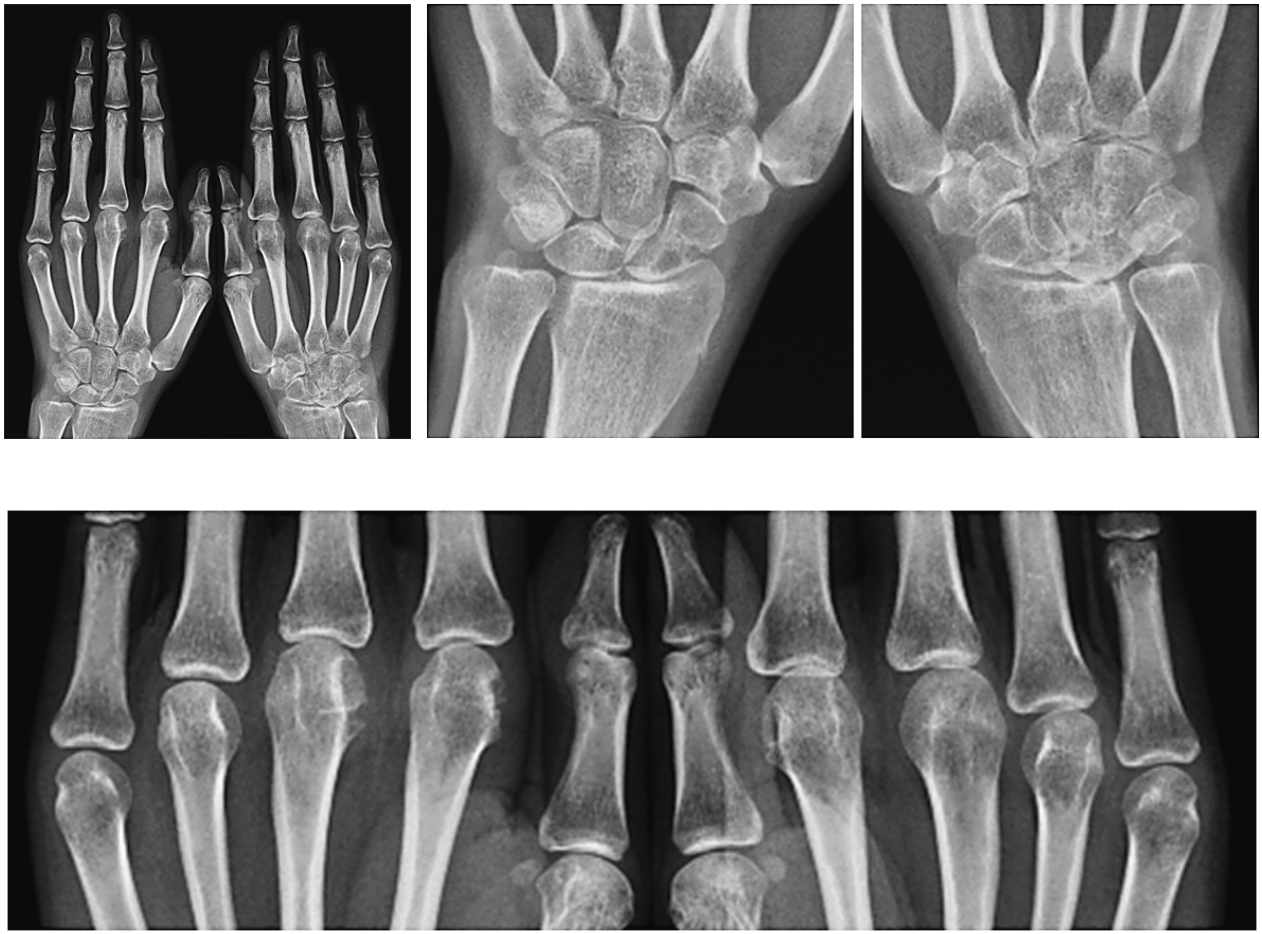


Active inflammation of isolated joints
No specific diagnostic findings



Paraarticular osteoporosis.
Erosions articular margins.
Enlarged phalanges

17 F, Juvenile Idiopathic Arthritis

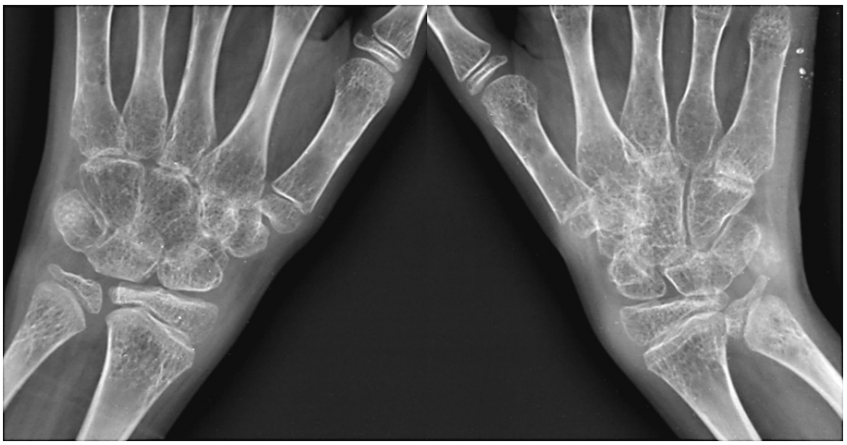


Para articular osteoporosis, erosions of carpal bones & metacarpal heads

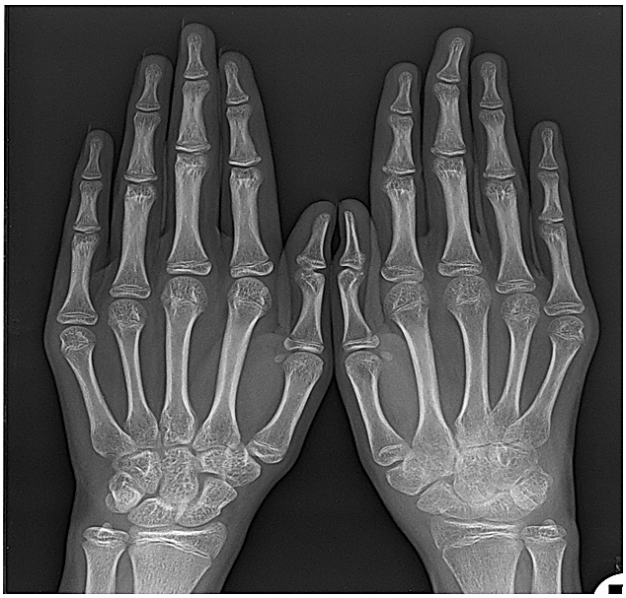
Juvenile idiopathic arthritis (JIA) is a heterogeneous group of diseases characterized by synovial inflammation. JIA has been further classified on the basis of the number of joints involved, additional symptoms, family history, and serologic findings. Imaging in patients with JIA has historically relied on radiography, which allows the accurate assessment of chronic changes of JIA, including growth disturbances, periostitis, and joint malalignment. However, radiographic findings of active inflammation are nonspecific.

- **There are several subtypes of JIA**
- **oligoarticular JIA**
  - affected ≤4 joints in the first six months of illness
  - peak age: 1-6 years
  - mainly affects medium and large joints
- **polyarticular JIA**
  - ≥5 joints are affected
  - peak age: 1-4 years; 7-10 years
  - mainly affects small and medium joints
- **systemic onset JIA** (a.k.a. Still disease)
  - see above
  - arthritis may present weeks to months after the onset of systemic symptoms

Juvenile Rheumatoid Arthritis (JIA)

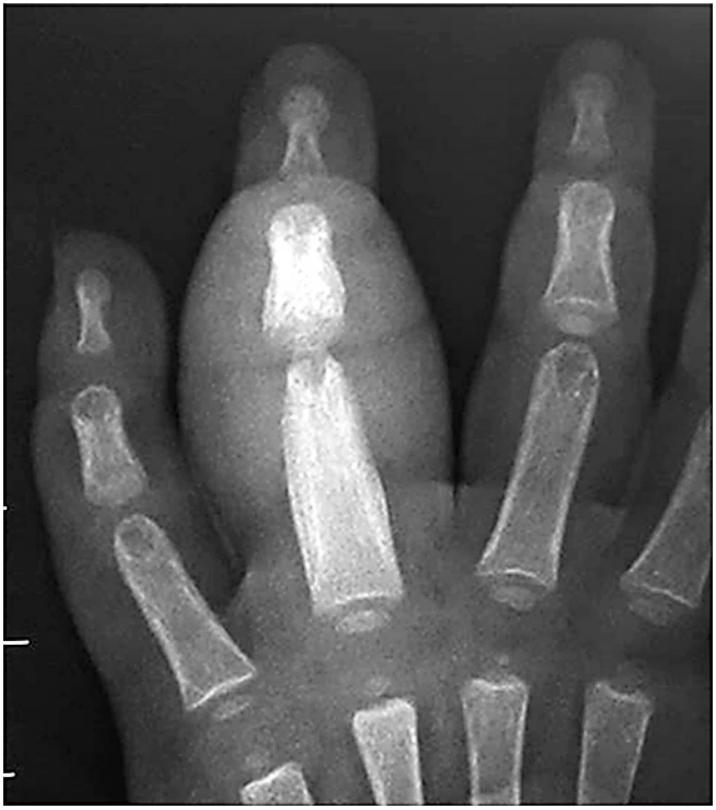


12 F, JRA



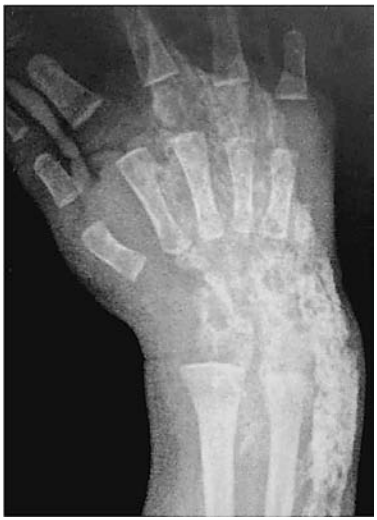
16 M, JRA

Psoriatic arthritis



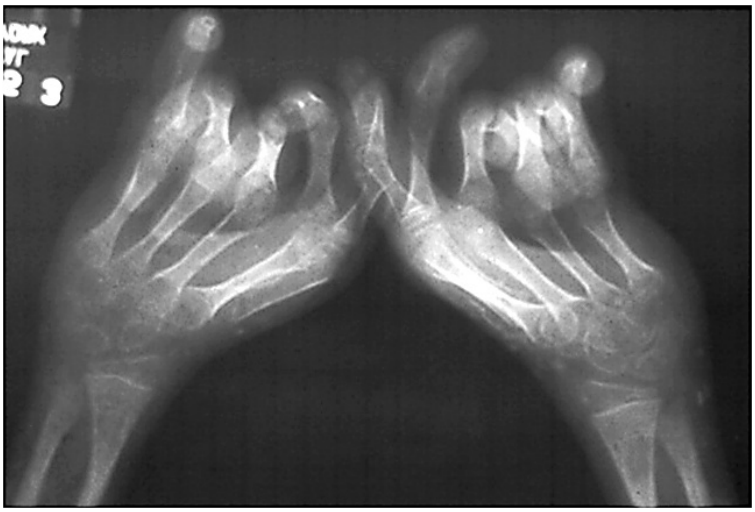
Psoriatic arthritis is an inflammatory arthritis associated with psoriasis. It is rare in children. It is usually negative for rheumatoid factor, and hence classified as one of the seronegative spondyloarthritides. Radiologically, no para articular osteoporosis is noted. Sausage shaped finger, reactive new bone formation with periosteal reaction are the main features.

Juvenile dermatomyositis

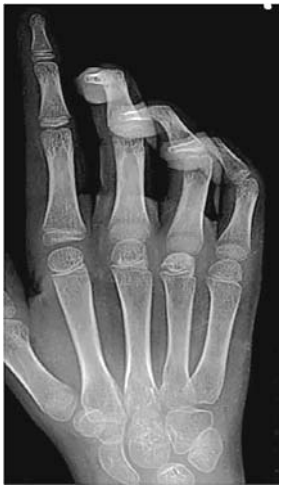


Note the soft tissue calcification

5 yr old, Dermatomyositis

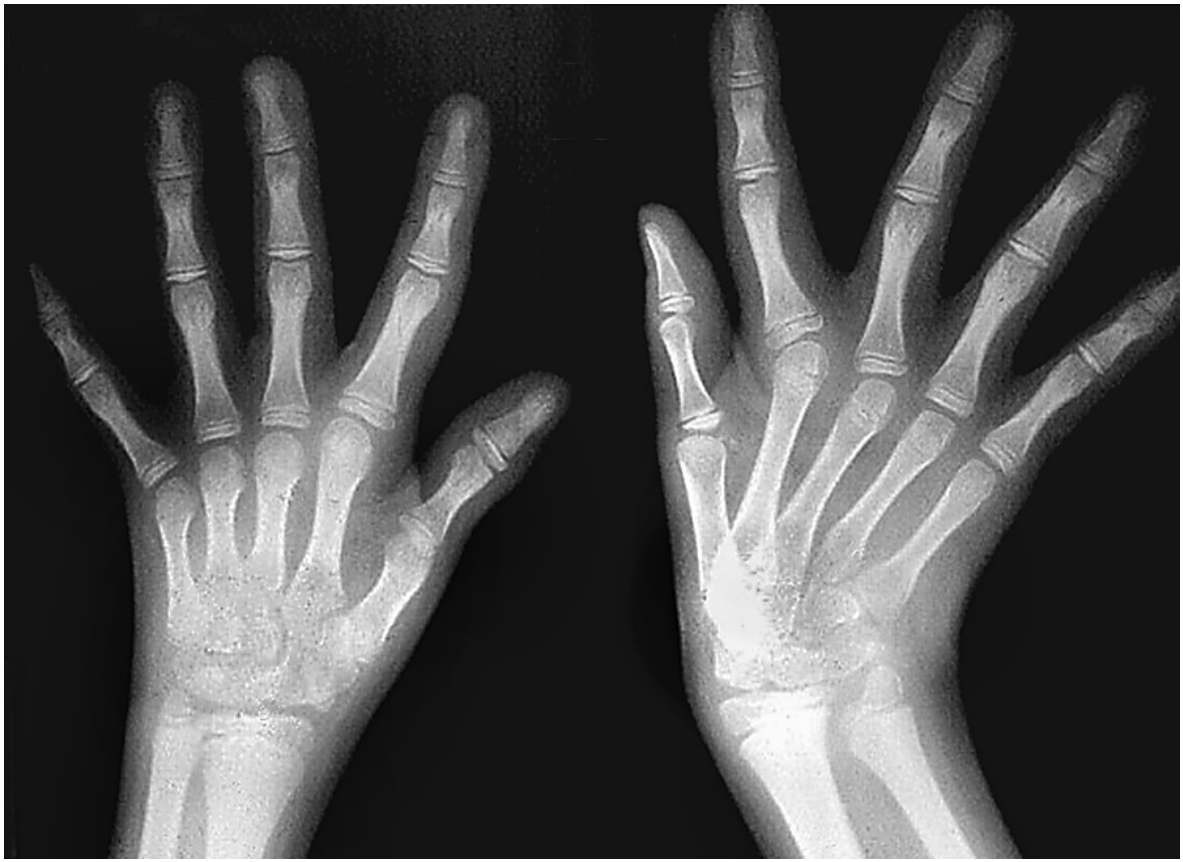


Contractures and soft tissue atrophy



8 yr old

Jacoud arthropathy

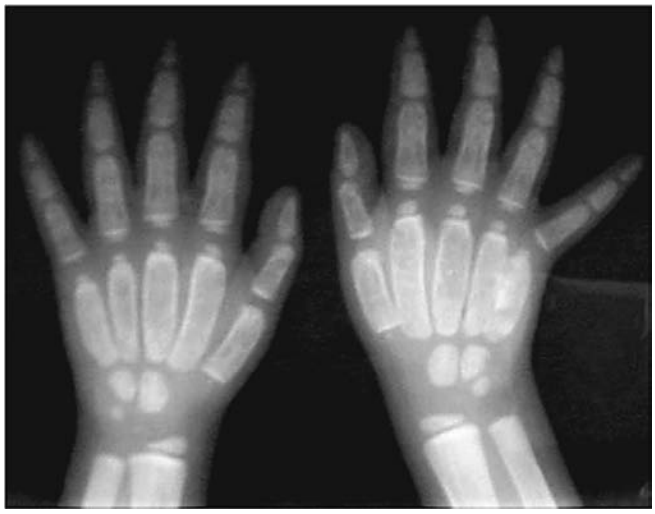


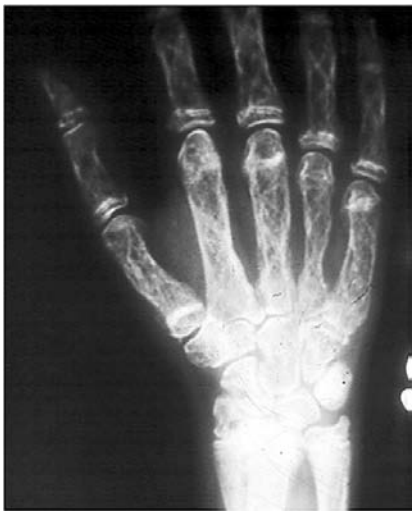
Sequelae of rheumatic fever with no erosions but subluxations mainly at the metacarpo phalangeal joints. To be distinguished from lupus arthritis.

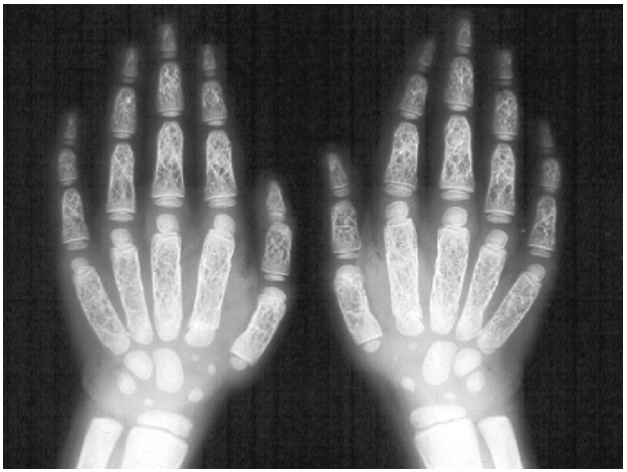
Phalangeal Tufts Preferentially Affected

- **Scleroderma:** Soft tissue calcifications
- **Sarcoid:** Acroosteolysis can occur in 50% of patients with sarcoid of the hands. Look for small, cortical, punched-out lesions OR a permeative, lace-like pattern.
- **Psoriasis:** Erosive disease at the distal interphalangeal joints
- **Neuropathy**
  - **Leprosy:** Linear calcification of digital nerves
- **Hyperparathyroidism:** Subperiosteal resorption
- **Thermal injury**
  - **Burns:** Contractures or soft tissue calcifications.
  - **Frostbite:** Usually spares the thumb.

Hemoglobinopathies





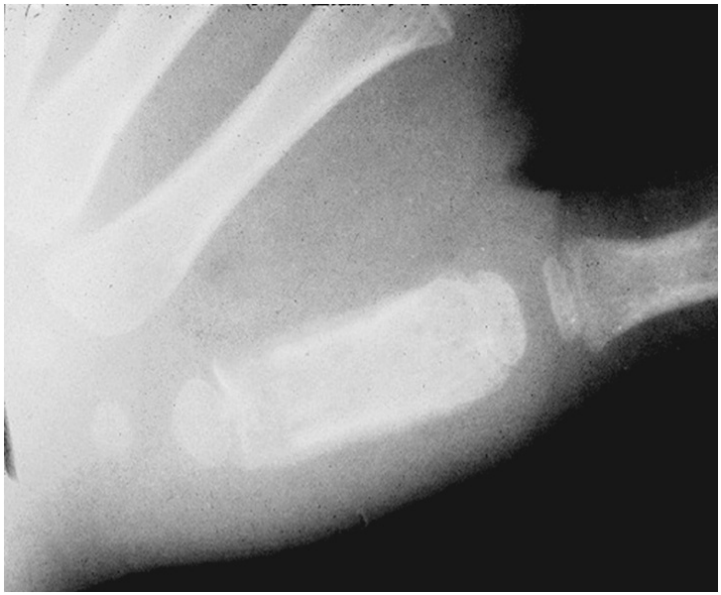


THALASSEMIA

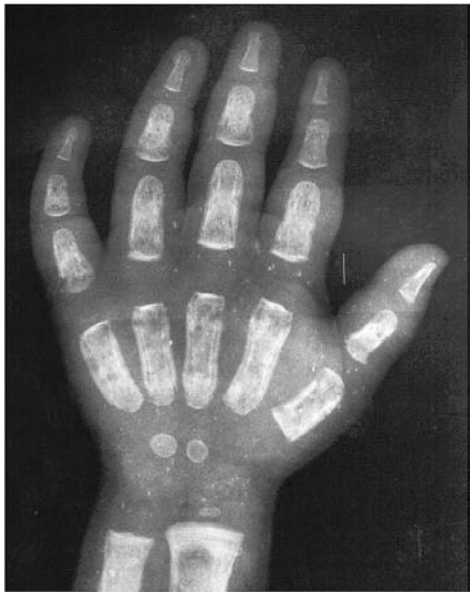
Cooley's Anemia

- Hypermedullosis
- Bulging cortices of metacarpals and phalanges
- Mosaic pattern of spongiosa

Sickle cell hemoglobinopathy

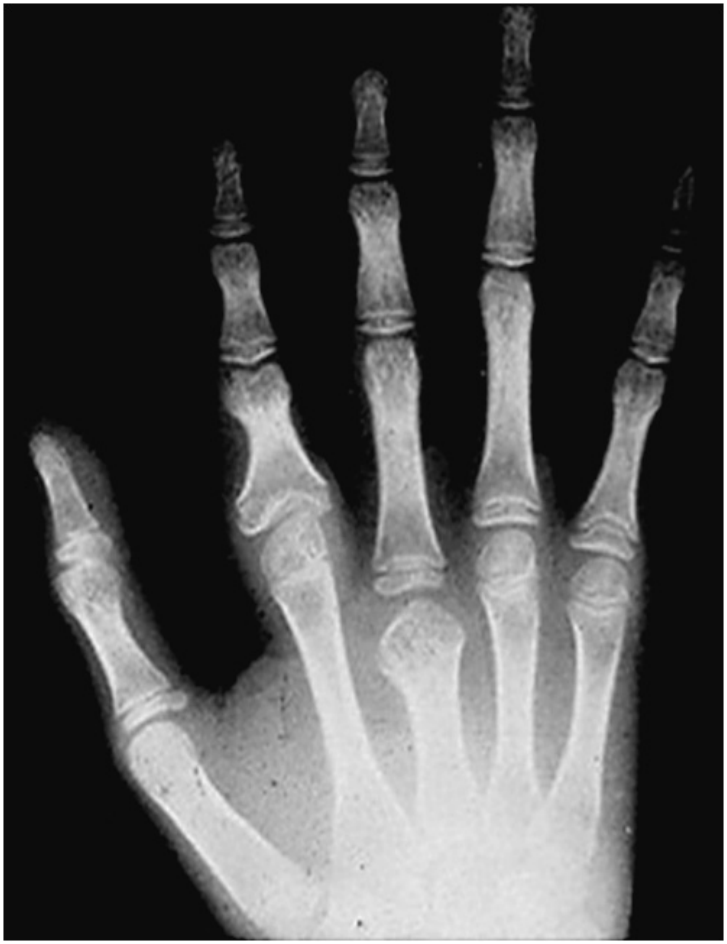


Sickle cell dactylitis
Lytic areas with periosteal reaction



Sickle cell dactylitis
In a 1 ½ yr old child

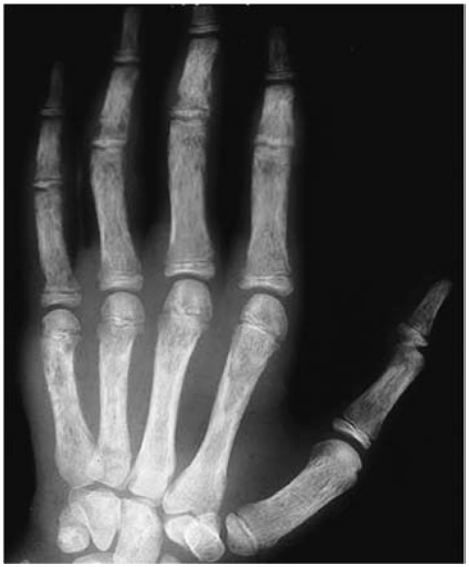
Sickle cell anemia



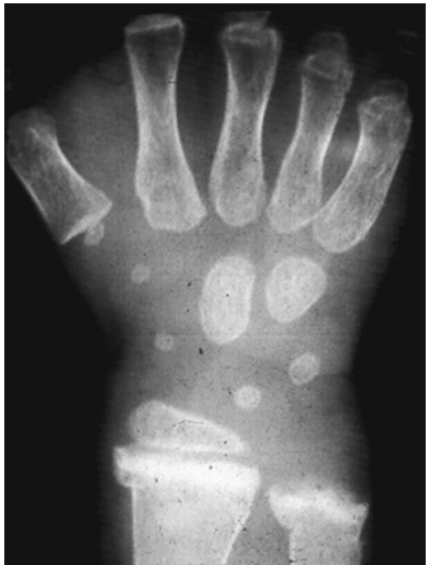
Short 3rd metacarpal and proximal phalanx of the index finger due to premature fusion of epiphysis in sickle cell anemia. Ischemia due to thrombosis of nutrient vessels.

Coned epiphyses.

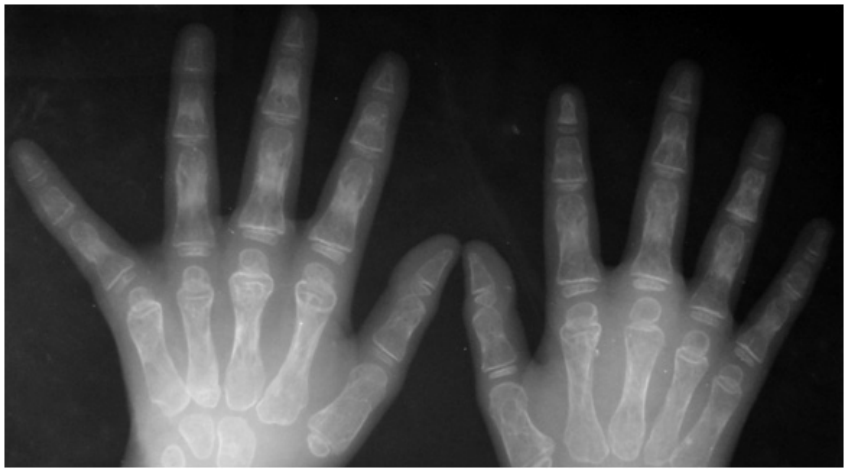
Leukemia



Moth eaten apperance
Osteopenia

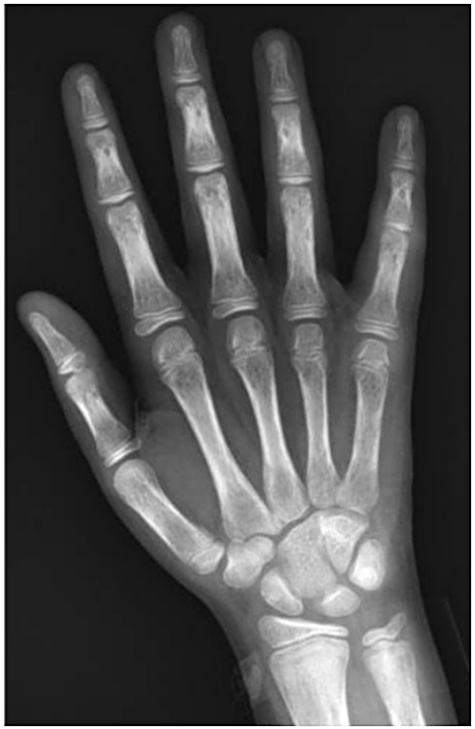


Note osteopenia and crumbling of metaphyseal ends of radius and ulna



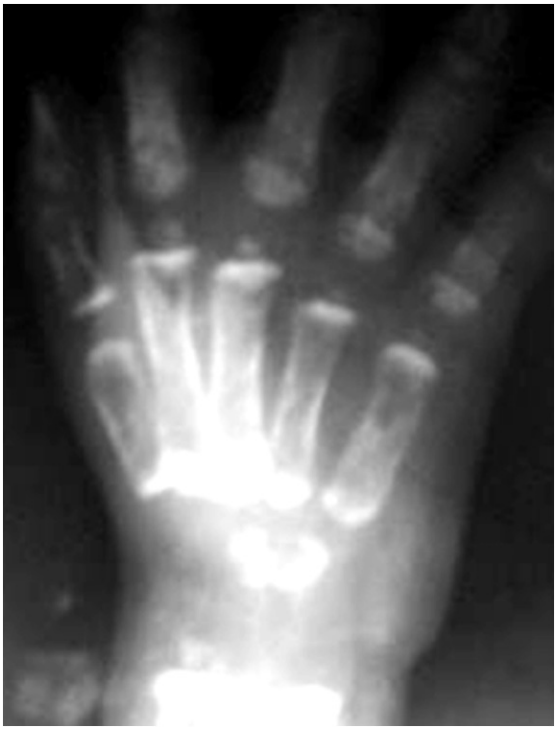
Osteopenia and metaphyseal changes of the metacarpals

9 M, Leukemia - Chronic ALL



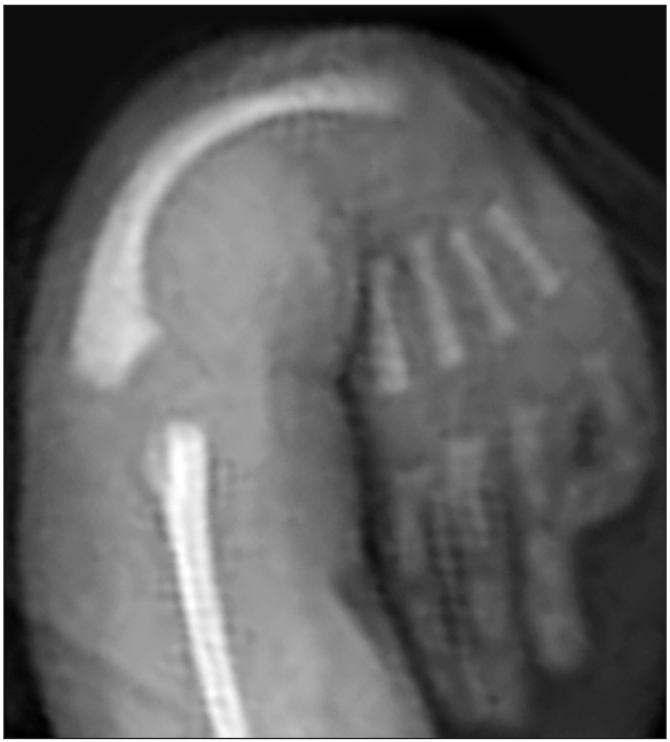
Mild bone marrow changes

2 yr, Acute lymphatic Leukemia



Osteopenia with bands of sclerosis at the metaphyses

Radial ray anomalies – 4 types
Bayne and Klug classification



Fanconi anemia

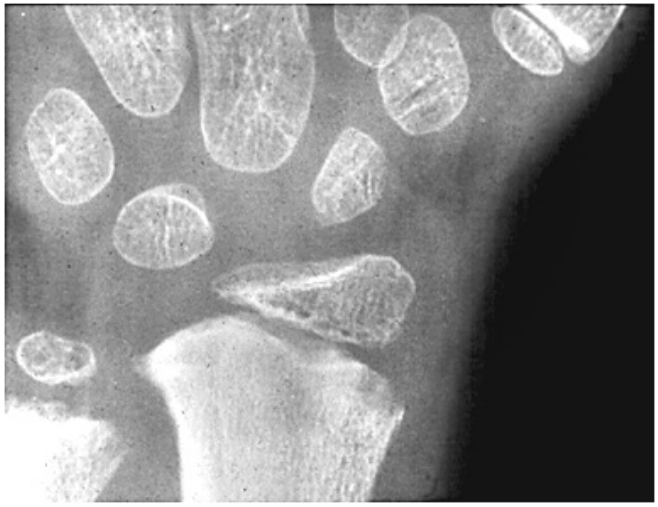
Type 1 **Deficient distal radial epiphysis**

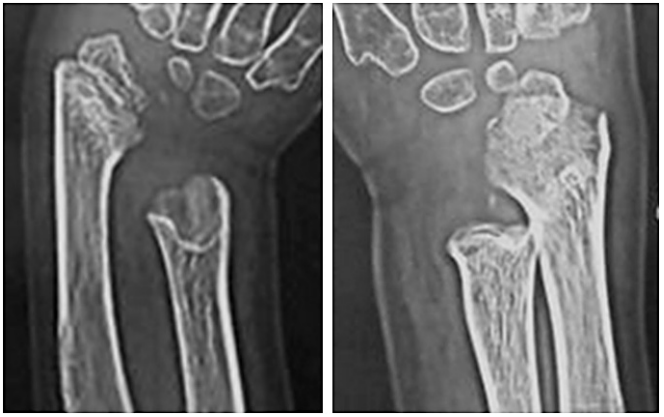
Type 2 **Deficient distal and proximal radial epiphyses**

Type 3 **Present proximally (partial aplasia)**

Type 4 **Completely absent (total aplasia – most common)**

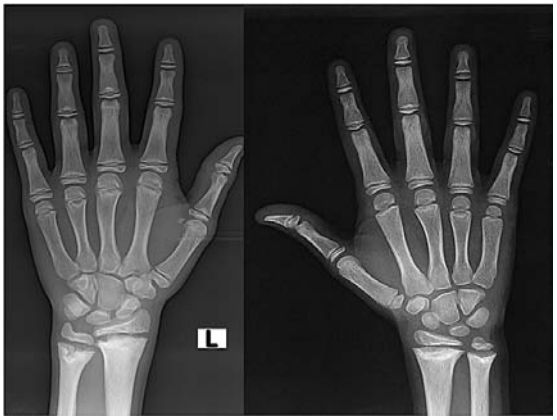
Hypophosphatasia deficiency of alkaline phosphatase or phosphoethanolamineria





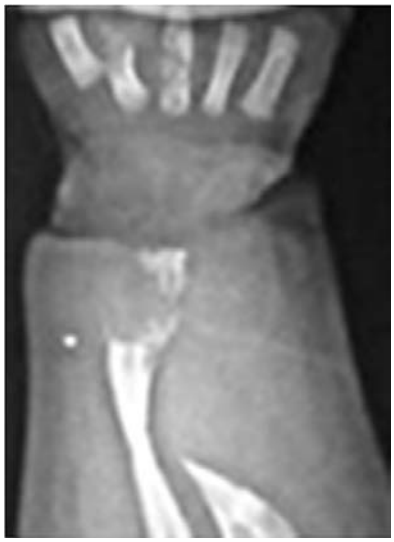
- Neonatal – TAR baby
- Infantile
- Juvenile
- Adult

Metaphyseal flaring, irregular periphyseal regions with large 'chewed out' metaphyseal lucencies

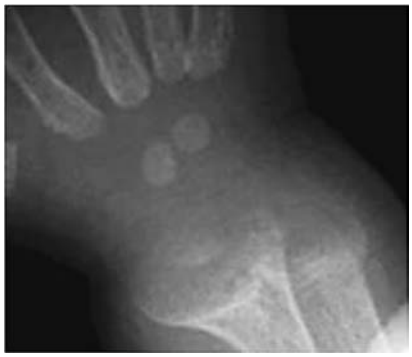


Both hands

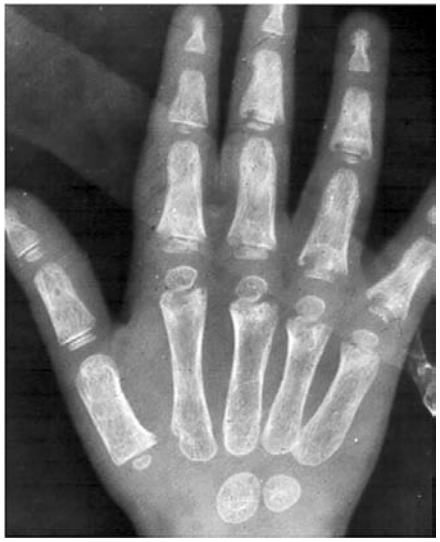
Hypophosphatasia - AR



New born



New born

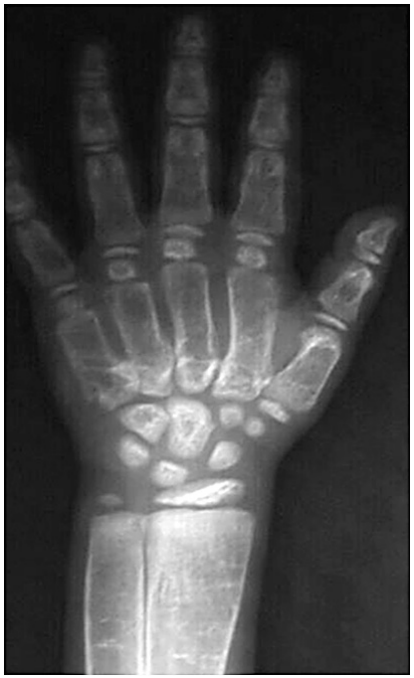


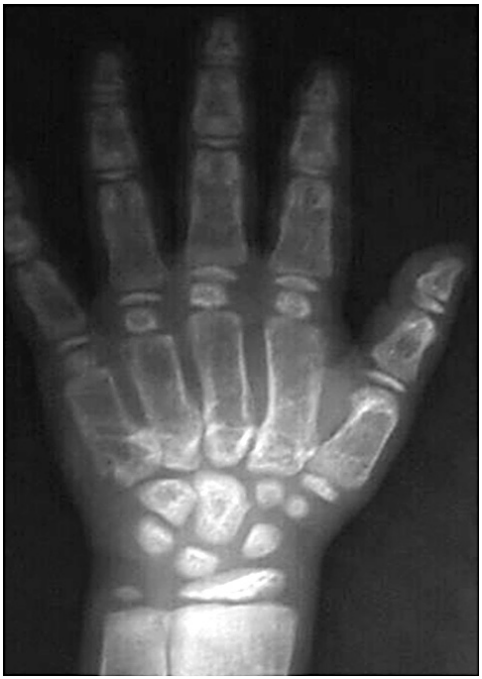
2 yrs

Hypophosphatasia (HPP) is a rare genetic disorder characterized by the abnormal development of bones and teeth. These abnormalities occur due to defective mineralization, the process by which bones and teeth take up minerals such as calcium and phosphorus. Radiologically, it resembles rickets in children.

Hyperphosphatasia

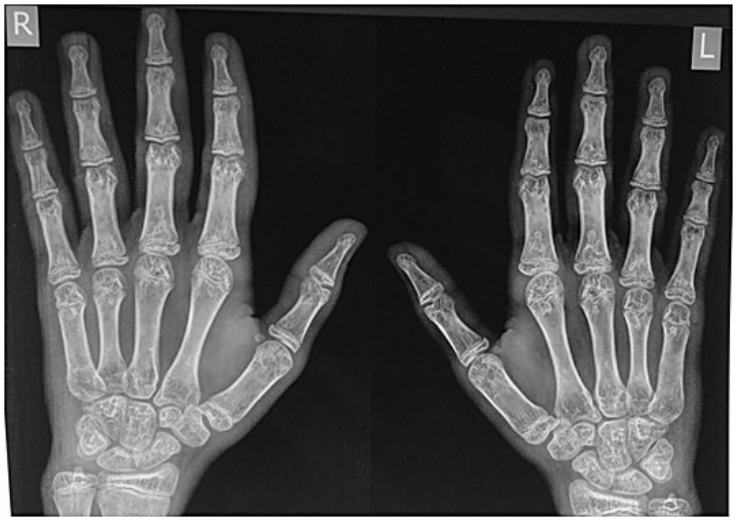
Hereditary hyperphosphatasia is a rare genetic bone disorder (osteopathy) that becomes apparent during infancy or early childhood. It is also called Juvenile Paget's disease as the radiographic appearances simulate Paget. Increased density with widening of the bones is noted.

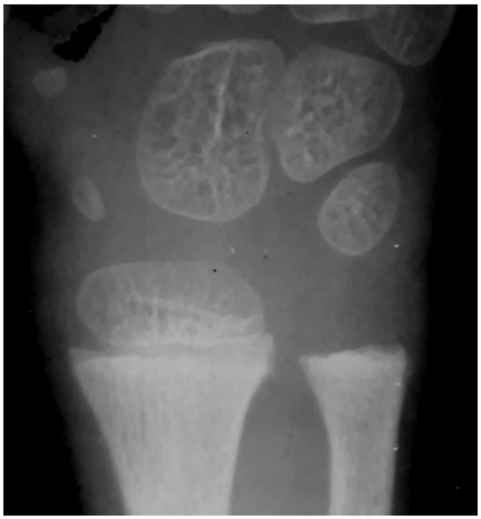




Autosomal recessive-
Genetic–TNFRSE11B
mutations 8

Homocystinuria



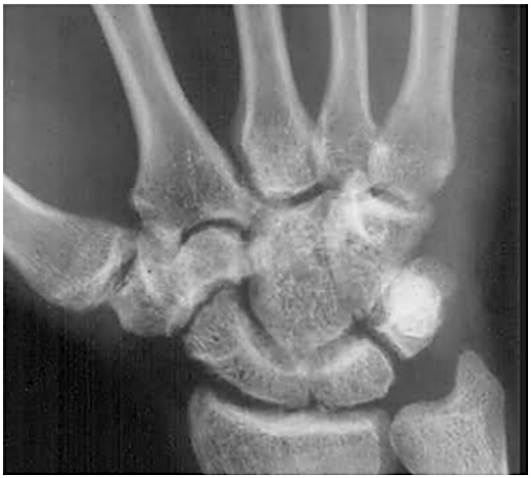


It is a disorder of methionine metabolism, leading to an abnormal accumulation of homocysteine and its metabolites (homocystine, homocysteine-cysteine complex, and others) in blood and urine. It is **due to Cystathionine Beta-Synthase Deficiency.** Radiologically, osteoporosis is the dominant feature. In the carpal bones, the capitate is larger than usual.

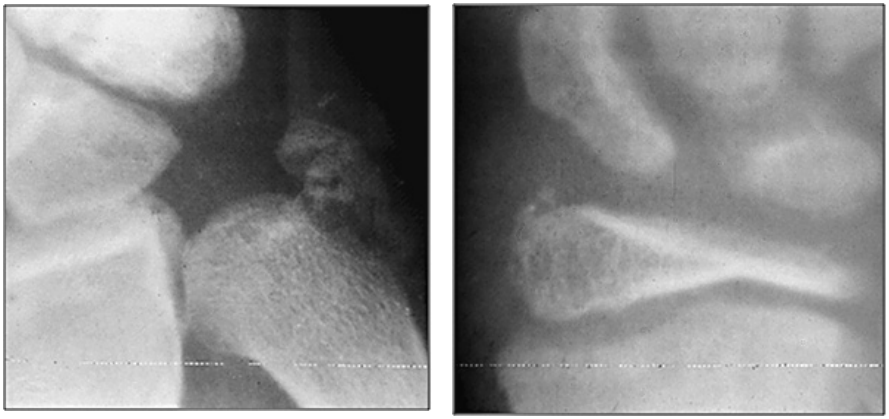
Wilson disease

Serum ceruloplasmin low. Copper accumulates in liver, kidney and cartilages

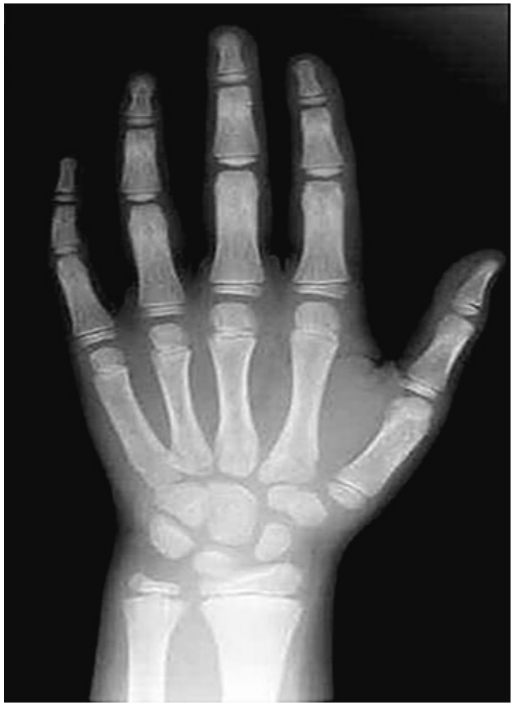
- **RICKETS**
- **OSTEOPOROSIS**
- **'FRINGED' ARTICULAR MARGINS**
- **FRAGMENTATION**
- **OSSICLE FORMATION**



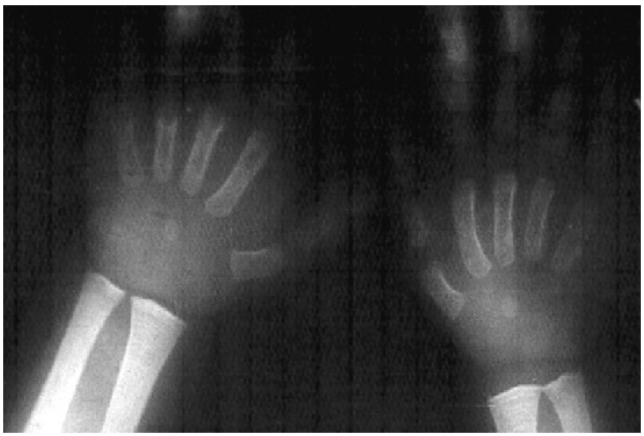
Radiologically, the bones show rachitic changes with cupping of the metaphysis and increased distance between epiphyses and metaphyses. Crenated articular margins is a major feature.



Fringing of articular margins + Rickets

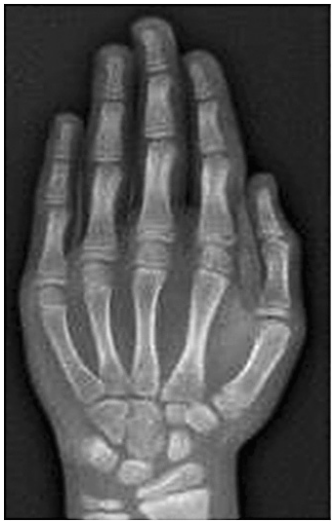


Hand radiograph of a 9 ½ years old girl. The bone age is 8 years - Hypothyroidism

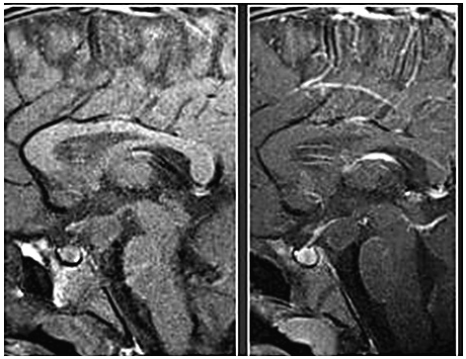


HYPOTHYROIDISM (CRETIN)
Delayed ossification centres – 2yr. old

Advanced bone age

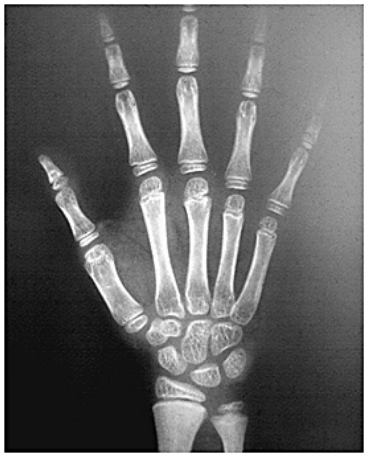


Hypothalamic Hamartoma

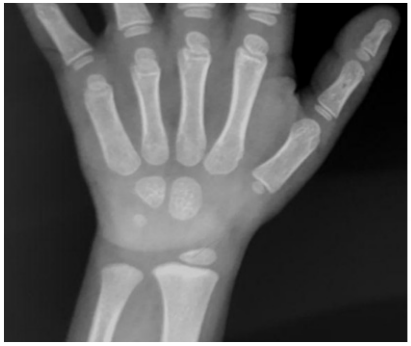


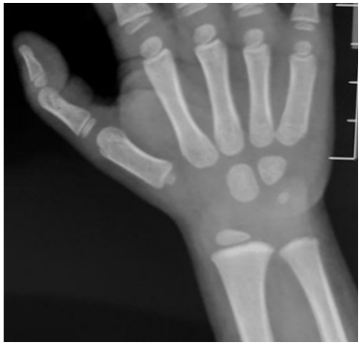
3 yr with precocious puberty, (8 carpal centers)

Hyperthyroidism - 6 yr

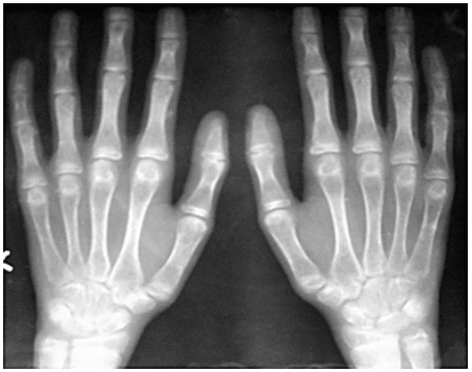


8 carpal centers





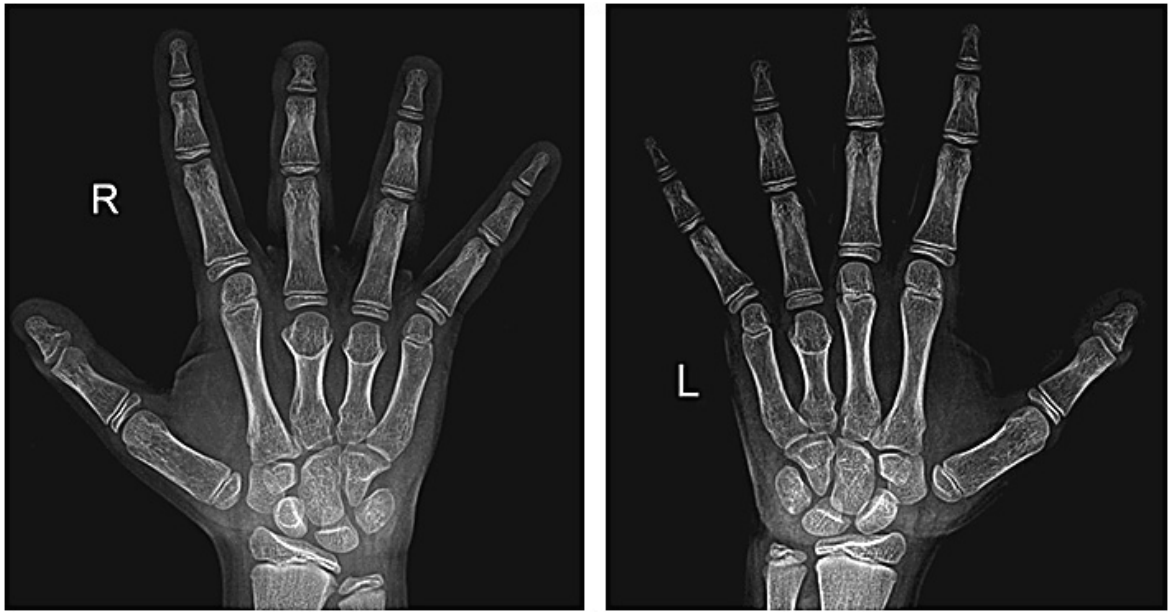
CINCA syndrome – Infant with 3 carpal centres (Chronic Infantile Neurological Cutaneous and Articular)



Cushing syndrome – osteoporosis

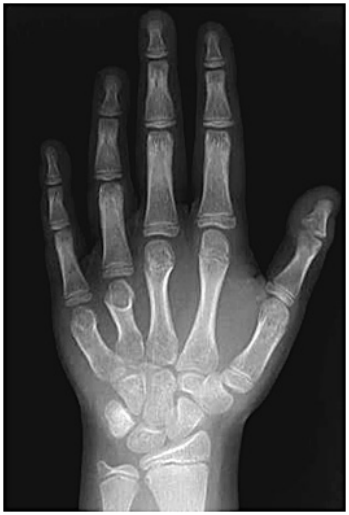
Idiopathic Hypoparathyroidism

Hypoparathyroidism is an endocrinal disorder caused by deficiency of parathyroid hormone which in turn results in decreased serum calcium levels and raised serum phosphorus levels

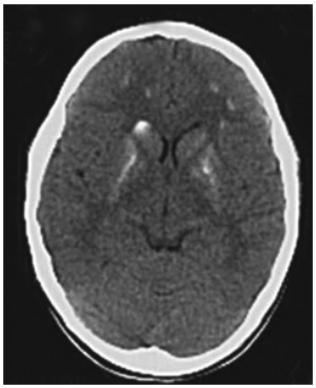


Short metacarpals

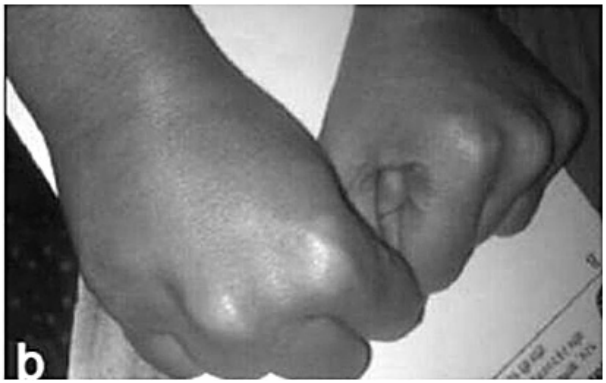
Pseudohypoparathyroidism



Short 4th and 5th metacarpals



Basal ganglia calcifications

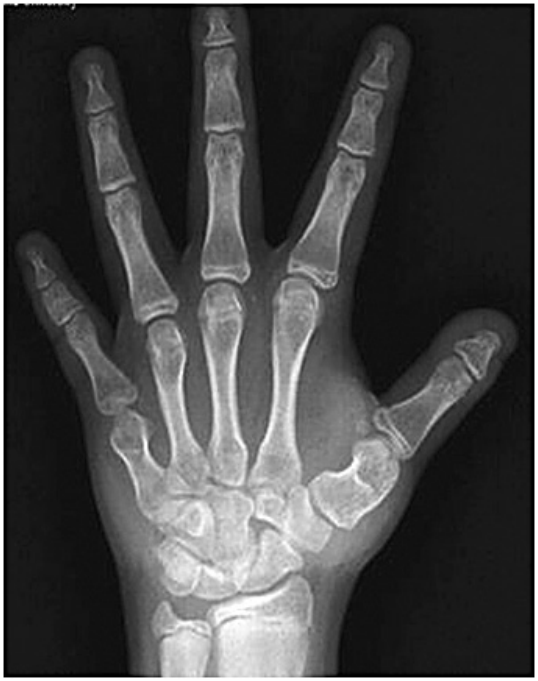


ARCHIBALD SIGN – ALBRIGHT'S
(short & dimpled 4/5th digits, i.e.,
'knuckle-knuckle-dimple-dimple' sign)
Positive metacarpal sign - TURNER

Pseudohypoparathyroidism is associated primarily with resistance to the parathyroid hormone. Those with this disorder have a low serum calcium and high phosphate, but the parathyroid hormone level (PTH) is appropriately high (due to the low level of calcium in the blood).

Pseudo-pseudo Hypoparathyroidism

Pseudopseudohypoparathyroidism is when the person Looks like someone with the former ("knuckle-kunckle-dimple-dimple" hand being a notable feature) but their blood work is that of a totally normal person.



Radiological findings include short metacarpals similar to other forms of hypoparathyroidism. These three types are genetical variants.

Causes of short fourth metacarpal

Common

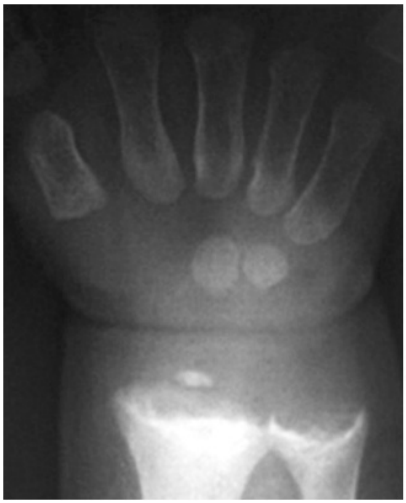
- Idiopathic, familial
- Post-infective
- Pseudohypoparathyroidism /Pseudo-pseudo Hypoparathyroidism
- Turner syndrome
- Post traumatic

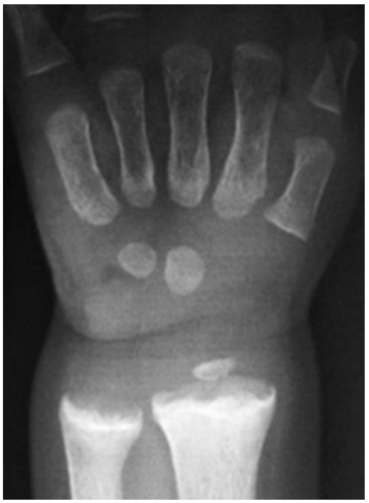
Rare

- Gorlin syndrome
- Hereditary multiple exostosis
- Sickle cell disease
- Homocystinuria
- Post variolar osteo articular lesions

Nutritional, Metabolic & Toxic

Nutritional rickets



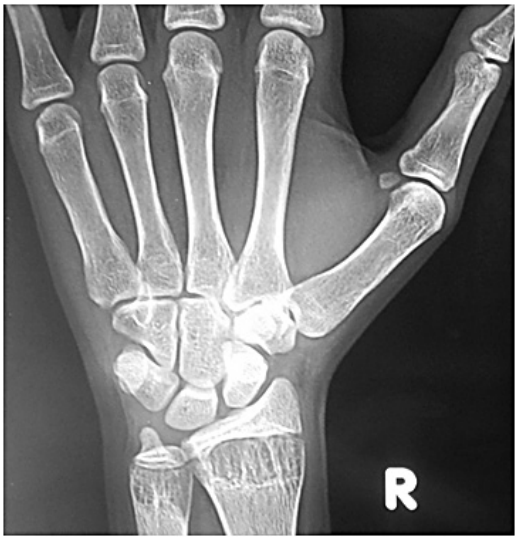


Three types of rickets related to vitamin D:

- **Vitamin D Deficient**
- **Vitamin D Dependant**
- **Vitamin D Resistant – X linked hypophosphatemia**

- **Delayed growth and maturation**
- **Widening of growth plate due to osteoid excess Metaphyseal cupping**
- **Cortical spurs projecting at right angles to metaphysis**
- **Coarse trabeculation / accentuation of primary trabeculae**
- **“Paint Brush”metaphyses**
- **Osteoid seams**

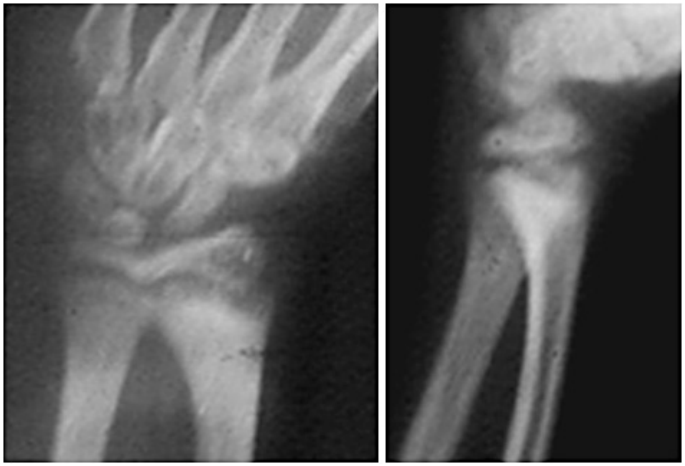
Some scientists consider vitamin D as a hormone.



17 years, Low vitamin D level

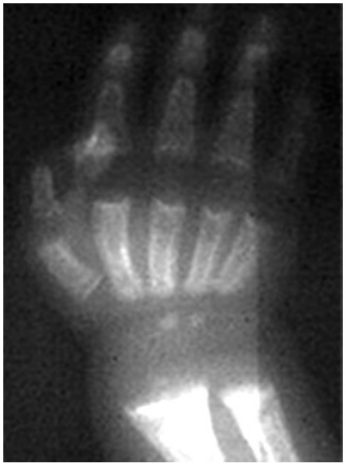
Vitamin D - Activation of vitamin D is controlled by the PTH hormone (parathyroid). Any problem with this activation process of vitamin D will lead to deficiency due to poor diet, lack of sun exposure, GI, liver or kidney disease.

Some antiepileptic drugs interfere with hepatic enzymes resulting in rachtic changes.

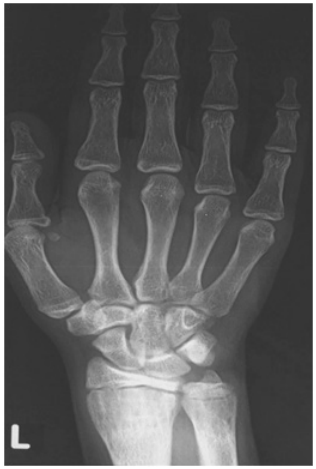


Dilantin therapy for epilepsy resulting in rickets

Rickets

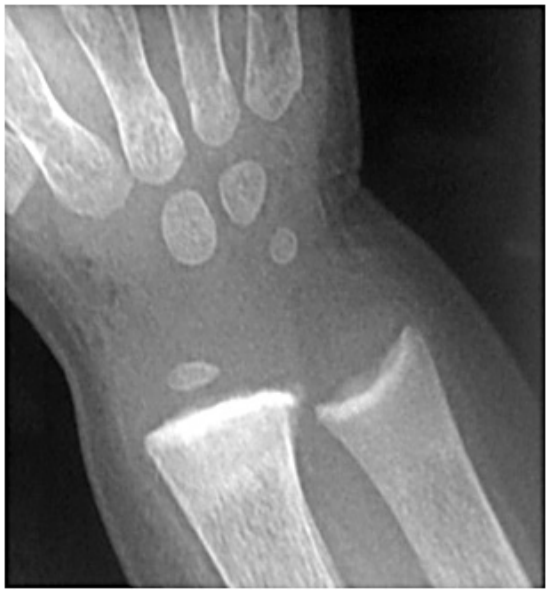


Florid Rickets



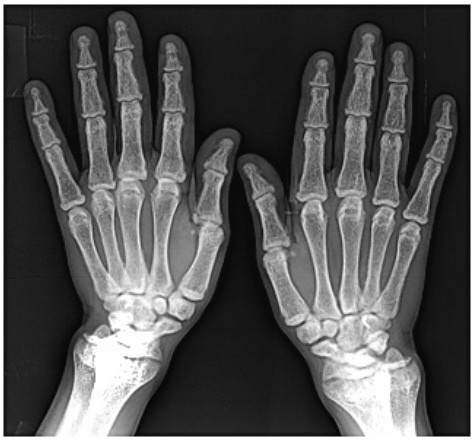
15 F,
Vitamin D < 10

- **Delay in maturation**
- **Osteopenia**
- **Cupping of metaphyses**

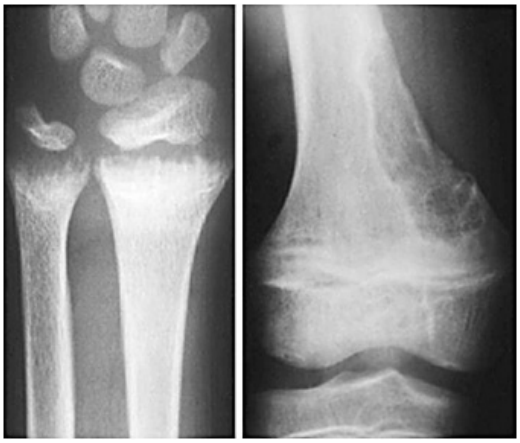


Healing Rickets

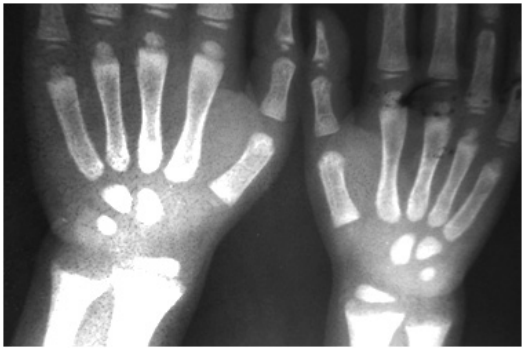
Non nutritional rickets



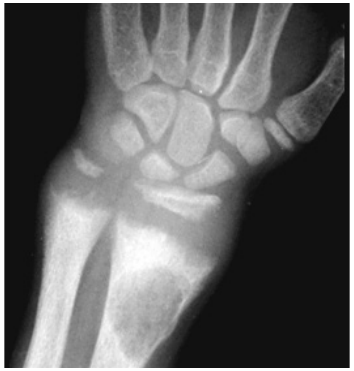
Renal rickets with secondary hyperparathyrodism



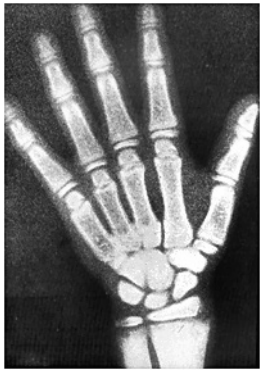
Non ossifying fibroma with rickets (Humoral)



Renal Rickets

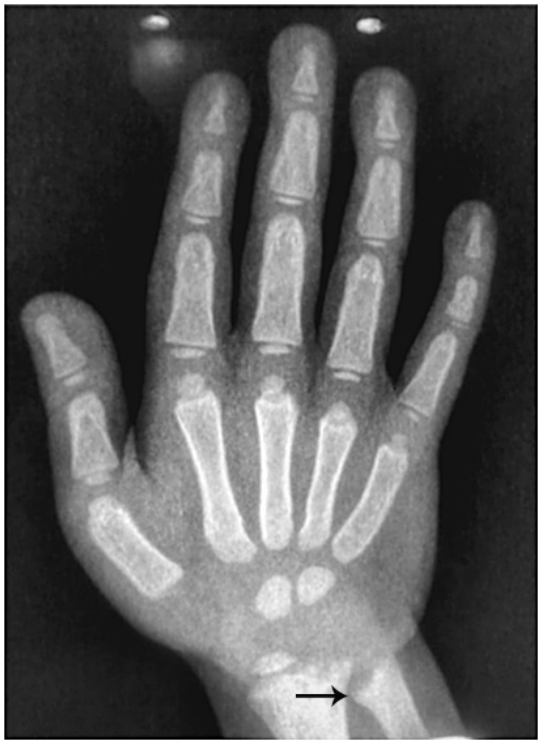


Renal Rickets + Brown tumor



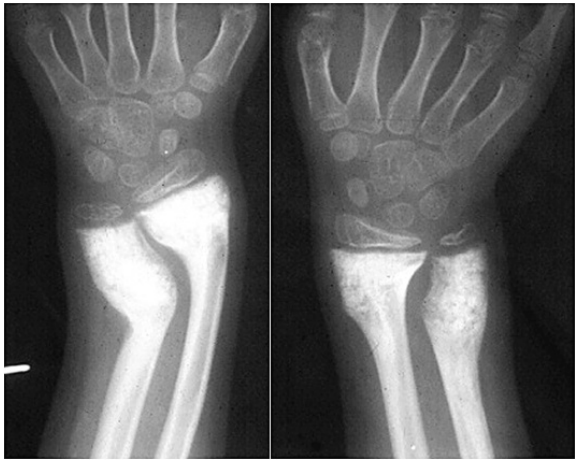
Fluorosis with rickets

X linked familial hypophosphatemic rickets



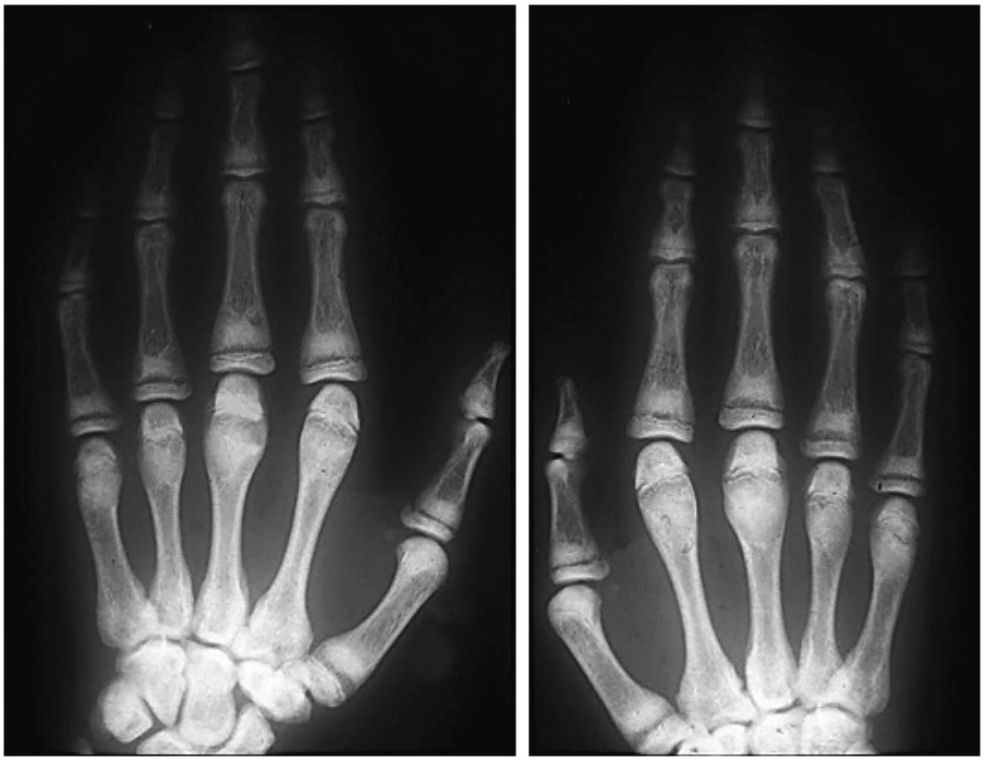
Ground glass appearance of bones with cupping of radius ulna, distally

Healed Rickets

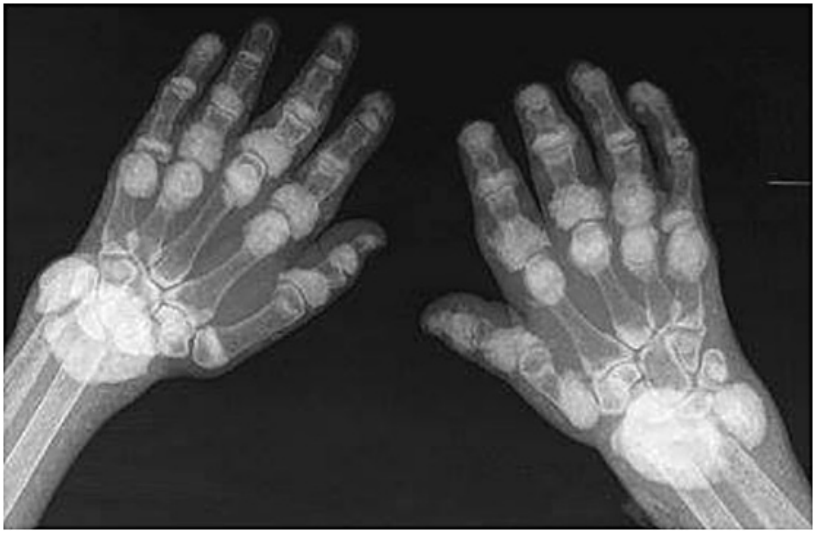


Treated with high doses of Vitamin D

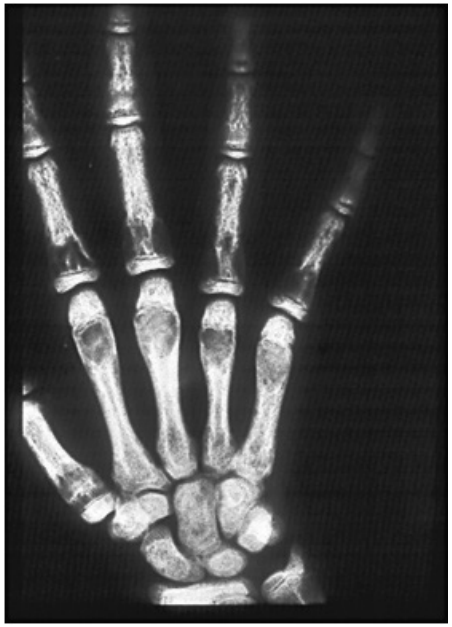
Oxalosis is a rare metabolic disorder that occurs when the kidneys stop eliminating calcium oxalate crystals from the body through the urine. Due to the renal failure, the oxalate crystals are deposited elsewhere in the body, mainly in growing bones. Kidney failure leads to renal osteodystrophy. Besides rachitic changes, the bones are dense and the epiphysis are denser.



Primary oxalosis with renal osteodystrophy



Oxalosis + tumoral calcinosis
Due to renal osteodystrophy

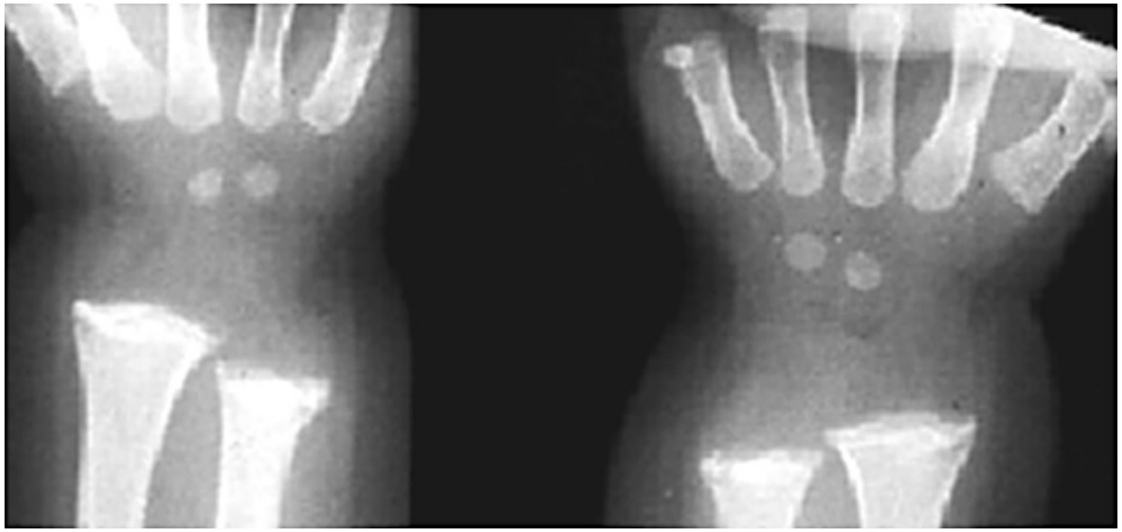


Coarse rarefaction and cystic changes in metaphyses, sclerotic epiphyses with renal osteodystrophy.

Scurvy – vitamin C deficiency

Scorbutic changes

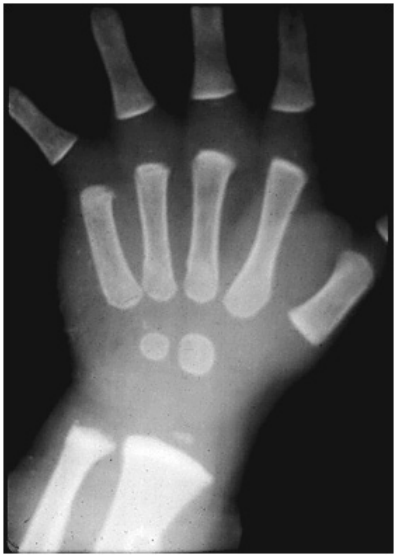
Osteoporosis, Pelkin's spurs, dense line with a proximal radiolucent lines in metaphyses



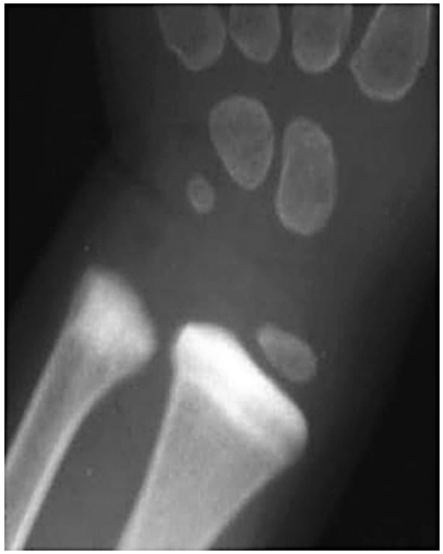
Toxic

Lead poisoning (Plumbism)

Dense bands at the growing ends of the bones and around carpal ossification centers



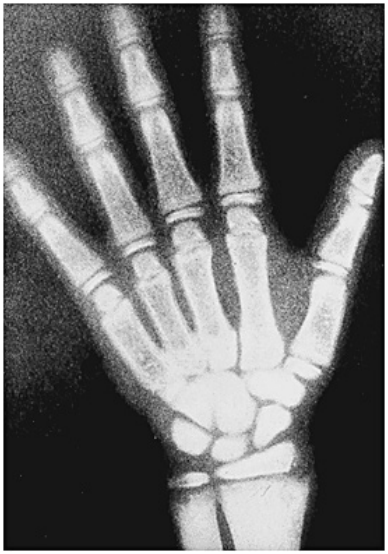
Lead poisoning (Plumbism)



Lead toxicity

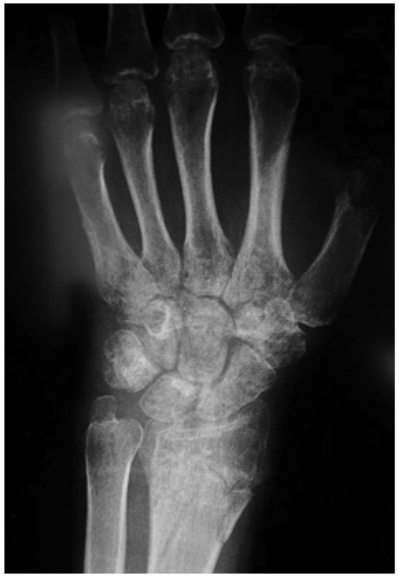
Skeletal

Fluorosis

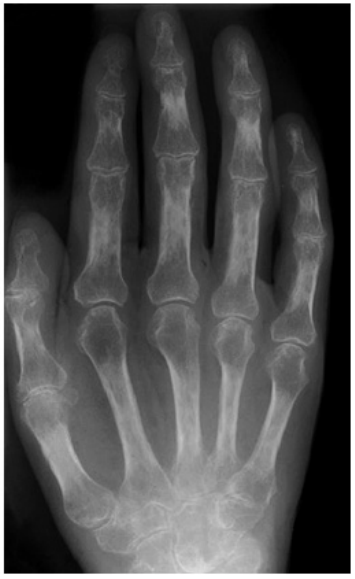


Dense bones with rachitic changes

Complex Regional Pain Syndrome - CRPS

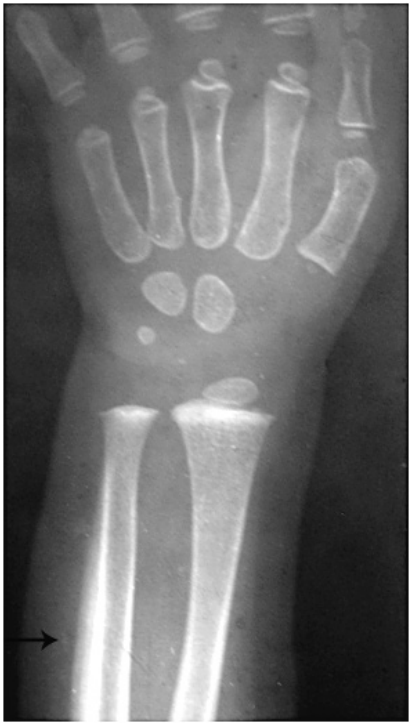


Immobilisation for fracture radius resulting in CRPS



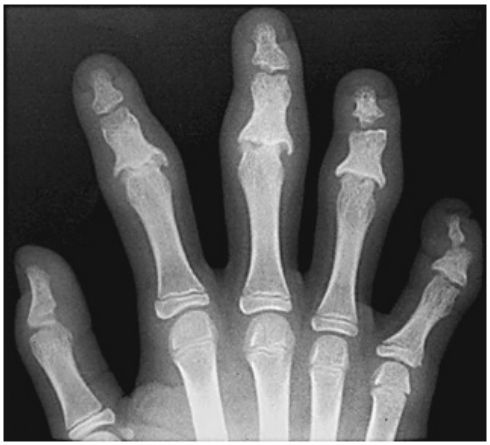
Para articular osteoporosis

Hyper vitaminosis A & D



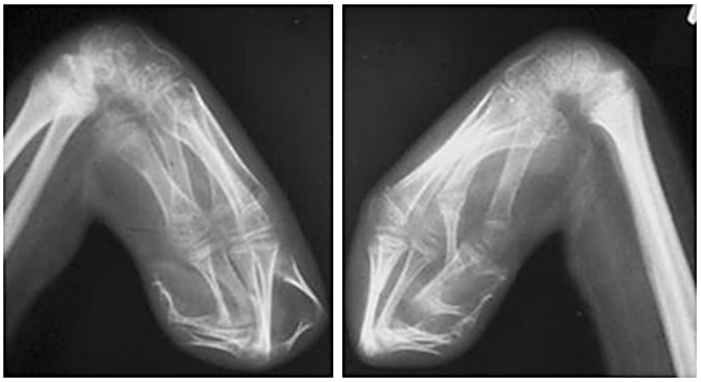
Osteoporosis of the bones, dense metaphyseal bands and periosteal reaction along ulna

Frost bite



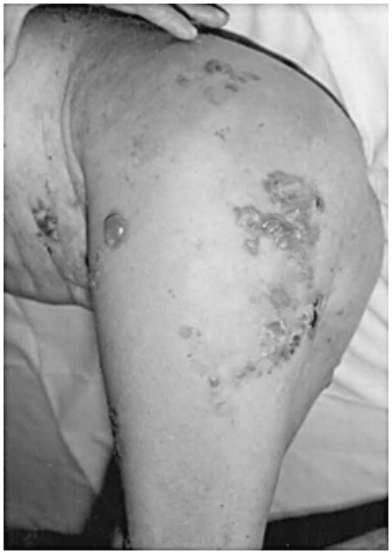
Erosive with reactive sclerosis at the bases of the middle phalanges

Epidermolysis bullosa



Marked contractures with tapering of distal phalanges – different from burns

Epidermolysis bullosa:
Hereditary disorder of marked squamous epithelial fragility and blister formation, affecting the skin and mucous membranes. Patients have numerous bullous slesions, which scar after the rupturing, leading to joint contractures, and esophageal strictures.

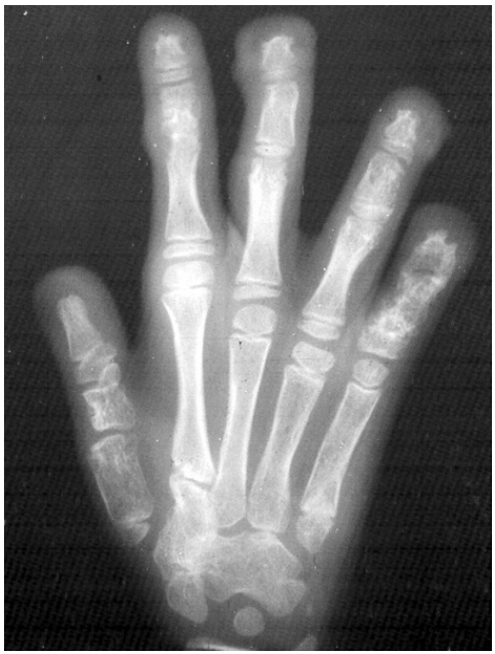


Skin over the shoulder

Section-10

PHACOMATOSES

The neurocutaneous syndromes are a group of inherited disorders featuring multiple, discrete lesions of 2 or more organ systems, most commonly the skin and brain.



Mesenchymal dysplasia in neurofibromatosis

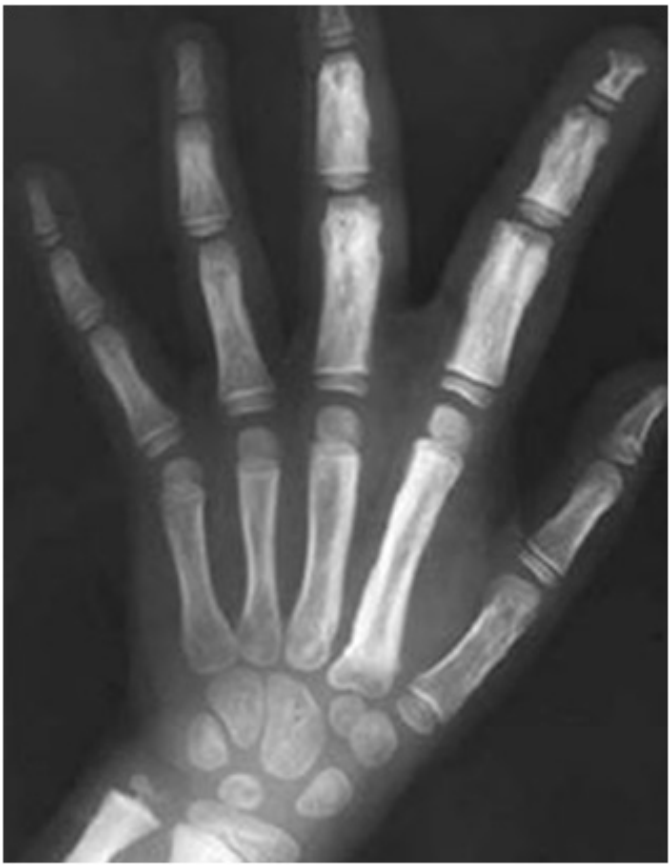
- **Neurofibromatosis 1 & 2**
- **Tuberous sclerosis**
- **Macrodystrophia lipomatosa**
- **Klippel Trenaunay Weber syndrome**
- **Proteus syndrome**

Neurofibromatosis 1 & 2

Note the bizarre shaped bones with developmental deformities of the phalanges, metacarpals and carpals. Cystic changes in the phalanges should not be mistaken for tuberous sclerosis.

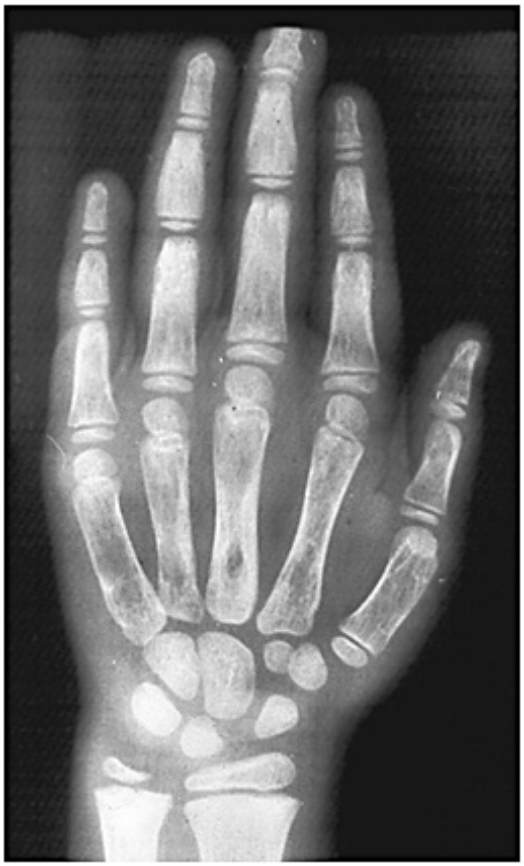
Note also growth abnormalities

NF1



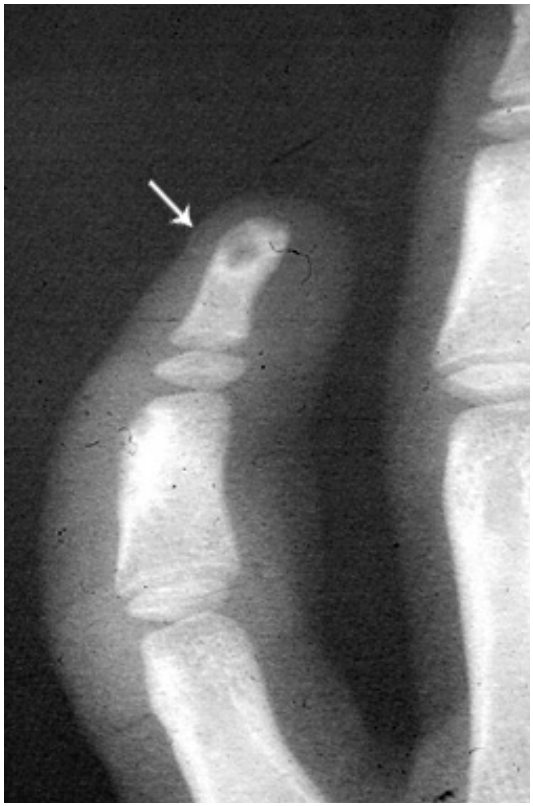
Mesenchymal dysplasia
2nd & 3rd fingers

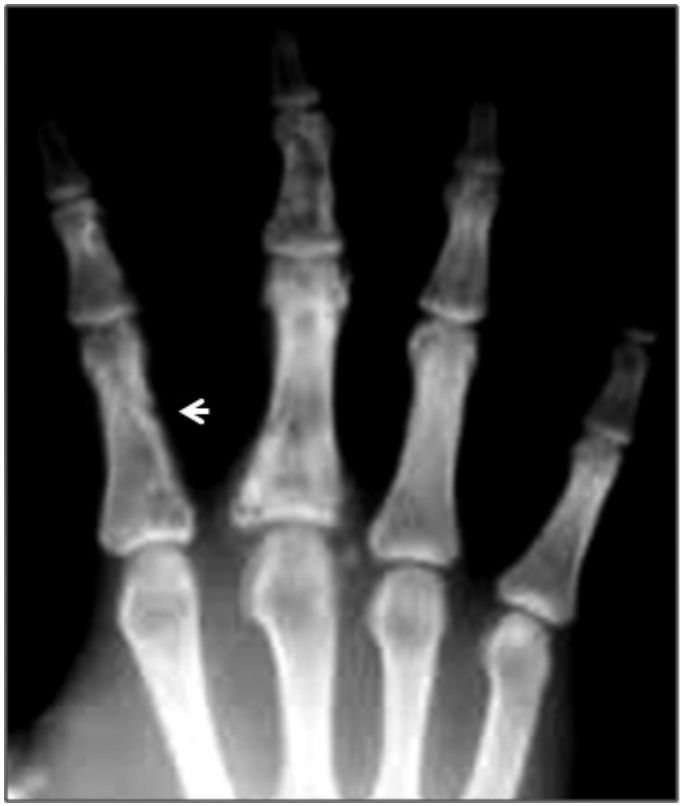
NF1



Mesenchymal defect
in 3rd metacarpal

Epiloa / Tuberous Sclerosis - AD

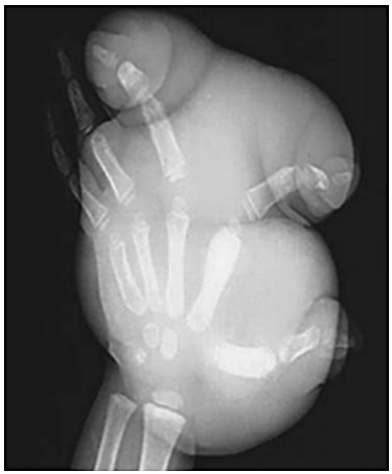


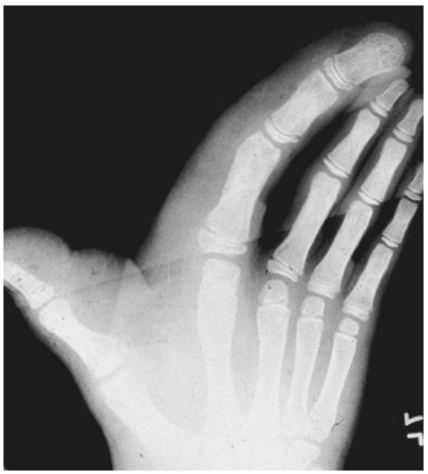


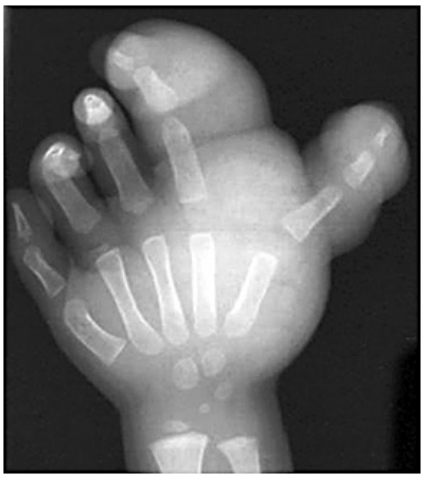
Little finger

Note cortical pitting, sclerosis and cystic change in phalanges. Clinically, adenoma sebaceum, seizures and mental retardation.

Macrodystrophia lipomatosa





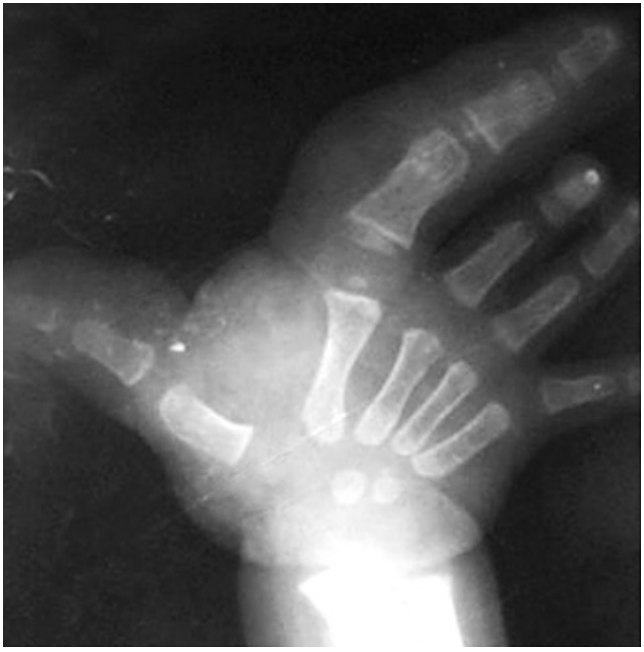


This may be part of generalised hamartomatous disorder. Anotomic location corresponds closely with the innervation of sclerotomes.

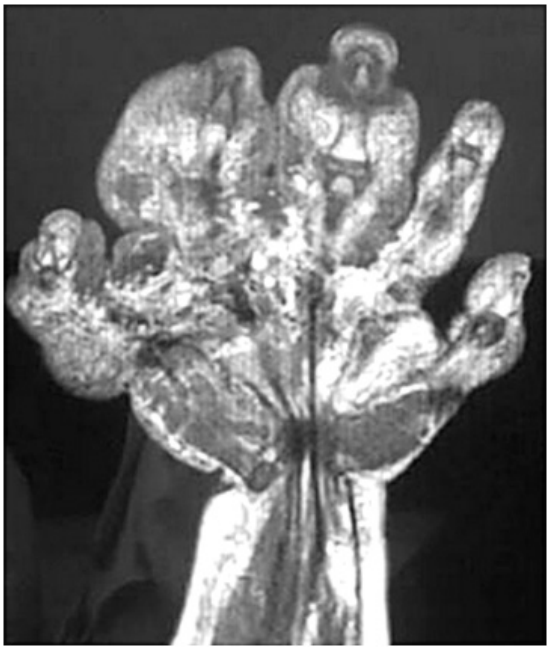
Differential diagnosis

- neurofibromatosis type 1 (NF1)
- fibrolipomatous hamartoma of the median or ulnar nerve
  - fatty tissue accumulates within the nerve sheath rather than within the region
- vascular malformation
  - haemangioma, including Maffucci syndrome
  - arteriovenous malformation (AVM)
  - Klippel-Trenaunay-Weber syndrome

Macrodystrophia lipomatosa

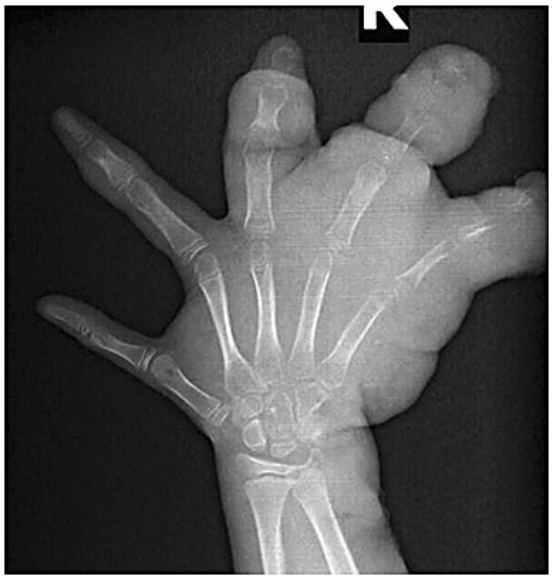


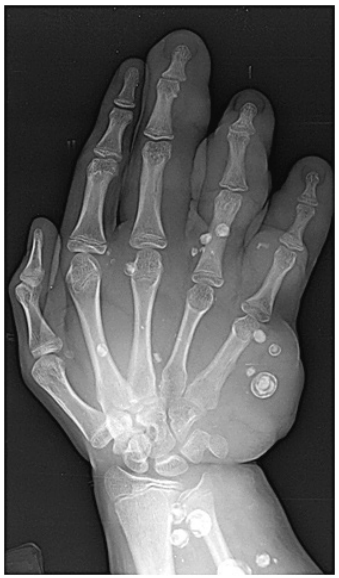
Involvement of thumb and index finger

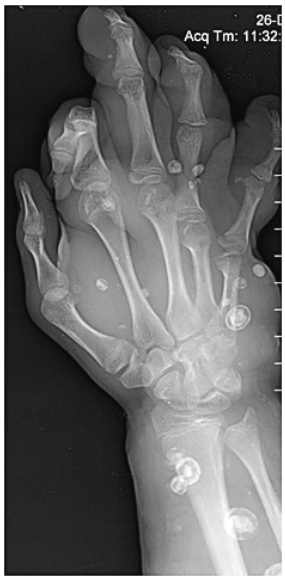


MRI – medial 3 fingers are involved

Klippel Trenaunay Weber syndrome



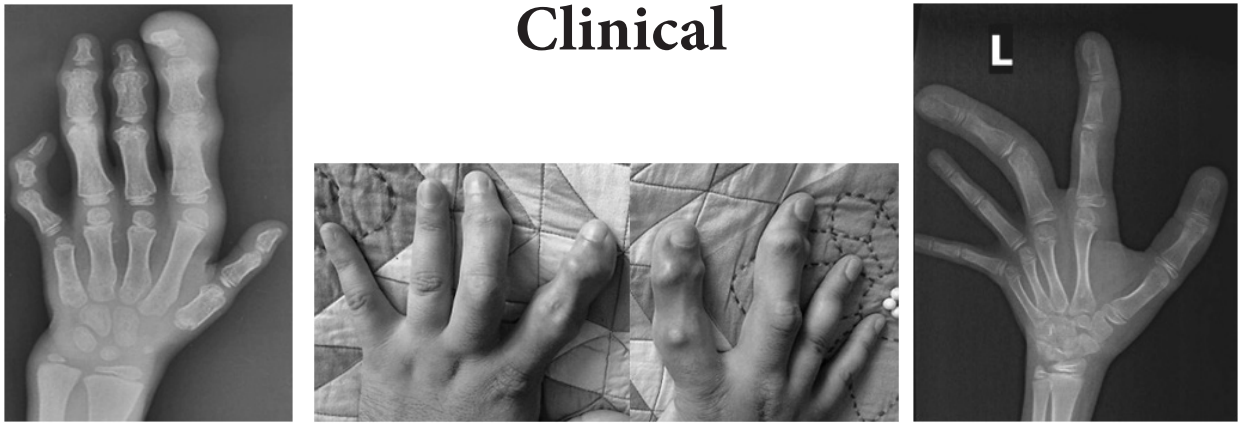




Represents low-flow vascular malformation.

Generally involves the lower limb. Most common major finding is overgrowth of subcutaneus soft tissues. The effected fingers are thicker and longer than others. Multiple phleboliths are seen in venous channels.

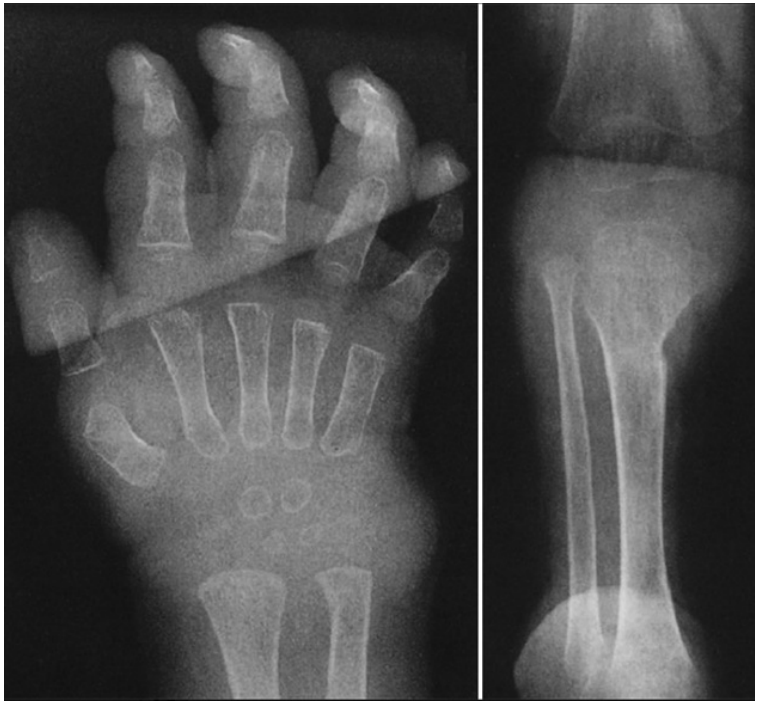
Clinical



Asymmetric macrodactyly with hyperostosis

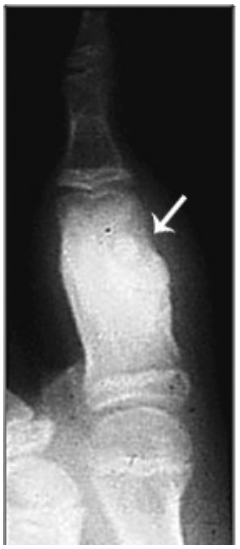
Proteus syndrome (1979) is a rare disorder named after the name of Greek God Proteus who could change his shape at will to avoid capture. It is characterized by overgrowth of the bones, skin, and other tissues. Organs and tissues affected by the disease grow out of proportion to the rest of the body. The overgrowth is usually asymmetric, which means it affects the right and left sides of the body differently. Congenital disorder in which local gigantism is associated with progressive overgrowth of all the messenchymal elements. The involvement is almost always unilateral.

Myofibromatosis / Infantile myofibromatosis / Aggressive infantile fibromatosis



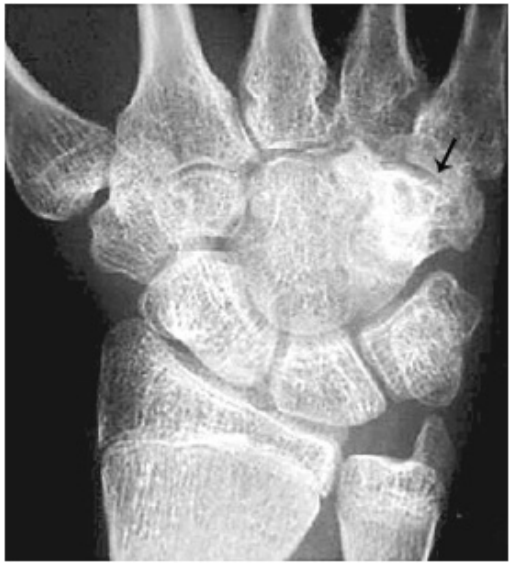
Almost 90% of cases occur within the first 2 years of life, with 50% occurring in newborns. Three categories of IM are described: solitary, multicentric without visceral involvement, and generalized with both cutaneous and visceral involvement. The multicentric form of IM involves the skin, subcutaneous tissues, muscles, and bone. The bones most commonly involved are the skull, femur, tibia, spine, and ribs. Involvement of the central nervous system has also been reported.

Benign Neoplasms



Osteoid osteoma phalanx with central calcific focus

A benign osseous tumor which may be periosteal, intracortical, medullary and sub articular. A lucent nidus with surrounding sclerosis is often noted. When the nidus is not seen on conventional films, CT scan is advised. The diameter of the nidus is < 2cm.



Osteoblastoma of the hamate bone

A benign osseous tumor with a nidus > 2cm in diameter. Radiologically, four morphological patterns are noted.

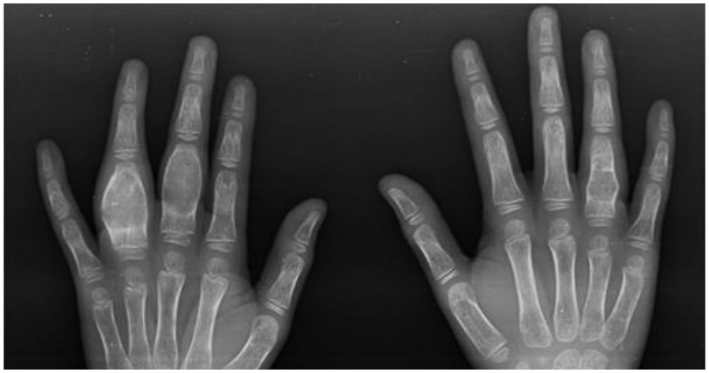
1.Giant osteoid osteoma,

2. Aneurysmal bone cyst,

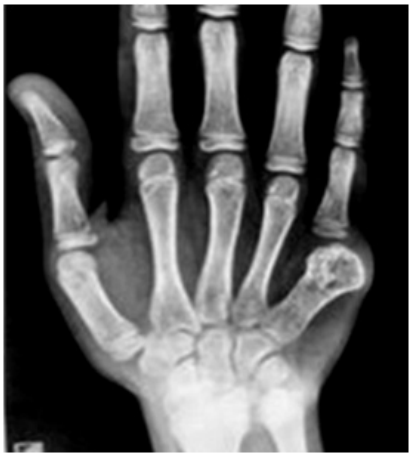
3. Fibrous dysplasia,

4. Osteosarcoma.

Cartilaginous tumors

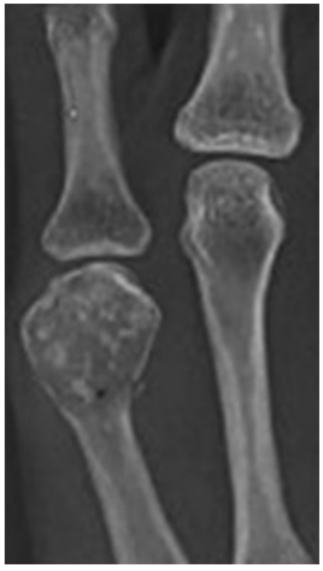


Ollier's – Multiple enchondromata

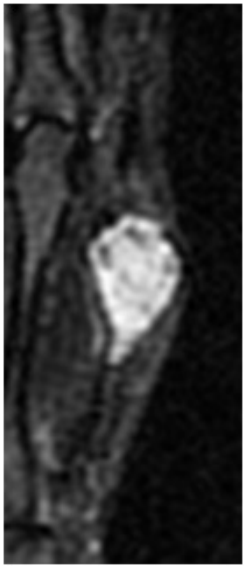


Enchondroma of fifth metacarpal head

Note multiple calcifications with pathological fracture

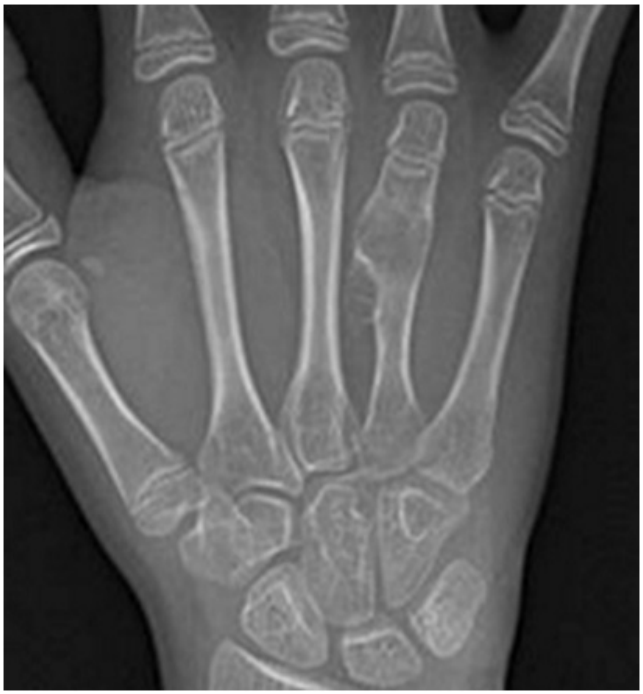


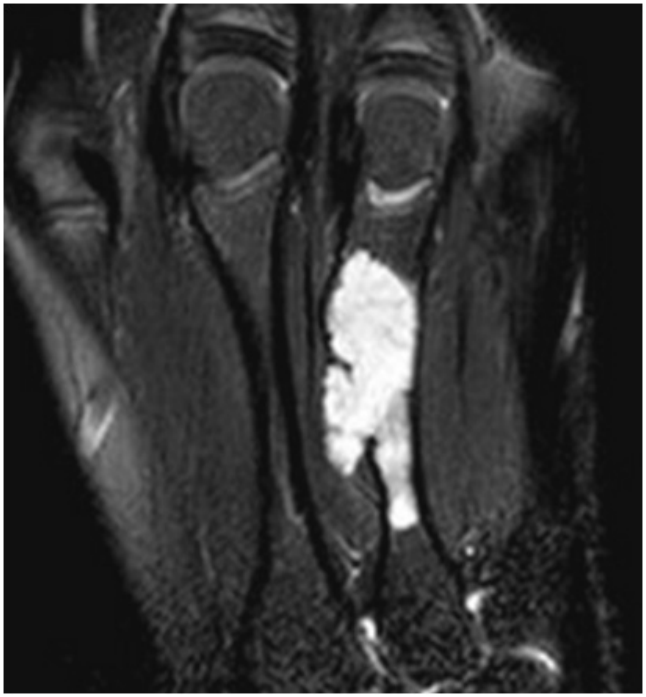
18 yr old, enchondroma 2nd metacarapal head



MRI

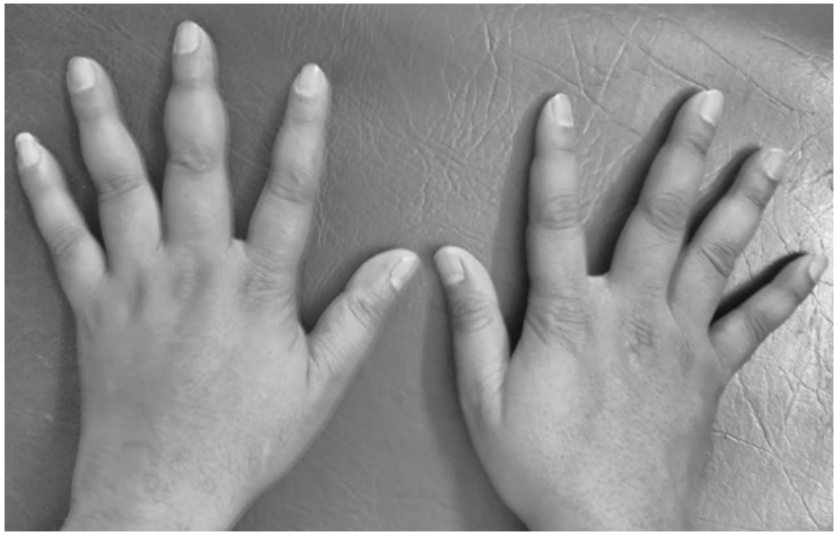
Enchondroma Protruberans 4th metacarpal

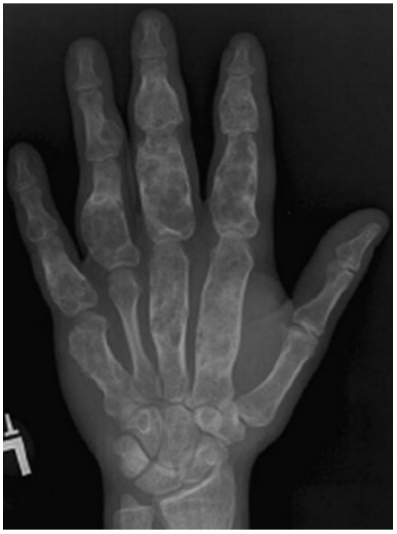




MRI

Multiple enchondromata

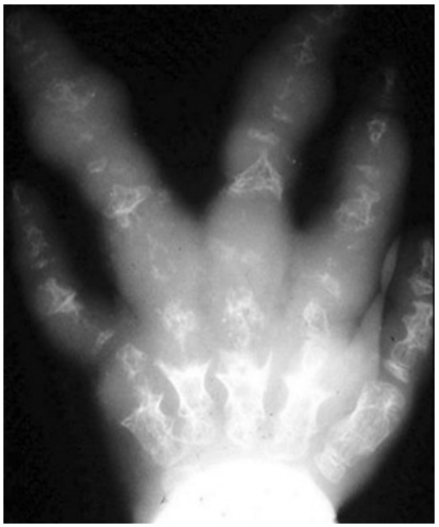




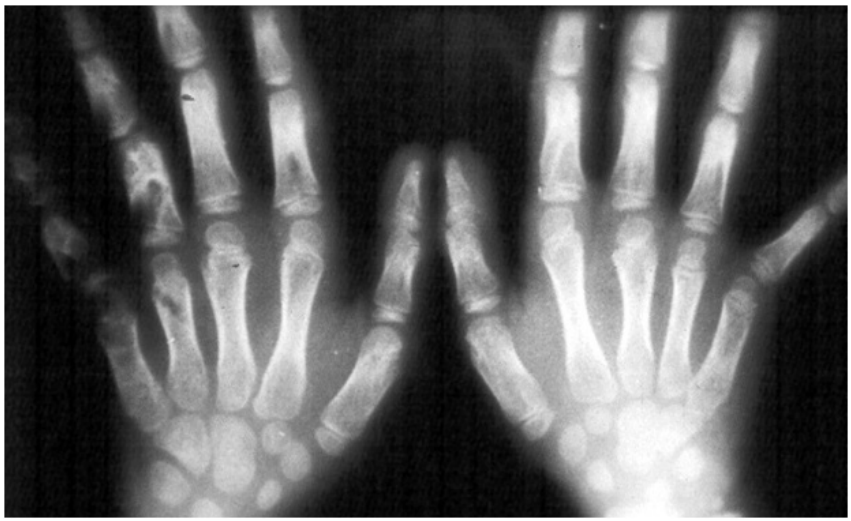
Benign cartilaginous lesions are more common in children:

1. **Enchondroma**
2. **Multiple enchondromatosis**
3. **Osteochondroma**
4. **Multiple exostosis**
5. **Ollier's dyschondroplasia**
6. **Periosteal chondroma**
7. **Chondroblastoma**
8. **Chondro myxoid fibroma**
9. **Trevor disease**
   (Dysplasia epiphysealis hemimelica)
10. **Intra cortical chondroma**

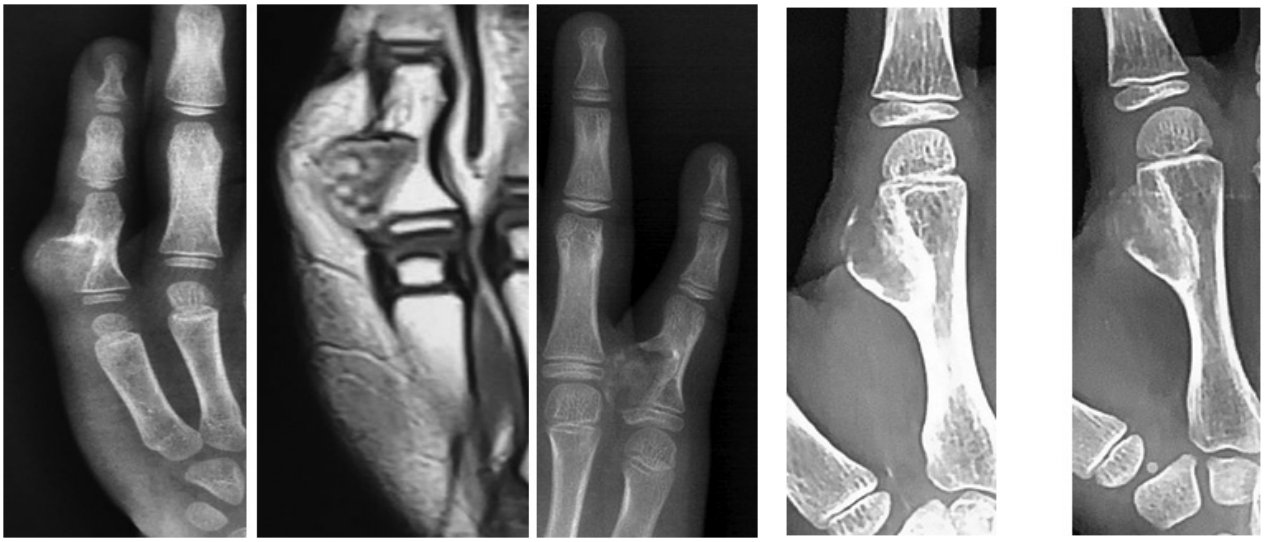
Ollier's dyschondroplasia



Multiple enchondromata, cartilaginous dysplasia with linear columns of hyaline cartilage. Shortening of the bones may be seen.



Periosteal chondroma

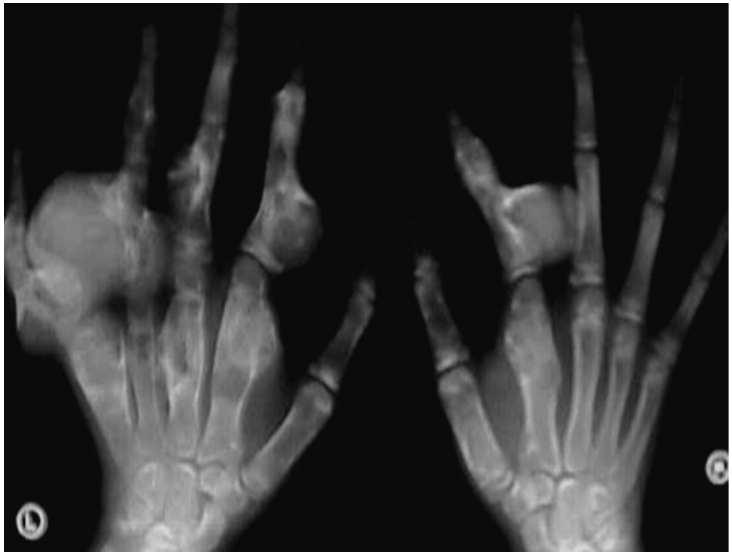


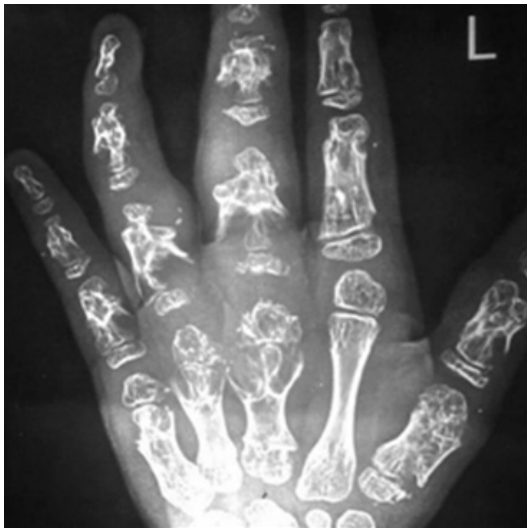
Little fingers

2nd metacarpal

It is also called 'Juxta cortical chondroma' and is a chondromatous lesion arising from the periosteum. It may grow into the medullary cavity. A characteristic cortical hook, similar to the hook noted in gout indicates the cartilaginous nature. MRI is rarely necessary. Nodular calcification may be noted in the matrix. Note the out-growths in the proximal phalanges with hook shaped deformity in the diaphyses. Chondroid calcification may be present.

Muffucci syndrome

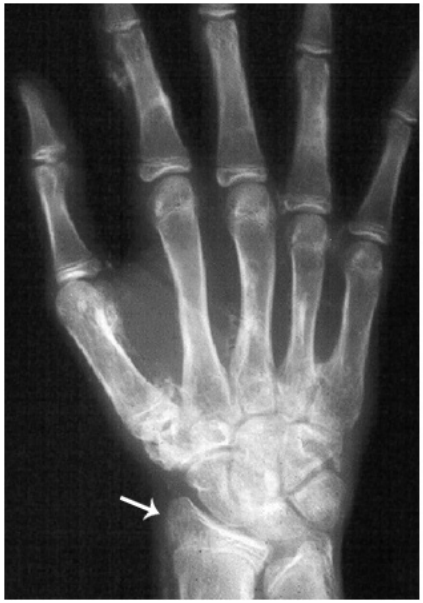




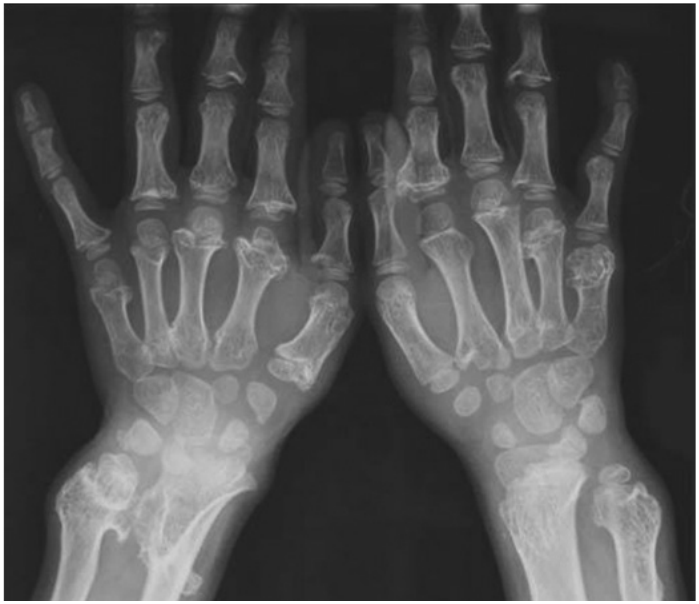
Multiple chondromata with soft tissue hemangioma

Note Phleboliths

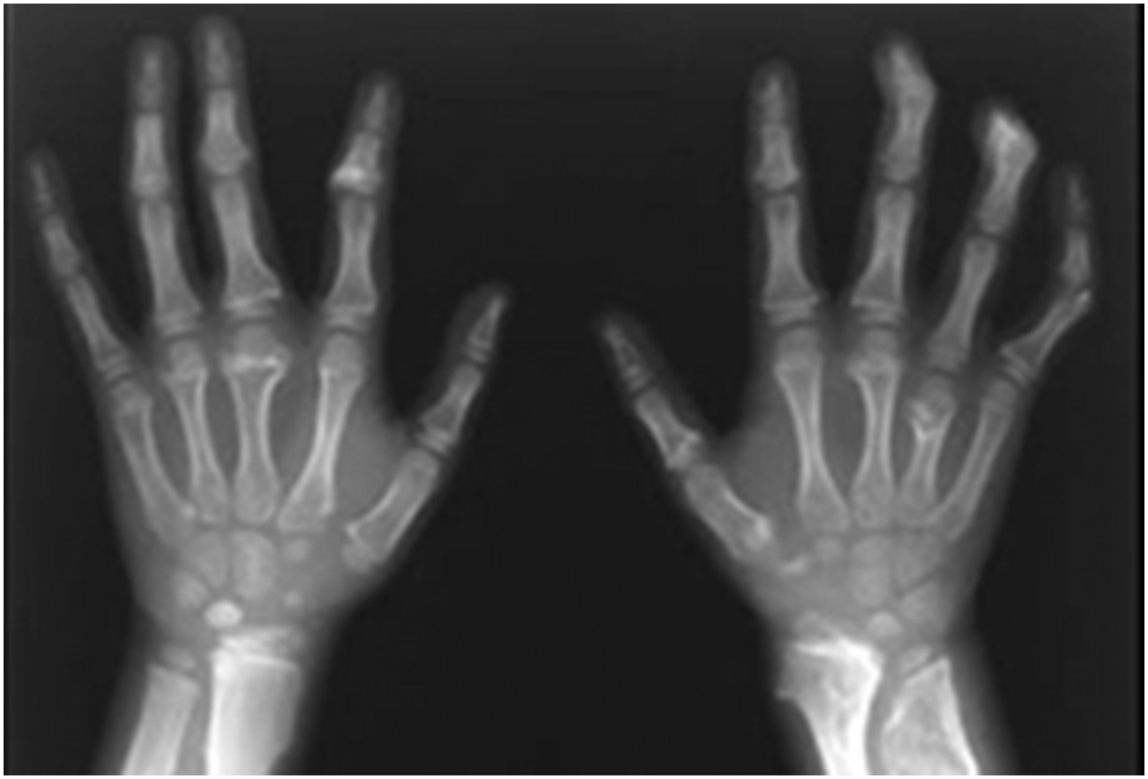
Multiple Hereditary Osteochondromata



Note multiple, scattered calcific densities with deformities at the wrist. Note pseudo Madelung deformity



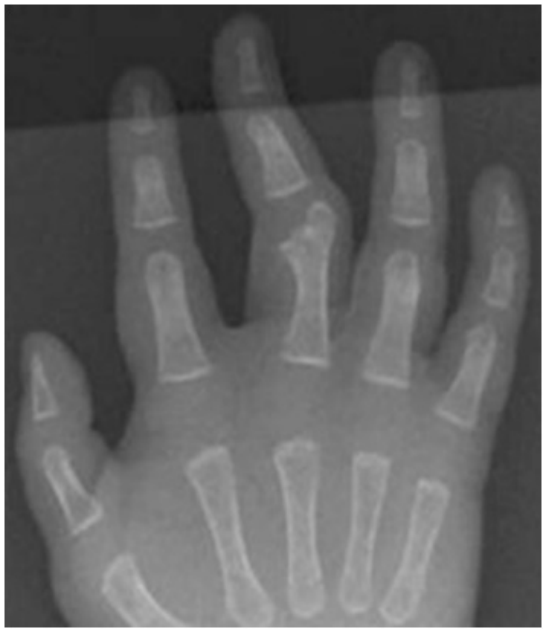
Bilateral, almost symmetrical

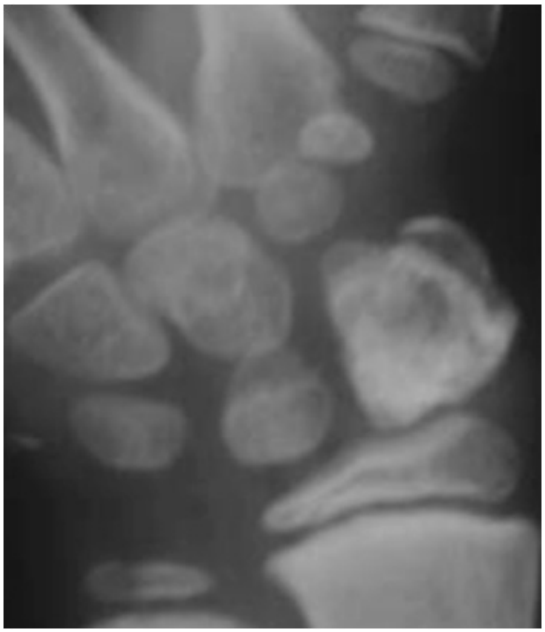


Multiple hereditary osteochondromata with Pseudo Madelung deformities

Trevor disease

Dysplasia Epiphysealis Hemimelica (DEH)





A rare cartilaginous lesion arising from the epiphysis or ossification centre. It may involve the adjacent bone and generally has an unilateral distribution.

Vascular lesions of bone

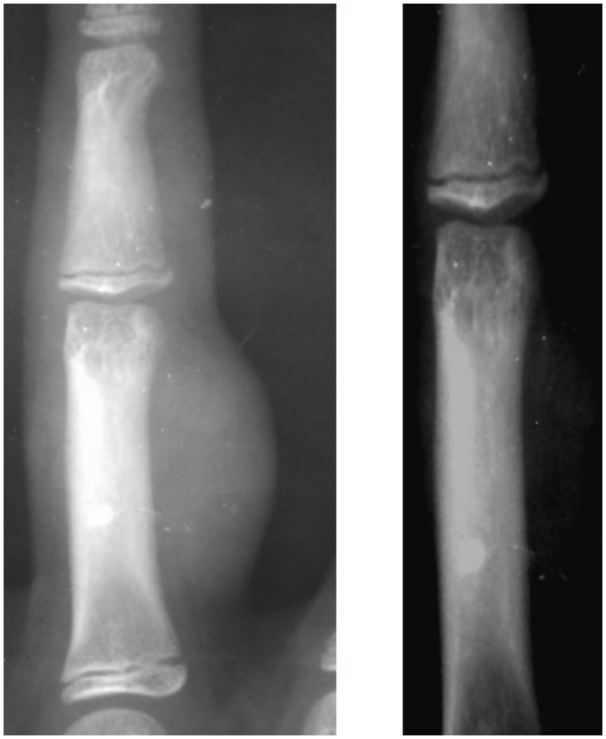
BENIGN:

- Hemangioma

- **Cavernous**
- **Capillary**
- **Venous**
- **Sclerosing**

To be differentiated from arteriovenous and venous malformations

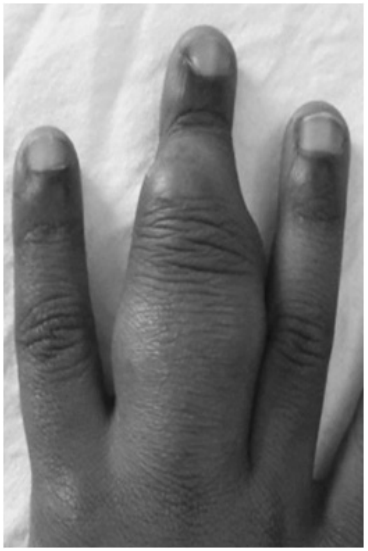
Sclerosing hemangioma

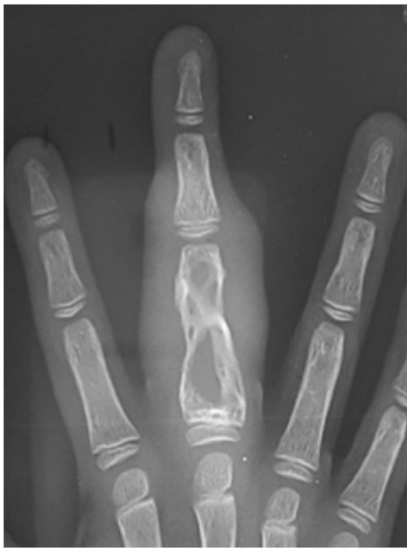


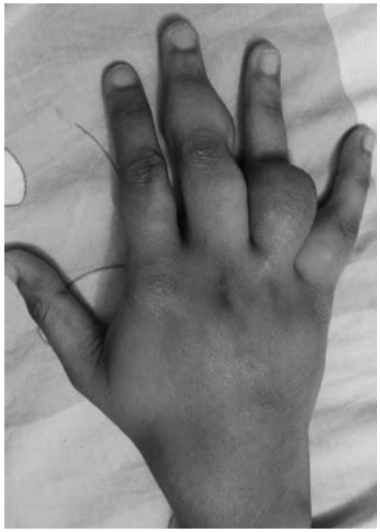
Soft tissue swelling, phlebolith and sclerosis of the bone

Hemangioma

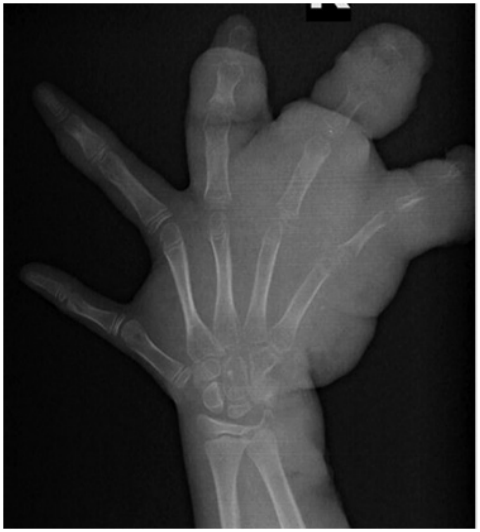
Cavernous Hemangioma of middle finger simulating spinaventosa





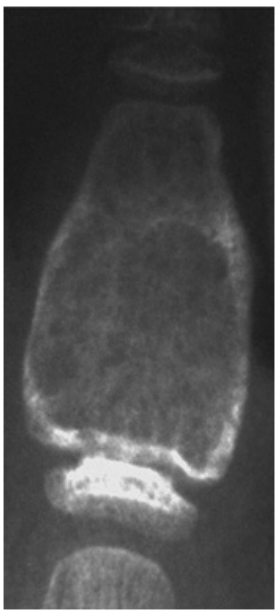


Hemangiomata

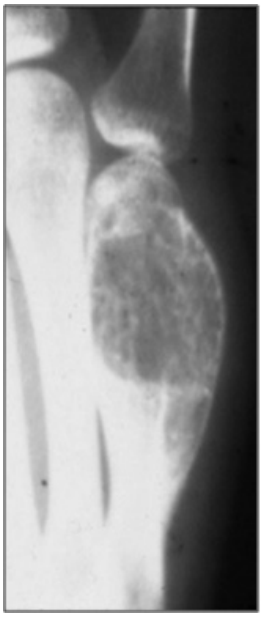


Lymphangioma

Primary aneurysmal bone cyst

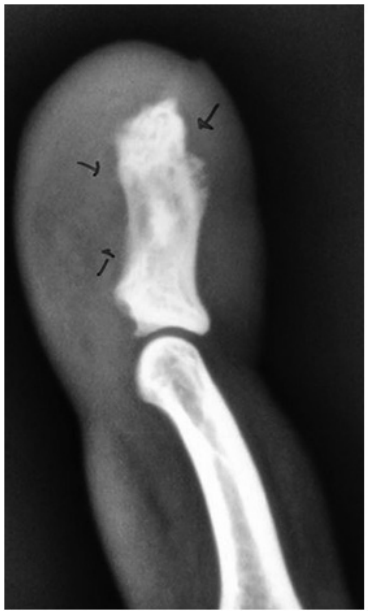


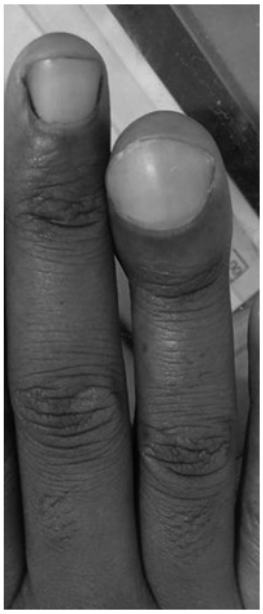
Proximal Phalanx



5th metacarpal

Glomus tumor



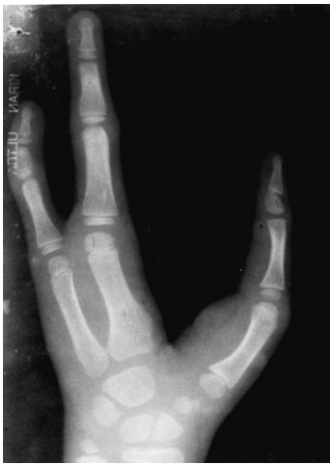


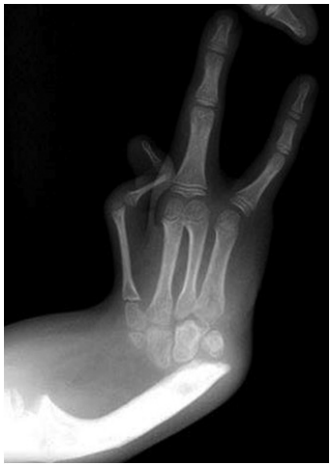
Expansion & sclerosis, clubbing

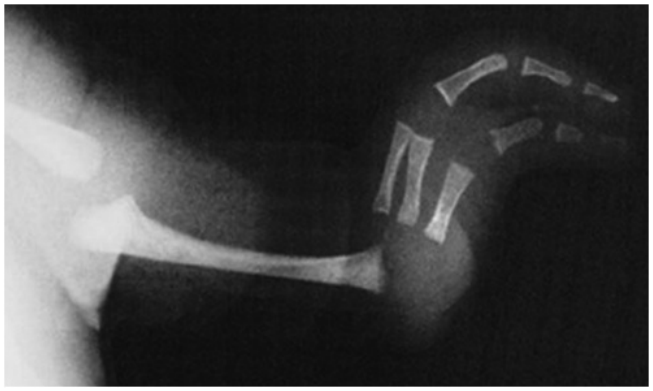
An expanding osteolytic lesion with thinning of the cortex with a peripheral shell. The zone of transition is narrow but can be wide and aggressive. Should not be mistaken for enchondroma or giant cell tumor. Secondary aneurysmal bone cysts can occur in giant cell tumors, non ossifying fibroma, chondroblastoma, osteoblastoma, telangiectatic osteosarcoma. Fluid – Fluid levels are seen on MRI.

Holt Oram syndrome

Syndrome is a set of medical science and symptoms that are correlated with each other and often with a particular disorder. There are several forme fruste examples.







Cardiac limb syndrome

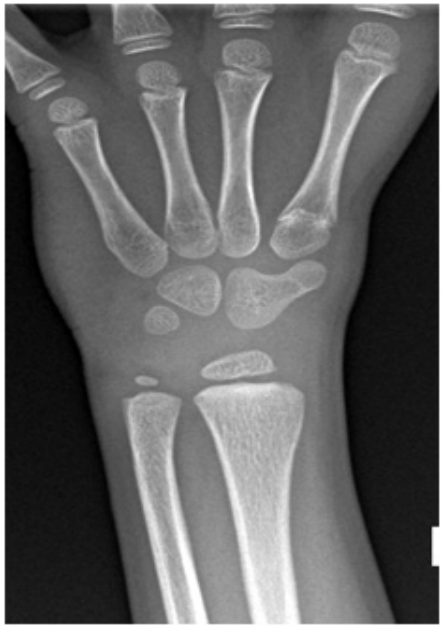
- **Thumb anomalies – finger like**
- **Absent metacarpals**
- **5th digit – short middle phalanx**
- **Hypoplasia of radial carpals**
- **Radial ray anomalies**
- **Shoulder and clavicle may also be involved**

ASD / VSD

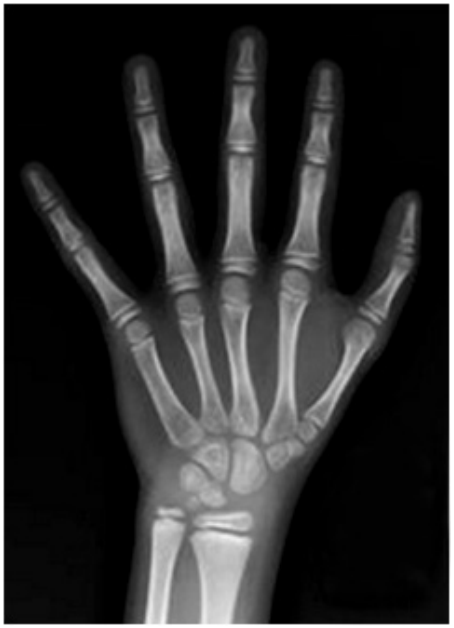
Fanconi Anaemia

Stunted growth and loss of appetite
3rd degree consanguinity

Radial ray deficiency



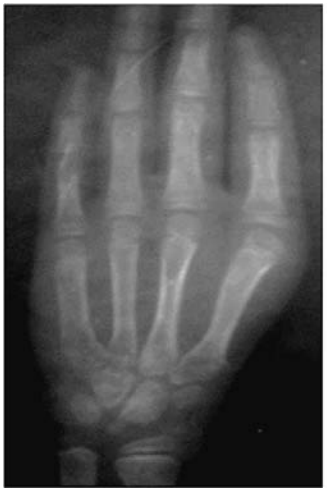
Type 5

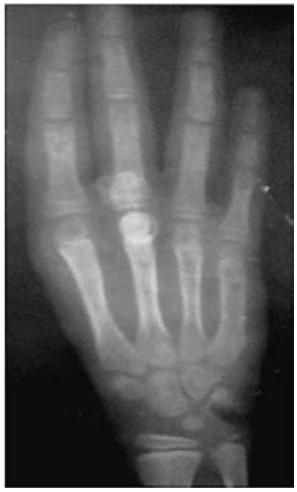


Type 1

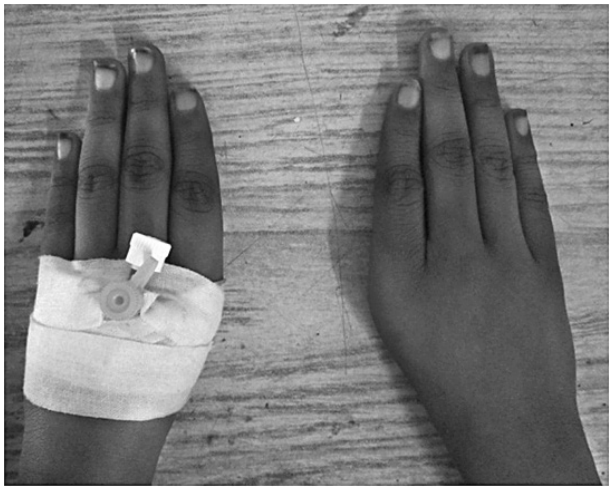
- **FANCONI ANAEMIA**
- **HOLT ORAM**
- **VACTERL**
- **TAR**

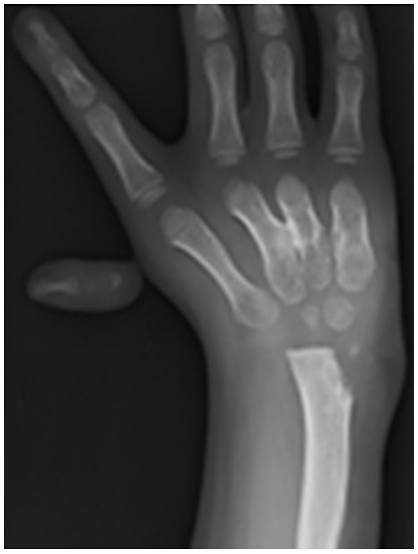
Hypocellular marrow with erythroid prominence and supressed myelomegakaryopoiesis. Negative for granulomas of infiltrates. Features are suggestive of evolving hypocellular marrow. Kindly correlate clinically and with the cytogenetics



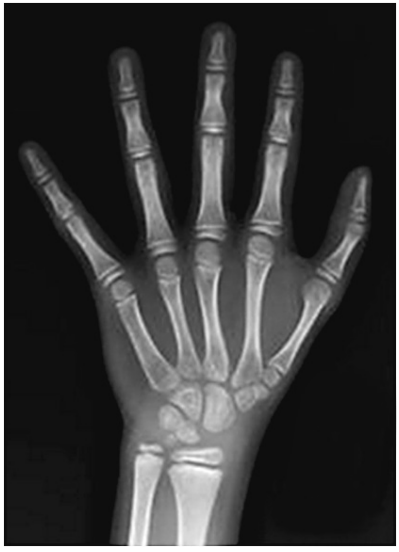


Fanconi's anaemia, Hb – 5 g%





Absence of radial ray



Fanconi anemia – aplasia of first metacarpal and thumb

Type I - the thumb is small, normal components are present but undersized. Two muscles of the thumb, the abductor pollicis brevis and opponens pollicis, are not fully developed ,.

Type II - is characterized by a tight web space between the thumb and index finger which restricts movement, poor thenar muscles and an unstable middle joint of the thumb metacarpophalangeal joint.

Type III - thumbs are subclassified into two subtypes by Manske. Both involve a less developed first metacarpal and a nearly absent thenar musculature. Type III-A has a fairly stable carpometacarpal joint and type III-B does not. The function of the thumb is poor. Children with type III are the most difficult patients to treat because there is not one specific treatment for the hypoplastic thumb. The limit between pollicization and reconstruction varies. In this group careful attention should be paid to anomalous tendons coming from the forearm (extrinsic muscles, like an aberrant long thumb flexor – flexor pollicis longus).

Type IV - is called a pouce flottant, floating thumb. This thumb has a neurovascular bundle which connects it to the skin of the hand. There's no evidence of thenar muscles and rarely functioning tendons. It has a few rudimentary bones. Children with type IV are difficult to reconstruct. This type is nearly always treated with an index finger pollicization to improve hand function.

Type V - is no thumb at all and requires pollicization.

Constriction band syndrome
(Streeter's dysplasia)

It is not so uncommon and the etiology refers to constricting amniotic bands

Classification (Patterson)

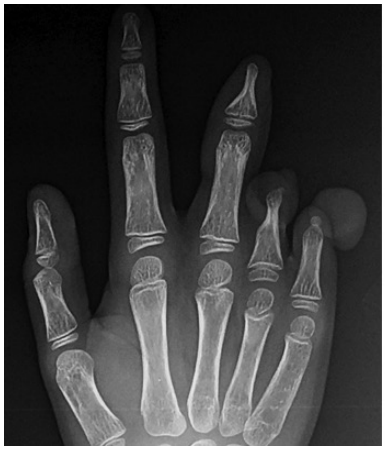
a) **Simple constrictions (partial/circumferential)**

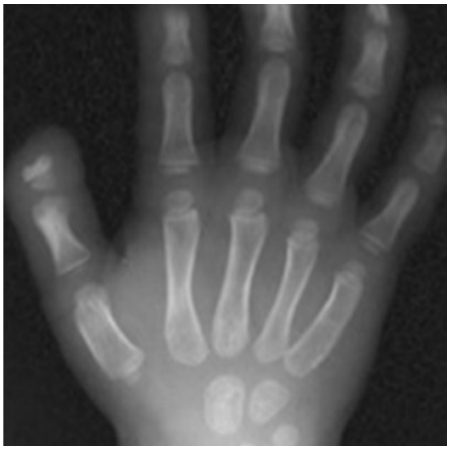
b) **Constrictions with distal deformity (lymphedema may or may not be present)**

C) **Constrictions with acrosyndactyly characteristic (Fenestrated syndactyly)**

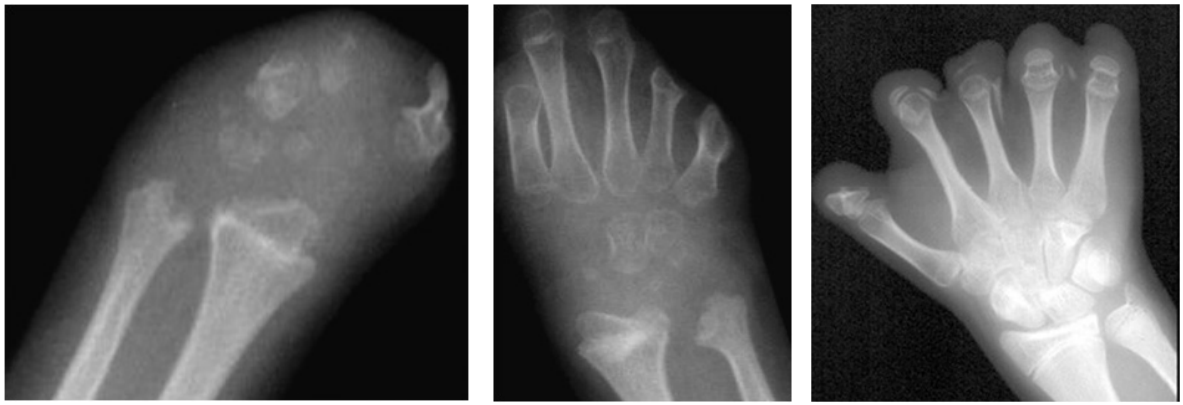
d) **Intrauterine amputation**

Amniotic band syndrome

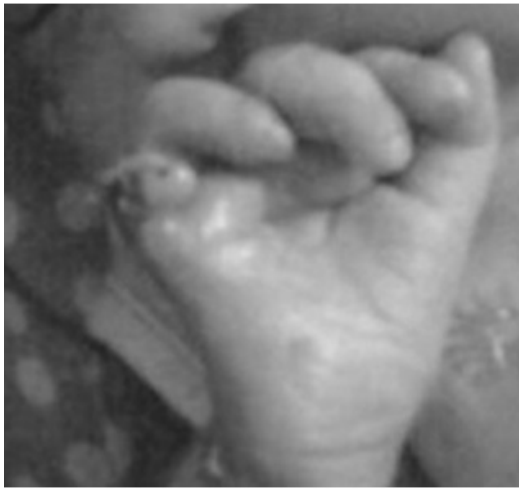




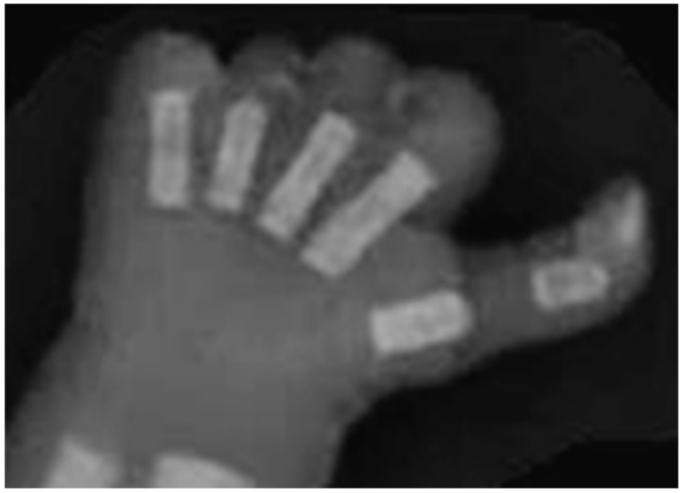
Amniotic band constriction (also known as **"amniotic band** syndrome", "ADAM complex", **"Amniotic band** sequence", "Congenital constriction **bands"** and "Pseudoainhum") is a congenital disorder caused by entrapment of fetal parts (usually a limb or digits) in fibrous **amniotic bands** while in utero.



Amniotic band syndrome

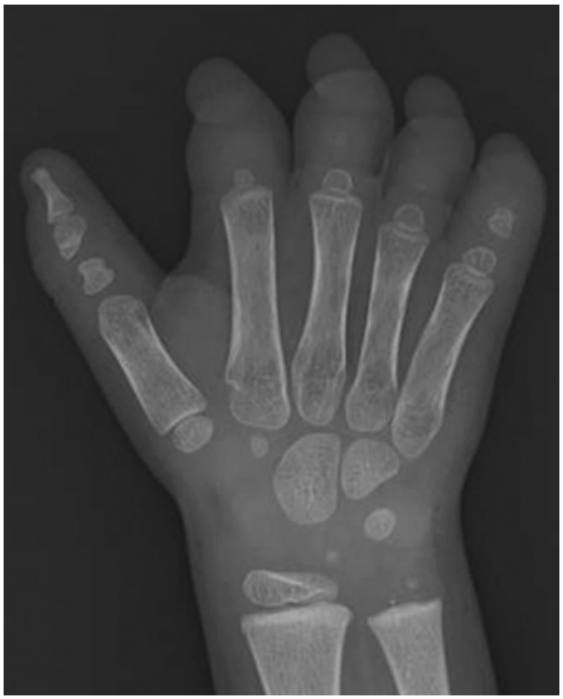


Amniotic Band Syndrome 2 ½ month old baby



Amniotic band Syndrome

Symbrachydactyly



- Type 1 – Triphalangeal type
- Type 2 – Diphalangeal type
- Type 3 – Monophalangeal type
- Type 4 – Aphalangeal type
- Type 5 – Ametacarpia type
- Type 6 – Acarpia type
- Type 7 – Forearm amputation type

A congenital abnormality, characterized by limb anomalies consisting of brachydactyly, cutaneous syndactyly and global hypoplasia of the hand or foot. In many cases, bones will be missing from the fingers and some fingers or toes may be missing altogether.

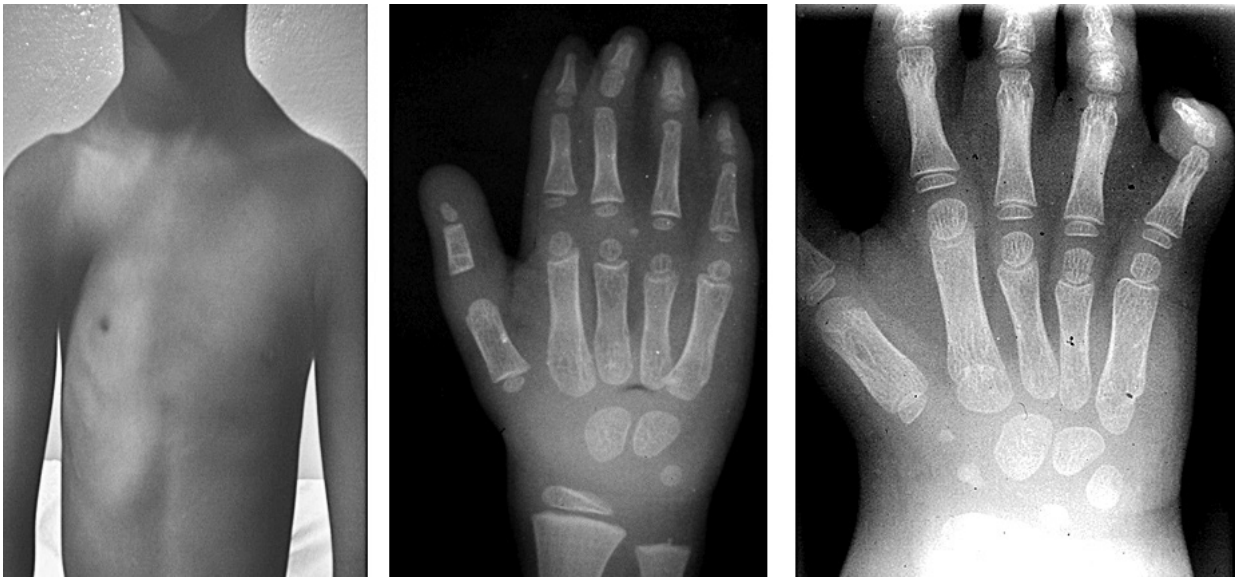
Hand deformities in generalized skeletal disorders

Most common – multiple exostoses

Other syndromes –

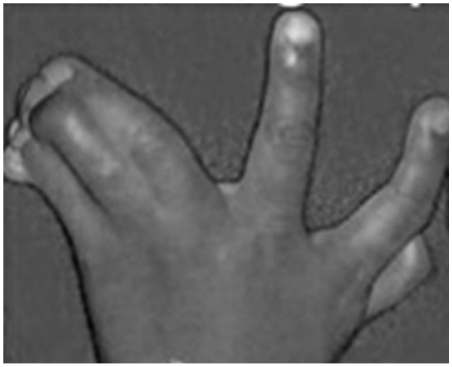
- **Poland syndrome (symbrachydactyly)**
- **Apert syndrome (complex syndactyly)**
- **Haas syndrome**
- **Freeman sheldon syndrome (wind blown hand)**
- **Mohr Wriedt syndrome (radial clinodactyly of index finger)**
- **Pierre – Robin syndrome (clasped thumb)**

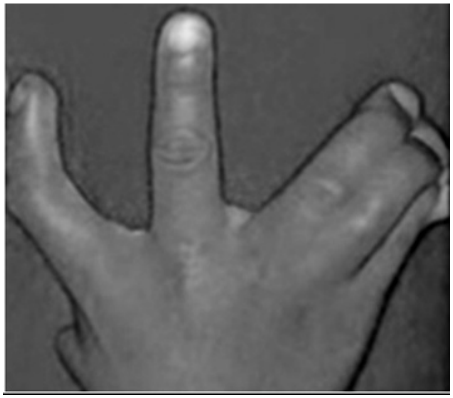
Poland Syndrome (1841)



It is a congenital defect characterized by an underdeveloped chest muscle and short webbed fingers on one side of the body. Short ribs, less fat, and breast and nipple abnormalities may also occur on that side.

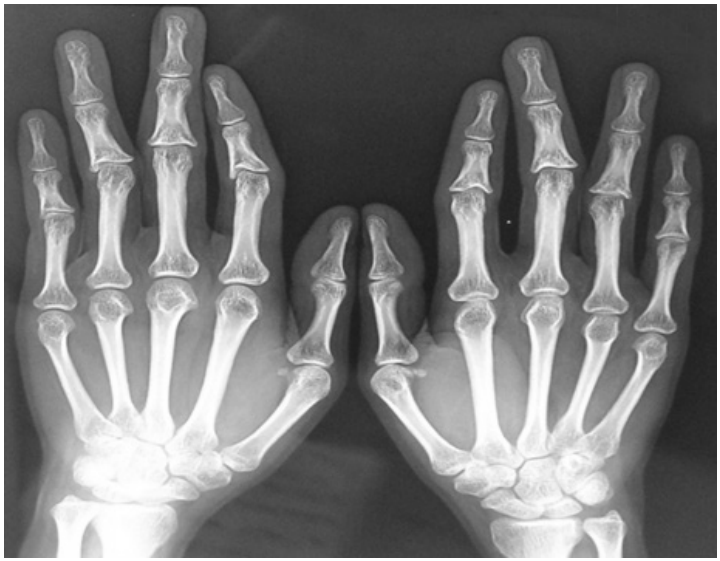
Haas syndrome





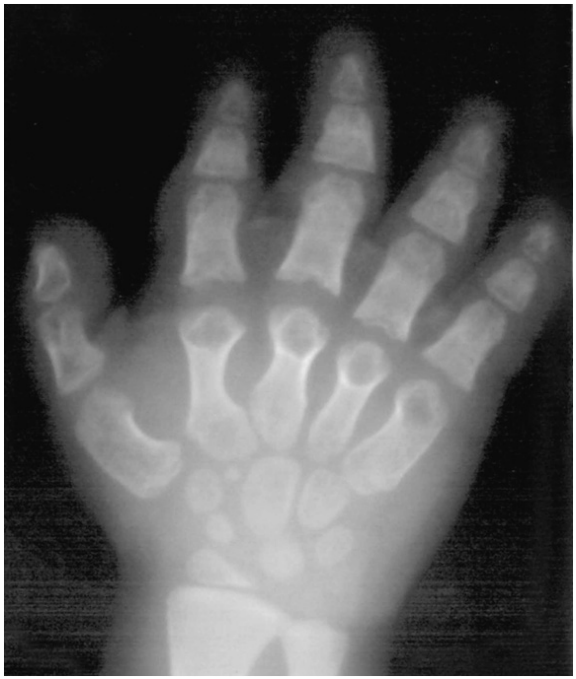
Presence of 6 metacarpals is characteristic > 5 digits All having 3 phalanges

Tricho rhino phalangeal syndrome (Giedion)

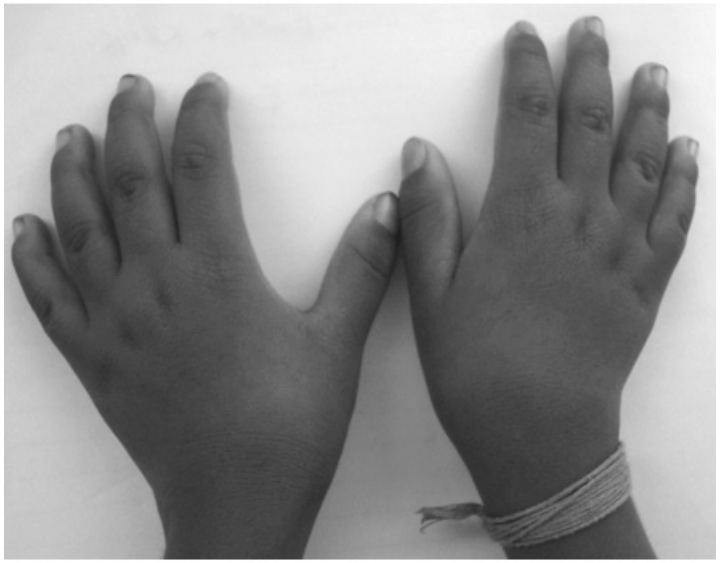


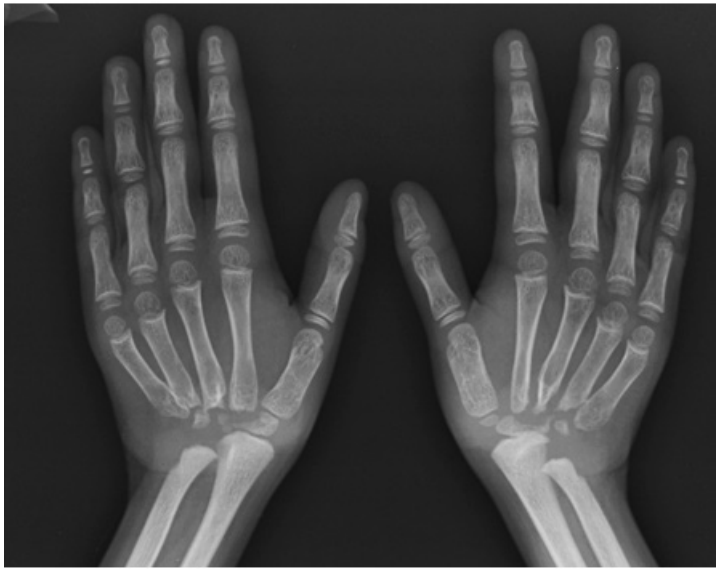
Rare inherited disorder
Note the coned epiphyses
Clinically, sparse frontal hair, pear shaped nose and deformities of the phalanges

Acrodysostosis is a rare skeletal dysplasia, first described by Maroteaux and Malamut in 1968. Though most case reports have occurred sporadically, it is believed to be an autosomal dominant condition.

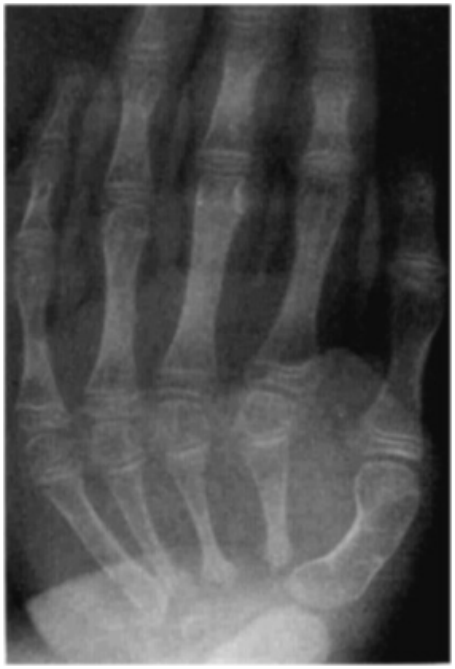


The metacarpals and phalanges show typical cone-shaped epiphyses, which fuse prematurely. Cone shaped epiphyses are a rare and distinctive clue to the diagnosis. Acrodysostosis, pseudohypoparathyroidism and acromesomelic dwarfism may present with cone shaped epiphysis. Even though these conditions share some important clinical features, advanced bone age and first ray hyperplasia are two important findings which distinguish acrodysostosis from the other conditions(3). A pointer in neonates with suspected acrodysostosis is the extensive epiphyseal stippling, which almost always disappears by 8 months of age(3).



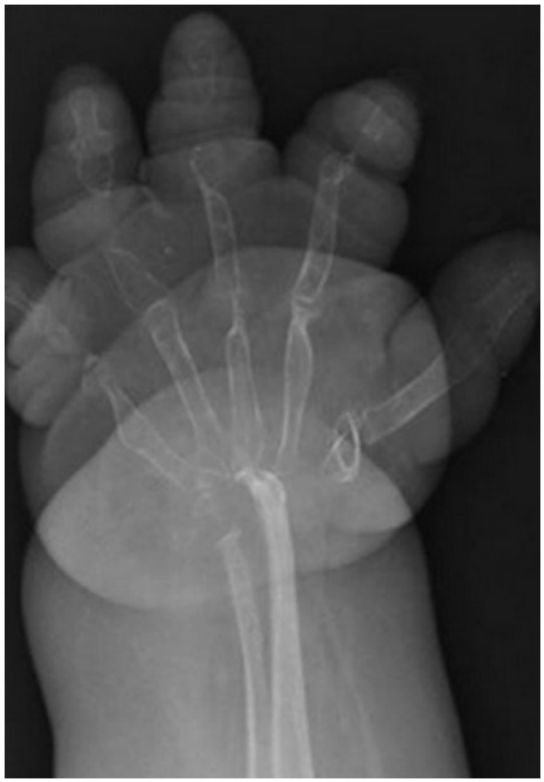


Familial Carpotarsal osteolysis with nephropathy



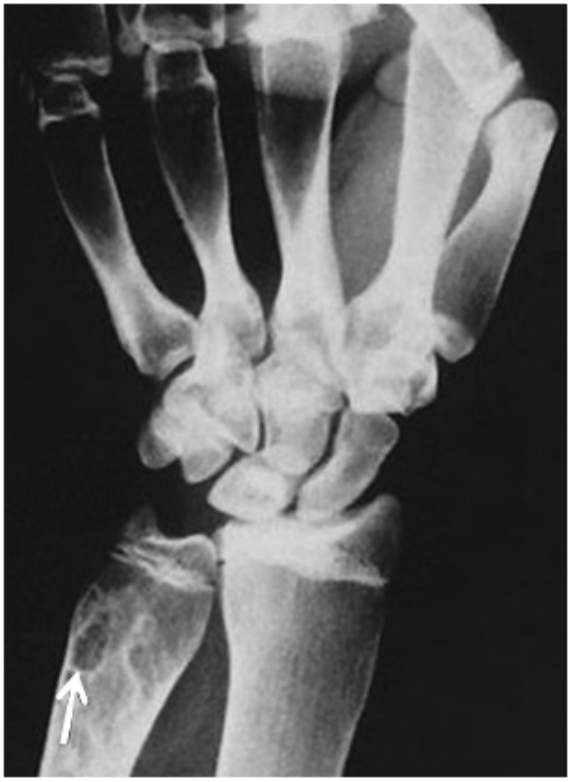
Pointed bases of metacarpals, carpal bones destroyed

Winchester Grossman syndrome



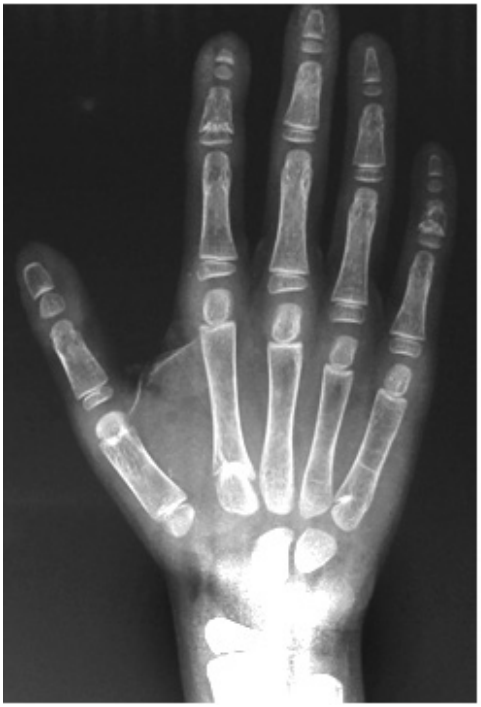
Carpal and metacarpal osteolysis, phalangeal resorption. A disease that should be classified as a nonlysosomal connective-tissue disturbance and not as a form of acid mucopolysaccharidosis.

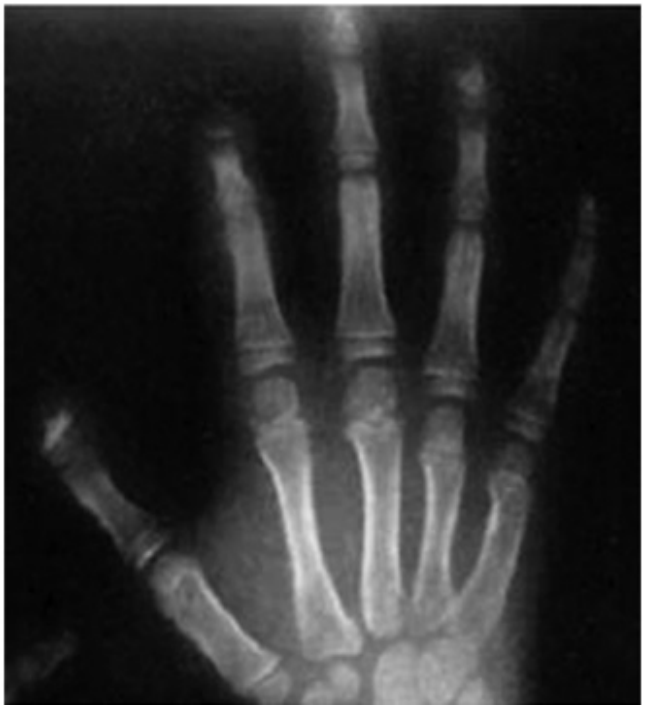
Nasu Hakola Syndrome



Cerebral calcification and cystic changes in bones. Polycystic Lipomembranous osteodystrophy with sclerosing leucoencephalopathy. Genes, DAP12 or TREM2.

A Band of Lysis In Middle of Distal Phalanx

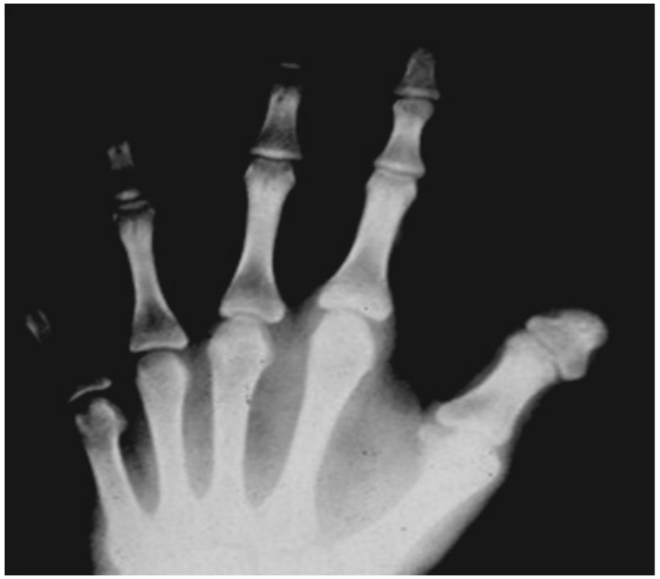


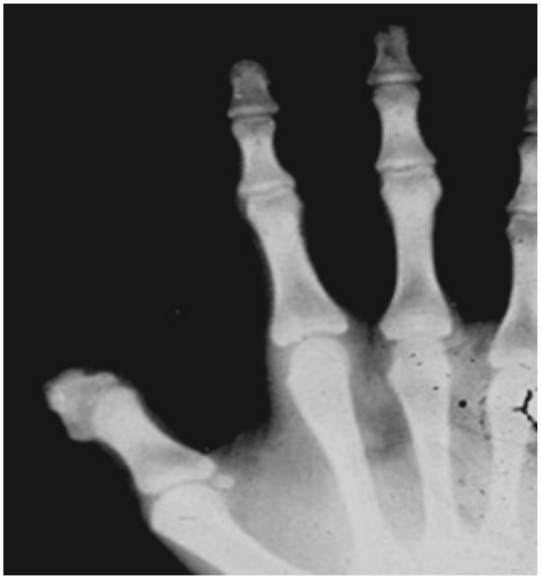


Hajdu-Cheney syndrome:

Hajdu-Cheney syndrome: **rare disorder of bone metabolism. The diagnosis is made by finding acroosteolysis with any three of the following: Wormian bones, open skull sutures, platybasia, micrognathia, mid-facial flattening, premature loss of teeth, coarse hair and short stature.**

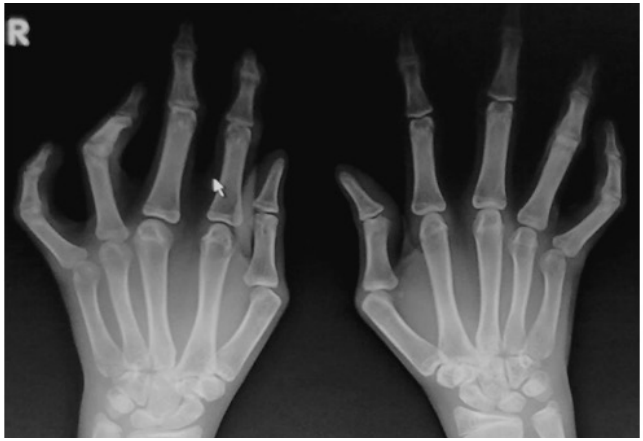
Rubinstein Taybi Syndrome



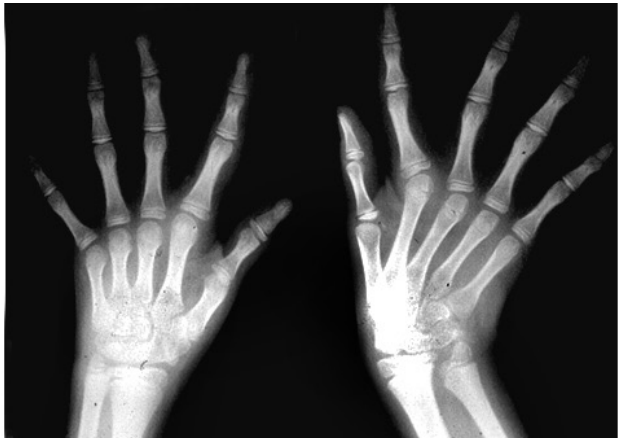


- Short and wide terminal phalanges of thumb and great toe
- Short, wide and tufted terminal phalanges of the fingers
- Flaring of ilia
- Retarded bone age
- ASD / VSD
- Urinary tract anomalies

Arthrogryopsis Multiplex Congenita



Asymmetrical subluxed joints



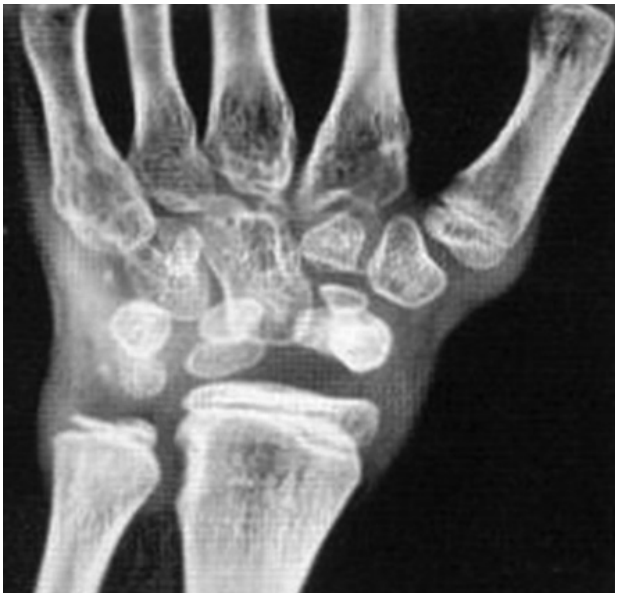
Companion case

Arthrogryposis multiplex congenita (AMC) refers to the development of multiple joint contractures affecting two or more areas of the body prior to birth.

Arthrogryposis (Larsen syndrome)

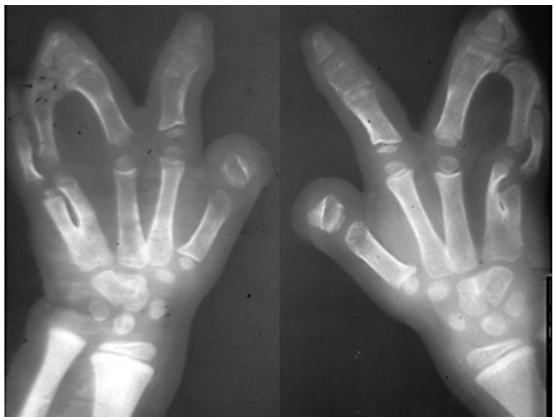
It is a descriptive term comprising disorders due to contractures and dislocation and includes Larsen syndrome

Syndromes with Multiple Carpal Bones

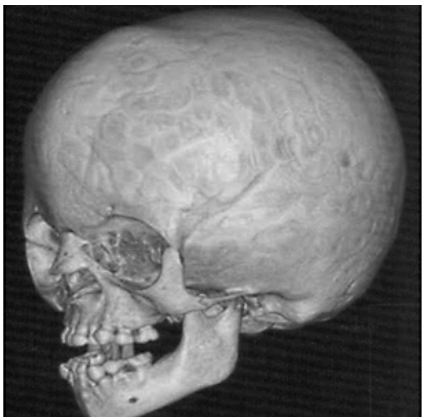


- **Larsen syndrome**
- **Brachydactyly A1**
- **Ulnar dimelia**
- **Hand-foot-uterus syndrome**
- **Holt-Oram. syndrome,**
- **Oto - palato syndrome,**
- **Chondroectodermal dysplasia,**
- **Diastrophic dysplasia,**
- **Gorlin's syndrome,**

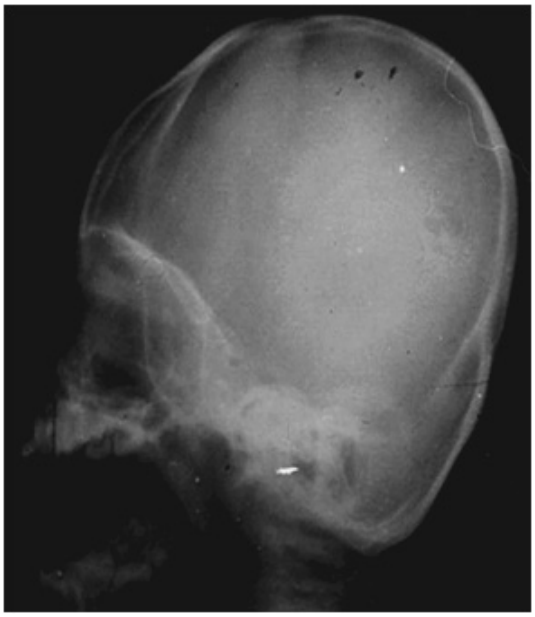
Apert syndrome



Gloved hand



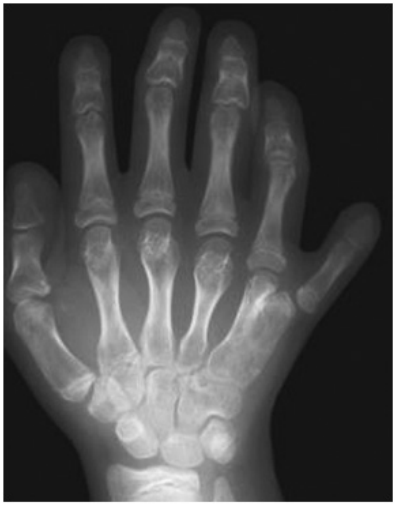
Craniostenosis

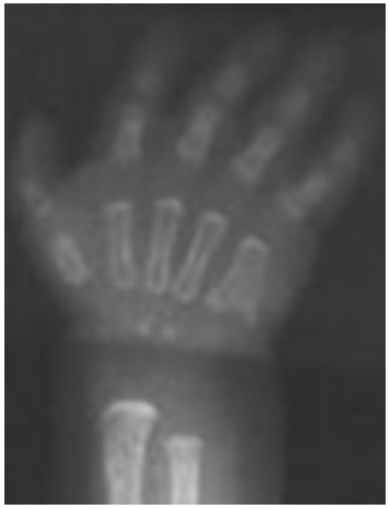


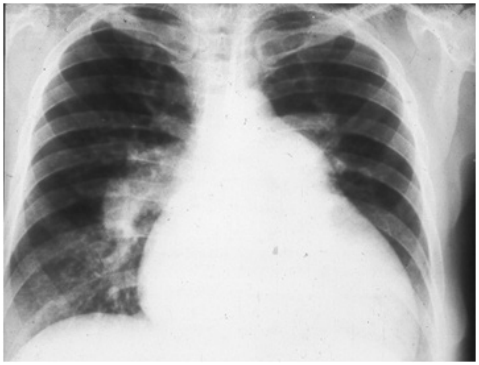
A rare congenital disorder characterised by craniostenosis, syndactyly of the hands and feet with tendency for fusion of osseous structures.

Ellis Van Creveld Syndrome

Chondroectodermal dysplasia







ASD

Mesomelic dwarfism with polydactily, syndactily and Septal defect

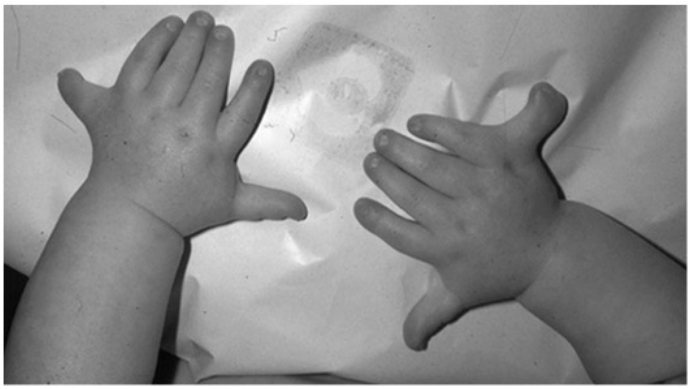
Post axial Polydactyly, Syndactyly, Syncarpus, deformed teeth &

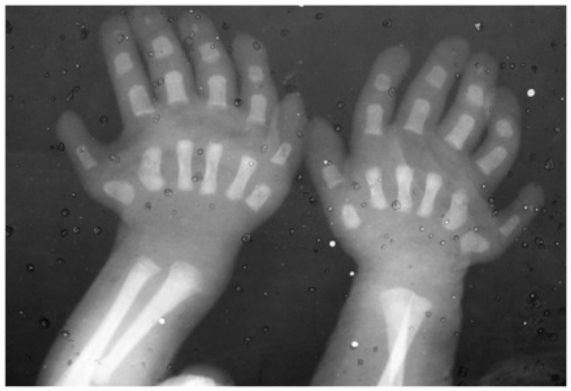
Scanty hair of the scalp

Chondroectodermal dysplasia/ Ellis –Van Creveld syndrome

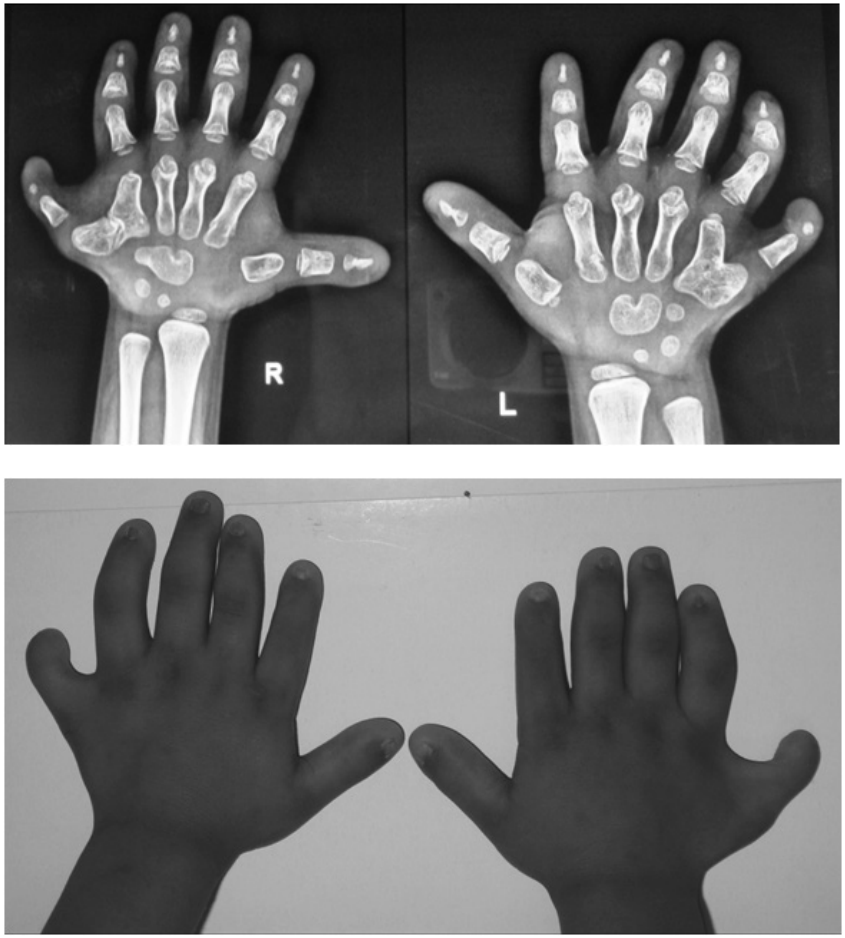
Short stature

- Short limbs more marked distally
- Absent / hypoplastic nails polydactyly, syndactyly
- Dysplastic teeth
- Upper lip anomalies
- Cardiac-ASD, single atrium



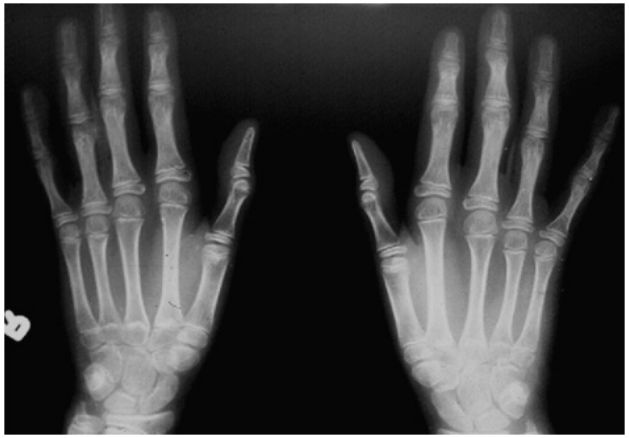


5 yr old child with polydactyly, syndactyly



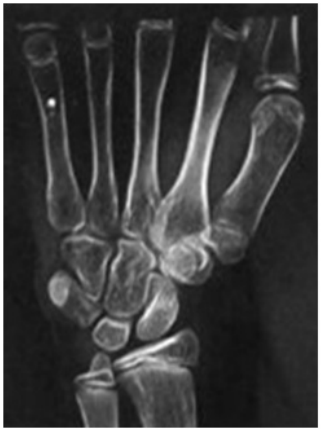
Chondroectodermal dysplasia

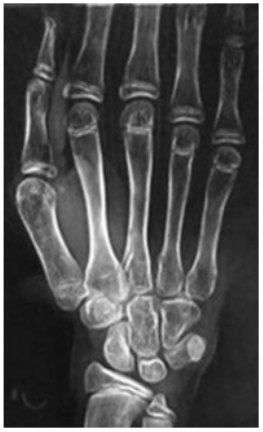
Marfan syndrome (AD)



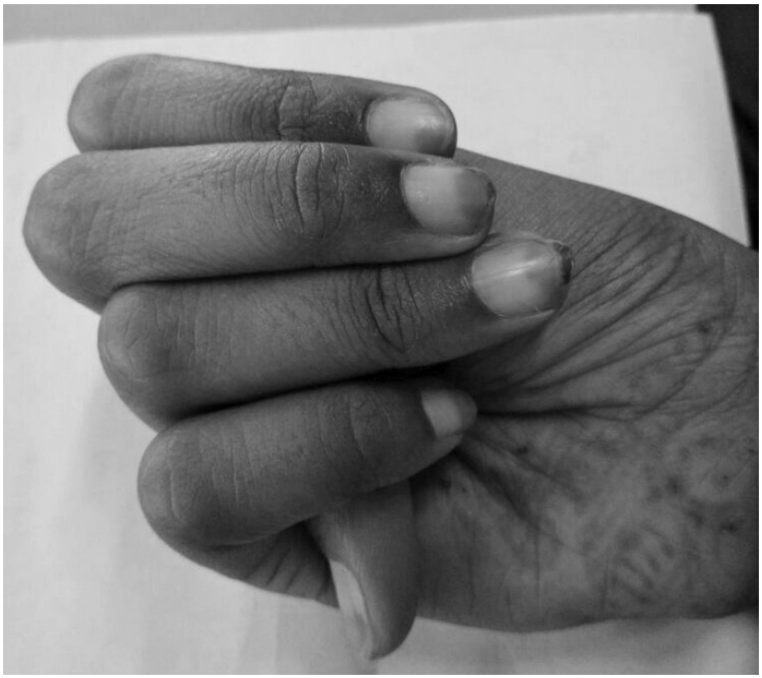
Arachnodactyly with cardio vascular defects
Elongated metacarpals and phalanges, metacarpal index high

- **The metacarpal index (MCI) is a radiographic measurement that can be used to confirm the presence of disproportionate metacarpal length.**
- **The first method of MCI calculation is by obtaining the average of the ratios of length / width of metacarpals 2-5.**
- **The second method involves dividing the sum of the lengths by the sum of the widths of these metacarpals.**
- **Values of between 8.4 and 9.4 have been used as cut-off for abnormal values.**





Steinberg sign

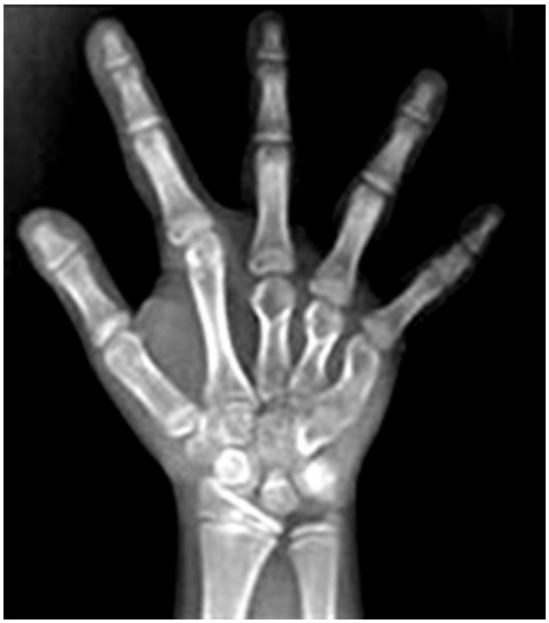


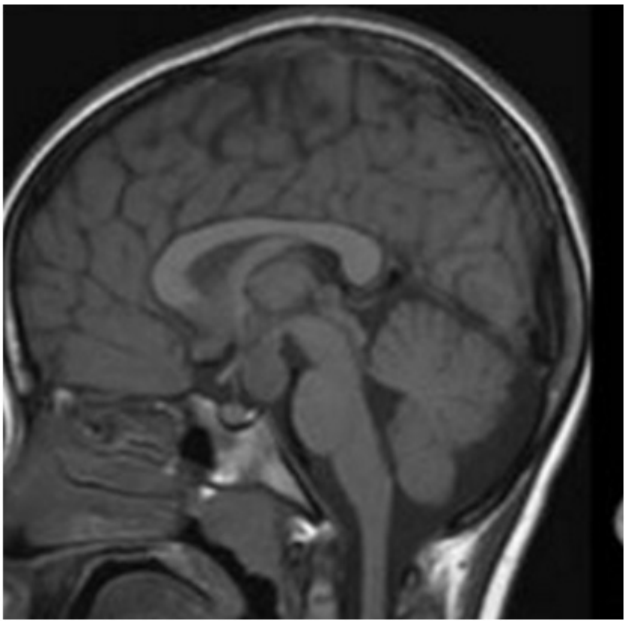
The Steinberg sign, also known as the thumb sign, is one of the clinical examination tests for Marfan syndrome in the hands. It is a clinical test in which the tip of the thumb is visible medial to the little finger when it is clasped in the clenched hand.

SYNDACTYLY WITH SYNDROMES

- Carpenter's
- Apert's
- Oculodento digital
- Conradi
- Down
- Neurofibromatosis
- Pierre – robin
- Prader willi
- Pseudo hypoparathy
- Trisomy – 13
- Trisomy – 18
- TAR
- Russel – silver
- Ellis Van Creveld
- Fanconi
- Goltz
- Hallerman-Streiff
- Orodigito facial
- Popliteal pterygium
- Otopalato digital

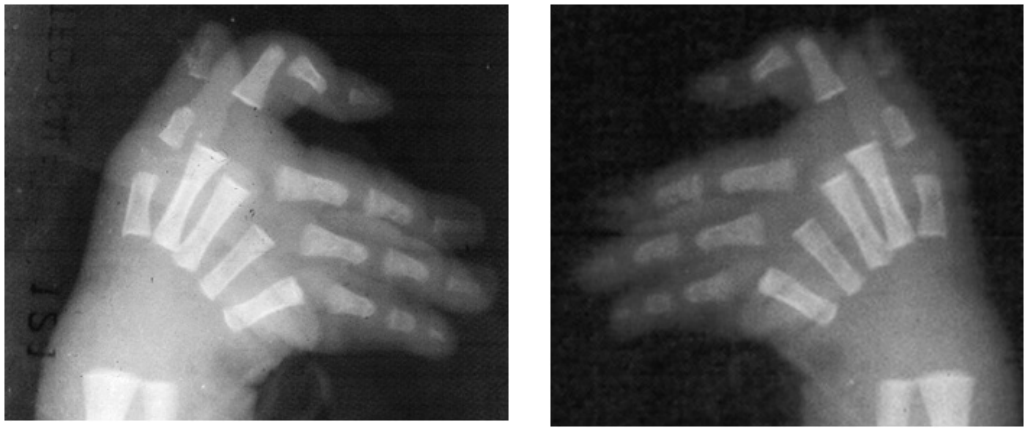
Pallister Hall Syndrome





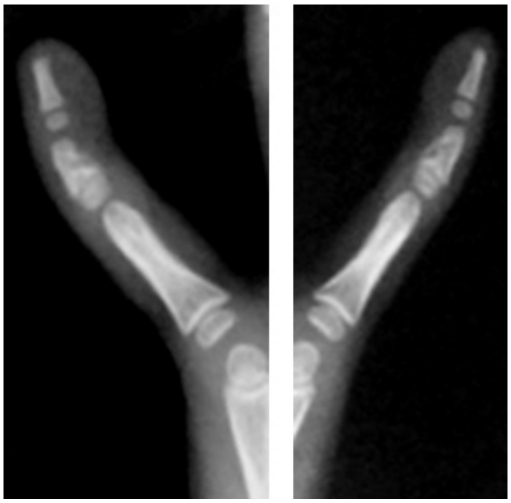
Hypothalamic hamartomas

Hypothalamic hamartomas with digital malformations (here: short 3rd, 4th and 5th metacarpals , clinodactyly i.e. short mid phalanx of 5th digit and apparent soft tissue syndactyly between 2nd and 3rd digits)



Trisomy 18 (Edwards syndrome)

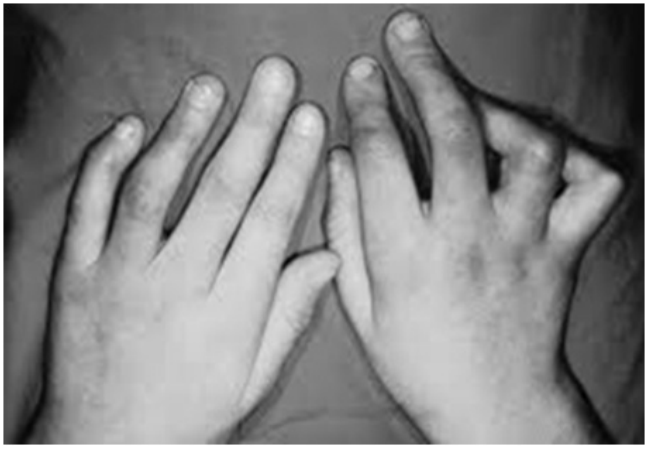
Hands typically present with overlapping digits, in which the second and fifth fingers override the third and fourth fingers, respectively. V-Shaped deformity between 2nd and 3rd metacarpals. Flexion deformity of the index finger.

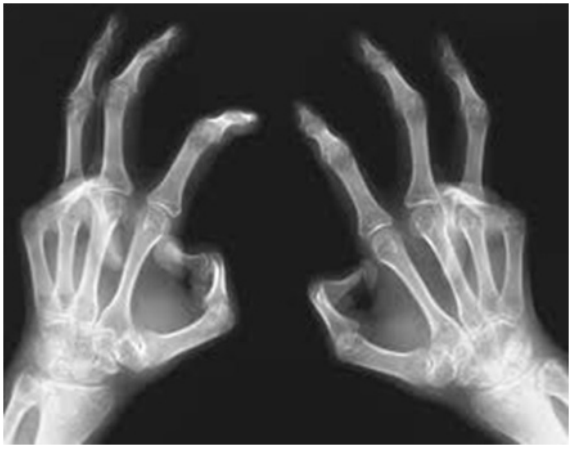


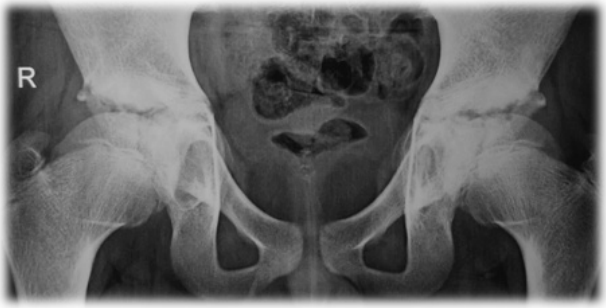
Down syndrome Trisomy 21

Short middle phalanges of little fingers, bilaterally. C1-C2 subluxation

Camptodactyly-Arthropathy-Coxa Vara-Pericarditis Syndrome



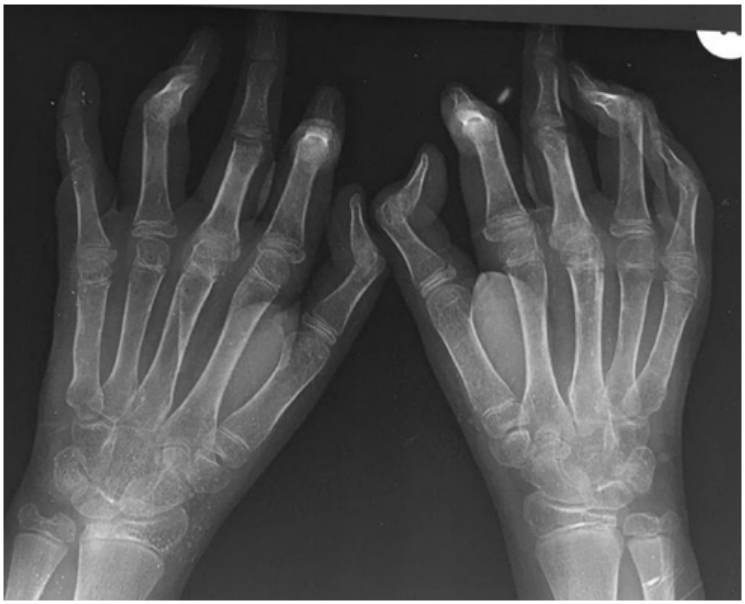




A rare genetic disorder mapped to chromosome 1q25–31.

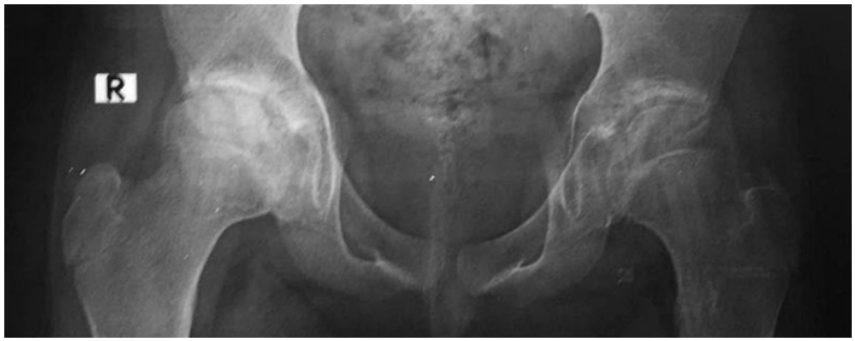
Classically this occurs at the proximal interphalangeal joints specifically of the little finger of the hand, although any finger may be affected. Coxa Vara of hips .

15 M, Camptodactyly-Arthropathy-Coxa Vara-Pericarditis Syndrome

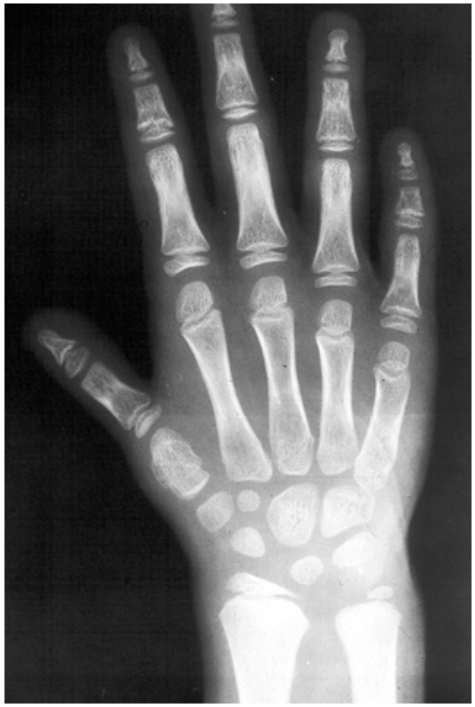


Flexion contraction of the proximal interphalangeal joints, difficulty in walking, sitting down

Mild coxa vara with non specific changes in the hips.



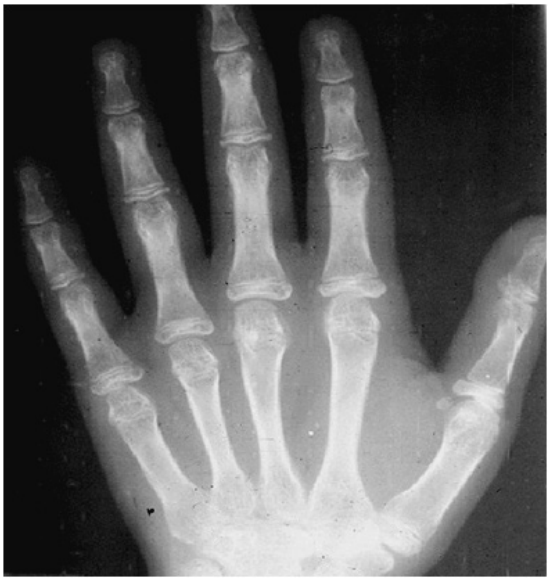
Cornelia De lange syndrome



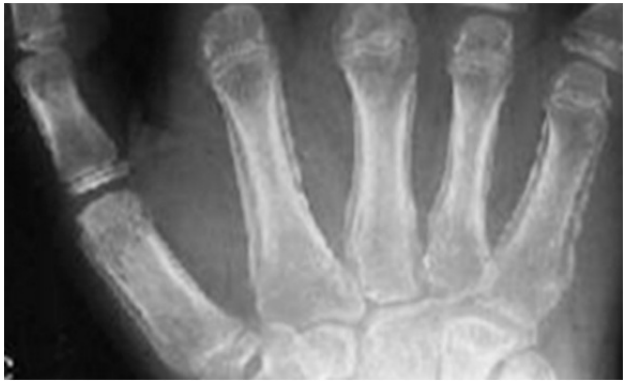
Short first metacarpal bone, combined with relatively long third and fourth metacarpals, deformed metaphyses of the radius

Turner syndrome

11 yr old girl with webbed neck

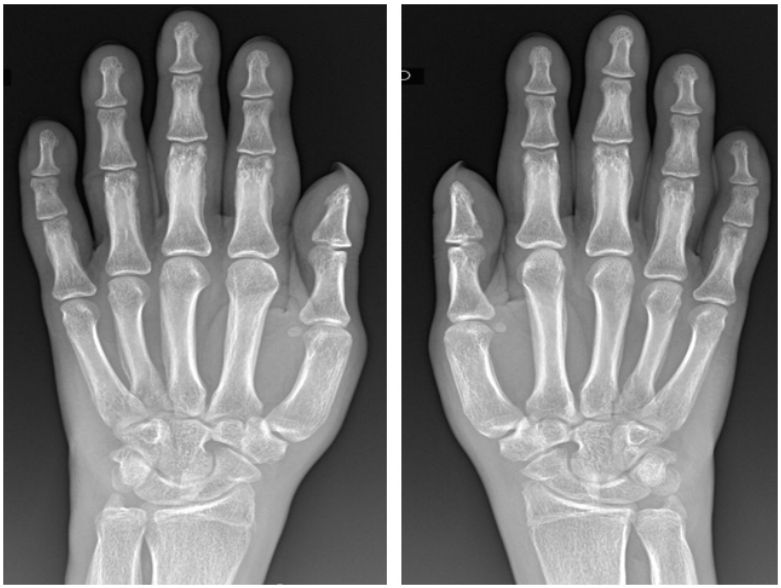


Short 4th metacarpal with drumstick fingers



Hypertrophic osteoarthropathy (HOA) is a syndrome of clubbing of the digits, periostitis of the tubular bones, and arthritis. Pulmonary and non pulmonary causes.

Cyanotic heart disease with periosteopathy

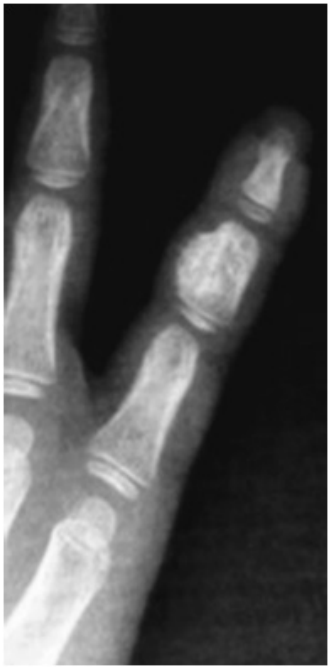


16 yr with tetralogy of Fallot, clubbing of the fingers and periosteal reaction along the metacarpals and proximal phalanges.

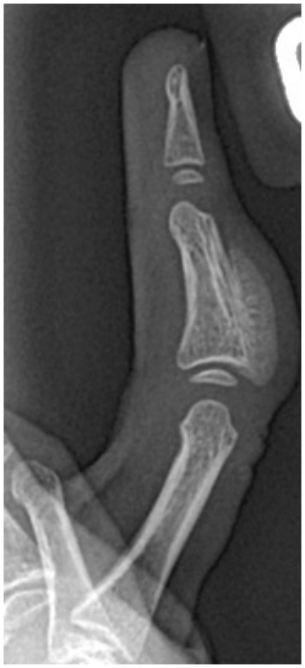
Periosteal Reaction in Pediatrics

- Physiological (During rapid growth)
- Premature birth (Prostaglandin E)
- Healing trauma
- Infection –
- Metabolic (Scurvy, hypervitaminosis A & D, healing rickets etc.,)
- Hyperphosphatasia
- Caffey disease
- Inflammation - Eosinophilic granuloma, sarcoidosis, JIA, psoriasis
- Infarction
- Skeletal dysplasias - Engelmann
- Neoplastic – Leukemia, malignant bone tumors, neuroblastoma, mets
- Idiopathic – Hypertrophic osteoarthropathy

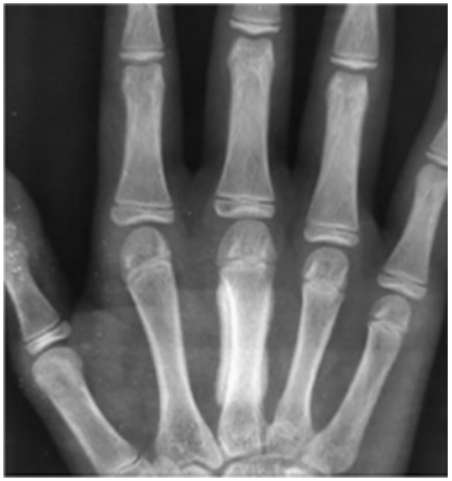
Bizarre parosteal osteochondromatous proliferations (BPOP)



4 F, Nora lesion
(Post traumatic)

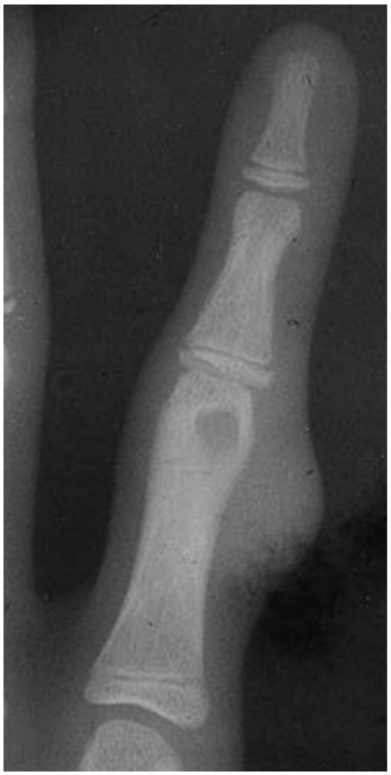


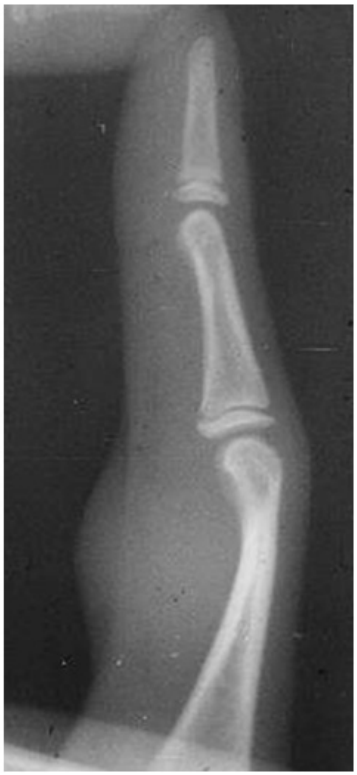
Middle phalnx of
index finger



Focal periostitis of
unknown etiology

Pigmented Villonodular Synovitis – localised – Giant cell tumor of the tendon sheath





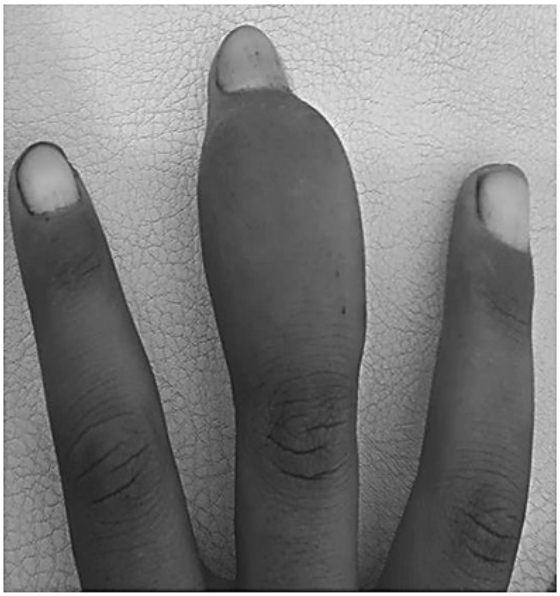
GCTTS may arise from the synovium and pressure erosion can occur on the adjacent phalanx. It is rare in children.

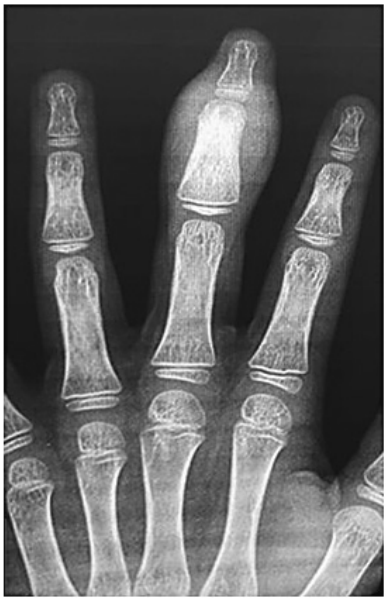
11 yr old with soft tissue swelling antero laterally at the proximal phalanx of the index finger with lytic lesion in the phalanx

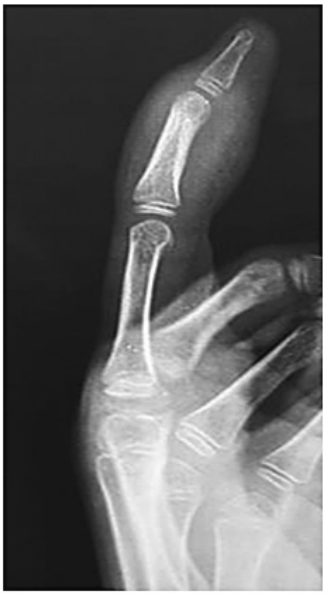
8 F, Giant cell tumor of tendon sheath

(PVNS) Focal Pigmented Villonodular Synovitis

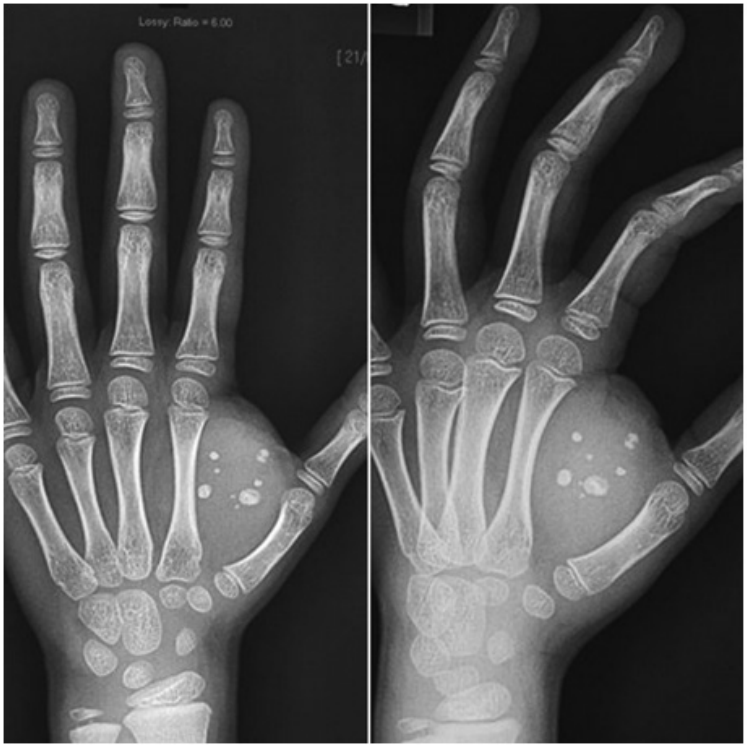
Soft tissue swelling with minimal involvement of the cortexExtra articular



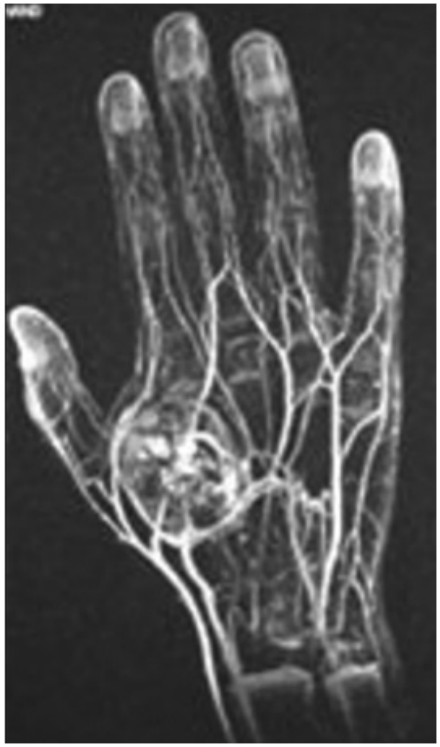




Soft tissue venous Hemangioma



Plain



Angiography

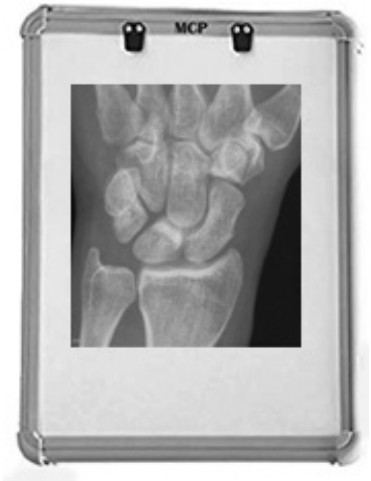
MISSED & MISSABLE TRAUMA - MIMICS

Ten Commandments In Skeletal Trauma

1. **Films / Digital images should be of good quality (poor films invite erroneous diagnosis)**
2. **Know normal anatomy**
3. **Beware of normal variants and anomalies**
4. **Comparison views specially under the age of 18 years**
5. **Study the soft tissues including fat pads**

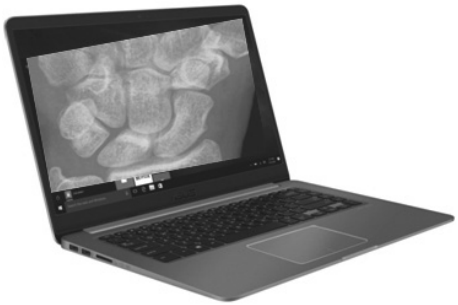
Ten Commandments In Skeletal Trauma (Cont.)

6. **More views, Special views and stress views (without discomfort to the patient)**
7. **Differentiate chip fractures from accessory ossicles and calcifications**
8. **Study the whole film (in a long Bone Trauma, both distal and proximal joints should be included)**
9. **Benefit of doubt to the patient**
10. **Follow up films and further imaging e.g. CT, MRI, US etc.,**



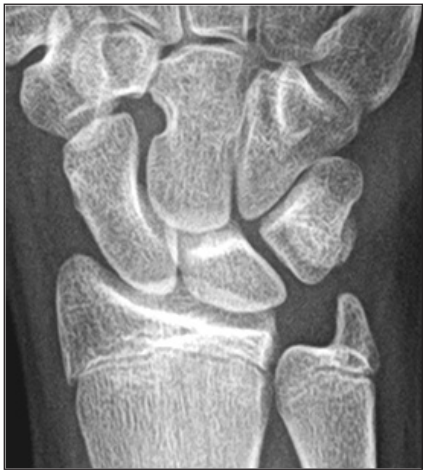
View box

Magnifying lens (Antique)

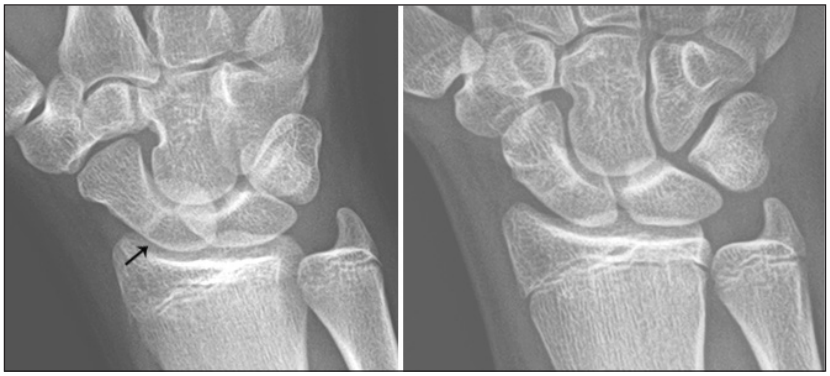


Modern – zoom the spot

17 yr old fall on out stretched hand



Missed

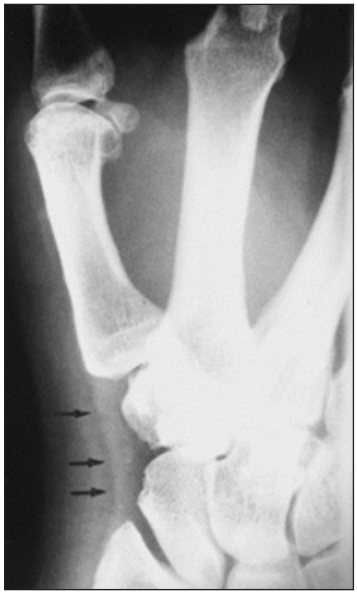


10 weeks later

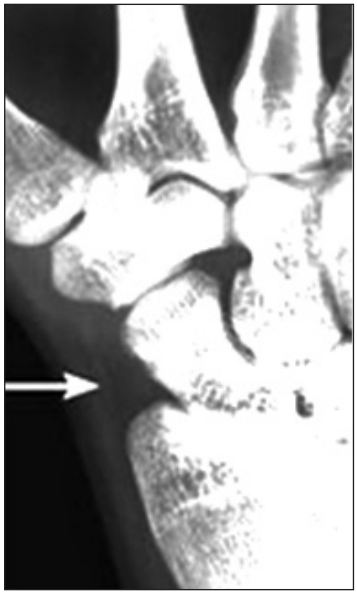
Follow-up films/images in the same position with same technique are important

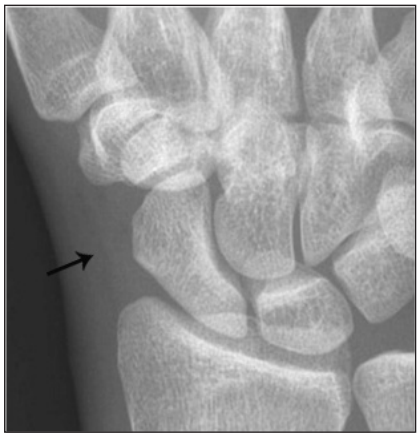
Wrist is the most commonly injured part in the body. The complex shape and articulations of the carpus make it possible to miss the trauma. Carpal bone fractures account for 18% of hand fractures.

Scaphoid fat pad sign



Normal



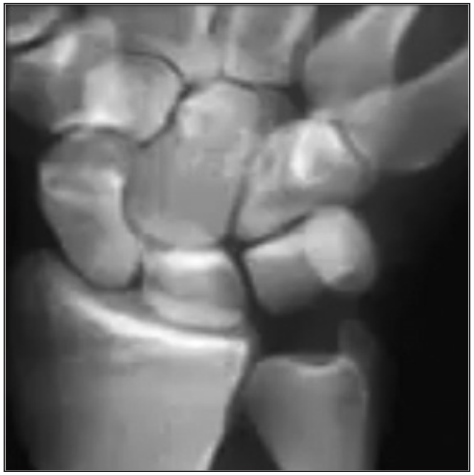


Loss of fat pad – scaphoid fracture

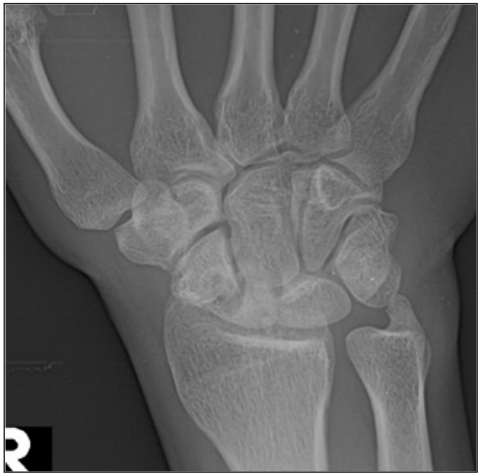
Scaphoid fracture

Missed

6 weeks later



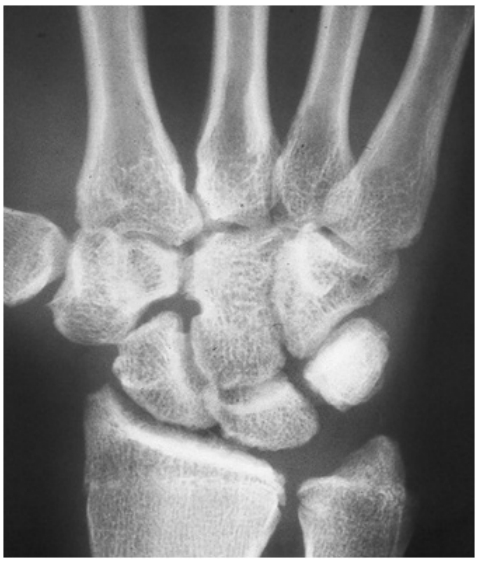
Missed



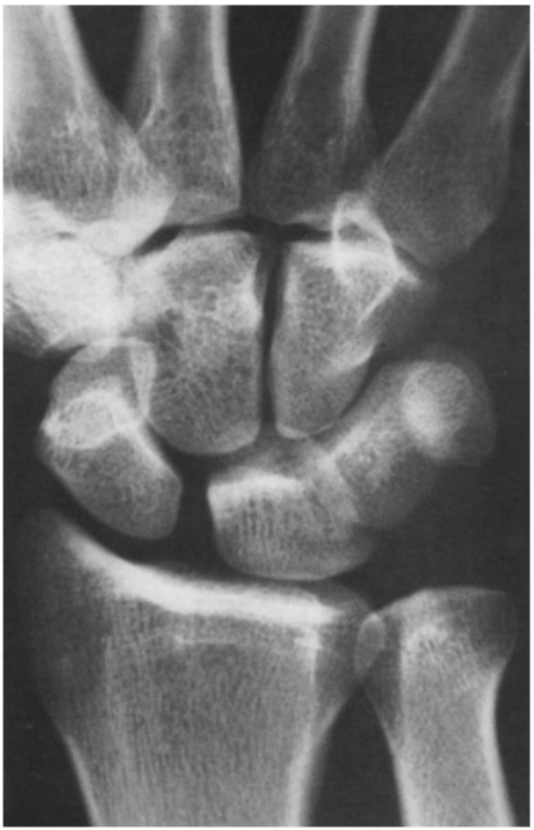
Recognized later

Rotary subluxation of scaphoid

Increased gap between scaphoid and lunate bones which should not exceed >3mm. The shape of the scaphoid assumes a circle and is called Signet ring sign.

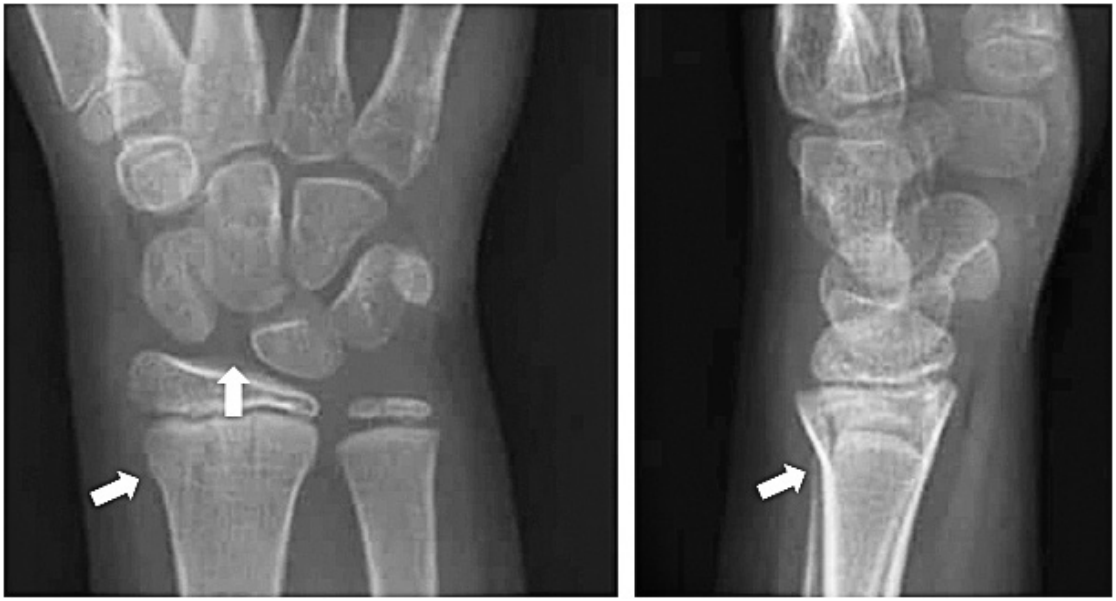


Normal scaphoid
– Lunate relationship



> 6mm

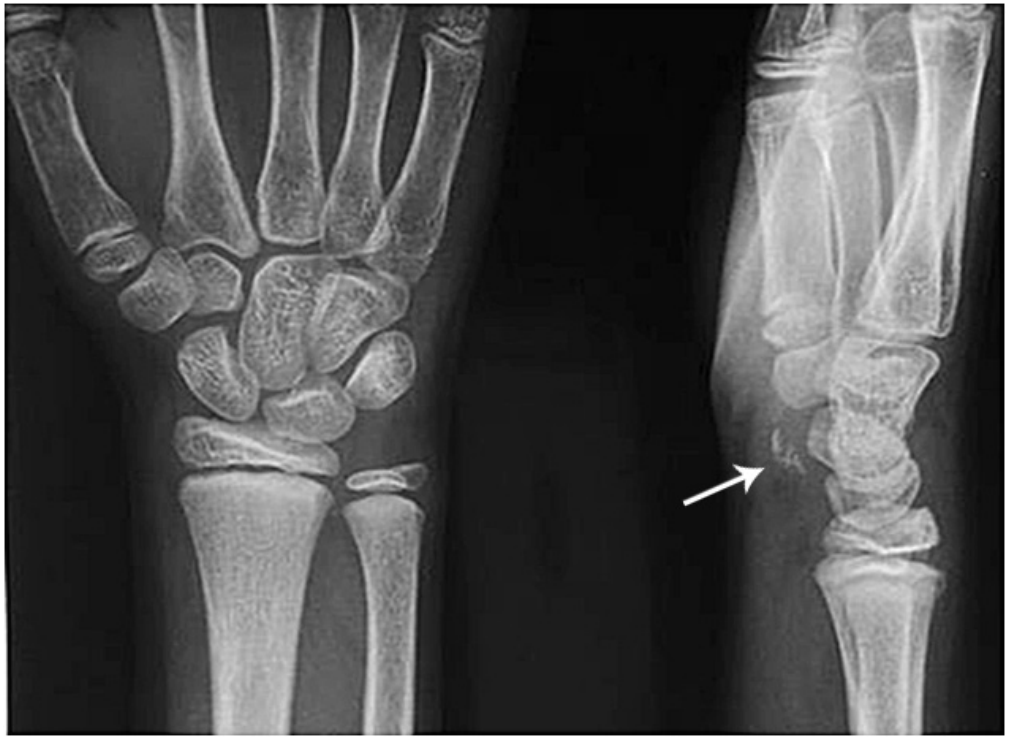
Scapholunate dissociation with distal radial Torus fracture



Do not be satisfied with one finding, look all around

Scapholunate dissociation (SLD) is the most common type of carpal instability. Another reason is that compression forces transmitted through the capitate has a tendency to separate the scaphoid and lunate. It occurs due to injury to scapholunate interosseous ligament (SLIL). SLIL may either be injured alone or in combination with other ligaments such as radioscaphocapitate ligament or dorsal intercarpal ligament.

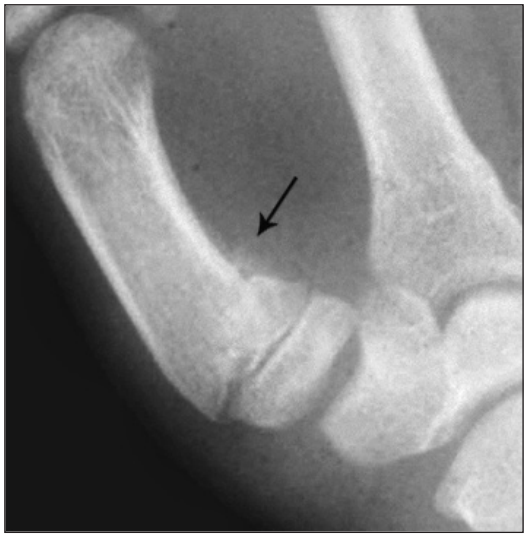
Acute trauma – 9 yr old



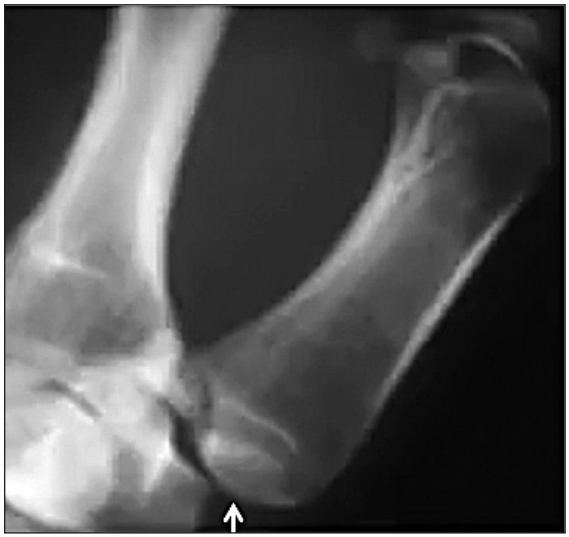
Incomplete mineralization of pisiform at this age should not be mistaken for trauma

Bennett fracture

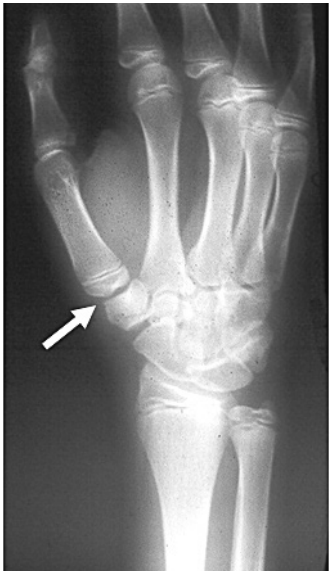
Fracture of the base of the thumb resulting from forced abduction of the first metacarpal. It is defined as an intra-articular two-part fracture of the base of the first metacarpal bone.



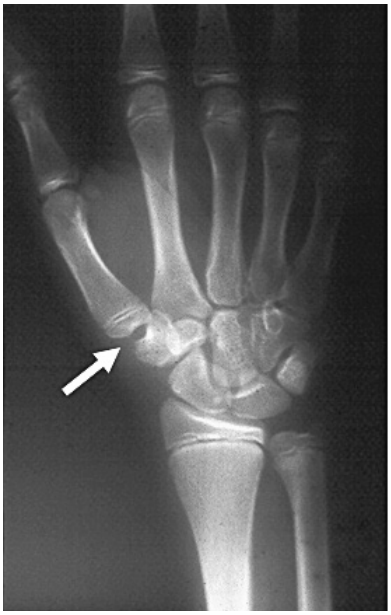
Actually Salter II



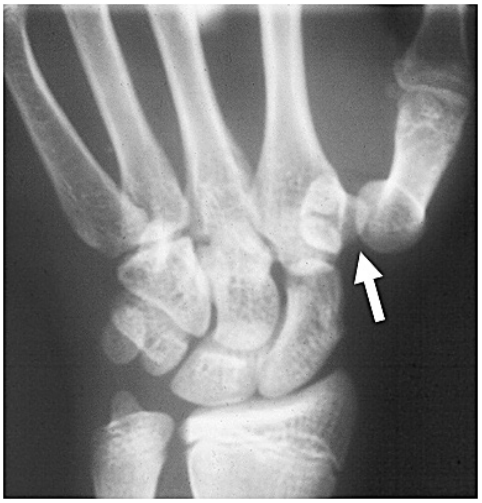
Bennett fracture dislocation



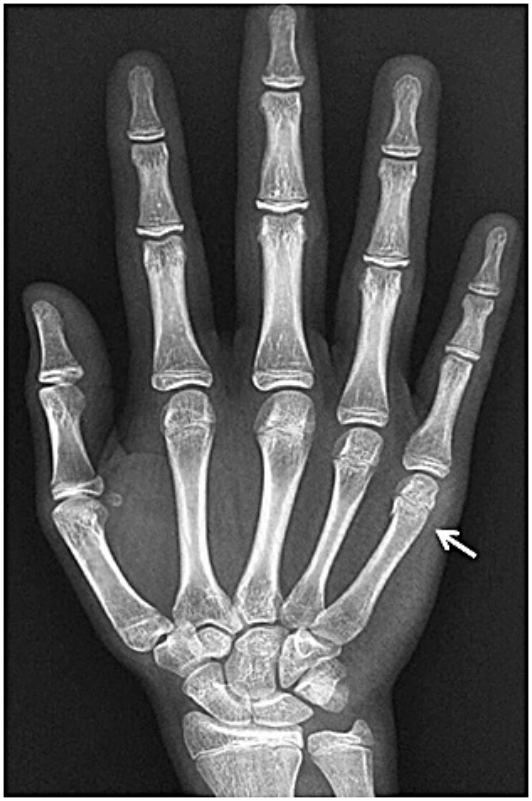
Normal



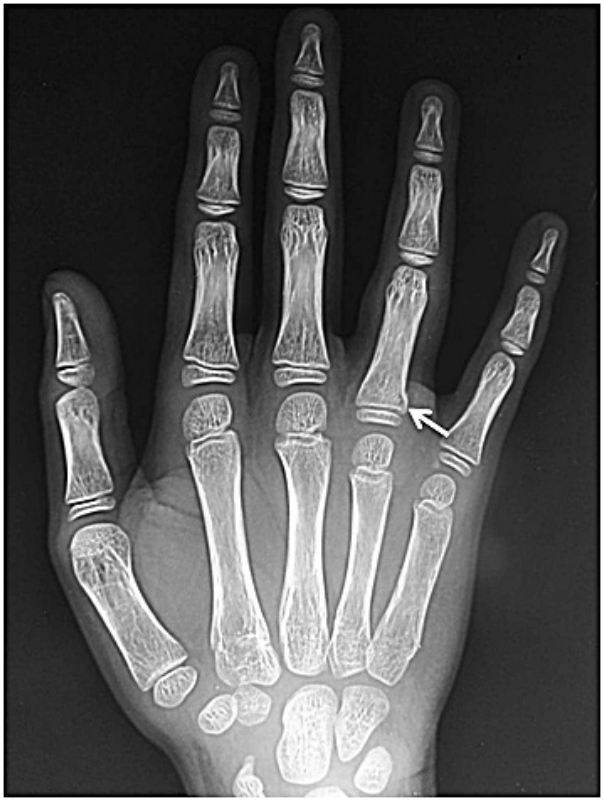
Subluxation at 1st carpo metacarpal joint (missed)



Dislocation of the first carpo metacarpal joint.

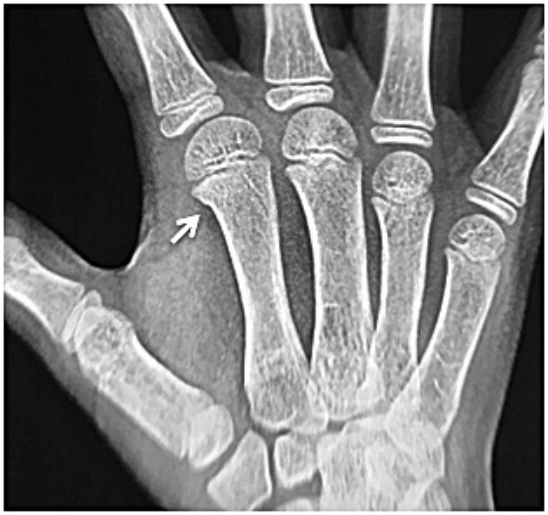


Fracture neck of 5th metacarpal

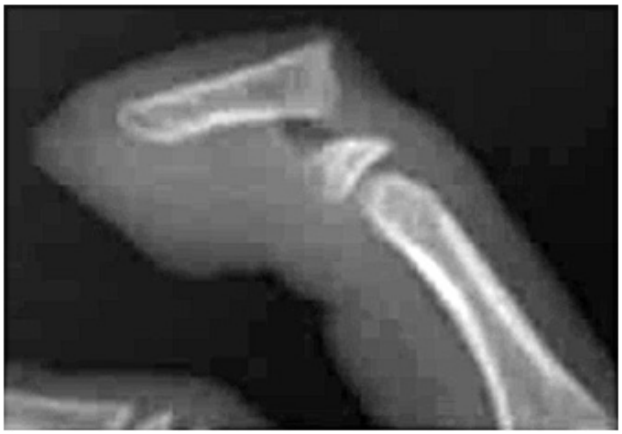


Fracture base of proximal phalanx of 4th finger

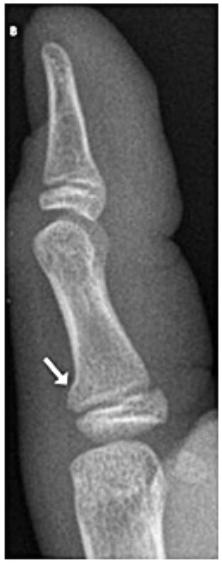
Fracture neck of 2nd metacarpal



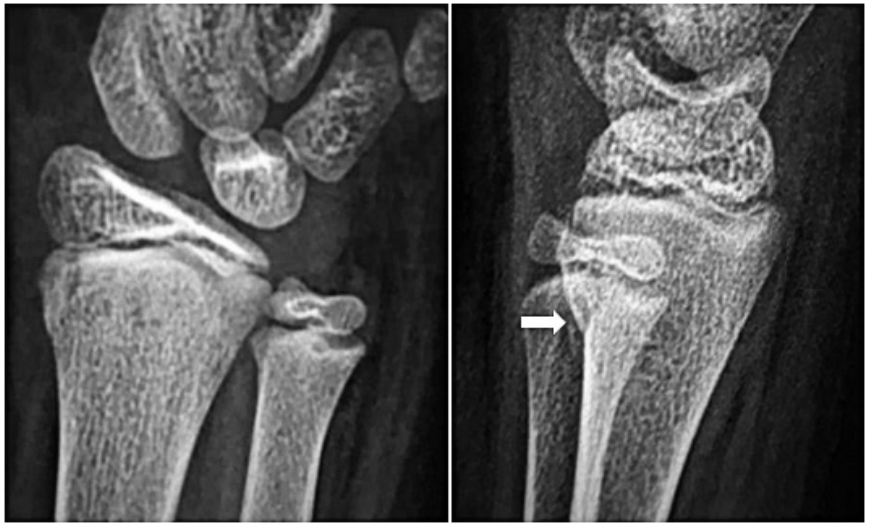
Seymour Fracture



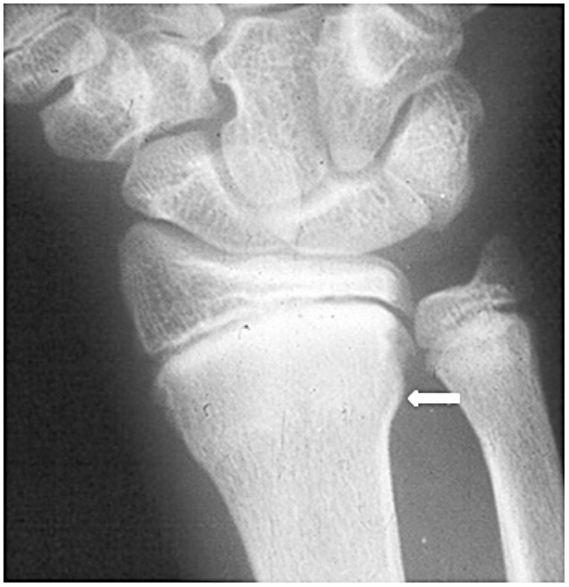
Buckle fracture metaphysis of proximal phalanx of the thumb



The Seymour fracture is a clinically important subtype of mallet finger type injury. It is comprised of a distal phalanx physeal fracture that has an associated nail bed injury commonly with ungual subluxation.

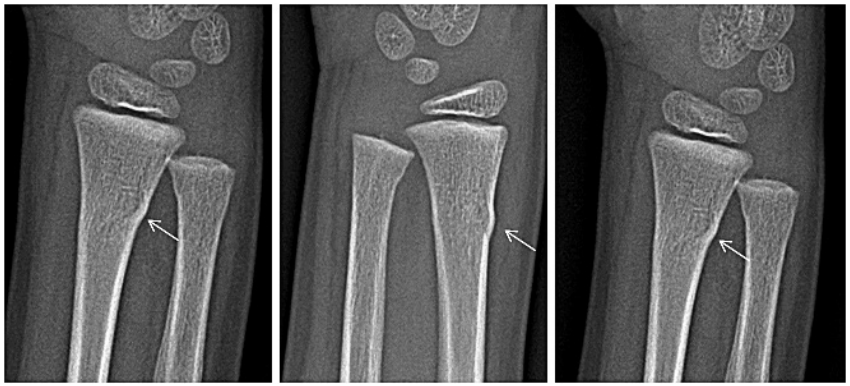


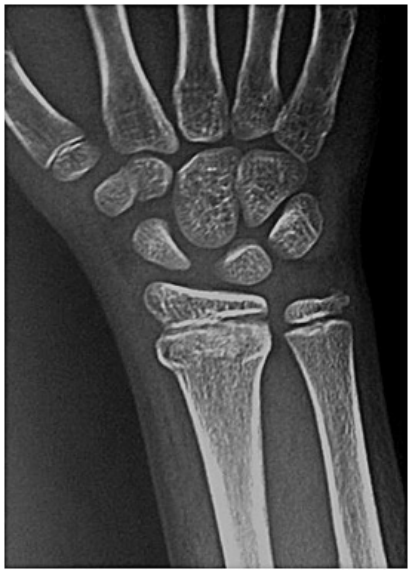
Fracture distal radius



Impacted fracture radius

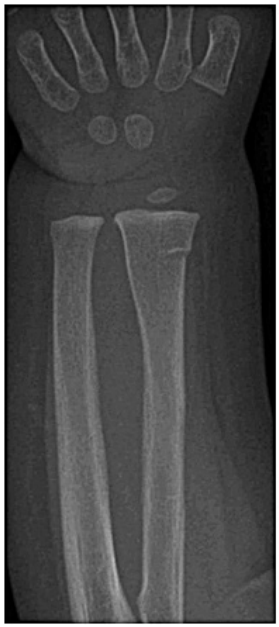
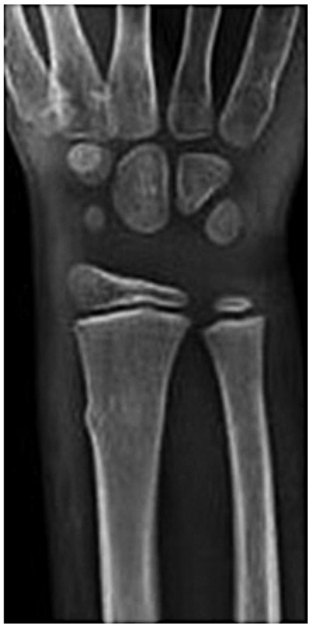
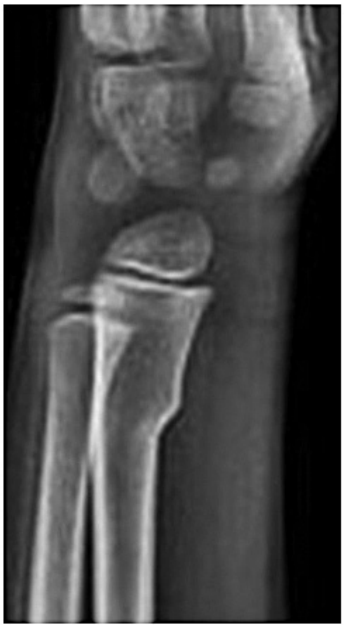
Torus fracture



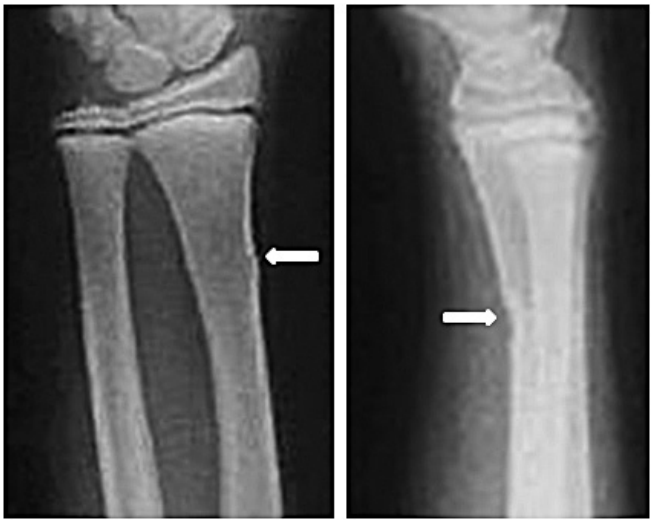


- Due to longitudinal compressive force
- Also called as buckle fracture: focal angular deformity at metaphyseal-diaphyseal junction of long bones.

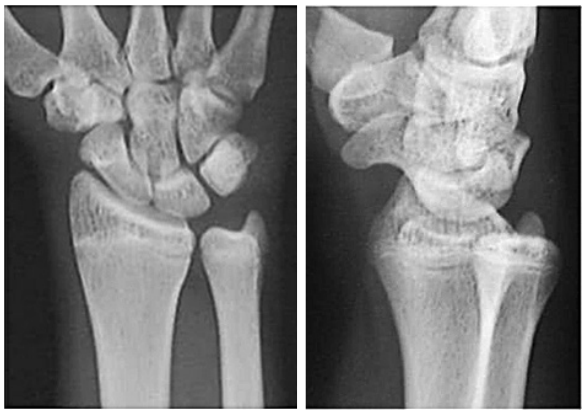
Green stick fracture


Buckling Fracture

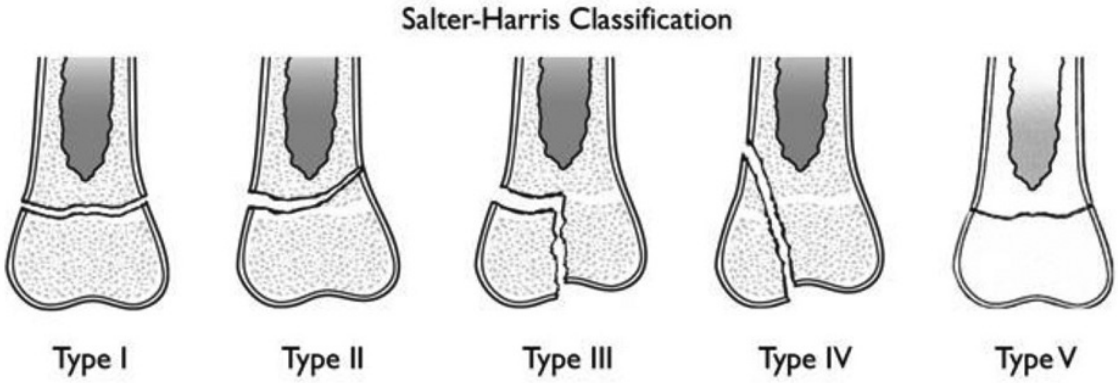


Distal radioulnar dislocation



Periosteum is intact. There is no displacement. (Green Stick # - Only one cortex is broken the other cortex is intact)

Salter Harris Physeal Fractures

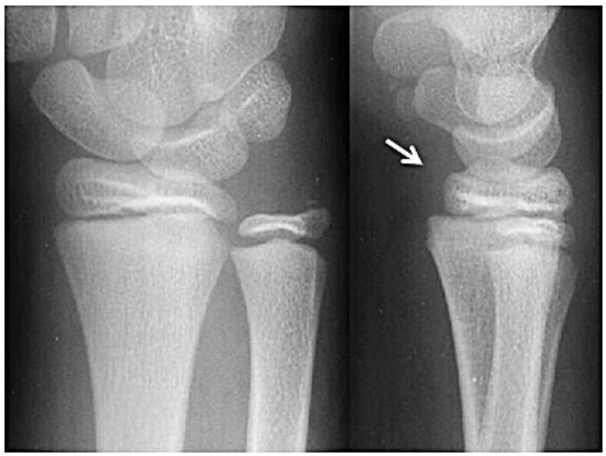


Of these types, type 1 and 5 fractures are frequently missed

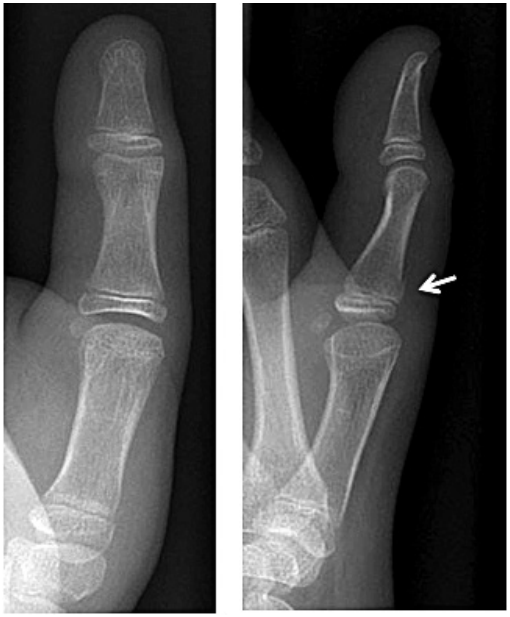
Salter Harris Fracture: Type VI

A newer classification, called the Peterson classification, adds a type VI fracture, in which a portion of the epiphysis, physis and metaphysis are missing.

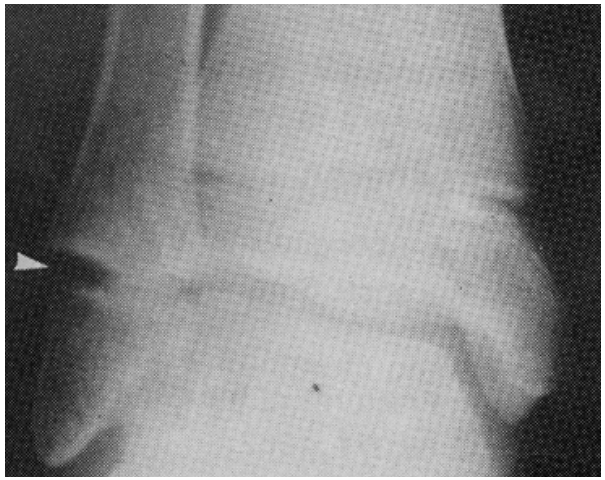
Salter 1 fracture



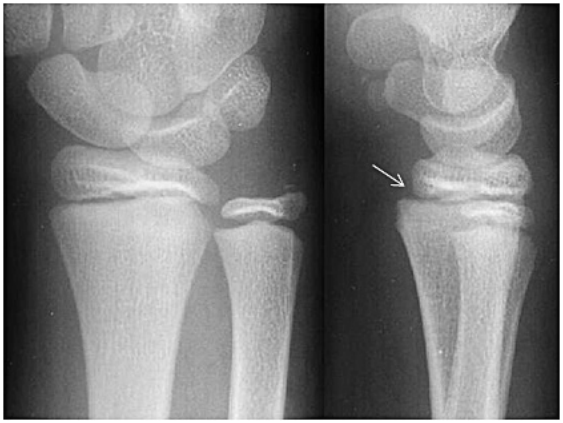
Radius - Missed on PA view



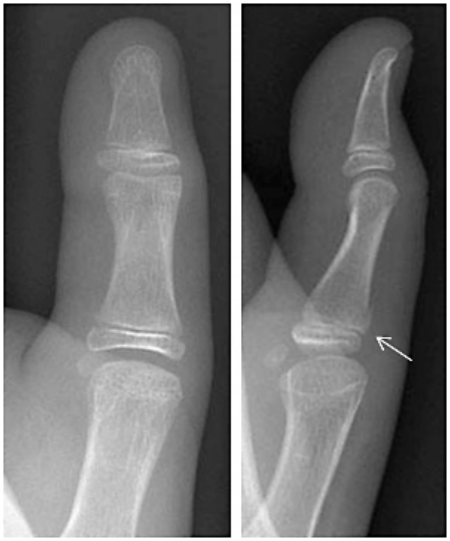
Base of proximal phalanx



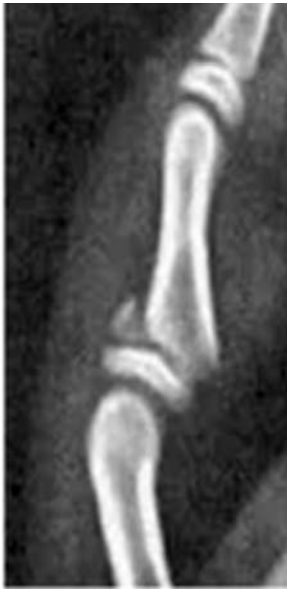
Fibula



Salter I fracture - Missed on PA view

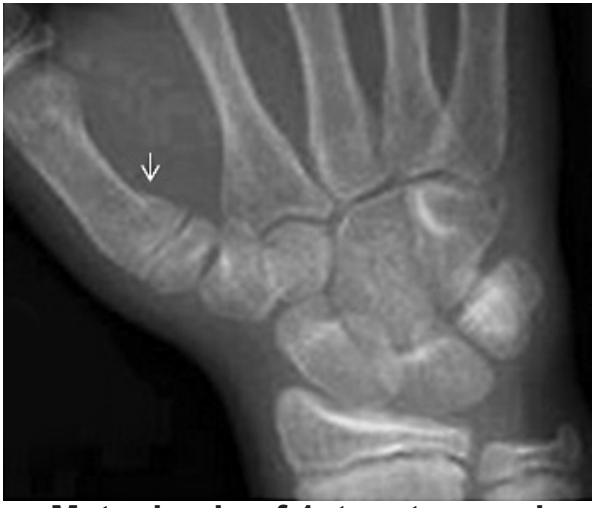


Base of proximal phalanx



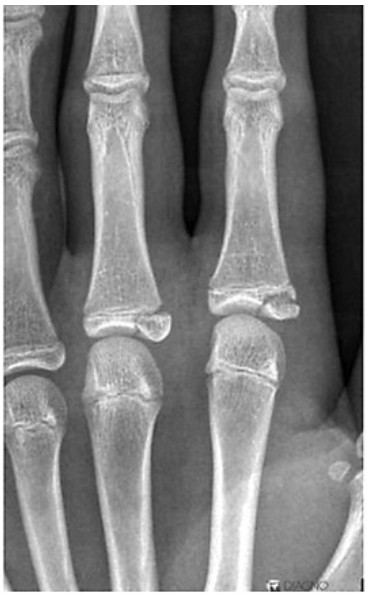
Mallet fracture Middle phalanx

Salter II fractures

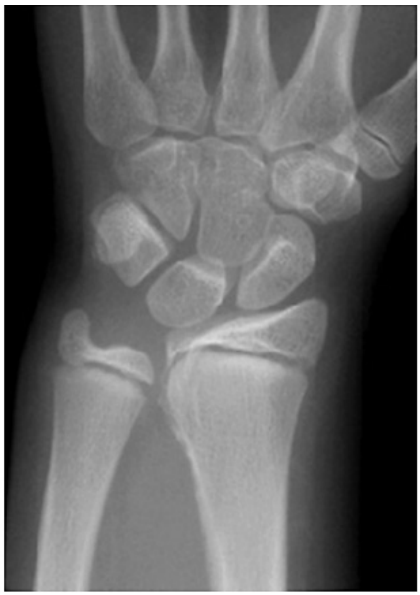


Metaphysis of 1st metacarpal

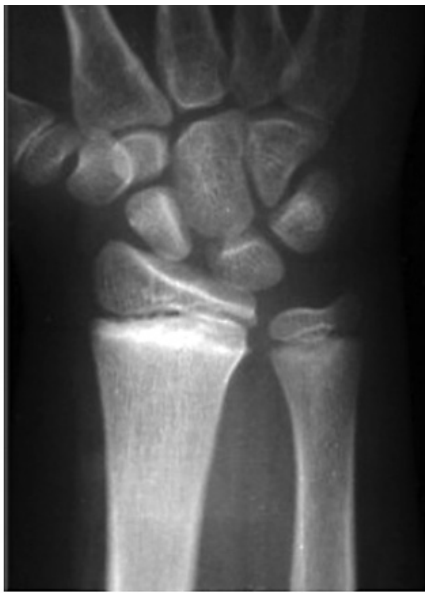
Salter Harris Fracture Type III



Salter Harris Fracture Type IV

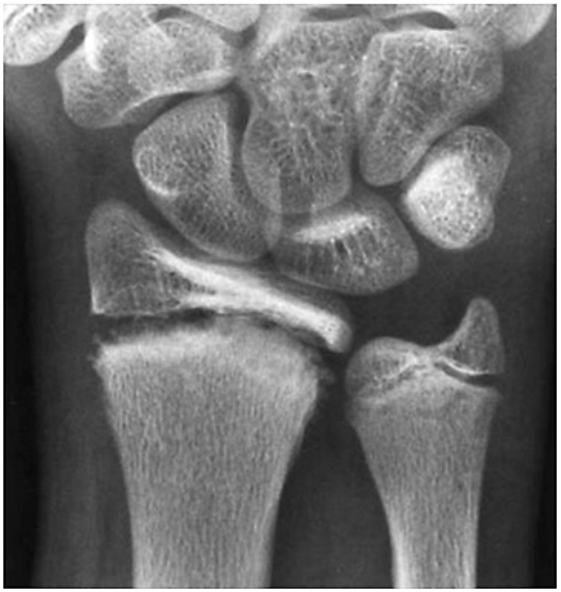


Salter Harris Fracture Type V

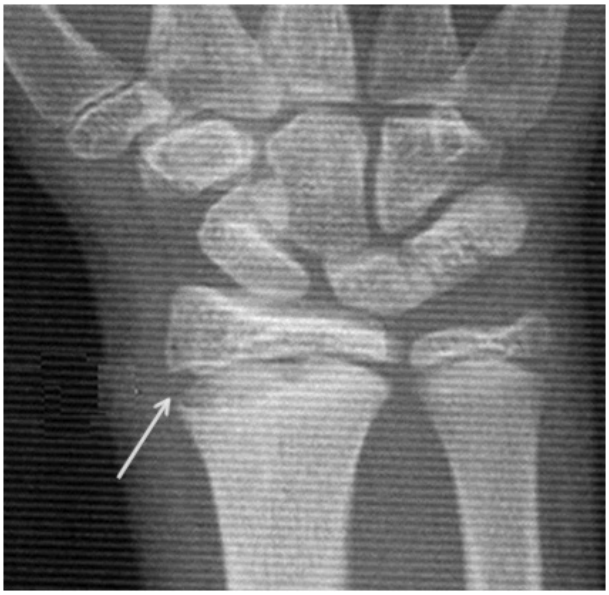


Missed on PA view

Gymnast's wrist with physeal damage

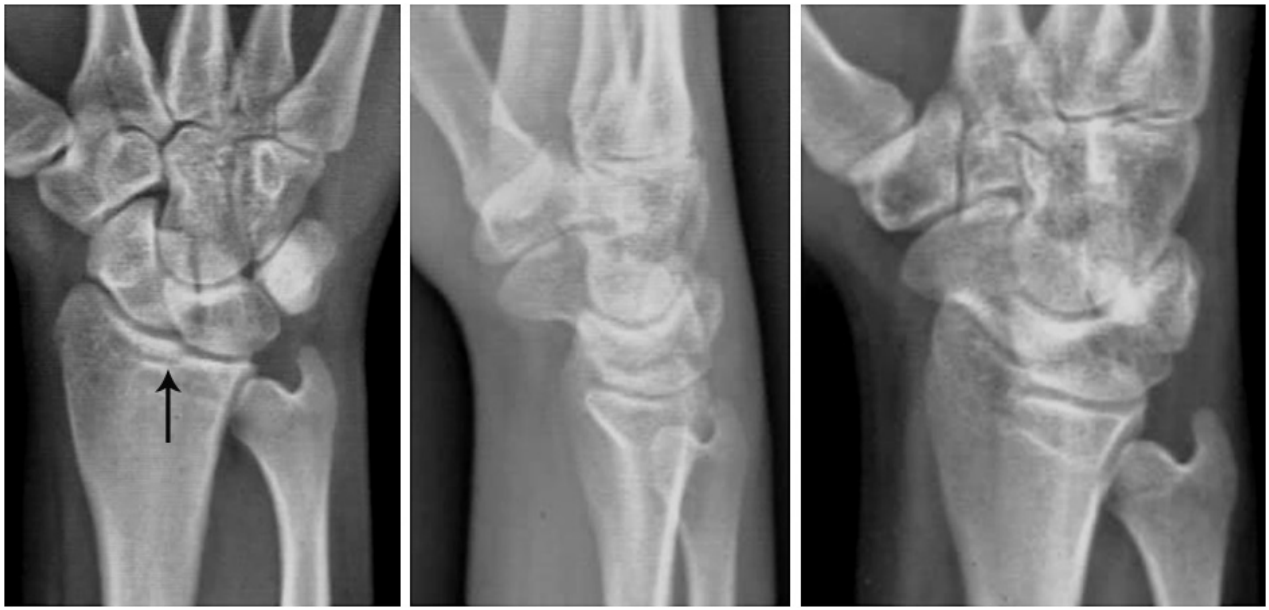


Mistaken for rickets

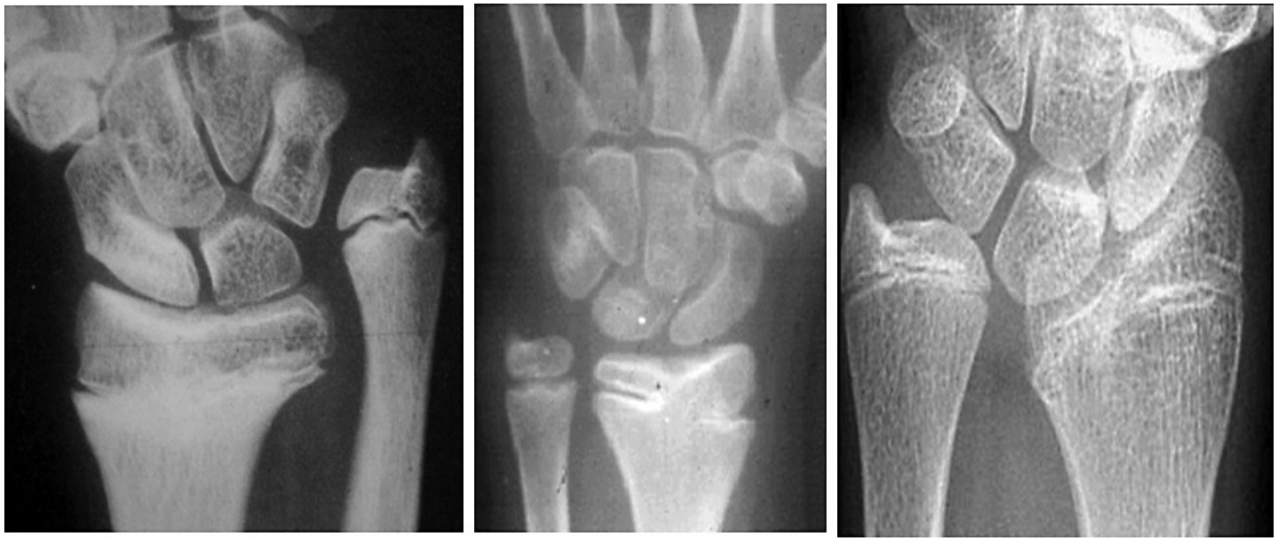


Physeal injuries are also common in neurological states. Eg., congenital insensitivity to pain

17 yr old, osteochondral fracture, distal end of radius



Late Sequelae Of Missed Physeal Injury

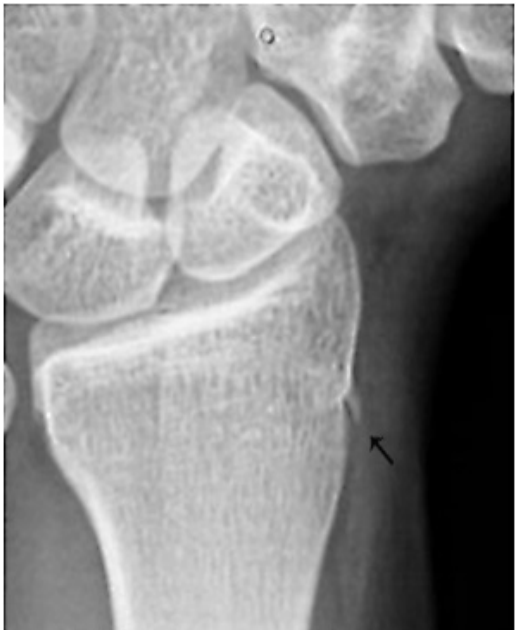


Madelung deformity

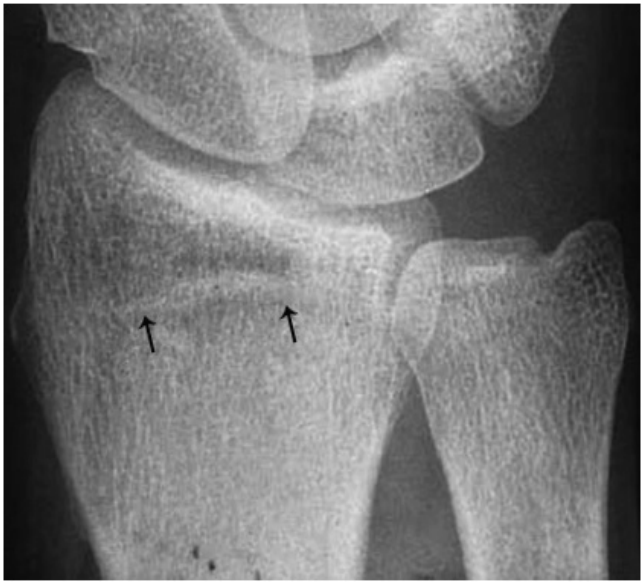
Common complication of type 5 & 6 Salter Harris fractures

Fracture mimics

Fracture mimics involve normal variations simulating fractures. An accessory centre or mach line may be called a fracture.



The normal spurlike projection of the epiphysis at the epiphyseal line may simulate avulsion injury.



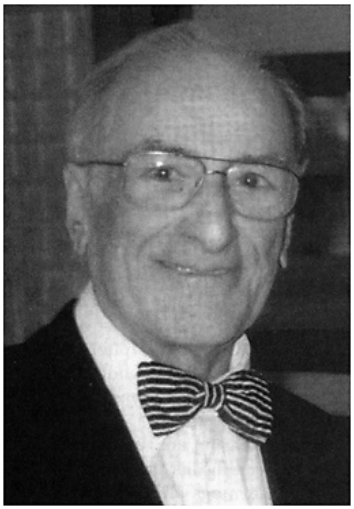
Physeal line - not to be mistaken for an impacted fracture

Causes Of Missable Fracture

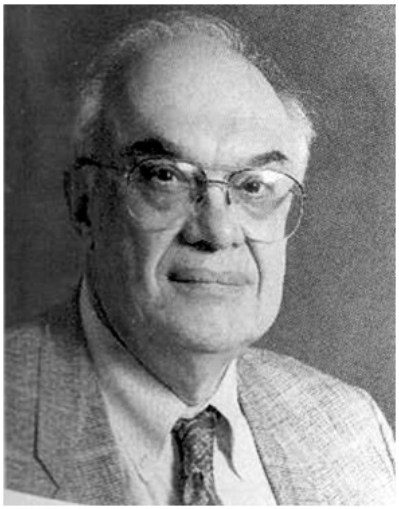
- Poor technique
- Inadequate investigation
- Perceptual error
- Incomplete knowledge
- Misjudgement
- Combination of all the above

"The eye cannot see what the mind does not know"

Extra Reading



**Hooshang Taybi,
1919-2006**



Andrew K. Poznanski

Taybi H, Lachman RS Radiology of syndromes, Metabolic disorders and Skeletal Dysplasias (4th Ed.), Chicago year book. Out of 600 syndromes 500 involve hands.

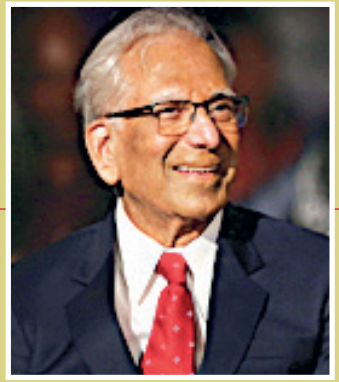
**Poznanski Andrew K.
The Hand in
Radiologic diagnosis.
3rd Edition
Philadelphia. W. B. Saunders**

- **Kakarla Subbarao, X-ray palmistry in pediatrics; Proceedings of the Academy of Medical sciences, Andhra pradesh, Vol – 7 , No. 1, Jan 1965.**

- **Kakarla S, Benign tumors of the bones of the hands; JMSR, 2018; 6(2): 49-58. DOI: http://dx.doi.org/10.17727/JMSR.2018/6-9**

- **Kakarla S Tumoral lesions of the bones of the hands – Pictorial essay; J Med Sci Res 2018; 6(3): 86-92. DOI: http://dx.doi.org/10.17727/JMSR.2018/6-15**

- **Kakarla Subbarao – Pediatric Bone Tumors Chapter 31; Section VI Skeletal system: 710-746 (Selected topic from pediatric radiology 2018 – Editor MD Rahalkar's).**



Prof. Kakarla Subbarao

MBBS, MS (Rad), FFR (Eng), FACR, FICR, FICRI, DSc (Hon)

Prof. Kakarla Subbarao, 94 is a world renowned radiologist. He was a professor of Radiology at Osmania Medical College, Hyderabad. Subsequently, he left for US and he served as professor of Radiology at Albert Einstein College of Medicine, New York, and New York College of Podiatric Medicine. Upon returning to India, he worked as founder Director of Nizam's Institute of Medical Sciences (NIMS), Hyderabad, and subsequently Director, Vice chancellor of the same institute. He was Chairman of Indian College of Radiology and Imaging and National President of Indian Radiological and Imaging Association. He was Founder President of Musculoskeletal Society of India. He was founder of Susruta Society of Radiology now named as Association of American Radiologists of Indian Origin (AARI). He was Founder Chairman of Telugu Association of North America. He was Life time Trustee of Andhra Mahila Sabha. He has established an International School for children to foster the concept of holistic education and integrated personality development. He has been conferred with 'Padma Sri' award by Government of India. He has received Life time Achievement Awards from ten (10) Non-profit organisations. He has won many awards, Gold Medals and Orations in recognition of his selfless services rendered to the nation in the Field Of Medicine.

Presently he is Emeritus Prof. of NIMS, Visiting Professor of KIMS, Sec and Chairman for Krishna Foundation for Research Centre, Hon. Edi. of the Journal for Medical and Scientific Research and Chairman at KREST (Kakarla Subbarao Radiological & Imaging Educational Sciences Trust).

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