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REVIEW OF RADIOLOGICAL APPEARANCE OF BENIGN BONE TUMOURS.

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Abstract
Benign bone tumours are rare and often asymptomatic, typically discovered incidentally through imaging. Radiological evaluation is essential for diagnosing and managing these tumours, as it provides valuable information on their location, size, and characteristics, helping to distinguish them from malignant lesions. The appearance of benign bone tumours varies: osteoid osteomas present as small, well-defined lytic lesions with a central nidus and surrounding sclerosis; chondroblastomas appear as lytic lesions with a "soap bubble" appearance; simple bone cysts appear as unilocular, fluid-filled lesions; and fibrous dysplasia shows a "ground-glass" pattern due to fibrous tissue replacement. In general, benign tumours exhibit well-defined borders, lack of cortical destruction and no soft tissue extension. The World Health Organization (WHO) classification system provides a framework for standardizing the diagnosis and management of these tumours. Overall, radiological imaging is crucial for the proper diagnosis, assessment, and follow-up of benign bone tumours, guiding clinical decisions and improving patient outcome.

Introduction
Primary bone tumours are rare in clinical practice and are usually benign. Most of these tumours are asymptomatic and are often discovered incidentally during imaging for other reasons. Imaging plays a crucial role in determining the appropriate management, as the radiographic appearance of the lesion can often help to ascertain its nonaggressive nature. In many cases, the benign nature of the tumour can be confirmed based on the imaging findings. The WHO classification (5th Edition) of soft tissue and bone tumours provides a standardized framework for diagnosing and managing these tumours[1].

Classification of benign bone tumours[1]:-
A. Chondrogenic tumour :- Enchondroma, Osteochondroma, Chondroblastoma, Chondromyxoid fibroma (CMF)
B. Osteogenic tumours :- Osteoid osteoma, Osteoblastoma
C. Osteoclastic giant cell rich tumours :- Aneurysmal bone cyst, Giant cell tumor of bone.
D. Mesenchymal tumours of bone :- Simple bone cyst, Intraosseous lipoma, Fibrous dysplasia.

Enchondroma

Enchondromas are relatively common benign intramedullary cartilage neoplasms, typically seen in individuals aged 10 to 30 years. They most commonly occur in the short tubular bones of the hands and feet, which account for about 50% of cases, but can also affect other bones formed from cartilage. The majority of these lesions arise in the metaphysis or diametaphyseal region of the affected bone[1].

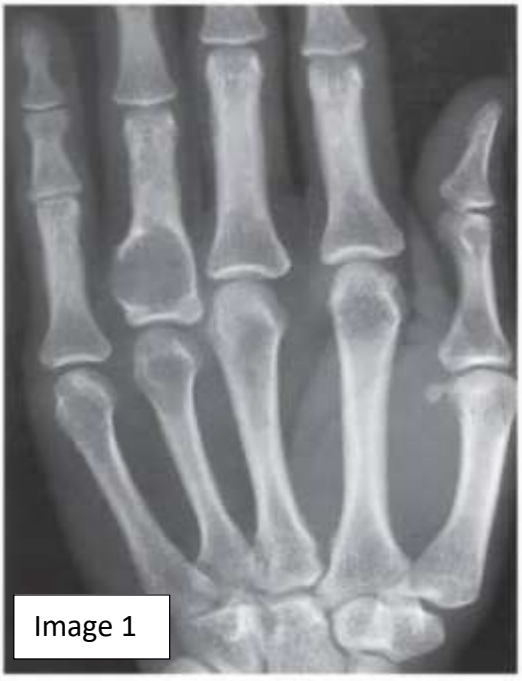
Key imaging features[4]:-

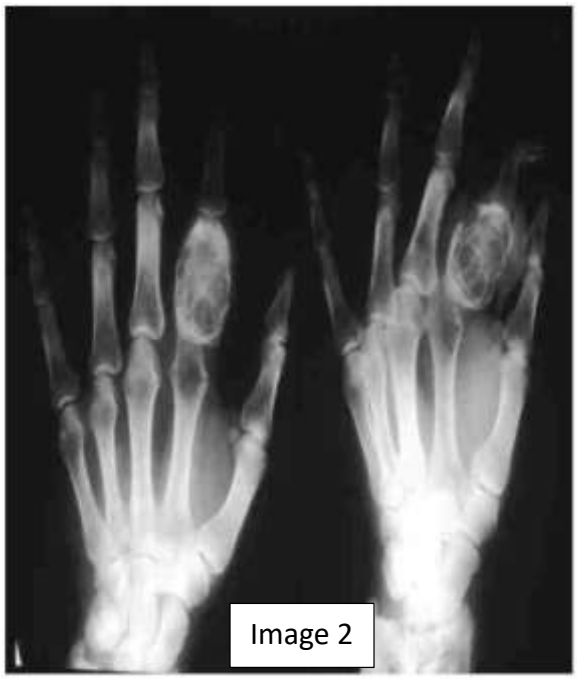
- Intramedullary mixed lucent lesion (1–2 cm) with thin sclerotic rim.
- Lesion with narrow zone of transition
- Expansion of the cortex without cortical breach, mild scalloping of inner cortex.
- Internal ground-glass appearance +/-calcification/chondroid matrix.
- Septal and peripheral (multilobular rim like) enhancement with no surrounding edema
- Pathological fracture – a frequent presenting complaint of enchondromas of the hands or feet.

Enchondromatosis is associated with few syndromes:-

1. Ollier's syndrome :- Multiple osteochondromas
2. Maffucci's syndrome:- multiple osteochondroma with hemangiomas.

Image 1: X-ray PA view of hand of A 15 years old male came with swelling of ring finger for 2 to 3 months , which is painless and increasing in size.
A well-defined lytic lesion with narrow zone of transition involving proximal phalanx of 4th finger. Lesion shows expansion of cortex with cortical breach.
Image 2 : Similar characteristic lesion is noted involving 1st finger of left hand in x-ray PA and oblique view.





Osteochondroma

Solitary osteochondroma is the most common bone tumour, accounting for 10-15% of cases[1]. The majority of osteochondromas are asymptomatic, but symptomatic lesions are typically found in individuals under 20 years of age. These tumours are most commonly seen in those aged 10–20 years, with a higher prevalence in males. They are typically located in the metaphyseal region of the long bones in the lower extremity, with the distal femur being the most frequent site, followed by the proximal tibia and proximal humerus. Although rare, osteochondromas can also occur in unusual locations, including the small bones of the hands, feet, pelvis, scapula, and spine.
Representative image 3.

Key imaging features[3]:

- Mineralized surface lesion with corticomedullary continuity (best depicted on CT and MR in regions of complex anatomy)
- Two possible patterns of corticomedullary continuity:
- broad continuity (sessile osteochondroma) or narrow continuity (pedunculated osteochondroma)
- Possible chondroid matrix (ring and arc calcification) within hyaline cartilage cap
- Septal and peripheral enhancement of the cartilage cap.

Feature suggestive of malignant transformation :-

• Unexplained pain
• Growth of cartilage cap in skeletally mature patient
• Erosion or destruction of adjacent bone
• Significant soft tissue mass containing irregular mineralization
• Cartilage cap thickness of more than 1.5 cm in skeletally mature patient

Image 3 :- Xray AP and lateral view of knee joint , pre and post contrast T1WI of 12 year old girl presented with swelling near knee joint, which has increased with time and minimally painful.
There is a pedunculated osteochondroma arising from the lateral cortex of tibia at the meta-diaphyseal junction. No discrete associated soft tissue mass. No joint effusion or abnormal soft tissue calcifications.

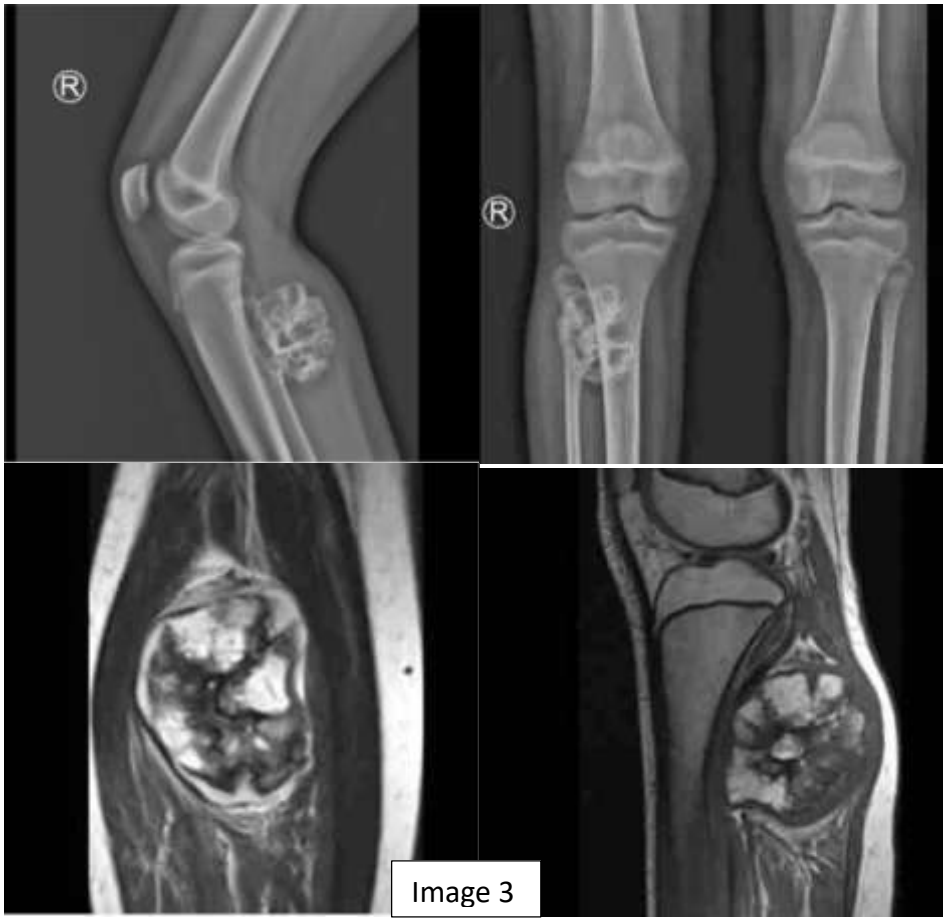


Image 3

Chondroblastoma

Chondroblastomas are rare cartilaginous tumours, accounting for less than 1% of all primary bone tumours. These tumours typically arise in the epiphyses or apophyses of bones, with the most common anatomic sites being the distal femur, proximal humerus, and proximal tibia. The most frequent

presenting symptom is bone pain. Additionally, there is a male to female (M : F) ratio of 2 : 1 for individuals affected by this condition[1].

Key imaging features[2]:-

- Epiphyseal/apophyseal location with possible metaphyseal extension
- Small (1-4 cm) geographic oval or rounded lytic lesion
- Thin sclerotic margin
- Internal calcification in 60%
- Periosteal reaction and cortical thickening.
- Prominent perilesional marrow edema tissue edema
- Reactive joint effusion and synovitis
- Chondroid matrix in one-third (best depicted on CT)

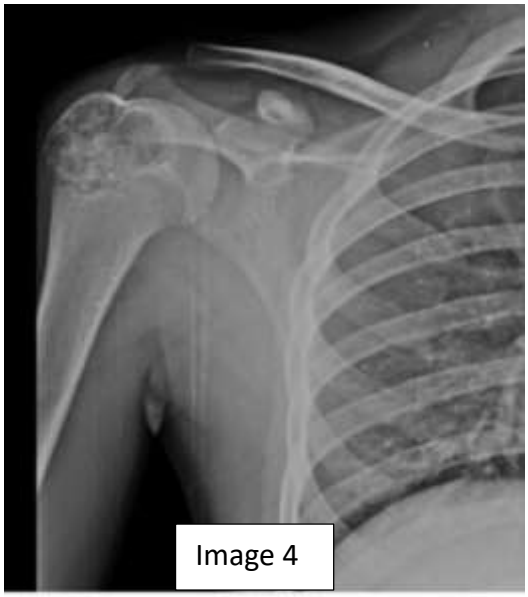


Image 4 :- AP view of right humerus.

15/M, presented with shoulder pain for 2 months.
Large lucent lesion in proximal humerus centered on the epiphysis extending across the almost fused physis into the metaphysis. Possible central calcification. No periosteal reaction. No soft tissue mass, narrow zone of transition.

Chondromyxoid Fibroma[5]

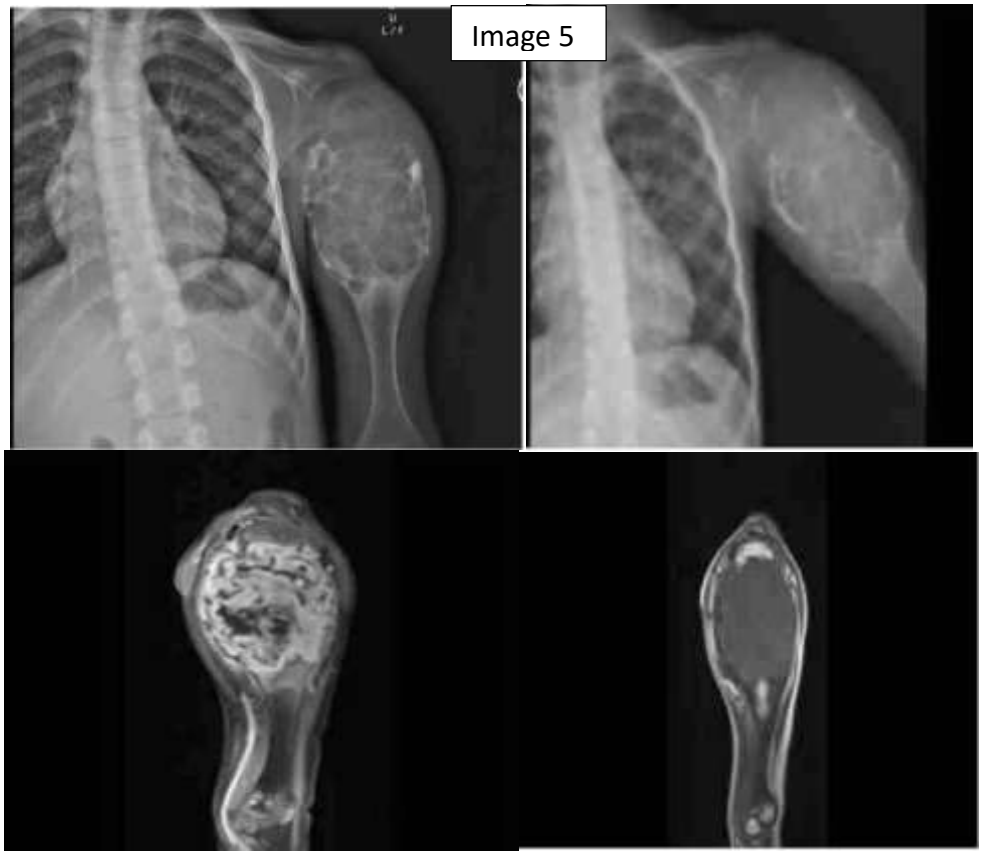
Chondromyxoid fibroma is a rare benign primary bone tumour that originates from cartilage. It most commonly affects individuals between the ages of 10 and 30 years. The tumour is frequently found in the proximal tibia, accounting for about 50% of cases, though it can also occur in the femur and ribs. The tumour is typically located in the metaphysis, with possible extension into the epiphysis; however, it never occurs exclusively in the epiphysis.

Key imaging features:

- Well-defined focal round or oval bone lesion with geographic bone destruction
- Perilesional sclerosis with lobulated margins and internal trabeculations
- Eccentric expansion.
- Periosteal reaction and changes in the adjacent soft tissue
- Internal calcification is uncommon, occasional septations
- Intense post contrast enhancement on MR

Image 5 :- Xray left upper arm AP and Lateral, T1WI, PC T1WI

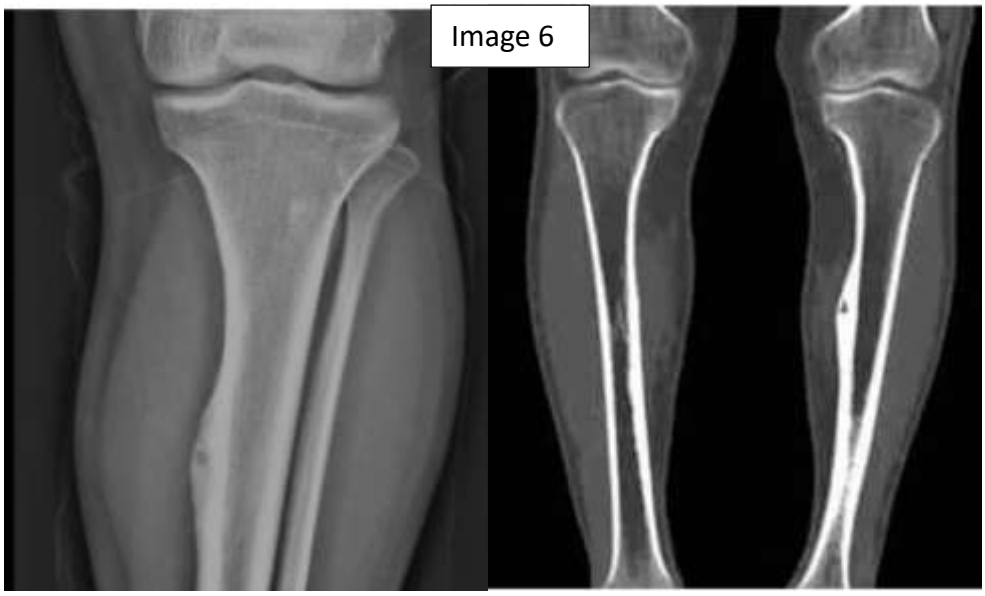
A 7-year-old male presented with a large swelling on his left arm, which has been progressively increasing in size and is accompanied by pain.
Expansile lesion of the proximal humerus with sharp zones of transition. Lesion shows chondroid matrix with ground glass appearance with internal incomplete septations. No matrix calcification or soft tissue component.



Osteoid osteoma
Osteoid osteoma is a benign osteoblastic neoplasm, accounting for approximately 3% of all primary bone tumors. It typically affects individuals in the first three decades of life. The classic presentation of osteoid osteoma includes localized pain that is worse at night, which is often alleviated with nonsteroidal anti-inflammatory drugs (NSAIDs). The tumor is most commonly located in the cortical bone (75%), although it can also be found in the intramedullary or, more rarely, subperiosteal regions. It typically occurs in the diaphysis or metasdiaphysis of the long bones, with the proximal femur being the most common site, followed by the tibia. Other sites of occurrence include the spine (particularly the posterior elements), pelvis, hands, and feet.

Key imaging features:
- Lucent nidus (<1.5-2 cm) with surrounding dense reactive sclerosis
- Thin, serpentine grooves in the surrounding sclerosis (vascular groove-highly specific feature)
- Prominent perilesional edema and enhancement
- If intra-articular : joint effusion and synovitis
- Avid enhancement of nidus.

Image 6 :- Xray AP upper tibia and coronal reformatted images of CT scan
Well defined lytic lesion is noted involving cortex of upper diaphyses region of left tibia, lesion shows narrow zone of transition and adjacent cortical thickening without cortical breech



Osteoblastoma

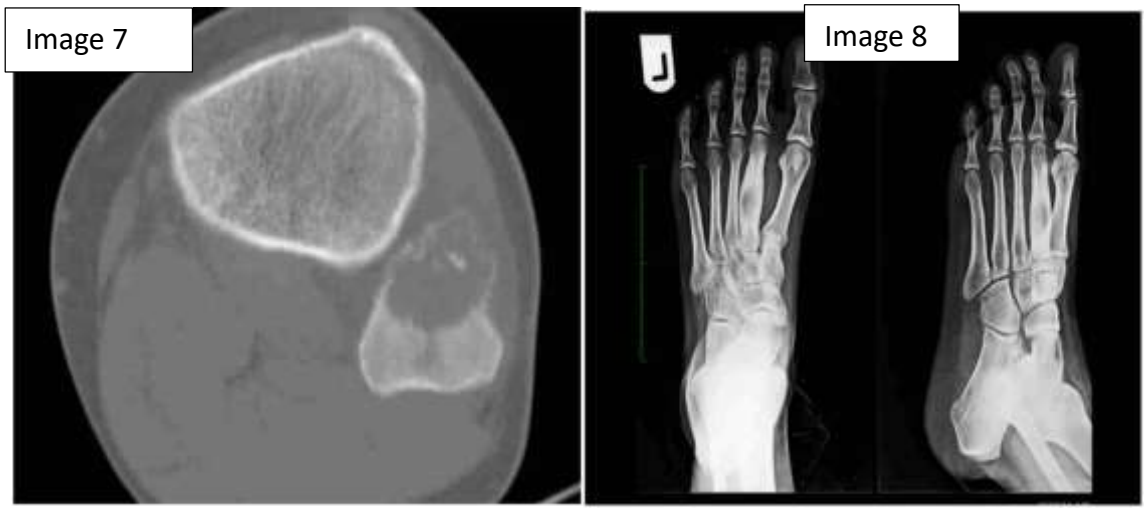
This benign osteoblastic lesion is rarer than osteoid osteoma, accounting for approximately 1% of all primary bone tumours. The most common site of occurrence is the spine, particularly the posterior spinal elements or, less commonly, the body. It most commonly affects individuals in the 2nd to 4th decades of life. Other sites where these lesions can occur include the jaw, as well as the diaphysis or metaphysis of long tubular bones, with the femur and tibia being the most frequent locations.

Key imaging features:

- Lucent centre with surrounding sclerosis- similar to osteoid osteoma
- Greater than 2 cm in size and less intense sclerosis
- Expansile lytic lesion with foci of calcification and sclerotic rim
- Aggressive lesions with cortical destruction, soft tissue infiltration, and periosteal reaction
- Calcification seen in 30%
- Cystic lesion with ABC like fluid –fluid levels.

Image 7 :- Axial CT of Leg showing a lytic expansile lesion involving fibula with adjacent cortical thinning and few areas of cortical breech. Lesion shows narrow zone of transition with no adjacent soft tissue involvement. Lesion shows internal foci of calcification.

Image 8 :- Xray foot AP and oblique view showing a well defined lytic lesion involving second metatarsal bone with adjacent cortical thickening involving diaphyseal region



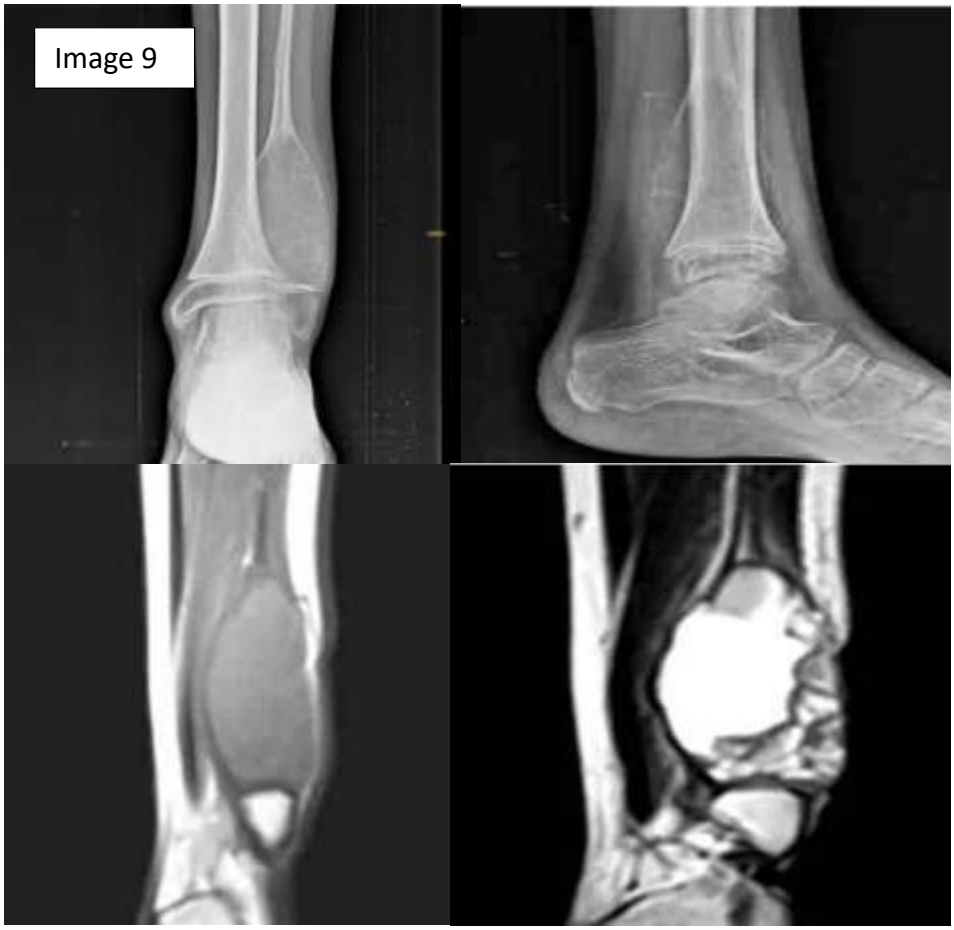
Aneurysmal bone cyst

A benign lytic lesion accounting for 1% to 2% of all primary bone tumours. It most commonly affects individuals under 20 years of age, with approximately 75% of cases occurring before epiphyseal closure. These lesions typically present as solitary expansile masses. The most common sites for these lesions include the long bones, the posterior elements of the spine and the pelvis.

Key imaging features:-

- Geographic expansile lytic lesion with "bubbly" appearance
- There is variable degree of thin and expanded but intact cortex
- Thin internal strands of bone/ trabeculation
- Multilobular fluid-fluid levels separated by thin intrinsic septae
- Primary ABC: thin internal enhancement
- Secondary ABC: solid nodular enhancing components related to the underlying bone lesion

Image 9:- Xray AP and lateral view of lower leg and T1WI, T2WI of leg of 10 Y/ F, presented with swelling above the ankle joint which is progressive and minimally painful. Geographic expansile lytic lesion with bubbly appearance and thin internal septations. Lesion shows narrow zone of transition. On MR imaging multiple fluid-fluid level with internal septations are noted.



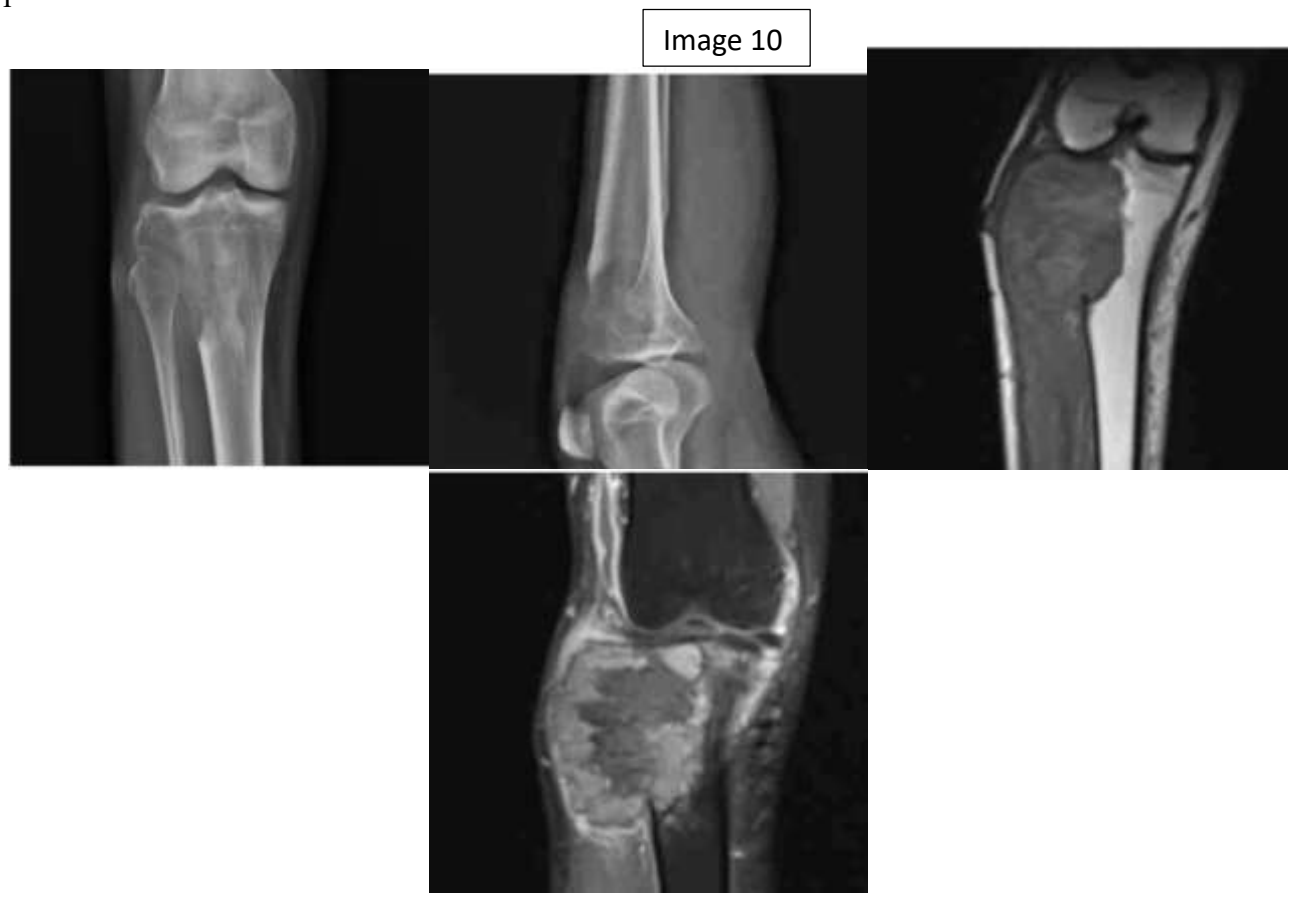
Giant cell tumor

Giant cell tumour of bone (GCTB) accounts for 5% of all primary bone tumours. It most commonly affects individuals in their 3rd to 6th decades of life. While GCTB is usually benign, it can be locally aggressive and has the potential to metastasize to the lungs. Multifocal GCTB has also been reported, although malignant transformation is rare. The tumour is most commonly found at the ends of long bones, accounting for 70-80% of cases. The most frequent anatomic sites are the distal femur and proximal tibia, with 50%-65% of cases occurring around the knee, as well as the distal radius.

Key imaging features[6]:

- Geographic lytic lesion with nonsclerotic margins
- Eccentric metaphyseal location extending to subchondral bone
- Cortical thinning and marked expansion (ballooning)
- Thin internal strands of bone/ trabeculation, +/- new bone in the angle between original cortex and the expanded part.
- Fluid–fluid level(s) on CT and MRI.
- Spine : posterior elements
- Rare origin : surface of bone in a subperiosteal location.
- Contrast enhancement

Image 10 :- Xray AP and lateral view of knee joint with T1W and PC T1WI showing well defined lucent lesion in epi-metaphysical region of right tibia. Lesion shows narrow zone of transition, expansive growth with few areas of cortical breech. On MR imaging the lesion shows heterogeneous post contrast enhancement.



Simple bone cyst (Unicameral bone cyst)

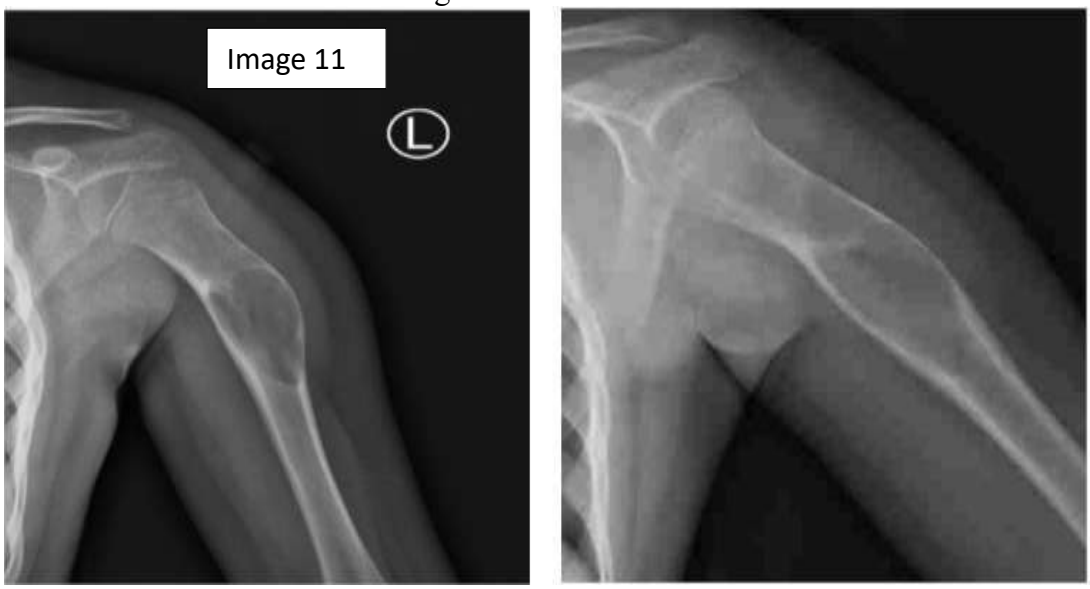
A simple bone cyst is a fluid-filled unilocular intramedullary lesion, accounting for 3% to 5% of primary bone tumours. It most commonly affects individuals in the 1st and 2nd decades of life. The most common site for a simple bone cyst is the humerus, which accounts for more than 50% of cases, followed by the femur, proximal tibia, and anterior calcaneum in adults. These cysts are typically located in the metaphysis, but as the host bone grows, they can extend into the diaphysis. In children, the most common complication associated with this lesion is a pathologic fracture.

Key imaging features:

- Children
- Geographic lytic lesion

- Thin sclerotic margin abutting open physis of long bone (humerus -50%). Adults:
- Geographic lytic lesion in anterior calcaneum
- No periosteal reaction (unless complicated by fracture)
- Fluid attenuation on CT
- Fallen fragment sign when complicated by fracture
- Thin peripheral rim enhancement
- Nodular enhancement can be seen after pathologic fracture

Image 11 :- AP and lateral view of left upper humerus showing a w ell defined lytic lesion with expansile growth, narrow zone of transition is noted involving diaphyseal region of left humerus, lesion shows few areas of cortical thinning.



Intraosseous lipoma

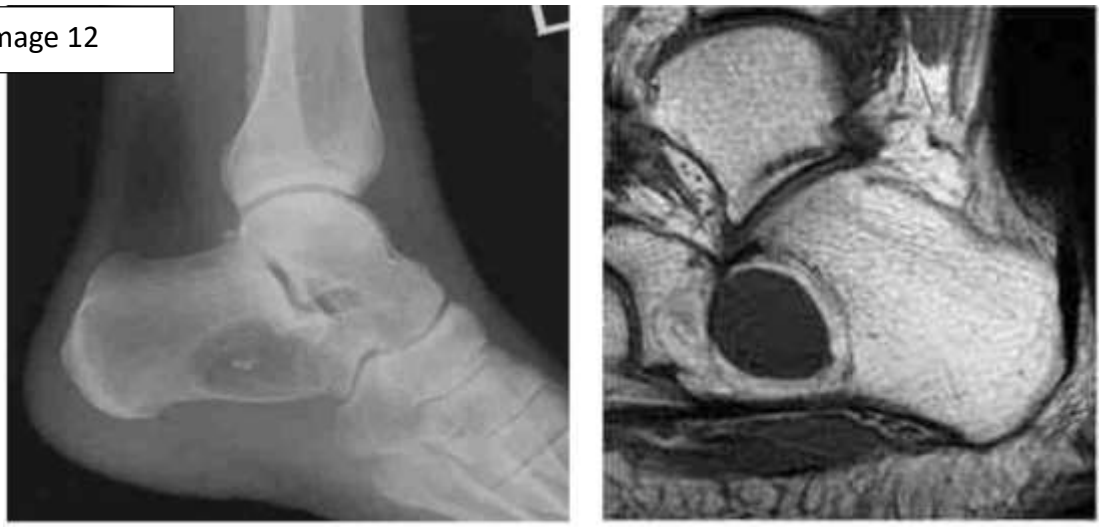
This is a rare benign neoplasm, typically seen in adults, and it accounts for less than 0.1% of all bone tumours. The lesions can be intramedullary, intracortical, or parosteal in location. The most common site, with over 70% of cases, is in the bones of the lower limbs, including the calcaneum and the inter- and subtrochanteric regions of the femur. These tumours are usually located in the metaphysis, though they may extend into the diaphysis.

Key imaging features:

- Well-defined mildly expansile lytic lesion
- Peripheral sclerotic rim (70%)
- Homogeneous fatty signal intensity
- Cystic areas and peripheral or central calcification (bull's-eye appearance)

Image 12 :- X-ray lateral view of calcaneum and T1W sagittal images of 25/M, male came with dull aching pain over heal, showing well defined , lytic lesion with peripheral sclerotic rim with homogeneous fatty signal intensity on MR imaging, lesion shows central area of calcification.

Image 12



Fibrous Dysplasia

Fibrous dysplasia is a congenital non-hereditary lesion where medullary bone is replaced by fibrous tissue. It typically occurs in intramedullary location and is most commonly located in the diaphyseal or metadiaphyseal regions. Fibrous dysplasia accounts for 5% of benign bone tumours and can be either monostotic or polyostotic, with 20% of cases being polyostotic. Polyostotic fibrous dysplasia often presents at a younger age. The most frequent sites of involvement include the femur, pelvis, skull, mandible, ribs, and humerus.

Key imaging features[7]:-

- Elongated, mildly expansile lesion in long bone
- Scalloping +/- bone expansion.
- No periosteal new bone
- Variable internal matrix depending on the underlying constituents

Ground glass/ Lytic /Purely sclerotic (uncommon)

- Limb deformities: tibial bowing, acetabular protrusion, Shepherd's crook of proximal femur
- Growth disparity
- Skull shows mixed lucencies and sclerosis, mainly on the convexity of the calvarium and the floor of the anterior fossa.
- Leontiasis ossea is a sclerosing form affecting the skull base and face.

Image 13:- Xray AP view of left leg and sagittal pre and post contrast T1WI of 13/F, presented with tender left leg with anterior bowing of tibia showing which on x-ray appears as large expansile , relatively well-defined lytic lesion with fibrous stroma involving
diaphyseal region of left tibia, which on MR imaging shows post contrast enhancement.
Image 14 :- Shepherd crook deformity in Fibrous Dysplasia

Image 13

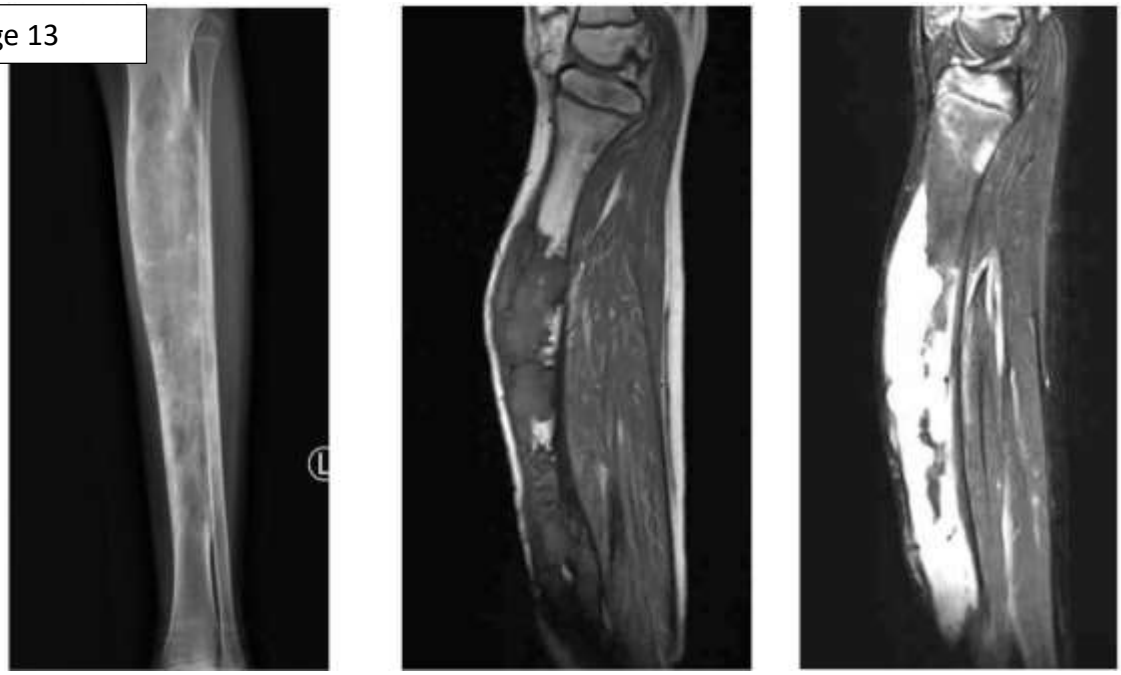
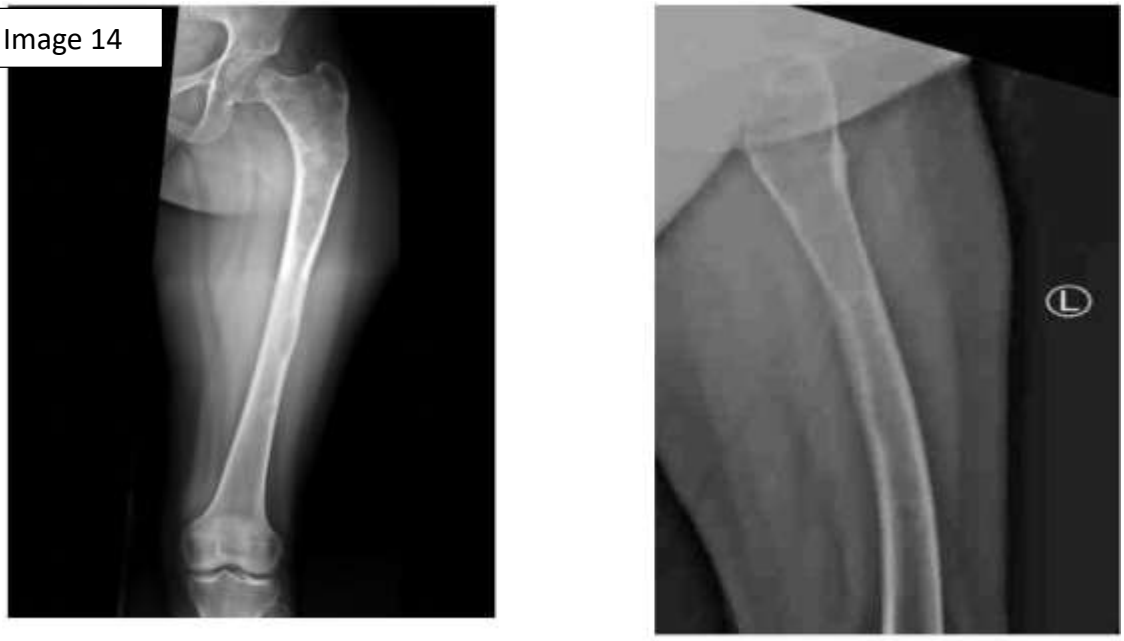


Image 14



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