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Radiology of Ribs: Spectrum of Normal Variants and Pathological Conditions - A Pictorial Essay

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Abstract: ***The ribs, as flat bones forming a crucial part of the chest wall, provide significant diagnostic insights through various imaging modalities. This pictorial essay aims to enumerate normal variants and pathologic conditions of the ribs, select appropriate imaging modalities, and describe distinguishing imaging features. Radiographic techniques such as chest X - ray, Multidetector CT with 3D reconstruction, and MRI, along with Fine Needle Aspiration Cytology or biopsy, are essential for diagnosis. The findings are categorized into normal variants, congenital conditions, metabolic conditions, primary and secondary neoplasms, and miscellaneous conditions. This comprehensive analysis underscores the importance of clinical history and symptom evaluation, cost - effective chest radiographs, and the role of supplementary cross - sectional imaging in diagnosing rib pathologies and distinguishing them from pulmonary diseases.***

Keywords: rib pathology, imaging modalities, chest radiograph, congenital rib conditions, rib neoplasms

1. Learning Objectives

- To enumerate most of the normal variants and pathologic conditions of ribs.
- To select the appropriate imaging modality for rib lesions.
- To describe salient imaging features for differentiating rib lesions.

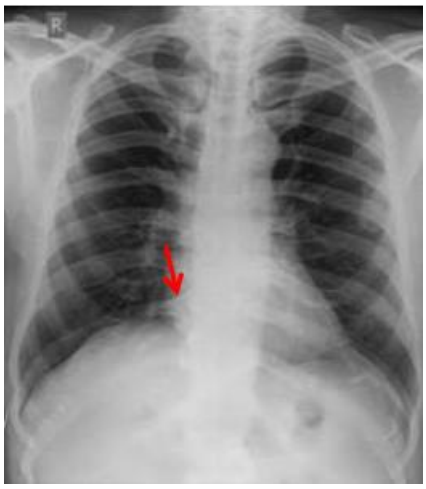
2. Findings and Procedure

We are presenting this pictorial essay in five categories
1) Normal and normal variants
2) Congenital conditions
3) Metabolic conditions
4) Primary and secondary neoplasms
5) Miscellaneous

1) Normal and normal variants

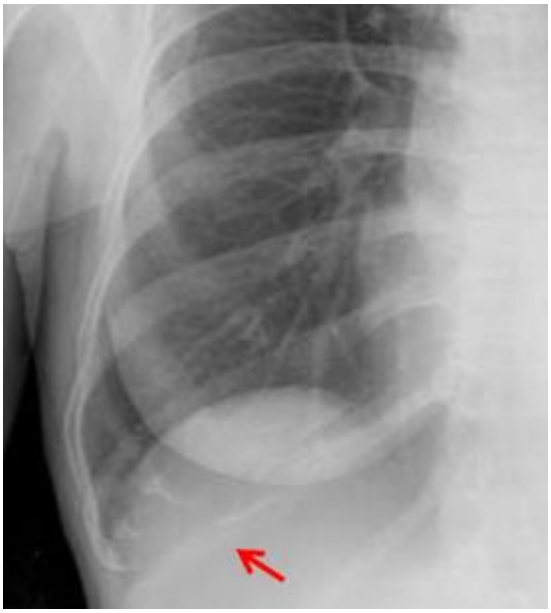
Type of Calcification

Male



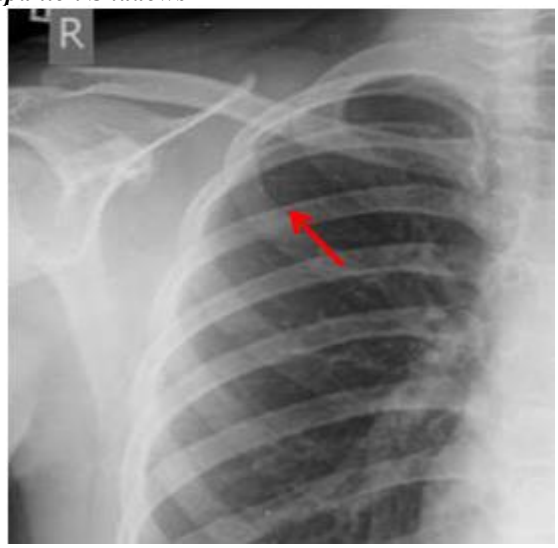
Peripheral and band like - Rail road track appearance

Female



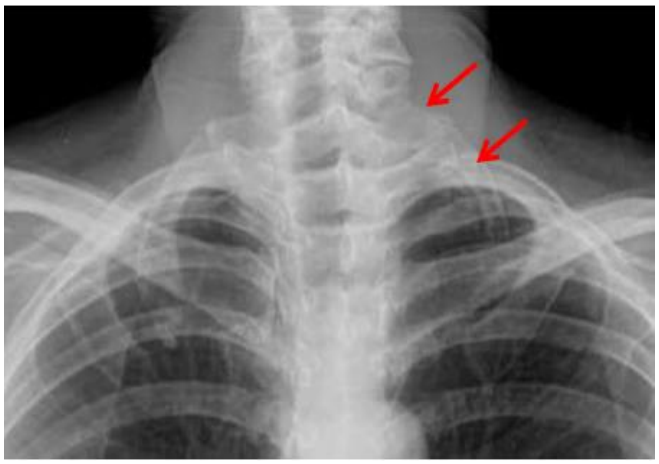
Centre and appears nodular - Wagging tongue like

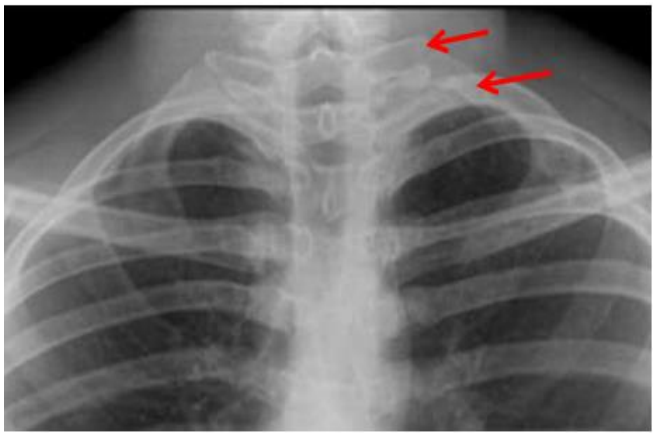
Companion Shadows



Faint soft tissue density that parallel segment of rib (usually 1st and 2nd ribs). Normal 1 – 5 mm. Clinical significance – thickness increased in obesity.

Cervical Ribs and Hypoplastic First Ribs



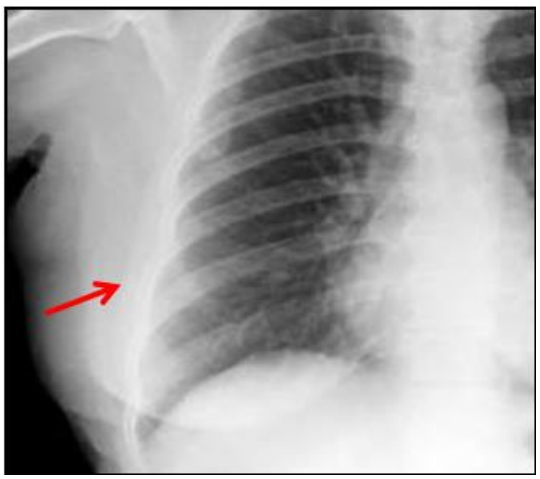


How to differentiate cervical rib from hypoplastic first rib?

In chest X ray frontal projection look at the direction of transverse process of the attached vertebra – which is directed inferiorly in cervical rib and superiorly in hypoplastic first rib.

Clinical Significance: cervical rib can cause thoracic outlet syndrome wheras hypoplastic first rib does not

Short Rib



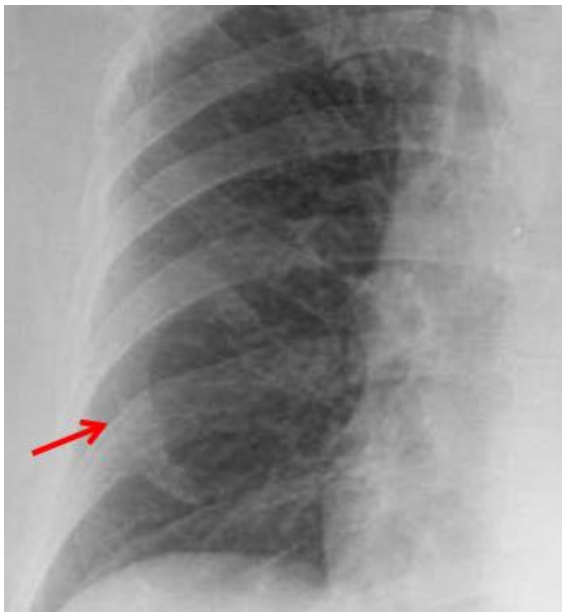
Diagnosed if the lateral margin of the affected rib is more than 4 mm medial to a tangent drawn between the lateral margins of adjacent ribs.

Pseudoarthrosis of First Rib

Joint - like cavity with opposing bulbous rib ends at midcourse of the first rib.

Clinical significance – Confusing cause for a palpable hard mass in the supraclavicular fossa.

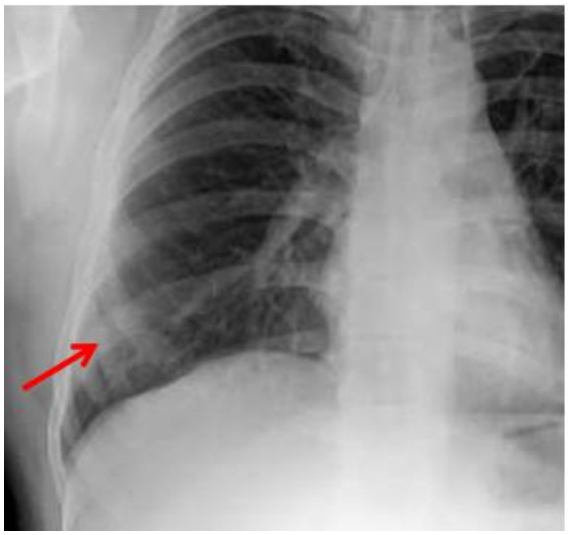
Von Luschka's Bifurcated Rib

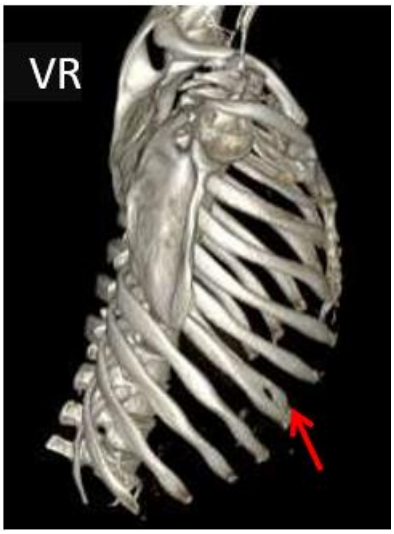


Most common rib anamoly

Clinical significance – May simulate a lung cavity.

RIB FORAMEN

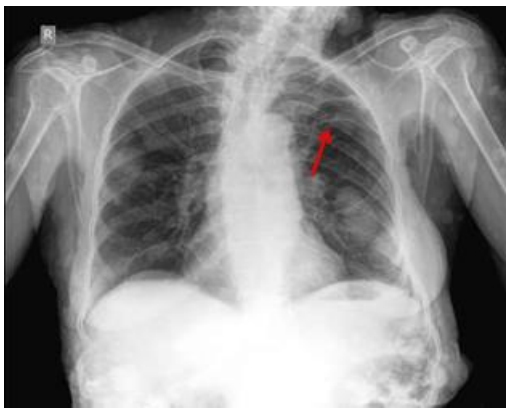




Well circumscribed radiolucent foramen in rib.
Clinical significance: May simulate bifid rib or a lung cavity.

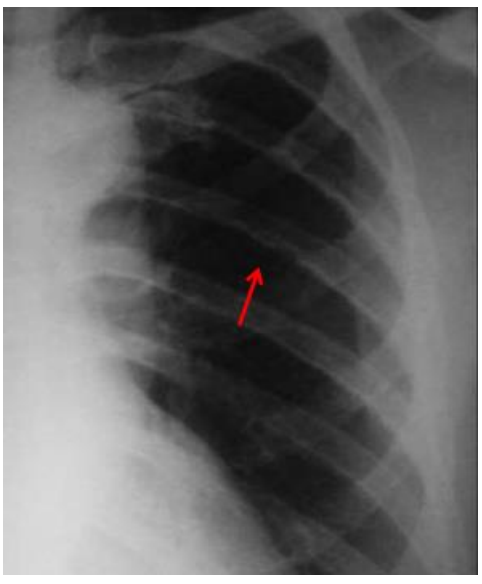
2) Congenital conditions

NEUROFIBROMATOSIS



Ribs appear thin, slender, irregular, scalloped and separated by neurofibromas - **Twisted ribbon appearance**

RIB NOTCHING



Classical rib notching is seen in Coarctation of aorta in the inferior aspect of 3rd to 8th posterior ribs.

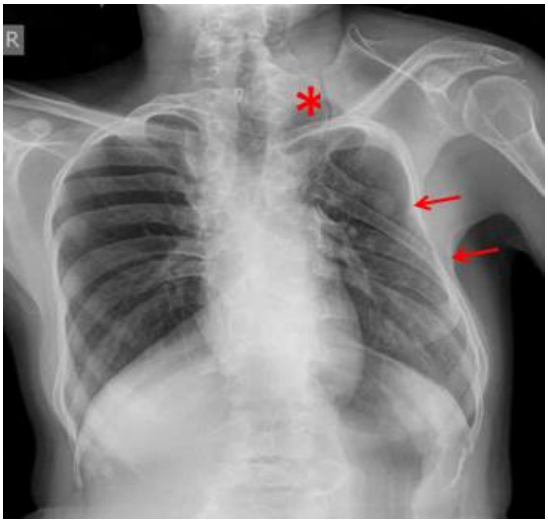
Osteopetrosis

Generalized increase in bone density - **Bone within bone appearance.**

Diffuse sclerosis of all bones, splayed costochondral junction.

Clinical significance – Chest and long bone radiograph play major role in ifferentiating osteopetrosis from other systemic diseases like leukemia.

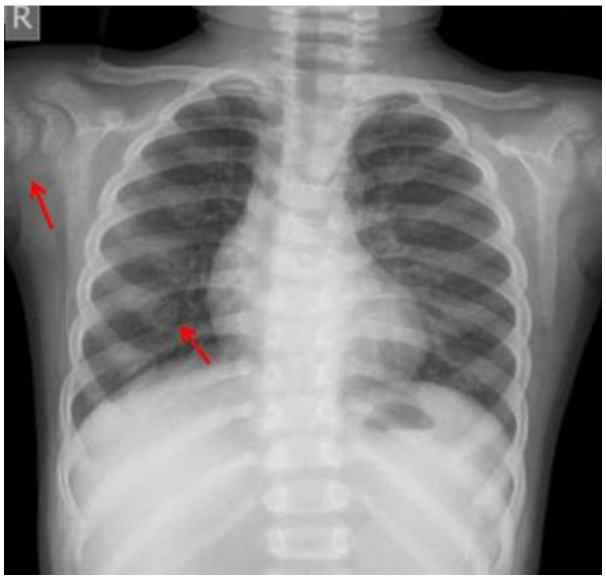
Klippel - Feil Syndrome



Klippel feil syndrome with omovertebral bone (*) Rib findings are - absent or fused ribs, chest wall asymmetry and cervical rib.

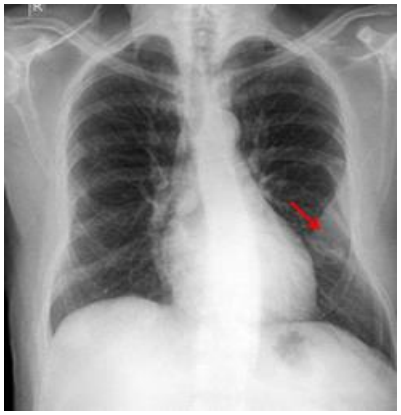
3) Metabolic Conditions

RICKETS



Rachitic rosary - bulbous enlargement of the costochondral junctions with adjacent cupped anterior rib ends.

Hyperparathyoidism



Browns tumour – Expansile lytic lesion with homogeneous texture.

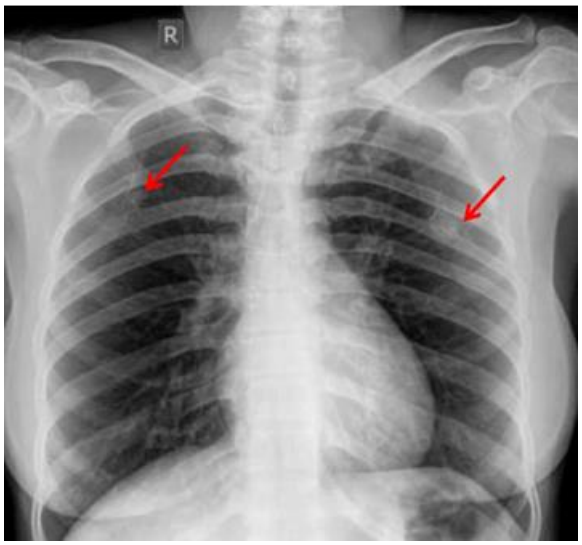
Clinical significance – to be differentiated from expansile metastasis and plasmacytoma

4) Primary and Secondary Bone Neoplasms

Enchondroma

Ribs are rare site for solitary enchondroma and frequently involved in multiple enchondromatosis (Ollier's disease).

Osteochondroma

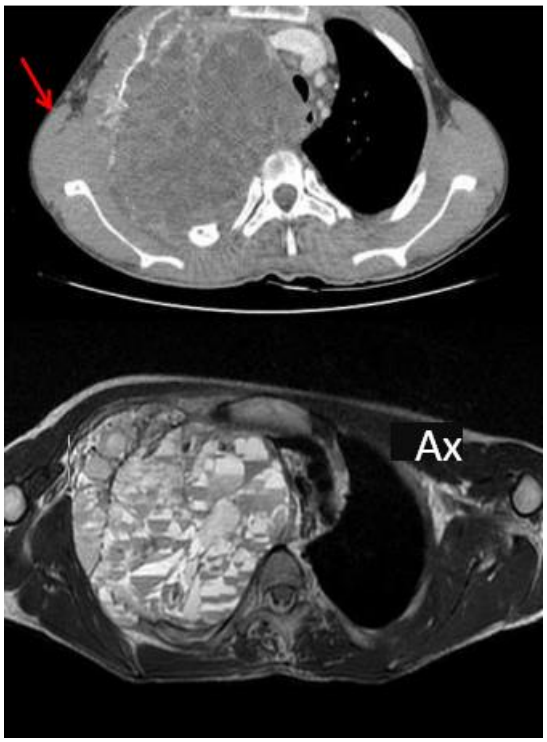


Sessile or pedunculated.

Clinical significance – associated with spontaneous hemothorax.

Osteosarcoma

Osteosarcoma right 2nd rib with secondary ABC



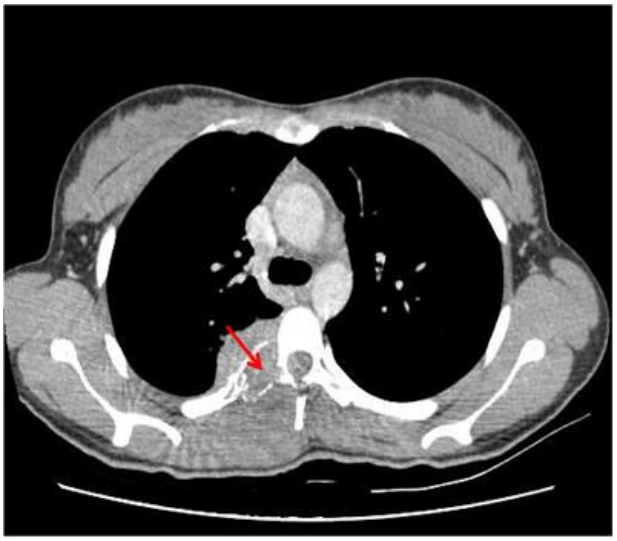
Radiological features of rib osteosarcoma are minimal expansion, cortical breaks, soft tissue component and osteoid type matrix mineralization.

Cross sectional imaging plays a major role to know the extent of disease

Chondrosarcoma

Ewings Sarcoma

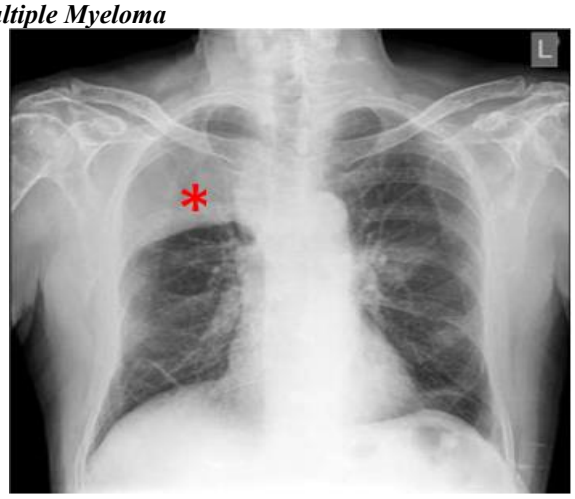
Most common primary malignant rib neoplasm. Radiologically chondosarcoma appears as lobulated masses containing the typical stippled, punctate or ring and arc like calicfications (chondroid type)



Common malignant tumour that affects the ribs of children and adolescents.

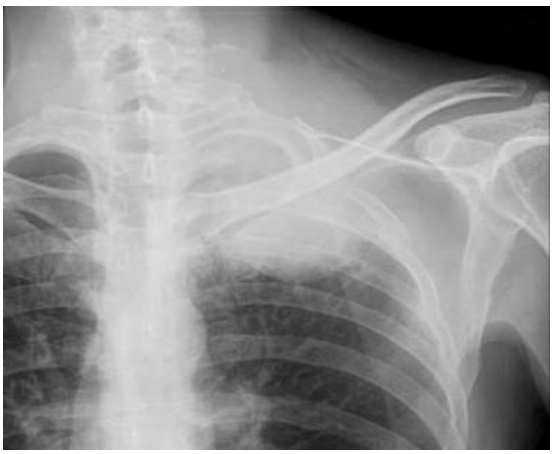
Purely destructive lesion with minimal expansion and associated with disproportionate soft tissue component.

Multiple Myeloma



Ribs can show diffuse osteoporosis, diffuse osteolytic round to oval lesions, punched out rain drop lesions or expansile lytic lesions with extrapleural soft tissue component

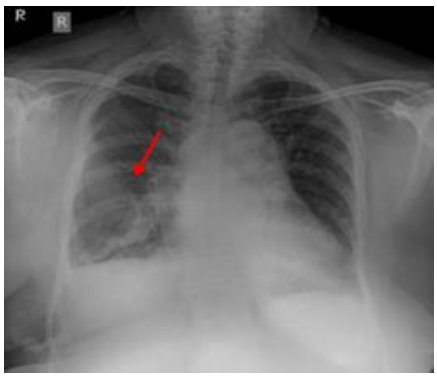
Pancoast Tumor



Non–small cell carcinomas that originate in the lung apex and invade the chest wall or soft tissues of thoracic inlet. Radiologically it shows apical mass with underlying bone erosion, most often 2nd rib followed by other ribs and vertebral body.

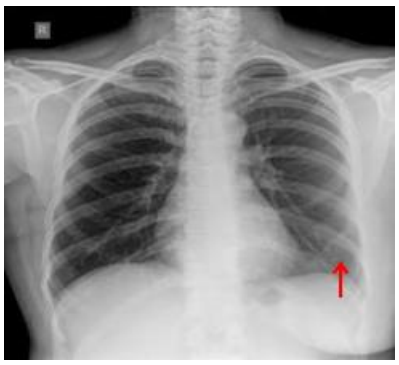
Carcinoma Breast Direct Involvement

Carcinoma Breast Direct Involvement



Direct invasion of ribs by carcinoma breast can be seen in locally advanced carcinoma or in local recurrence after surgery.
Chest radiograph shows diffuse haziness with underlying rib erosion which usually involves multiple ribs.

Lytic Metastasis



More common usually from carcinoma breast, lung, salivary glands and bowel.

Expansile Lytic Metasasis

Metastases from highly vascular like carcinoma thyroid and kidney are frequently lytic and expansile with extrapleural soft tissue component.

Differentials include plasmacytoma, myeloma and browns tumor.

Sclerotic Metastasis

Common primary for sclerotic metastasis is carcinoma prostate in males and carcinoma breast in females.

5) Miscellaneous

Fractures

Clinical significance: Exuberant callus may result in opacities over the lungs. Multiple rib fractures may cause pneumothorax, flail chest and haemothorax.

Fibrous Dysplasia

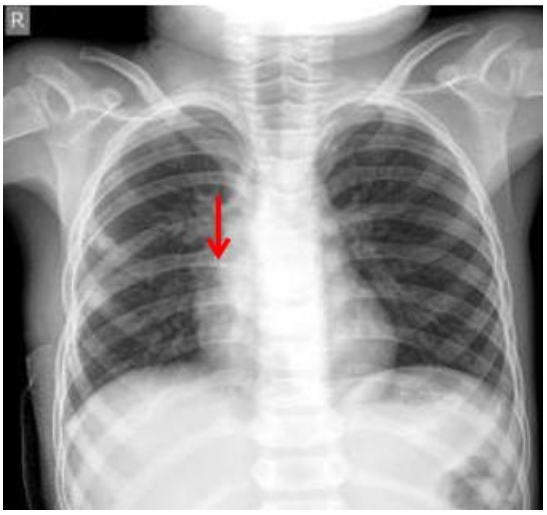
Mono - ostotic

Poly - ostotic

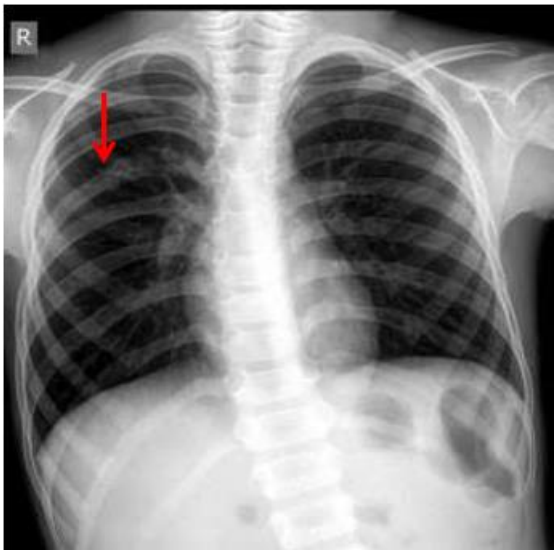
Affected rib shows expansion, ground glass matrix, thinning of cortex and modeling effect.

Clinical significance: Poly - ostotic fibrous dysplasia (3%) can be associated with endocrine dysfunction (McCune - Albright syndrome).

Post - OP Remodelling



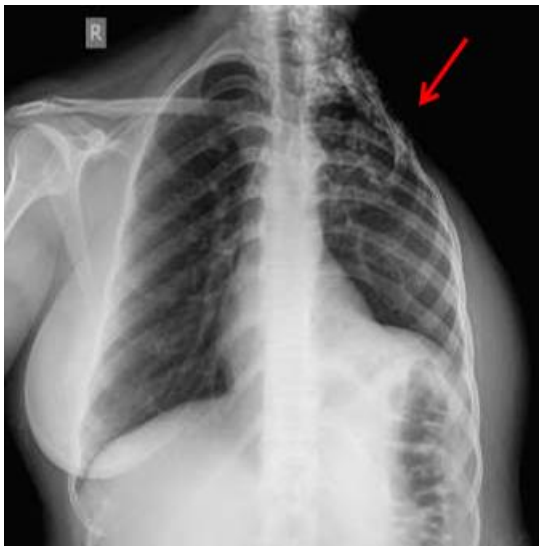
Immediate post op



6th month follow up

Case of Ewing's sacroma right 6th rib - immediate post - op x - ray shows resected right 6th rib and residual periosteum. 6 month follow up radiograph shows regrowth and rempodelling of right 6th rib

Osteoradionecrosis



Appear very dense on plain radiograph and confined to the field of RT

Osteoradionecrosis of left upper ribs - treated case of left humerus osteosarcoma forequarter amputation and RT

3. Conclusion

- In a case of suspected rib lesion clinical history and presenting symptoms should be well evaluated.
- Chest radiograph is useful in most of the conditions which is cost effective and can avoid unnecessary radiation exposure from CT.
- In evaluating chest radiograph all the normal variants and pathological conditions
- of ribs are to be kept in mind to rule out or rule in any pulmonary pathology.
- Supplementary cross sectional imaging in selected cases like primary malignancies of ribs is indicated to know the nature and extent of disease.

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